Draft Watershed Plan-Environmental Assessment

Santa Clara Watershed Project

Lead Federal Agency:

U.S. Department of Agriculture

Natural Resources Conservation Service

Sponsoring Local Organization:

Washington County, Utah

In Cooperation With:

Bureau of Land Management

Shivwits Band of Paiutes

Utah Trust Lands Administration

February 2025

Draft

Watershed Plan-Environmental Assessment for the Santa Clara Watershed Project

Washington County, Utah

Lead Agency: U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS)

Cooperating Agencies: Bureau of Land Management (BLM); Shivwits Band of Paiutes (Shivwits); Utah Trust Lands Administration (UTLA)

Sponsoring Local Organization: Washington County, Utah

Authority: This Watershed Plan- Environmental Assessment (EA) has been prepared under the authority of the NRCS Watershed and Flood Prevention Operations Program, which includes the Flood Prevention Operations Program authorized by the Flood Control Act of 1944 (Public Law [PL] 78-534) and the provisions of the Watershed Protection and Flood Prevention Act of 1954 (PL 83-566 [PL 83-566] Stat. 666 as amended [16 U.S.C. Section 1001 et seq.]).

Abstract: Washington County is proposing to install or re-establish a series of detention basins in Dammeron Valley and Diamond Valley in Washington County, Utah, and provide armoring along the Santa Clara River on Shivwits tribal land near Ivins, Utah. The detention basins and armoring would provide flood protection to local communities and a Shivwits tribal agricultural area.

The proposed project would include the construction of three detention basins in dry washes east of Dammeron Valley, the re-routing of existing flows to an adjacent channel on the south end of Dammeron Valley, the repair of three existing detention basins in Diamond Valley, armoring of an existing channel in Diamond Valley, and armoring portions of the south bank of the Santa Clara River near the junction of Gunlock Road and Old Highway 91. Two existing drainage ditches accessing the Santa Clara River would also be repaired and armored, and a pipeline would be installed to provide irrigation water to approximately 30 acres of the floodplain for agricultural purposes. The installation cost for this project would be approximately $14,961,918. Costs funded by the NRCS would be $14,604,418. Washington County would contribute $357,500 to the project.

Comments: The NRCS has completed this Draft Watershed Plan-EA in accordance with the National Environmental Policy Act and NRCS guidelines and standards. Reviewers should provide their comments to NRCS during the allotted Draft Plan-EA review period. Comments need to be submitted by July 13, 2025, to become part of the Administrative Record. Please send comments to the NRCS:

Anders Fillerup

NRCS Utah State Office

125 S State St. Room 6416

Salt Lake City, UT 84138

Email: anders.fillerup@usda.gov

Non-Discrimination Statement:

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the State or local Agency that administers the program or contact USDA through the Telecommunications Relay Service at 711 (voice and TTY). Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at How to File a Program Discrimination Complaint and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Mail Stop 9410, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

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Ancestral Land Acknowledgement

NRCS, through the review of the NPS Native American Graves Protection and Repatriation Act Native American Consultation Database (NACD), the U.S. Department of Housing and Urban Development Tribal Directory Assessment Tool (TDAT), the BIA website, and the Utah Division of Indian Affairs (UDIA) website, and previous NEPA & NHPA consultations, identified 14 Federally Recognized Tribes (Ute Indian Tribe of the Uintah & Ouray Reservation; Navajo Nation; Pueblo of Zuni; Hopi Tribe of Arizona; Moapa Band of Paiute Indians of the Moapa River Indian Reservation; Kaibab Band of Paiute Indians of the Kaibab Indian Reservation; Shivwits Band of Paiute Indians; Chemehuevi Indian Tribe; Paiute Indian Tribe of Utah; Koosharem Band of Paiutes; Kanosh Band of Paiutes; Las Vegas Tribe of Paiute Indians of the Las Vegas Indian Colony; Cedar Band of Paiutes; San Juan Southern Paiute Tribe) with ancestral land, traditional use, and/ or traditional cultural property claims within the project area and the immediate vicinities. Consultation with these 14 entities continued throughout this plan's development, refer to Appendix A for that correspondence.

WATERSHED PLAN AGREEMENT

SANTA CLARA RIVER WATERSHED, UTAH

WATERSHED WORK PLAN AGREEMENT

between

Washington County

(Referred to herein as Sponsor)

and the

Natural Resources Conservation Service,

U.S. Department of Agriculture

(Referred to herein as NRCS)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Washington County Water Conservancy District for assistance in preparing a plan for works of improvement for the Santa Clara River Watershed, Utah, under the authority of the Watershed Protection and Flood Prevention Act, as amended (16 U.S.C. Sections 1001 to 1008, 1010, and 1012);

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act (Public Law 83-566), as amended, has been assigned by the Secretary of Agriculture to the NRCS; and

Whereas, there has been developed through the cooperative efforts of the Sponsor and the NRCS a Watershed Work Plan and Environmental Assessment for works of improvement for the Santa Clara River Watershed, Utah, hereinafter referred to as the Watershed Project or Plan, which Plan is annexed to and made part of this agreement;

Now, therefore, the Secretary of Agriculture through the NRCS and the Sponsor hereby agree on this Watershed Plan and that the works of improvement for this project will be installed, operated, and maintained in accordance with the terms, conditions, and stipulations provided for in this Watershed Plan and including the following:

1. **Term**. The term of this agreement is for the installation period and evaluated life of the project (51 years) and does not commit the NRCS to assistance of any kind beyond the end of the evaluated life.

2. **Costs**. The costs shown in this plan are preliminary estimates. Final costs to be borne by the parties hereto will be the actual costs incurred in the installation of works of improvement.

3. **Real Property**. The Sponsor will acquire such real property as will be needed in connection with the works of improvement. The amounts and percentages of the real property acquisition costs to be borne by the Sponsor and the NRCS are as shown in the cost-share table in section 5 hereof.

The Sponsor agrees that all land acquired for measures, other than land treatment practices, with financial or credit assistance under this agreement will not be sold or otherwise disposed of for the evaluated life of the project except to a public agency that will continue to maintain and operate the development in accordance with the operation and maintenance agreement.

4. **Uniform Relocation Assistance and Real Property Acquisition Policies Act**. The Sponsor hereby agrees to comply with all of the policies and procedures of the Uniform Relocation Assistance and Real Property Acquisition Policies Act (42 U.S.C. Section 4601 et seq. as further implemented through regulations in 49 CFR Part 24 and 7 CFR Part 21) when acquiring real property interests for this federally assisted project. If the sponsor is legally unable to comply with the real property acquisition requirements, it agrees that, before any Federal financial assistance is furnished; it will provide a statement to that effect, supported by an opinion of the chief legal officer of the state containing a full discussion of the facts and law involved. This statement may be accepted as constituting compliance.

5. **Cost-Share for Watershed Project Plans**. Table 1. Santa Clara River Watershed Agreement—Cost-Share Percentages and Amounts shows the estimated cost-share percentages and amounts for Watershed Project Plan implementation.

Table 0-1. Cost-Shareable Items—Operations, Maintenance, and Replacement Cost by Project Increment (Dollars)[2]

Works of Improvement	0%/[3]	NRCS	0%/[3]	Sponsors	Total
Construction Costs: Diamond	100%	$5,473,508	0%	$0	$5,473,508
Construction Costs: Dammeron	100%	$6,896,688	0%	$0	$6,896,688
Construction Costs: Shivwits	100%	$728,925	0%	$0	$709,800
Engineering Technical Assistance Costs[4]: Diamond	100%	$437,881	0%	$0	$437,881
Engineering Technical Assistance Costs[4]: Dammeron	100%	$551,735	0%	$0	$551,735
Engineering Technical Assistance Costs[4]: Shivwits	100%	$22,500	0%	$0	$30,000
Project Admin. Costs[1]: Diamond	100%	$218,940	0%	$0	$218,940
Project Admin. Costs[1]: Dammeron	100%	$275,868	0%	$0	$275,868

Works of Improvement	0%/3	NRCS	0%/3	Sponsors	Total
Project Admin. Costs[1]: Shivwits	100%	$7,500	0%	$0	$7,500
Subtotal	–	$14,613,543	–	$0	$14,613,543
Combined Shareable and Non-Shareable Costs Total:	98%	$14,613,543	2%	$356,875	$14,970,418

Footnote for Table 0-1:

[1] The sponsors and NRCS will each bear the costs of project administration that each incurs.

[2] Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. May 2025

[3] As per NWPM Section 500.42 and Figure 500-E2, PL-566 cost share rates depend on the authorized purposes of the particular watershed plan. For flood prevention measures, PL-566 pays 100% of construction and engineering. Installation of compensatory mitigation is considered part of the construction of the flood control measure (per text between Figures 500-E1 and 500-E2). Real property rights acquisition is 100% sponsor cost for most PL-566 activities. However, acquisition of property rights for mitigation and recreation may be cost-shared (see referenced sections).

[4] Cost-sharable at 100% NRCS if Sponsor hires engineering for structure design. Not cost-shareable if sponsor's engineering is for elements required for real property rights (road improvements, power line modification, livestock water supply line, etc.).

Table 0-2. Non-Cost-Shareable Items—Operations, Maintenance, and Replacement Cost by Project Increment (Dollars)[4]

Works of Improvement	0%/3	NRCS	0%/3	Sponsors	Total
Construction Costs: Diamond	0%	$0	100%	$20,000	$20,000
Construction Costs: Dammeron	0%	$0	100%	$6,000	$6,000
Construction Costs: Shivwits	0%	$0	100%	$242,975	$242,975
Engineering Costs: Diamond	0%	$0	100%	$2,000	$2,000
Engineering Costs: Dammeron	0%	$0	100%	$600	$600
Engineering Costs: Shivwits	0%	$0	100%	$7,500	$7,500
Real Property Landrights[1]: Diamond	0%	$0	100%	$0	$0
Real Property Landrights[1]: Dammeron	0%	$0	100%	$65,000	$65,000

Works of Improvement	0%/3	NRCS	0%/3	Sponsors	Total
Real Property Landrights[1]: Shivwits	0%	$0	100%	$0	$0
Mitigation: Diamond	0%	$0	100%	$0	$0
Mitigation: Dammeron	0%	$0	100%	$0	$0
Mitigation: Shivwits	0%	$0	100%	$8,500	$8,500
Permits: Diamond	0%	$0	100%	$500	$500
Permits: Dammeron	0%	$0	100%	$800	$800
Permits: Shivwits	0%	$0	100%	$500	$500
Project Admin Costs[2]: Diamond	0%	$0	100%	$0	$0
Project Admin Costs[2]: Dammeron	0%	$0	100%	$0	$0
Project Admin Costs[2]: Shivwits	0%	$0	100%	$2,500	$2,500
Subtotal	–	$0	-	$356,875	$356,875
Combined Shareable and Non-Shareable Costs Total:	98%	$14,613,543	2%	$356,875	$14,970,418

Footnote for Table 0-2:

[1]The sponsors and NRCS will each bear the costs of project administration that each incurs.

[2]If actual non-cost-sharable item expenditures vary from these figures, the responsible party will bear the change.

[3]As per NWPM Section 500.42 and Figure 500-E2, PL-566 cost share rates depend on the authorized purposes of the particular watershed plan. For flood prevention measures, PL-566 pays 100% of construction and engineering. Installation of compensatory mitigation is considered part of the construction of the flood control measure (per text between Figures 500-E1 and 500-E2). Real property rights acquisition is 100% sponsor cost for most PL-566 activities. However, acquisition of property rights for mitigation and recreation may be cost-shared (see referenced sections).

[4] Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. May 2025

6. **Land Treatment Agreements**. The Sponsor will obtain agreements from owners of not less than 50 percent of the land above each multiple-purpose and floodwater-retarding structure. These agreements must provide that the owners will carry out farm or ranch conservation plans on their land. The Sponsor will ensure that 50 percent of the land upstream of any retention reservoir site is adequately protected before construction of the dam. The Sponsor will provide assistance to landowners and operators to ensure the installation of the land treatment measures shown in the Watershed Plan. The Sponsor will encourage landowners and operators to continue to operate and maintain the land treatment measures after the long-term contracts expire, for

the protection and improvement of the watershed.

7. **Floodplain Management**. Before construction of any project for flood prevention, the Sponsor agrees to participate in and comply with applicable Federal floodplain management and flood insurance programs.

8. **Water and Mineral Rights**. The Sponsor will acquire or provide assurance that landowners or resource users have acquired such water, mineral, or other natural resources rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

9. **Permits**. The Sponsor will obtain and bear the cost for all necessary Federal, State, and local permits required by law, ordinance, or regulation for installation of the works of improvement.

10. **NRCS Assistance**. This agreement is not a fund-obligating document. Financial and other assistance to be furnished by the NRCS in carrying out the plan is contingent upon the fulfillment of applicable laws and regulations and the availability of appropriations for this purpose.

11. **Additional Agreements.** A separate agreement will be entered into between the Sponsor and the NRCS before either party initiates work involving funds of the other party. Such agreements will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

12. **Amendments**. This plan may be amended or revised only by mutual agreement of the parties hereto, except that the NRCS may deauthorize or terminate funding at any time if it determines that the Sponsor has failed to comply with the conditions of this agreement or when the program funding or authority expires. In this case, the NRCS must promptly notify the Sponsor in writing of the determination and the reasons for the deauthorization of project funding, together with the effective date. Payments made to the Sponsor or recoveries by the NRCS must be in accordance with the legal rights and liabilities of the parties when project funding has been deauthorized. An amendment to incorporate changes affecting a specific measure may be made by mutual agreement between the Sponsor and the NRCS having specific responsibilities for the measure involved.

13. **Prohibitions**. No member of or delegate to Congress, or resident commissioner, may be admitted to any share or part of this plan, or to any benefit that may arise therefrom; but this provision may not be construed to extend to this agreement if made with a corporation for its general benefit.

14. **Operation and Maintenance (O&M)**. The Sponsor will be responsible for the operation, maintenance, and any needed replacement of the works of improvement by performing the work or arranging for such work, in accordance with an O&M Agreement. An O&M agreement will be entered into before Federal funds are obligated and will continue for the project life of 51 years.

Although the sponsor's responsibility to the Federal Government for O&M ends when the O&M agreement expires upon completion of the evaluated life of measures covered by the agreement, the Sponsor acknowledge that continued liabilities and responsibilities associated with works of improvement may exist beyond the evaluated life.

15. **Emergency Action Plan**. Prior to construction, the Sponsor must prepare an Emergency Action Plan (EAP) for each dam or similar structure where failure may cause loss of life or as required by state and local regulations. The EAP must meet the minimum content specified in NRCS Title 180, National Operation and Maintenance Manual (NOMM), Part 500, Subpart F, Section 500.52, and meet applicable State agency dam safety requirements. The NRCS will determine that an EAP is prepared prior to the execution of fund obligating documents for construction of the structure. EAPs must be reviewed and updated by the Sponsor annually.

16. **Nondiscrimination Provisions.** In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

    Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the State or local Agency that administers the program or contact USDA through the Telecommunications Relay Service at 711 (voice and TTY). Additionally, program information may be made available in languages other than English.

    To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at How to File a Program Discrimination Complaint and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Mail Stop 9410, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

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    By signing this agreement, the recipient assures the Department of Agriculture that the program or activities provided for under this agreement will be conducted in compliance with all applicable Federal civil rights laws, rules, regulations, and policies.

17. **Certification Regarding Drug-Free Workplace Requirements (7 CFR Part 3021**). By signing this Watershed Agreement, the Sponsor is providing the certification set out below. If it is later determined that the Sponsor knowingly rendered a false certification, or otherwise violated the requirements of the Drug-Free Workplace Act, the NRCS, in addition to any other remedies available to the Federal Government, may take action as authorized under the Drug-Free Workplace Act.

    Controlled substance means a controlled substance in Schedules I through V of the Controlled Substances Act (21 U.S.C. Section 812) and as further defined by regulation (21 CFR Sections 1308.11 through 1308.15);

    Conviction means a finding of guilt (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statutes;

    Criminal drug statute means a Federal or non-Federal criminal statute involving the manufacturing, distribution, dispensing, use, or possession of any controlled substance;

    Employee means the employee of a grantee directly engaged in the performance of work under a grant, including: (i) all direct charge employees; (ii) all indirect charge employees unless their impact or involvement is insignificant to the performance of the grant; and (iii) temporary personnel and consultants who are directly engaged in the performance of work under the grant and who are on the grantee's payroll. This definition does not include workers not on the payroll of the grantee (e.g., volunteers, even if used to meet a matching requirement; consultants or independent contractors not on the grantees' payroll; or employees of sub-recipients or sub-contractors in covered workplaces).

Certification:

A. The Sponsor certifies that they will or will continue to provide a drug-free workplace by:

    (1) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition.

    (2) Establishing an ongoing drug-free awareness program to inform employees about:

        (a) The danger of drug abuse in the workplace;

        (b) The grantee's policy of maintaining a drug-free workplace;

(c) Any available drug counseling, rehabilitation, and employee assistance programs; and

(d) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace.

(3) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (1).

(4) Notifying the employee in the statement required by paragraph (1) that, as a condition of employment under the grant, the employee must:

(a) Abide by the terms of the statement and

(b) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction.

(5) Notifying the NRCS in writing, within 10 calendar days after receiving notice under paragraph (4)(b) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer or other designee on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice must include the identification numbers of each affected grant.

(6) Taking one of the following actions, within 30 calendar days of receiving notice under paragraph (4) (b), with respect to any employee who is so convicted.

(a) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended, or

(b) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency.

(7) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (1), (2), (3), (4), (5), and (6).

B. The Sponsor may provide a list of the sites for the performance of work done in connection with a specific project or other agreement.

C. Agencies must keep the original of all disclosure reports in the official files of the agency.

18. Certification Regarding Lobbying (7 CFR Part 3018) (for projects > $100,000)

B. The Sponsor certifies to the best of their knowledge and belief that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the Sponsor, to any person for influencing or attempting to influence an officer or employee of an agency, Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned must complete and submit Standard Form LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The Sponsor must require that the language of this certification be included in the award documents for all sub-awards at all tiers (including subcontracts, sub- grants, and contracts under grants, loans, and cooperative agreements) and that all sub-recipients must certify and disclose accordingly.

B. This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C., Section 1352. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

19. **Certification Regarding Debarment, Suspension, and Other Responsibility Matters—Primary Covered Transactions (7 CFR Part 3017).**

A. The Sponsor certifies to the best of their knowledge and belief, that they and their principals:

(1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(2) Have not within a 3-year period preceding this proposal been convicted of or had a civil judgment rendered against them for

commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(3) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State, or local) with commission of any of the offenses enumerated in paragraph A(2) of this certification; and

(4) Have not within a 3-year period preceding this application/proposal had one or more public transactions (Federal, State, or local) terminated for cause or default.

B. Where the Sponsor is unable to certify to any of the statements in this certification, such prospective participant must attach an explanation to this agreement.

20. **Clean Air and Water Certification**. (Applicable if this agreement exceeds $100,000, or a facility to be used has been subject of a conviction under the Clean Air Act (42 U.S.C. Section 7413[c]) or the Federal Water Pollution Control Act (33 U.S.C. Section 1319[c]) and is listed by the Environmental Protection Agency (EPA), or is not otherwise exempt.)

A. The Sponsor signatory to this agreement certifies as follows:

(1) Any facility to be utilized in the performance of this proposed agreement is ( ), is not (X) listed on the Environmental Protection Agency List of Violating Facilities.

(2) To promptly notify the NRCS-State administrative officer prior to the signing of this agreement by the NRCS of the receipt of any communication from the Director, Office of Federal Activities, or EPA indicating that any facility which is proposed for use under this agreement is under consideration to be listed on the EPA List of Violating Facilities.

(3) To include substantially this certification, including this subparagraph, in every nonexempt sub-agreement.

B. The Sponsor signatory to this agreement agrees as follows:

(1) To comply with all the requirements of section 114 of the Clean Air Act as amended (42 U.S.C. Section 7414) and section 308 of the Federal Water Pollution Control Act (33 U.S.C. Section 1318), respectively, relating to inspection, monitoring, entry, reports, and information, as well as other requirements specified in section 114 and section 308 of the Air Act and

the Water Act, issued there under before the signing of this agreement by the NRCS.

(2)That no portion of the work required by this agreement will be performed in facilities listed on the EPA List of Violating Facilities on the date when this agreement was signed by the NRCS unless and until the EPA eliminates the name of such facility or facilities from such listing.

(3)To use their best efforts to comply with clean air standards and clean water standards at the facilities in which the agreement is being performed.

(4)To insert the substance of the provisions of this clause in any nonexempt sub- agreement.

C. The terms used in this clause have the following meanings:

(1)The term “Air Act” means the Clean Air Act, as amended (42 U.S.C. Section 7401 et seq.).

(2)The term “Water Act” means Federal Water Pollution Control Act, as amended (33 U.S.C. Section 1251 et seq.).

(3)The term “clean air standards” means any enforceable rules, regulations, guidelines, standards, limitations, orders, controls, prohibitions, or other requirements which are contained in, issued under, or otherwise adopted pursuant to the Air Act or Executive Order 11738, an applicable implementation plan as described in section 110 of the Air Act (42 U.S.C. Section 7414) or an approved implementation procedure under section 112 of the Air Act (42 U.S.C. Section 7412).

(4)The term “clean water standards” means any enforceable limitation, control, condition, prohibition, standards, or other requirement which is promulgated pursuant to the Water Act or contained in a permit issued to a discharger by the EPA or by a State under an approved program, as authorized by section 402 of the Water Act (33 U.S.C. Section 1342), or by a local government to assure compliance with pretreatment regulations as required by section 307 of the Water Act (33 U.S.C. Section 1317).

(5)The term “facility” means any building, plant, installation, structure, mine, vessel, or other floating craft, location, or site of operations owned, leased, or supervised by a sponsor to be utilized in the performance of an agreement or sub-agreement. Where a location or site of operations contains or includes more than one building, plant, installation, or structure, the entire location will be deemed to be a facility except where the Director, Office of Federal Activities, or EPA determines that independent facilities are collocated in one geographical area.

21. **Assurances and Compliance**. As a condition of the grant or cooperative

agreement, the sponsor assures and certifies that it is in compliance with and will comply in the course of the agreement with all applicable laws, regulations, Executive orders and other generally applicable requirements, including those set out below which are hereby incorporated in this agreement by reference, and such other statutory provisions as a specifically set forth herein.

State, Local, and Indian Tribal Governments: OMB Circular Nos. A-87, A-102, A-129, and A-133; and 7 CFR Parts 3015, 3016, 3017, 3018, 3021, and 3052.

Nonprofit Organizations, Hospitals, Institutions of Higher Learning: OMB Circular Nos. A-110, A-122, A-129, and A-133; and 7 CFR Parts 3015, 3017, 3018, 3019, 3021 and 3052.

22. **Examination of Records**. The Sponsor must give the NRCS or the Comptroller General, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to this agreement, and retains all records related to this agreement for a period of three years after completion of the terms of this agreement in accordance with the applicable OMB Circular.

23. **Signatures**

Sponsor: Washington County	
By:	
Title:	
Date:	
Address:	Zip Code:

The signing of this plan was authorized by a resolution of the governing body of Washington County, Utah, adopted at a meeting held on_________.

____

Address ___________________________________

Secretary [or other Title]

Date: _______________________________

United States Department of Agriculture
Natural Resources Conservation Service

	EMILY FIFE
Title:	NRCS State Conservationist
Date:	

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Summary (Office of Management and Budget Fact Sheet)

S-1.0 Title of the Proposed Action

Watershed Plan-Environmental Assessment for the Proposed Santa Clara Watershed Project Plan-Environmental Assessment

S-2.0 Watershed Name

Santa Clara Watershed

S-3.0 County, State

Washington County, Utah

S-4.0 Congressional District

Utah Congressional District 2

S-5.0 Sponsoring Local Organization

Washington County, Utah

S-6.0 Cooperating Agencies

Bureau of Land Management (BLM)

Shivwits Band of Paiutes (Shivwits)

Utah Trust Lands Administration (UTLA)

S-7.0 Authority

This Plan-Environmental Assessment (Plan-EA) has been prepared under the authority of U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Watershed and Flood Prevention Operations Program, which authorizes funding to help urban and rural communities protect, improve, and develop land resources in watersheds up to 250,000 acres in size. The Program includes the Flood Prevention Operations Program authorized by Flood Control Act of 1944 (Public Law [PL] 78-534) and the provisions of the Watershed Protection and Flood Prevention Act of 1954 (PL 83-566) Stat. 666 as amended (16 U.S.C. Section 1001 et seq.). The Plan-EA has been prepared in accordance with Section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969, PL 91-190, as amended (42 U.S.C. 4321 et seq.).

S-8.0 Purpose and Need for Action

In general, the purpose of this project is agricultural water management, flood protection, and watershed protection. Specifically, the purpose is 1) to detain peak summer flood flows thus protecting residents, homes, properties, and other infrastructure within Dammeron Valley and Diamond Valley, 2) to provide a working pipeline resulting in increased agricultural water availability (flooding has resulted in erosion of historic agriculture fields and damaged a pipeline and stormwater drainage ditches), and 3) to provide erosion protection along the Rock Hollow Wash and Santa Clara River. In total, the proposed project would provide improved flood protection in the affected communities for approximately 748 people, 69 homes, roads/highways, and approximately 4 acres of agricultural lands (4 acres in Dammeron Valley and 30 acres on the Shivwits site).

The need exists to provide for enhanced flood control and improved a water distribution in Washington County, Utah. Successful project development would increase public protection and rural resiliency. As authorized by PL 83-566 (The U.S. Watershed Protection and Flood Prevention Act of 1954, as amended), Washington County has requested federal assistance to construct and restore a series of detention basins and a flood channel in the Dammeron and Diamond valleys, to install stream bank protection along Rock Hollow Wash in Diamond Valley, and to install stream bank protection and repair irrigation and drainage systems on Shivwits tribal lands. Residents within the project area currently experience occasional, sometimes severe flooding, and the existing irrigation system is not meeting user needs. Existing facilities are old, are only partially functional, and have limited ability to control floods and distribute irrigation water.

S-9.0 Description of the Action Alternative

Washington County is proposing to construct or repair six detention basins in Dammeron Valley and Diamond Valley in Washington County, Utah; 0.29 mile of armoring along Rock Hollow Wash in Diamond Valley; provide 0.53 mile of armoring along the Santa Clara River; and provide irrigation and drainage improvements on Shivwits tribal land near Ivins, Utah. The detention basins, armoring, and irrigation and drainage improvements would provide flood protection to the local communities and protect and improve a historic Shivwits tribal agricultural area.

The proposed project would include the construction of three detention basins in dry washes east of Dammeron Valley, the re-routing of existing flows to an adjacent tributary of Sand Cove Wash on the south end of Dammeron Valley, the repair and re-establishment of three existing detention basins in Diamond Valley, armoring and protection of Rock Hollow Wash in Diamond Valley, and armoring portions of the south bank of the Santa Clara River near the junction of Gunlock Road and Old Highway 91 on Shivwits tribal lands. Two existing stormwater drainage ditches would also be repaired and armored on Shivwits land, and an 8-inch water pipeline would be installed, replacing an existing pipeline.

S-10.0 Resource Information

Table S-1 identifies relevant resource information for the proposed project area.

Table S-1. Existing Resource Information

Resource	Description
Latitude/Longitude	37°18’21.27” N 113°40’12.06” W (Dammeron Valley) 37°15’04.01” N 113°36”43.98 W (Diamond Valley) 37°11’19.36” N 113°46’05.68” W (Shivwits site)
Elevation	3,200 to 4,680 feet above sea level
Hydrologic Unit Code	15010008 Upper Virgin River
Climate (U.S. Climate Data 2021)	July average high/low: 101/68 degrees Fahrenheit January average high/low: 55/30 degrees Fahrenheit
Topography	Flat floodplain, rolling hills
Annual Precipitation (U.S. Climate Data 2021)	11.56 inches
Santa Clara Watershed	243,008 acres
Proposed Detention Basin Storage Capacity (6 basins)	Approximately 518 acre-feet
Land Use	Residential (106 acres), Tribal agriculture (30 acres), other Tribal use (34 acres), and public use (190 acres)
Land Ownership	Private (30 percent), Shivwits (17 percent), UTLA lands (10 percent), and BLM-administered public lands (43 percent)
Population (Washington County) (U.S. Census 2024) Census results for 2023	202,452
Demographics (Washington County) (U.S. Census 2023)	White: 92.6 percent African American: 1.0 percent American Indian: 1.7 percent Asian: 1.2 percent Native Hawaiian/Pacific Islander: 0.9 percent Hispanic/Latino: 12.4 percent Two or More Races: 2.5 percent
Farms Present, Washington County (USDA 2022)	553
Land in Farms, Washington County (USDA 2022)	105,541 acres

Resource	Description
Average Farm Size, Washington County (USDA 2022a)	191 acres
Relevant Resource Concerns	See **Table S-5**

S-11.0 Alternative Plans Considered

Potential alternative plans were evaluated for all three sites within the project area. However, no alternative detention basin sites are available in the Dammeron Valley and Diamond Valley areas that would meet the purpose and need of the Action Alternative and provide for property and human safety. In Dammeron Valley, four unnamed tributaries produce drainage through the community. Three of the four tributaries are proposed to have detention basins installed. The fourth tributary was considered for a detention basin, but due to topographical constraints and the unfeasibility of placing a dam within the tributary, a new detention basin at this site was eliminated from further consideration. In lieu of a basin, a new 0.35-mile ditch is proposed to be constructed that would direct flows from the tributary into an existing unnamed wash that is tributary to Sand Cove Wash.

In Diamond Valley, two tributaries and three existing detention basins are present. It is proposed to rehabilitate and improve the three existing detention basins. Rock Hollow Wash bank stabilization would be constructed to protect existing homes. No additional locations were found to be suitable for detention basin installation or wash stabilization.

At the Shivwits portion of the project area, several actions were evaluated through meetings and other correspondence with the Shivwits tribal leadership. No alternative actions beyond those being proposed in this Plan-EA are available that would provide for the restoration of agriculture lands, a working irrigation pipeline and stormwater drainage ditches, and Santa Clara River stabilization. Potential actions, such as constructing entirely new ditches or placing armoring beneath the ordinary high-water mark were evaluated but determined to be less effective and/or more environmentally damaging than the Action Alternative; as a result, these actions are not considered further.

Alternative actions such as constructing flood walls and removing structures such as homes and businesses out of the areas subject to severe flooding were considered. A nonstructural alternative was also considered. These alternatives were determined to be infeasible due to increased cost, the impractical nature of moving residences and businesses, and a lower probability of flood control success. These alternatives would not meet the purpose and need of the proposed project.

No Action Alternative—The No Action Alternative is considered and consists of the most likely future condition if none of the federally assisted action alternatives are selected. Analysis of the No Action Alternative is required by NEPA.

Therefore, based on the rationale described above, the only alternatives considered in this document are the Action Alternative and the No Action Alternative.

The National Economic Efficiency (NEE) Alternative is the alternative or combination of alternatives that reasonably maximizes the net economic benefit of the project consistent with protecting the nation's environment. The NEE Alternative is the Action Alternative.

S-12.0 Project Costs and Funding Source

A summary of the estimated installation cost for the Preferred (NEE) Alternative is shown in **Table S-2**. NRCS provides PL 83-566 funding for construction, engineering, and wetland/floodplain conservation easements.

Table S-2. Estimated Project Installation Cost (Dollars)[1]

Installation Cost Items	Estimated PL-83-566 Funds	Estimated Other Funds	Estimated Total
Dammeron Valley	$7,724,290	$72,400	$7,796,690
Diamond Valley	$6,130,328	$22,500	$6,152,828
Shivwits Area	$758,925	$261,975	$1,020,900
Total	$14,613,543	$356,875	$14,970,418

Footnote for Table S-2:

[1] Price base 2022.

Source: Gordon, May 2025

A funding schedule has been identified for the initial stage of the proposed project and is presented in **Table S-3**.

Table S-3. Initial Funding Schedule

Fiscal Year	-	PL-83-566	Other Funds	Total
2025	Dammeron Valley	$7,724,290	$72,400	$7,796,690
2025	Diamond Valley	$6,130,328	$22,500	$6,152,828
2025	Shivwits Area	$758,300	$262,600	$1,020,900
Total Project	-	$14,613,543	$356,875	$14,970,418

Footnote for Table S-3:

[1] Structures estimated to last 50 years and 1 year implementation, price base 2022

Source: Gordon, May 2025

S-13.0 Project Benefits

The primary benefits resulting from successful implementation of the Action Alternative would be enhanced flood control in the unincorporated communities of Dammeron Valley and Diamond Valley and agriculture land protection, stream irrigation and drainage system restoration, and stream bank protection along the Santa Clara River on Shivwits lands near Ivins. The enhanced flood control resulting from construction and repair of the detention basins and flood channel would add an element of safety by protecting residents, properties, and other infrastructure. Damage to historic agriculture fields, drainage and irrigation systems, and the Santa Clara River would be mitigated. Total annual net benefit after cost is estimated to be $2,289,691 (**Table S-3**). The unincorporated communities of Dammeron Valley and Diamond Valley have a combined population of approximately 2,000. Therefore, the measures in this plan would qualify for PL-566 requirements for a rural area. Additionally, over 20 percent of the benefits would benefit the agricultural community which would also qualify the proposed project for PL_566 requirements.

S-14.0 Net Economic Benefits

The estimated average annual economic benefits for the Action Alternative are summarized in **Table S-4**. The Action Alternative is also the NEE Alternative for the project, per Sections 505.2 and 505.35.B (1) (iv) of the National Watershed Program Manual.

Table S-4. Estimated Annual Net Economic Benefited (Dollars)[1]

—	Average Annual Costs[3]	Average Annual Benefits[2]	Benefit-Cost Ratio	Net Benefits
Dammeron Valley	$358,669	$1,074,410	3.00	$715,741
Diamond Valley	$307,083	$1,917,963	6.25	$1,610,880
Shivwits Area	$37,390	$160	0.0043	-$37,230
Grand Total	**$703,142**	**$2,992,533**	**4.26**	**$2,289,391**

Footnote for Table S-4:

[1] Discount rate 2.5 percent with a 51-year period of analysis. Price base 2022.

[2] Taken from **Table 8-4**.

[3] Taken from **Tables 8-5** and **8-6**.

Source: Gordon, May 2025

S-15.0 Period of Analysis

The standard period of analysis under PL 83-566 is a minimum of 50 years and a maximum of 100 years. The period of analysis for the Santa Clara Watershed Project is 51 years. This includes an approximately 12-month construction period and the 50-year anticipated project life.

S-16.0 Project Life

The life of the project is estimated to be 50 years.

S-17.0 Environmental Impacts

Table S-5 provides a summary of resources/issues of concern and potential environmental impacts associated with implementation of the proposed project.

Table S-5. Summary of Resource Concerns of Potential Environmental Affects

Resource Concern	Summary of Concern/Affect	Anticipated Environmental Consequences Summary
Soil Resources (upland erosion and sedimentation)	Soil disturbance would result from proposed project construction activities.	A total of approximately 127 acres of surface disturbance would occur during the 12-month construction period. The majority of this disturbance would occur in areas already affected by current land use activities. Approximately 97 acres of disturbance would be short-term and not extend beyond the 12-month construction period. Approximately 30 acres of surface disturbance would result from long-term Tribal agriculture use. Best Management Practices (BMPs) would be implemented during and after construction to reduce the amount of soil loss. Soil loss would not extend beyond the 127 acres of construction related disturbance and, with the exception of the anticipated agricultural use, would be short-term.
Waters of the U.S. (WOTUS)	One river, two drainage ditches, and nine washes are present within the project area and could be affected by construction activities. Consultation with USACE on WOTUS determination is ongoing.	Erosion control activities along approximately 0.53 mile of the Santa Clara River may result in short-term water quality reductions. Other project repair and construction activities would have negligible impacts on any water resources. No WOTUS values would be affected.

Resource Concern	Summary of Concern/Affect	Anticipated Environmental Consequences Summary
Riparian Areas	Erosion control activities along the Santa Clara River could disturb riparian habitat.	Stream bank stabilization would affect approximately 0.53 acre within the riparian area along the Santa Clara River. No impacts are anticipated to a nearby 0.5-acre wetland located in the Shivwits portion of the project area. No riparian areas are present in the Dammeron Valley and Diamond Valley sites.
Floodplain Management	Construction of detention basins, armoring the Santa Clara River, and other proposed actions would improve floodplain management in the project area by reducing the potential for damages resulting from significant precipitation events.	Floodplain management in the project area would improve. Potential for damaging floods in the Dammeron Valley and Diamond Valley portions of the project area would be reduced. Armoring of the river and repair of drainage ditches would reduce the potential of floodplain erosion.Renewed long-term use of the agriculture area within the floodplain would result.
Air Quality	Air quality in the project area is good and could be affected by emissions from construction activities.	Emissions from construction equipment and fugitive dust would be anticipated in the short term (approximate 12-month construction period). However, implementation of BMPs would ensure that construction activities would not violate air quality standards. No long-term, operational-related effects would occur.

Resource Concern	Summary of Concern/Affect	Anticipated Environmental Consequences Summary
U. S. Fish and Wildlife (USFWS) Designated Threatened, Endangered, and Candidate Species	Five listed and one candidate species were identified as potentially occurring within or near the project area and could be affected by project development.	Protocol-level surveys did not locate any listed or candidate plant, animal, or insect species within the project area. Some species may occur within the 300-foot buffer area, but potential habitat is present. Implementation of BMPs would mitigate potential effects to any species found within the project area or the 300-foot buffer area surrounding the area. Consultation with USFWS has been completed with concurrence of the findings documented in the BA and Plan-EA.
Vegetation (excluding USFWS-designated species)	Native plant species within the project area would be impacted due to construction-related, surface-disturbing activities on approximately 127 acres. The BLM-sensitive species, virgin thistle (*Cirsium virginense*), potentially occurs within the project area.	Surface-disturbing construction activities on approximately 127 acres would result in the loss of native vegetation. Approximately 94 acres of surface disturbance would occur in the Dammeron and Diamond Valley basins. The majority of this area has already been disturbed by human-related activities. No pristine areas would be affected. Approximately 33 acres of surface disturbance would occur within the Shivwits portion of the project area (30 acres of disturbance would result from renewed agricultural development). Applicant-committed conservation measures and BMPs would reduce the amount of surface disturbance and help reclaim disturbed areas.

Resource Concern	Summary of Concern/Affect	Anticipated Environmental Consequences Summary
Noxious Weeds and Invasive Species	Construction-related surface disturbance would result in an increased potential for the establishment of noxious weeds and invasive plant species on approximately 127 acres.	Construction activities on 127 acres would expose disturbed areas to the reestablishment of invasive plant species already present. BMPs, including the reseeding of disturbed areas with an NRCS- and BLM-approved native seed mix, would be implemented to minimize the reestablishment of invasive plants. Invasive species such as quagga and zebra mussels or carp are not found in the project area. Other invasive species such as the European starling, English sparrow, and raccoon may occur within the project area but would not be affected by project development and are not discussed further in this document.
Fish and Wildlife (excluding USFWS-designated species)	Construction and maintenance activities and an anticipated increase in human activity in the project area could impact wildlife and wildlife habitat within the project area. Approximately 25 State of Utah species of concern and BLM-sensitive species could be located within or near the project area.	Short-term effects, including increased noise and human presence, would occur during the 12-month construction activity. These activities may temporarily force animal species from the affected habitat. Effects would be minor and short term as similar habitat adjacent to the project area is abundant. Displaced species could easily move into these areas and return once construction activities are completed. Armoring the banks of the Santa Clara River would protect habitat for riparian species long term.

Resource Concern	Summary of Concern/Affect	Anticipated Environmental Consequences Summary
Migratory Birds/Bald and Golden Eagles	Six migratory bird species are potentially present in the project area. These species could be affected by construction activities.	Construction activities may disturb migratory birds and eagle habitat during the 12-month construction period. Implementation of applicant-committed BMPs such as timing restrictions would reduce the significance of any potential impact. If the need arose for construction during the general migratory bird breeding/nesting season (April through August), nest abandonment and loss of young could result. However, displaced species could easily move into abundant adjacent habitat and return once construction activities are completed. Armoring the banks of the Santa Clara River would protect habitat for riparian-dependent species.
Human Environment: Social Issues	The project area is subject to occasional severe flooding affecting crop production and human safety.	Project development would improve local socioeconomic conditions for the long term by reducing the potential for destructive flooding in Dammeron Valley and Diamond Valley and by providing the opportunity for agriculture in the Shivwits portion of the project. Human safety would be improved. Additional protection would be provided to approximately 748 people, 69 homes, 4 acres of agriculture land, and roads and highways.

Resource Concern	Summary of Concern/Affect	Anticipated Environmental Consequences Summary
Human Environment: Historic Properties/Cultural Resources/Native American Religious Concerns	Per 36 CFR 800.4, two Class III (intensive pedestrian) cultural resource surveys (Phase I and II of the project) resulted in the identification of 7 previously recorded sites, 4 new sites, and 5 new isolated occurrences within the project area. Section 106 consultation occurred with Tribes/Tribal Historic Preservation Offices (THPOs) and the Utah State Historic Preservation Office (SHPO). Tribal concerns regarding the proximity of the watershed development to sites located on the Shivwits Reservation were raised and resolved during a field visit. Consultation with various tribes, especially the Shivwits Band of Paiutes, has been maintained throughout the Plan-EA process. A summary of consultation with the various tribes is found in Section 7.17 and Appendix A (Phase II Section 106 Consultation). Native American religious concerns were sought through the Section 106 and in accordance with Executive Order 13007, 13175, and the American Indian Religious Freedom Act. No concerns were raised.	Per 36 CFR 800.5(b), the NRCS, through consultation with SHPO/THPO/Tribes/BLM, determined that the project would result in No Adverse Effects to historic properties. All historic properties within the Shivwits area of the project (42WS6520, 42WS6521, 42WS6522, and 42WS6523) will be crossed by the installation of a pipeline, bank riprap, or ditch riprap and will have a full-time archaeological and tribal monitor present for all ground-disturbing activities within 15 meters of all ground-disturbing activities. Two historic ditches would be beneficially protected by installation of bank riprap along the Santa Clara River. These ditches are contributing components of Sites 42WS6521 and 6523, respectively. Site 42WS2428, a historic road, has been heavily disturbed/destroyed and almost entirely reclaimed by vegetation in one crossing; it has lost all historic format in another crossing, and all elements of the segment are non-contributing to the overall eligibility of the site within the project area of potential effect. No Native American religious concerns and/or traditional cultural properties were identified within the project area through consultation.

Resource Concern	Summary of Concern/Affect	Anticipated Environmental Consequences Summary
Human Environment: Hazardous Materials	During construction, fuels and other hazardous materials would be used and stored on-site. The potential exists for accidental spills to occur.	The potential exists for short-term effects resulting from the accidental release of hazardous materials. Federal, state, and local laws and regulations pertaining to pollution and contamination of the environment would be implemented. Potential for contamination would be negligible. No hazardous material or superfund sites are located near the project area.
Human Environment: Noise	The 12-month construction period would result in increased noise levels in the project area, particularly in the communities of the Dammeron Valley and Diamond Valley areas.	Construction activities would have a short-term, temporary noise impact during the 12-month construction period. The effects would be minimal due to the short duration of construction and implementation of BMPs. Existing community activity and highway use would continue to generate similar background noise.
Human Environment: Public Health and Safety	The Dammeron Valley and Diamond Valley sites are subject to occasional severe flooding, and flooding along the Santa Clara River is eroding the stream banks and has destroyed adjacent stormwater drainage ditches.	Project development would reduce the severity of the flooding in the Dammeron Valley and Diamond Valley areas and reduce erosion along the Santa Clara River in the Shivwits area long term. Public safety would be improved for local residents.

S-18.0 Major Conclusions

Implementation of the Action Alternative would meet the purpose and need of the project as well as the goals and objectives.

Adverse effects would be minor and/or short-term during construction. Long-term beneficial effects would result from implementing the Action Alternative. Improved flood control management resulting in increased human safety, property protection, and improved water distribution for irrigation and other agricultural purposes would result. Santa Clara River and Rock Hollow Wash stream bank stabilization would reduce erosion currently occurring along the river and wash.

The Action Alternative is the most environmentally friendly alternative and has the greatest net economic benefits of the analyzed alternatives. This alternative represents both the Action Alternative and the NEE Alternative.

S-19.0 Areas of Controversy and Issues to Be Resolved

No areas of significant issues or controversy would be anticipated resulting from implementation of the Action Alternative.

S-20.0 Evidence of Unusual Congressional or Local Interest

There has been no evidence of unusual congressional interest in the proposed project. Public scoping results indicate that local interest is favorable toward the proposed project due to safety and agriculture benefits.

S-21.0 In Compliance

Is this report in compliance with the executive orders, public laws, and other statutes governing the formulation of water resource projects? **[X]** Yes [ ] No

1.0 Preparation of A Watershed Plan

1.1 Introduction

The Natural Resource Conservation Service (NRCS) is the lead federal action agency for the development of the proposed Santa Clara Watershed Project Plan-Environmental Assessment (Plan-EA). The Sponsoring Local Organization (SLO) is Washington County, a legal subdivision of the State of Utah. Washington County is charged with managing community development, emergency services, and public works including maintenance of highways, bridges, drainage facilities for roads, and other public works projects (Washington County 2021). These responsibilities include management of the drainage basins in Dammeron and Diamond Valley and erosion concerns along the Santa Clara River. The proposed project is located in Washington County, Utah.

Washington County proposes to construct or repair six detention basins (eight dams; two of the basins will have two dams), provide streambank stabilization along 0.29 mile of Rock Hollow Wash, and re-route stream diversions to better manage flood flow in the unincorporated communities of Dammeron Valley and Diamond Valley. The County further proposes to restore 0.53 mile of Santa Clara River stream bank integrity and repair irrigation and stormwater drainage structures on Shivwits Band of Paiute (Shivwits) lands east of Ivins, Utah. An overall view of the project area is shown in **Figure 1-1**. A figure of the Benefited Area is found in Appendix B. A view of the proposed detention basin sites and associated structures are depicted in **Figure 1-2** and **Figure 1-3**, and a view of the Shivwits structures is shown in **Figure 1-4**. Land ownership in the Dammeron Valley, Diamond Valley, and Shivwits portions of the project area are shown in **Figure 1-5**, **1-6**, and **1-7**. Detailed views of the individual structures are found in Appendix E-4A (Technical Documents, Alpha Engineering Technical Memo Dated March 3, 2021).

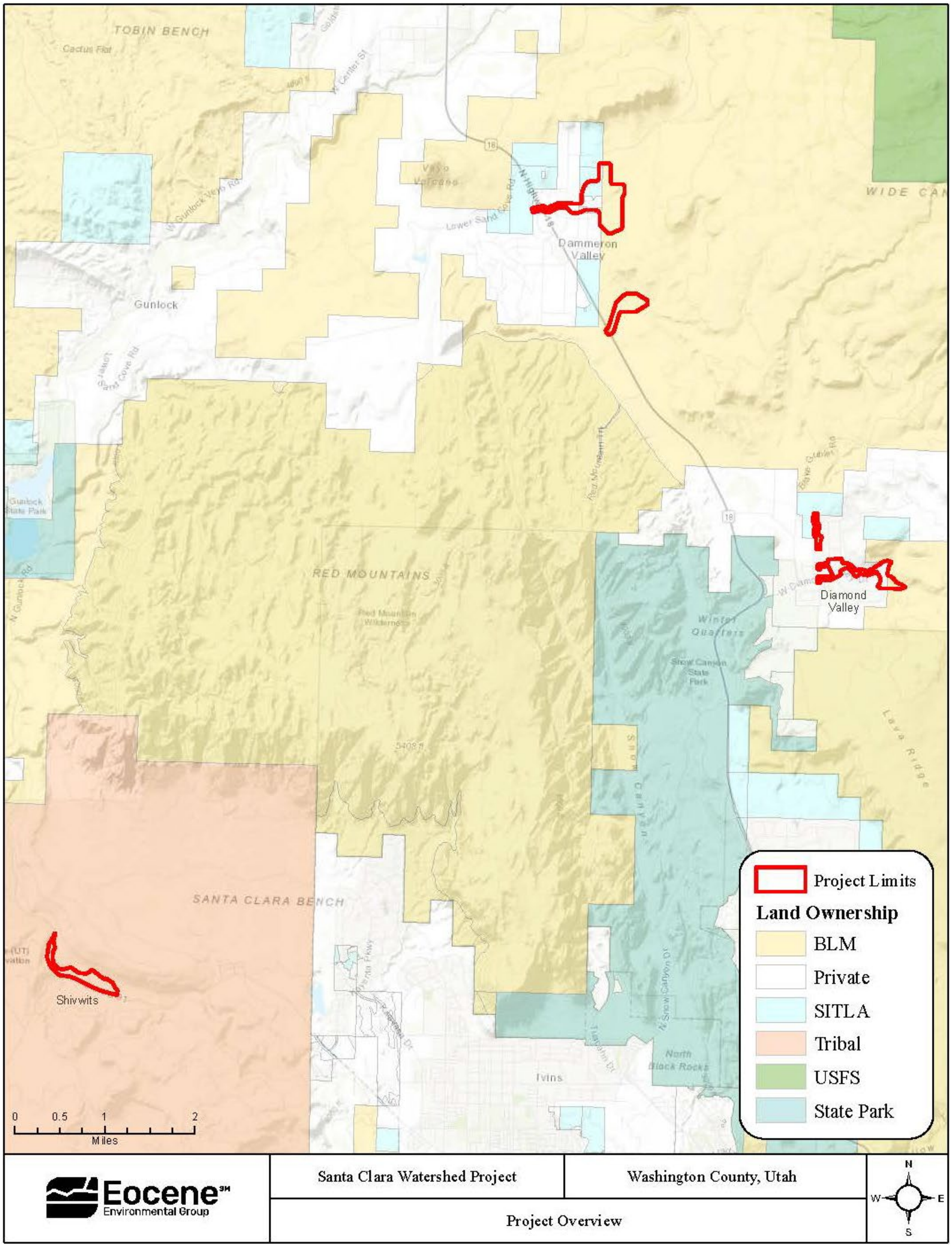

Figure 1-1. Overall view of the project area

The project sites would be located on private lands, Utah Trust Lands Administration (UTLA) lands, Bureau of Land Management (BLM)-administered public lands, and Shivwits Tribal lands. The BLM, UTLA, and Shivwits Tribe are cooperating agencies in this effort. While the three Dammeron Valley structures would be constructed on BLM–administered public lands, the protection afforded by the structures would be solely on private lands. No BLM–administered public lands would receive any protection or other benefits from the structures.

Federal funding for the project is being authorized through the Watershed and Flood Prevention Operations Program, which helps urban and rural communities protect, improve, and develop land resources in watersheds of up to 250,000 acres in size. This Plan-EA has been prepared to disclose and analyze the environmental consequences of project implementation, as proposed by Washington County. It contains a site-specific analysis of potential impacts that would result from the implementation of the Action Alternative or the No Action Alternative. The Plan-EA will assist in project planning and ensuring compliance with the National Environmental Policy Act (NEPA), Council on Environmental Quality NEPA regulations, and 40 Code of Federal Regulations (CFR) 1500–1508. Furthermore, the Plan-EA complies with the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (NRCS 1983) established pursuant to the Water Resources Planning Act of 1965 (Public Law [PL] 89-80), as amended by Executive Order 12322 (September 17, 1981), and NRCS NEPA policy and guidelines (NRCS 2010, 2011). The format of this Plan-EA follows the outline identified in the NRCS National Watershed Program Manual (NWPM) (NRCS 2015) Parts 500 through 506 and NRCS National Watershed Program Handbook Parts 600 through 606. The Plan-EA will assist the NRCS in determining if the selected alternative would have a significant impact on the quality of the human environment and if preparation of an Environmental Impact Statement (EIS) is required. If no significant impacts are identified in the Plan-EA, a Decision Record (DR) may be signed, approving the selected alternative. The DR, including a Finding of No Significant Impact (FONSI) statement, will document the reasons that implementation of the selected alternative would not result in significant environmental effects.

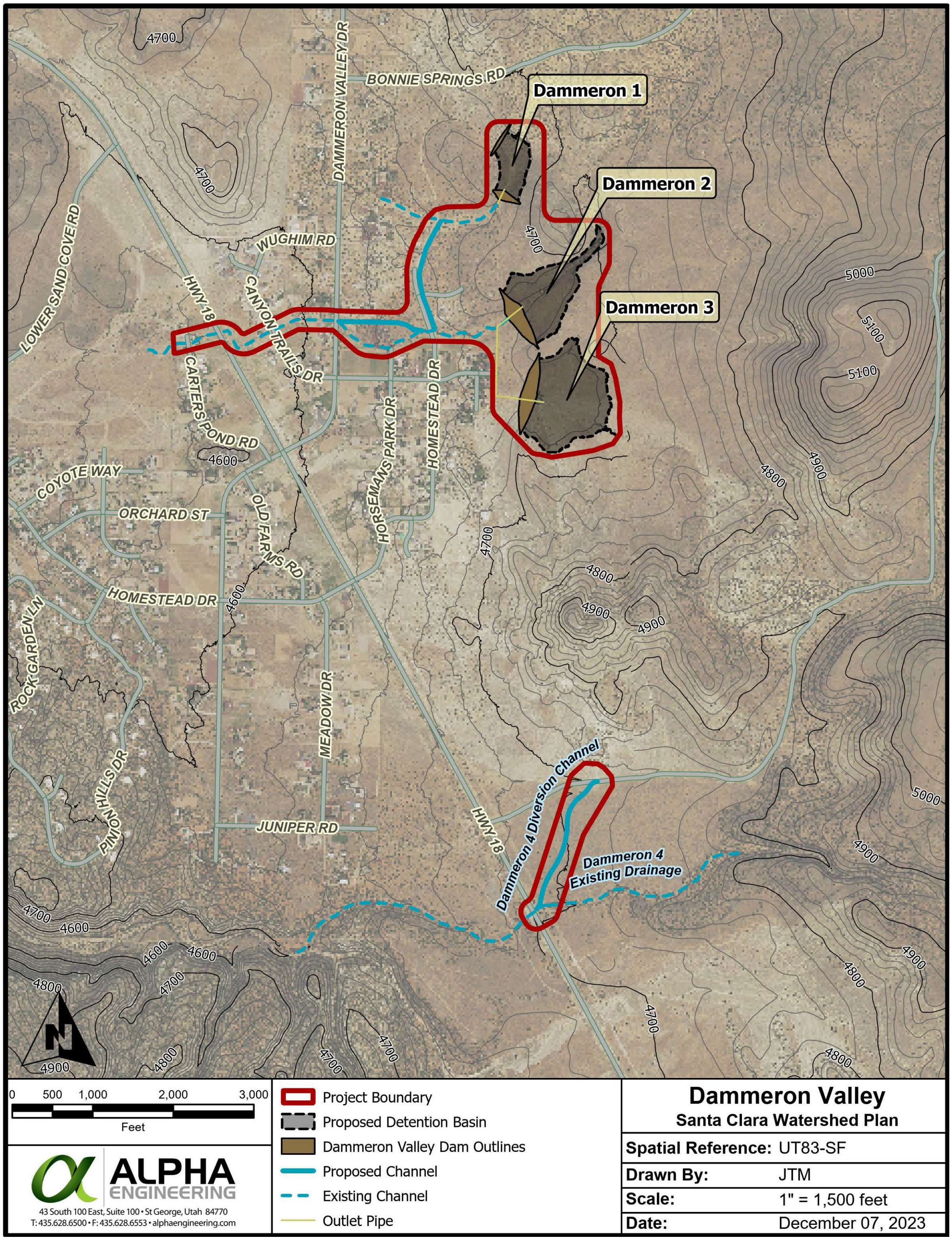

Figure 1-2. Dammeron Valley proposed detention basins and channel

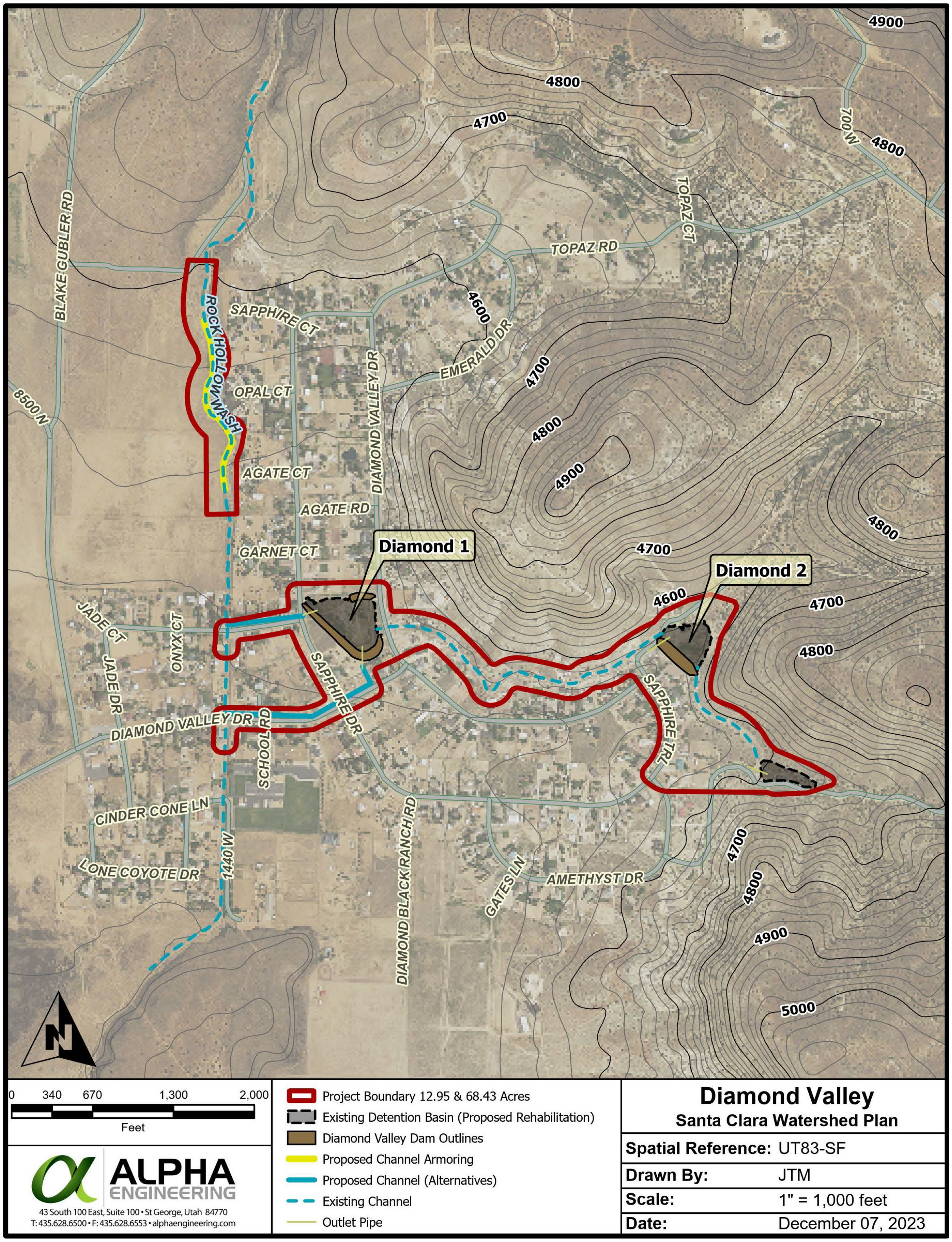

Figure 1-3. Diamond Valley existing detention basin, rehabilitation and channel armoring, and construction

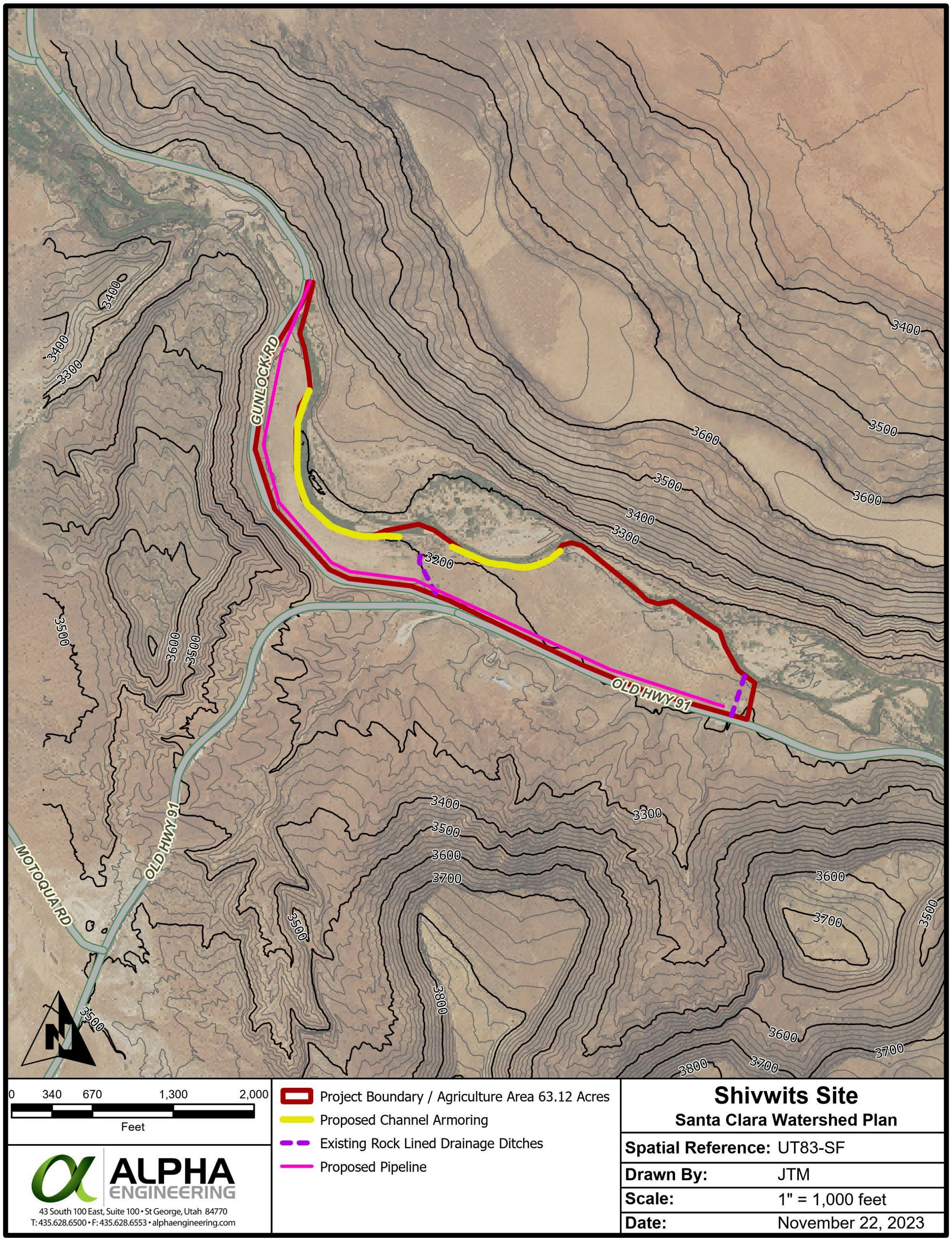

Figure 1-4. Shivwits Santa Clara River armoring, pipeline installation, and stormwater drainage ditch repair

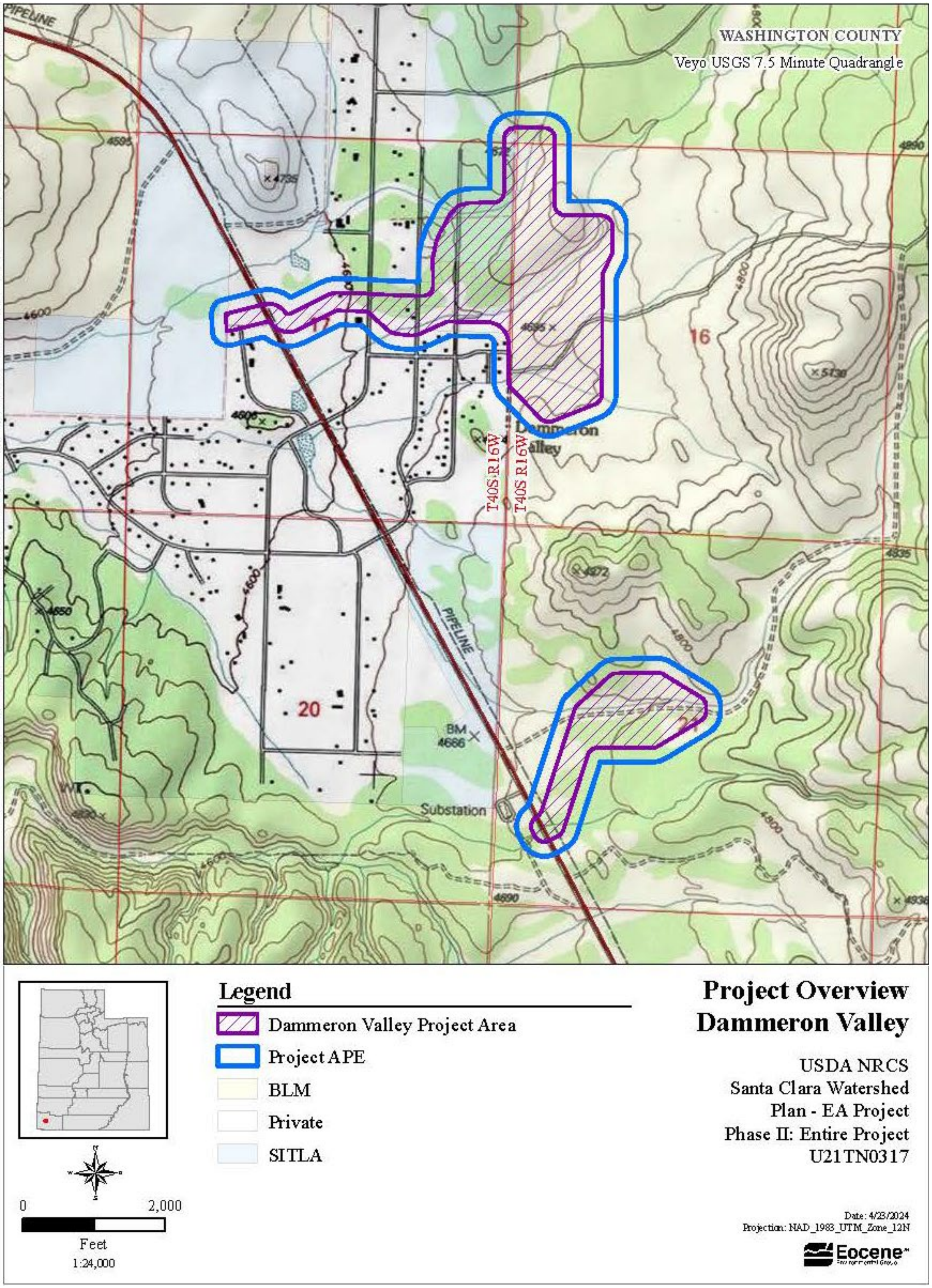

Figure 1-5. Dammeron Valley Site-Land Ownership

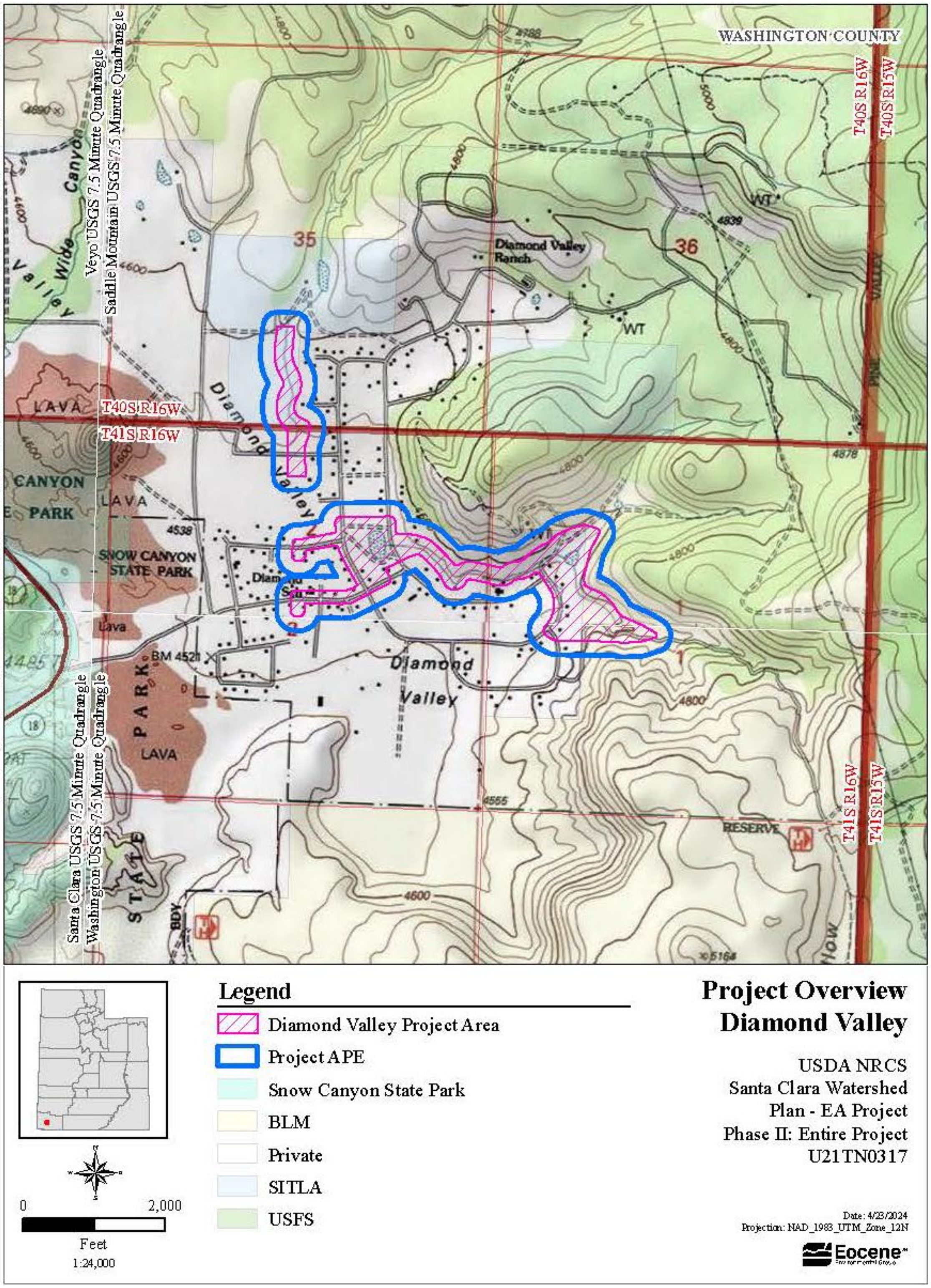

Figure 1-6. Diamond Valley Site-Land Ownership

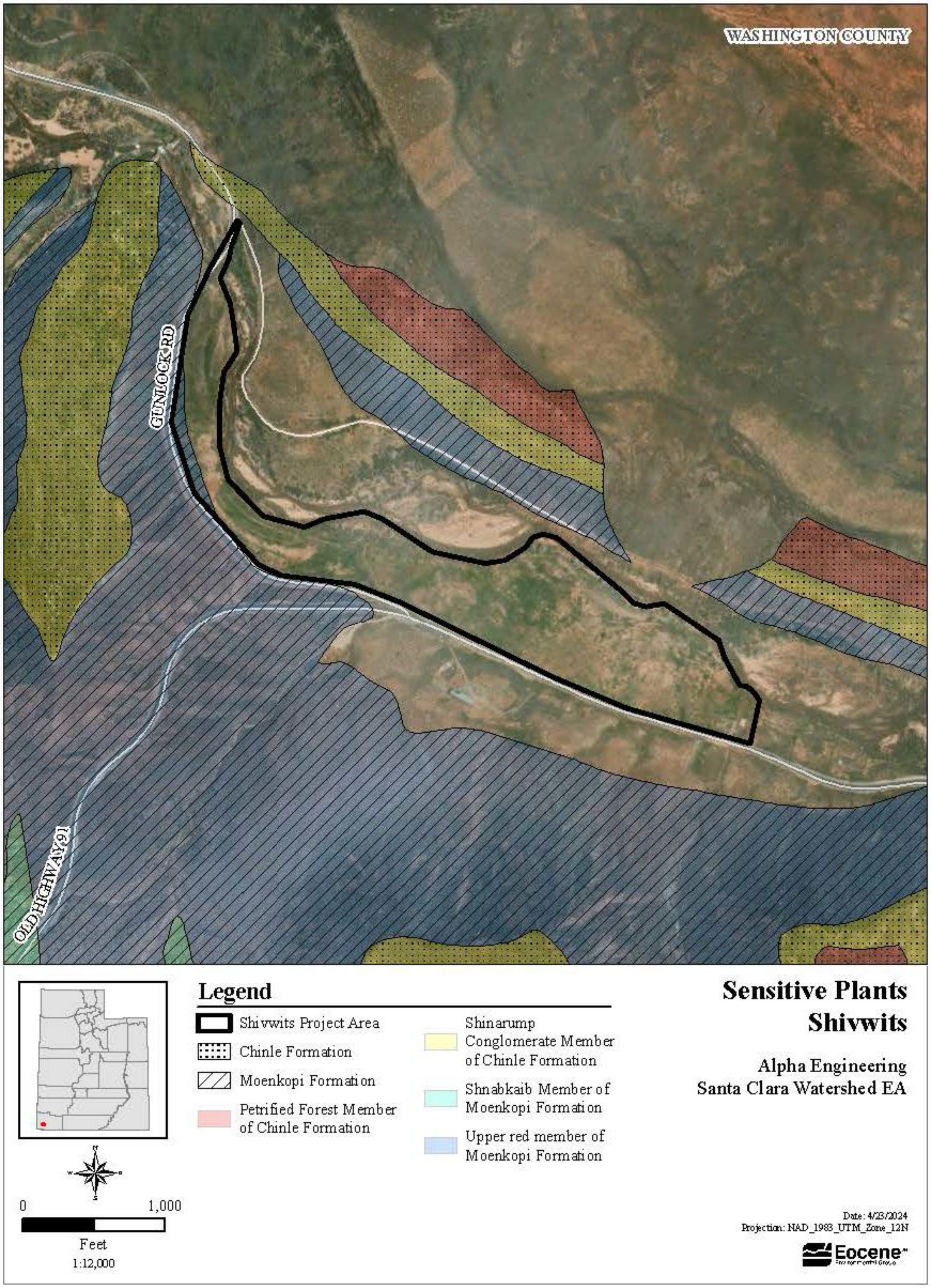

Figure 1-7. Sensitive Plant Formations

Watershed Plans are voluntary, comprehensive plans for a watershed or other large geographic area. NRCS areawide conservation planning policy requires consideration of all natural resources within a planning area, as well as social and economic considerations. Watershed Plans are developed through a voluntary locally led effort to achieve the following:

- Assess natural resource conditions and needs
- Set goals
- Identify programs
- Determine alternative actions and other resources to solve those needs
- Develop proposals and recommendations to solve those needs
- Implement solutions
- Measure success

The NRCS planning process consists of nine steps, divided into three phases, which cover development, implementation, and evaluation of an Areawide Conservation Plan. The three phases and nine steps are identified below:

<u>Phase 1—Collection and Analysis</u>

Step 1—Identify problems and opportunities

Step 2—Determine objectives

Step 3—Inventory resources

Step 4—Analyze resource data

<u>Phase 2—Decision Support</u>

Step 5—Formulate alternatives

Step 6—Evaluate alternatives

Step 7—Make decisions

<u>Phase 3—Application and Evaluation</u>

Step 8—Implement the plan

Step 9—Evaluate the plan

The nine-step NRCS planning process for Watershed Plans is considered and incorporated into this Plan-EA as follows in **Table 1-1**.

Table 1-1. Crosswalk of NRCS Nine-Step Planning Process and NEPA Requirements for This Plan-EA

Planning Step	NEPA Requirement	Section in this Plan-EA
Identify problems and opportunities	Purpose and Need	**Section 2**
Determine objectives	Purpose and Need	**Section 2**
Inventory resources	Affected Environment	**Sections 3 and 4**
Analyze resource data	Affected Environment	**Sections 3 and 4**
Formulate alternatives	Alternatives	**Section 5**
Evaluate alternatives	Environmental Consequences	**Section 6**
Make decisions	Action Alternative and Decision Document	**Section 8**
Implement plan	Mitigation and Monitoring	-
Evaluate plan	Supplemental Plan-EA/EIS (Adaptive Management)	-

1.2 Watershed Background

The Dammeron Valley and Diamond Valley basins are historic flood areas and experience occasional and sometimes severe flooding. Existing detention basins in the Diamond Valley area are not adequate to contain severe floodwaters, and no detention basin is present in the Dammeron Valley area. As a result, flooding has caused property damage and resident safety has been compromised. The unincorporated communities of Dammeron Valley and Diamond Valley have experienced flooding episodes that have harmed property and agriculture land and resulted in personal safety concerns. For example, in 2018, consecutive heavy storms in Dammeron Valley swamped dozens of homes and yards with mud and debris. Even after a considerable community effort with cleanup efforts, some homeowners still faced ruined basements and expensive rebuilding (**Appendix C**, **Photographs C-1** through **C-5**). More than 3 inches of rain were measured from a single storm, all coming over the course of a few hours (The Spectrum 2018). By comparison, the perception value from NOAA hydrographs depicts approximately 3.6 inches of precipitation for a 100-year 72-hour storm event (Alpha 2022a). In August 2022, two storm cells passed over the area. The resulting rain overwhelmed culverts and drainage areas causing residential flooding. Mud and debris also inundated several areas (St. George News 2022).

Due to flooding, approximately 0.2 mile of 2 stormwater drainage ditches accessing a historic agriculture area on Shivwits lands have been compromised and are not functioning, and stream erosion is occurring along the Santa Clara River in the area (**Appendix C**, **Photographs C-6** through **C-11**). In 2005, a severe Santa Clara River flood through the area resulted in the loss of 30 homes and widespread erosion damage along the river. Development of the detention basins and stream diversions would provide for improved flood management and increased personal and structure safety. Repair of the irrigation pipeline would provide irrigation water to a historic agriculture area.

As part of its flood control responsibilities, Washington County has facilitated the construction of several detention basins to help manage floods and the damage they cause. However, there are not enough functioning detention basins within the project area to adequately contain large flood events. Some existing basins have been compromised over time and are currently not fully functional. The concern exists that they will not be able to accommodate future severe flood episodes. Stream erosion along the Santa Clara River resulting from severe flooding has compromised the adjacent riparian zone and damaged a historic agriculture field. As a result, no agriculture activities have occurred in this area for some time. It has become necessary to develop additional detention basins, repair damaged stormwater drainage ditches, install an irrigation pipeline, and stabilize the Santa Clara River and Rock Hollow Wash to reduce erosion. This Plan-EA evaluates the benefits and environmental concerns that would result from project implementation along with the potential impacts of implementing the No Action Alternative.

The proposed project area is located in Washington County, Utah. The unincorporated community of Dammeron Valley is located along Utah State Route (SR) 18 approximately 14.8 miles directly north of St. George. Diamond Valley also is located on SR-18 and is found approximately 10 miles north of St. George. The Shivwits site is located along the Santa Clara River at the junction of Old Highway 91 and Gunlock Road, approximately 4.4 miles west of Ivins, Utah.

Informal Section 7 consultation with U.S. Fish and Wildlife Service (USFWS) has been ongoing throughout the NEPA process. The USFWS concurred with the May Affect, Not Likely to Adversely Affect determinations that were made for all listed species potentially occurring within the project area, and the project is not likely to jeopardize the continued existence of the candidate species, monarch butterfly (**Appendix A**(USFWS 2022).

1.3 Watershed Plan Changes

The Dammeron Valley and Diamond Valley portions of the project area have experienced a sustained change in land use since the mid-1970s. It is rural in nature with large areas of undeveloped land between homes. Prior to the development of the current subdivisions, the areas were historically used for livestock grazing and a small amount of farming. Agriculture in the area is primarily dry-land farming (see **Section 4.11** for details). The drainage areas are generally located east of the two valleys and are the source of the flooding. Detention basins and wash stabilization efforts are currently inadequate to contain major flooding events, resulting in property damage and public safety concerns. Additional measures are needed to address flood management, public safety, and agricultural protection for the changed conditions of the Dammeron Valley and Diamond Valley portions of the project area.

The Shivwits portion of the project area is rural in nature. There are no occupied residences present in the area (see **Section 4.11** for details). The Shivwits portion of the project area has historically been used for agriculture. However, due to damage to the irrigation pipeline, no planting and harvest in the area has occurred for several decades. Additional measures are needed to address streambank erosion and agricultural management for the changed conditions in the Shivwits portion of the project area.

1.4 Decision Matrix

The NRCS, with input from Washington County and involved cooperating agencies, must decide on a preferred federally assisted alternative with the greatest net benefits, otherwise known as the National Economic Efficiency (NEE) plan. The NRCS must also decide if implementation of the selected alternative would or would not constitute a major federal action that would significantly affect the quality of the human environment. If the NRCS determines that the implementation of the selected alternative would not significantly affect the quality of the human environment, a FONSI would be prepared and signed, at which point the proposed project may proceed. If the NRCS determines that implementation of the selected alternative would significantly affect the quality of the human environment, then an EIS and a Record of Decision would be prepared before the proposed project could proceed.

The BLM decision to be made is whether to grant a right-of-way (ROW) to Washington County for any actions that would occur on BLM-administered public lands. This Plan-EA will also serve as the necessary environmental documentation of actions located on Shivwits land and requiring Shivwits administration approval.

The SITLA decision to be made is whether to issue an easement for any surface-disturbing activities that would occur on SITLA-administered lands.

1.5 Conformance with Existing Federal, Tribal, State, County, and Local Land Use Plans

The Utah State legislature has delegated responsibility to Washington County to pass ordinances, rules, and regulations necessary and proper to provide for the public health, safety, and general welfare of its inhabitants. As a result, a County Code addressing flood control has been developed. This code authorizes Washington County to take actions to reduce losses resulting from floods and addresses county authority, findings, purposes, and objectives regarding flood management (Washington County 2004).

The Action Alternative is not specifically identified in either the General Plan of Washington County, Utah 2010, as amended (Washington County 2012), or the Washington County Flood Control Authority (FCA) (2021). These projects are outside of the boundary of the Washington County FCA. The FCA boundary only includes the city boundaries of St. George, Washington, and Santa Clara, Utah. However, it is recognized in the plan that Dammeron Valley and especially Diamond Valley have flood issues. Regarding Diamond Valley, the plan states, "Flood Control: Because of the closed nature of Diamond Valley, flooding has, over the years, been a problem in many parts of the valley. The county has completed a flood control plan to determine the projected amount of runoff that could occur at any given time. The county is working with the communities, as funding can be identified, to implement the engineering plan. This could include the installation of storm drains, or other measures, to help alleviate the flooding problem. This has been an ongoing problem for many years with which the county will continue to be involved." The Action Alternative falls under this commitment from the county. Regarding Dammeron Valley, the plan states, "Flood Control: Flood control has not been a major problem in Dammeron Valley compared to some of the other unincorporated communities in the county. During heavy storms, there have been times when the culverts under the state highway have not been sufficient to carry the runoff, but overall, Dammeron Valley has gotten by comparatively well." However, Dammeron Valley experienced serious flooding and associated structural damages in July 2018, demonstrating the need for enhanced flood control measures (The Spectrum 2018). Flood control is managed by the Washington County Public Works Department.

The Washington County Resource Management Plan (RMP) (Washington County 2018) recognizes the value of riparian areas within the area. In summary, the Management Plan states that Washington County values healthy, functional riparian areas for their ecological and aesthetic values and for their bank stabilization functions. Desired Future Conditions/Objectives include riparian areas that are healthy, ecologically functional, structurally stable, and supporting riparian flora and fauna. Management actions identified in the plan include working with federal, state, and municipal partners to manage existing riparian areas and encourage research into best riparian management practices.

In 2005, a master plan was prepared for the management and maintenance of the Santa Clara River, which is subject to severe flooding (Natural Channel Design, Inc. 2005). The plan provides specific instructions on how stream bank stabilization should be installed. While the plan does not address specific projects, the Shivwits portion of the Action Alternative would comply with the plan's stream bank stabilization recommendations.

The BLM St. George Field Office RMP was completed in 1999 and amended in 2001, 2016, and 2021 (BLM 1999). While the Proposed Action is not specifically addressed, project implementation would be in compliance with the RMP. The RMP ROW Objective is to continue to make public lands available for a variety of ROWs where consistent with planning goals and prescriptions for other resources. LD-12 states: "Applications for new ROWs on public lands will be considered and analyzed on a case-by-case basis. Proposals will be reviewed for consistency with planning decisions and evaluated under requirements of the NEPA and other applicable laws for resource protection. Mitigation needed to avoid adverse impacts will be integrated into project proposals and, where appropriate, alternatives identified to further reduce environmental impacts to lands, resources, or adjacent land uses." LD-19 identifies ROW avoidance and exclusion areas. No ROWs are proposed in any of these areas. A review of the RMP did not identify potential conflicts with any resource or management decisions in the original RMP or any of the subsequent amendments.

The Shivwits Band of Paiutes is a federally recognized Tribe and has tribal approval authority on the reservation. The Tribe has agreed to be a cooperating agency in the preparation of this Plan-EA. This Plan-EA will also serve as the necessary environmental documentation of actions located on Shivwits land and requiring Shivwits administration approval. A Shivwits Reservation Land Use Plan was published in 1999. The plan identifies the Shivwits portion of the project area as one of only five small potential agricultural land sites found within Reservation boundaries (Shivwits 1999).

1.6 Principles, Requirements, and Guidelines Analysis

The purpose of the Principles, Requirements, and Guidelines (PR&G) analysis is to ensure that the alternatives analyzed in this document contribute to the Federal Objective and Guiding Principles.

The Federal Objectives "specifies that federal water resource investments shall reflect national priorities, encourage economic development, and protect the environment." The Guiding Principles are Healthy and Resilient Ecosystems, Sustainable Economic Development, Floodplains, Public Safety, and Watershed Approach. Additional details on the Federal Objective are provided in the PR&G Report in **Appendix E**.

The PR&G study area is located within Lower Colorado Water Resource Region (Region 15) and the Upper Virgin River HUC 12 watershed (15010008). The overall analysis area that includes the combined 3 separate sites (Dammeron Valley, Diamond Valley, Shivwits site) is approximately 38,000 acres.

2.0 Purpose and Need

2.1 Purpose

In general, the purpose of this project is agricultural water management, flood protection, and watershed protection. Specifically, the purpose is 1) to detain peak flood flows, thus protecting residents, homes, properties, local watersheds, and other infrastructure within Dammeron Valley and Diamond Valley. Flood protection has historically been provided for the 100-year storm event meeting FEMA requirements. It is proposed to provide embankment protection that would provide for the 100-year storm event; 2) to provide a working pipeline resulting in increased agricultural water availability (flooding has resulted in erosion of historic agriculture fields and damaged a pipeline and stormwater drainage ditches); and 3) to provide erosion protection along the Rock Hollow Wash and Santa Clara River. In total, the proposed project would provide improved flood protection in the affected communities for approximately 748 people, 69 homes, roads/highways, and approximately 87 acres of agricultural lands (57 acres in Dammeron Valley and Diamond Valley and 30 acres on the Shivwits site).

Implementation of the Action Alternative would meet eligible program purposes as described in Title 390-National Watershed Manual 500.3 Eligible Purposes These purposes include flood prevention, agricultural water management, and watershed protection.

2.2 Federal Objectives

The federal objective would be to provide the necessary funding and other assistance necessary to implement the proposed project. Without the funding and support from the NRCS, the project would not likely be constructed.

2.3 Project Objectives

The Dammeron Valley and Diamond Valley basins are historic flood areas and experience occasional and sometimes severe flooding. The existing detention basins in the Diamond Valley area are not adequate to contain severe floodwaters, and no detention basins are present in the Dammeron Valley area. Severe flooding in the Santa Clara River is causing erosion and preventing agricultural development. The object of this proposed project is to reduce the potential for devastating flooding and resulting property damage and provide potential agriculture opportunities.

2.4 Constraints and Considerations

A full range of options were considered for detailed study. These included alternative detention basin and ditch sites, flood walls, removing homes and other structures, and a non-structural option was considered. After careful examination, these alternative actions were eliminated from detailed study, as they were considered infeasible, did not adequately meet the purpose and need for the project, had greater environmental effect, or were cost prohibitive. No alternative detention basin sites are available (See **Section 5.3** for a detailed discussion).

2.5 Need

The need exists to provide enhanced flood control and improved irrigation water distribution in Washington County, Utah. Successful project development would increase public protection and rural resiliency. As authorized by PL 83-566 (The U.S. Watershed Protection and Flood Prevention Act of 1954, as amended), Washington County has requested federal assistance to construct and restore a series of detention basins and a flood channel in the Dammeron and Diamond valleys, to install stream bank protection along Rock Hollow Wash in Diamond Valley, and to install stream bank protection and repair irrigation and drainage systems on Shivwits tribal lands. Residents within the project area currently experience occasional, sometimes severe flooding, and the existing irrigation system is not meeting user needs. Existing facilities are old, only partially functional, and have limited ability to control floods and distribute irrigation water.

2.6 Problems

Dammeron Valley and Diamond Valley have experienced significant population increases since 1976 (Washington County 2012). Residential homes, businesses, churches, and other structures have been constructed in the area. The human population has increased to approximately 748 people within the confined area of the 2 valleys (Weichert 2023; World Population Review 2023). Urbanization of undeveloped lands has altered water runoff patterns, increasing runoff quantities from impervious surfaces in developed areas and changing flow patterns. As a result, flooding and associated damages have become increasingly concerning due to expanding development. Both valleys are historic flood areas. The surrounding area, primarily to the east where the floods originate, is primarily undeveloped BLM-administered public land. Flooding has been a continuing problem, especially during significant storm events. During heavy storms, existing culverts, storm drains, drainage canals, etc. are often overrun, and floodwater inundates homes, agricultural fields, and other areas, causing significant physical and monetary damage (see photographs in **Appendix C**). See **Section 1.2** for a detailed discussion of the background of the Dammeron and Diamond Valley areas that have led to the current situation. Flooding in Dammeron Valley and Diamond Valley originates in drainages east of the communities. This flooding occurs in both washes and overland. These floods, while generally of short duration, can be severe and result in damage to the watershed, homes, businesses, and agricultural lands.

The Shivwits portion of the project area has also been damaged by flooding. The two existing stormwater drainage ditches that convey water to the Santa Clara River are currently inoperable due to erosion caused by river flooding and overland flow (**Appendix C**). The existing irrigation pipeline is also inoperable. As a result, the historic 30-acre agricultural area has not been used to raise crops several decades. The Santa Clara River is a 52-mile-long river that originates in the Pine Valley Mountains in Washington County. It flows west, then south, then briefly southeast before entering the Virgin River near St. George, Utah. It flows through the project area near Ivins, Utah. Streambank erosion and meandering continue to occur along the length of the Santa Clara River, including in the project area, due to occasional, sometimes severe flooding events. These events have eroded adjacent property.

2.7 Opportunities

The following are opportunities identified by the SLO, agencies, organizations, and the public during development of this Plan-EA:

- Decrease the potential for flood damage to the local watershed, residential and agriculture areas in Dammeron Valley
- Restore stormwater drainage ditches entering the Santa Clara River
- Provide an irrigation pipeline to the agricultural land at the Shivwits site to provide water to approximately 30 acres of currently unusable agricultural land
- Protect riparian habitat along the Santa Clara River

3.0 Scope of The Plan-EA

Scoping is an integral part of the NEPA process. A scoping process was completed to identify relevant resources or environmental concerns to be analyzed in detail and to determine which resources or concerns could be eliminated from detailed study. Resource concerns were identified for the project based on required scoping concerns outlined in the NWPM Section 501.24 B (NRCS 2015) and from additional concerns identified by the public, the SLO, and agencies during the scoping meeting and/or other planning or public meetings.

The public was notified of the proposed project through multiple channels, including landowner notification, newspaper notices, an online public meeting, and an NRCS website. A public scoping meeting was held via Zoom on January 27, 2021. A brief project background presentation was followed by a question-and-answer session. The meeting provided an opportunity for the public and various agencies to express any specific comments and concerns regarding the proposed project.

The scoping period concluded on February 12, 2021. A total of 35 public comments, 2 agency comments, and 4 tribal comments were received. A Scoping Summary Report was prepared that provides details of the scoping process, including public and agency comments received (**Appendix A**). Tribal consultation letters have also been included in Appendix A.

Potential resource issues/concerns and their relevancy to the Action Alternative are summarized in **Table S-4**. These are also analyzed in detail in **Section 4.0** of this Plan-EA. Resource issues determined not relevant to the Action Alternative have been eliminated from detailed study (**see Table S-4**).

Ongoing discussions and consultations have been conducted with federal, tribal, state, and other agencies throughout the Plan-EA process. Those consulted or otherwise contacted include the USFWS, U.S. Army Corps of Engineers (USACE), BLM St. George Field Office, Utah Division of Wildlife Resources (UDWR), Utah State Historic Preservation Office (SHPO), Utah Division of Water Resources (UDWRe), Washington County, and private landowners (see **Section 7.0** for details). Individual Tribes/Tribal Historic Preservation Offices (THPOs) consulted were the Shivwits Band of Paiute Indians, Kanosh Band of Paiutes, Cedar Band of Paiutes, Ute Indian Tribe of the Uintah and Ouray Reservation, the Paiute Indian Tribe of Utah (PITU), the Kaibab Band of Paiute Indians of the Kaibab Indian Reservation, the Koosharem Band of Paiutes, the Moapa Band of Paiute Indians of the Moapa River Reservation, the Las Vegas Tribe of Paiute Indians of the Las Vegas Colony, the Navajo Nation, the Pueblo of Zuni, the Hopi Tribe, and Chemehuevi Indian Tribe. Input from these agencies, organizations, Tribes, and private individuals has been incorporated into the Plan-EA.

A summary of resource concerns and their relevance to the proposed action is provided in **Table 3-1** below. Resources determined not to be relevant to the proposed action have been eliminated from detailed study. Resources determined to be relevant to the proposed action have been analyzed in detail in **Section 6.0** of this Plan-EA.

Table 3-1. Resource Concerns Summary

Resource/Concern	Relevant to the Action Alternative?	Rationale
Soils (upland erosion and sedimentation)	Yes	Approximately 127 acres of surface disturbance would result (97 acres of short-term disturbance resulting from construction activities and 30 acres resulting from long-term agriculture use), increasing short-term erosion potential.
Water Resources and Water Quality (surface and groundwater quality)	No	No changes in surface or subsurface water resources or quality are anticipated. Water that would be captured in the detention basins would be rainwater from the local watershed. It would not flow through any developments or feed lots prior to reaching the detention basins. Additionally, the water would only stay in the detention basins for 1–2 days and would not likely seep into the aquifer, which is several hundred feet below the surface. Therefore, it was determined that no changes to water quality would occur. No surface disturbance would occur within the Santa Clara River; therefore, there would not be any affect to water quality.
Sole Source Aquifers	No	None present
WOTUS	Yes	Streambank stabilization at the Santa Clara River would affect approximately 0.53 mile of WOTUS values by reducing erosion along a bend in the river. No other WOTUS values would be affected by construction activities in other portions of the project area.

Resource/Concern	Relevant to the Action Alternative?	Rationale
Riparian Areas	Yes	Armoring of the Santa Clara River would help protect the riparian area within the project area (0.53 mile), but minor surface disturbance could occur during installation.
Wetland Areas	No	A small wetland near the Santa Clara River would not be affected by project development.
Floodplain Management	Yes	Project development would help protect the floodplain along the Santa Clara River. Portions of the Shivwits site are located within a Federal Emergency Management Agency (FEMA)-designated Zone A floodplain. Flooding potential would be reduced in Dammeron Valley and Diamond Valley. Three existing dams would be repaired, and three new dams would be constructed. Existing ditches would be repaired.
Wild and Scenic Rivers	No	None present (National Wild and Scenic Rivers System 2024).
Air Quality	Yes	Local air quality could be affected by emissions from 12-month construction activities. However, due to the short duration of construction-related activities and implementation of Best Management Practices (BMPs) (see **Section 8.2**), construction activities would not be expected to violate any air quality standards.

Resource/Concern	Relevant to the Action Alternative?	Rationale
USFWS-Designated Threatened, Endangered, and Candidate Species	Yes	Potential habitat for the listed southwestern willow flycatcher, desert tortoise, Holmgren milkvetch, Shivwits milkvetch, and dwarf bear-claw poppy is present within a 300-foot buffer surrounding the Shivwits portion of the project area. Project development would not likely adversely affect these species (USFWS 2022).
Vegetation (excluding USFWS-designated species)	Yes	Native plant species' habitat located within the overall project area would be disturbed on approximately 127 acres during construction activities (94 acres in Dammeron Valley and Diamond Valley; 33 acres in the Shivwits area).
Noxious Weeds and Invasive Species	Yes	Surface disturbance on 127 acres would increase the potential of noxious weed and invasive plant species invasion and establishment. Much of the construction activity would occur in areas that are already disturbed with noxious weeds and invasive plant species already present. Invasive species such as quagga and zebra mussels or carp are not found in the project area. Other invasive species such as the European starling, English sparrow, and raccoon may occur within the project area but would not be affected by project development and are not discussed further in this document.

Resource/Concern	Relevant to the Action Alternative?	Rationale
Fish and Wildlife (excluding USFWS-designated species)	Yes	Several species of wildlife occur within and near the project area, including 25 State of Utah and BLM sensitive species. Activities could affect these species during the 12-month construction period. Effects would be minor due to abundant adjacent habitat.
Migratory Birds/Bald and Golden Eagles	Yes	Six species of migratory birds potentially occur within the project area and could be affected by project development.
Social Issues	Yes	The local economy would benefit from the anticipated reduction in destructive flooding. and loss of agriculture land.
Historic Properties/Cultural Resources/Native American Religious Concerns	Yes	A total of 11 cultural resource sites and five IOs were located within the project APE. No historic buildings or other built environmental resources were identified within the viewshed of the proposed Diamond and Dammeron Valley detention basins' APE. No cultural resources are located within the breach inundation zone. In addition to the identified 11 cultural resource sites, approximately 30 acres of historic agricultural fields are present within the Shivwits portion of the APE spiritual and religious value. These fields were used in the early 1900s by the Shivwits Tribe until flooding destroyed the necessary infrastructure. While sites located by surveys would be avoided, additional sites or isolated occurrences (IOs) may be discovered within the project area during construction.

Resource/Concern	Relevant to the Action Alternative?	Rationale
Hazardous Materials	Yes	No hazardous materials sites are located within the project area (Utah DEQ 2024). During construction activities, fuel and other hazardous materials would be used and stored on-site. A remote potential exists for accidental spills to occur.
Noise	Yes	Noise levels would be increased during the 12-month construction period and would be especially evident within the Dammeron Valley and Diamond Valley communities.
Public Health and Safety	Yes	Construction of the detention basins and the re-routing of flow areas would improve existing public health and safety conditions.
Recreation	No	No recreation values or structures would be affected.
Visual Resources	No	The visual appearance of the project area would not be changed.
Transportation Infrastructure	No	No changes to the local transportation infrastructure would occur.
Prime and Unique Farmlands	No	None present.
Groundwater	No	No groundwater resources would be affected.
Regional Water Management Plans and Coastal Zone Management Areas	No	The proposed project would comply with the Washington County Title 12 Flood Control Ordinance. No regional water management plans would be affected. No Coastal Zone Management Areas are present.
Sole Source Aquifers	No	No sole source aquifers would be affected.
Coral Reefs	No	None present.

Resource/Concern	Relevant to the Action Alternative?	Rationale
Ecological Critical Areas	No	None present.
Essential Fish Habitat	No	None present.
Forest Resources	No	No forest resources would be affected.
Climate Change	No	Implementation of the Action Alternative would not contribute to climate change.
Natural Areas	No	No natural areas such as wildlife refuges or habitat protection areas are located within the project or would otherwise be affected by implementation of the Action Alternative.
Land Use	No	No existing land uses would be altered. Historic agricultural use of the Shivwits site would resume after several years of inactivity, but no new areas would be developed. Development of the Action Alternative would be in compliance with federal and local land use plans.
Scenic Beauty	No	Development of the Action Alternative would not be in conflict with any scenic resource designations.
Parklands	No	None present
Ecological Coastal Areas	No	None present.
National Parks, Monuments, and Historical Areas	No	None present.
Scientific Resources	No	A desktop review and consultation with State of Utah and BLM paleontologists determined that no impacts would occur to paleontological resources from implementation of the Action Alternative. No surveys were recommended.

4.0 Affected Environment

The purpose of this section is to describe the ecological, cultural, social, and economic resources that could be potentially affected by implementation of the analyzed alternatives. These resources are summarized in **Table S-4** and **Table 3-1**. Only those resources potentially affected are discussed in detail in this section. Per requirements of the PR&Gs (USDA-NRCS, 2017), this Plan-EA describes ecosystem services associated with applicable resources. Ecosystem services are those benefits that people and their communities derive from the natural environment in which they live.

4.1 Soils

The Dammeron Valley and Diamond Valley sites of the project area consist primarily of alluvial and colluvial deposits and lava flows. The Cedar Mountain and Iron Springs formations are also present. Soils are generally reddish-brown sandy silts with basalt, gravels and cobbles, and visible bedrock present. Soils in both valleys are currently experiencing upland soil erosion and movement due to flooding events. Photographs, borings, and data sheets from geotechnical drilling and excavations of detention basin sites in Dammeron Valley and Diamond Valley are shown in **Appendix E-9c**.

The Shivwits portion of the project area consists of a floodplain covered with river and stream deposits. These deposits include light reddish-brown sandy silt residual gravels and cobbles and gray silty soils located near the Santa Clara River. The project area is surrounded by mostly steep hills consisting primarily of the Upper Red Member of the Moenkopi Formation. Soil in the Shivwits area is experiencing movement and loss due to flooding events in the Santa Clara River as well as drainages into the river.

As discussed in detail in **Appendix D** (Investigation and Analysis Report for Santa Clara Watershed), sediment accumulation within the detention basins is dependent upon the volume of sediment transported (sediment yield, the characteristics of the sediment load, flow velocity through the basin, etc.). The sediments in the Dammeron Valley drainage system are predominantly granular soils compared to the more-fine grained soils in the Diamond Valley drainage. Based on historical sediment accumulation and current analysis, an annual sediment yield of 0.25 acre-feet per square mile is assumed for Diamond Valley, and an annual sediment yield of 0.5 acre-feet per square mile is assumed for Dammeron Valley.

Biological soil crusts are present only in areas where surface disturbance is minimal. The majority of the project area surface has been disturbed due to flooding, agriculture, and community development, and biological crests are not present in these areas. Where present, these crusts can reduce wind and water erosion, fix atmospheric nitrogen into a form usable by plants, and contribute to soil organic matter (BLM 2008).

4.2 WOTUS

One river, two ditches, nine washes, and one potential wetland were identified within the project area during a desktop review and a focused field evaluation (Transcon 2021a: **Appendix E-9a**). The only known WOTUS resource located within the project area is the Santa Clara River (Transcon 2023a). The river runs the length of the Shivwits portion of the project area (approximately 1.15 miles). Within the project area, it contains permanent but widely variable amounts of flowing water. Riparian vegetation is present along the majority of the streambank. Portions of the streambank are steep-walled and exhibit signs of significant environmental erosion. CGunlock Reservoir, located approximately 5.2 river miles above the Shivwits portion of the project area, regulates the hydrology of the river in the area. The average daily flow below the reservoir is 22 cubic feet per second (cfs). The average annual peak flow for the river at Shem Dam is 666 cfs based on a 29-year period (NRCS 2014a). Photographs of aquatic resources located within the project area are found in **Appendix E-9b**. Consultation is ongoing with the USACE to determine WOTUS status of the ditches, washes, and wetland.

No known WOTUS values are located within the Dammeron Valley and Diamond Valley portions of the project area (Transcon 2023b; Transcon 2023c; Transcon 2023d). Consultation is ongoing with the USACE for a final determination on the ditches and washes located in the valleys. It is unlikely they are WOTUS as water flow is only present during flood events.

4.2.1 Ecosystem Services

The San Juan River flows through the Shivwits portion of the project area and provides the following ecosystem services:

- Provisioning services—water from the Santa Clara River was used by the Shivwits Band for agricultural purposes for several years until flooding and erosion compromised infrastructure necessary to get the water to the field.

- Cultural services—the land surrounding the Santa Clara River, including the agricultural field, has religious, cultural, and historical Tribal value(see Section 4.12 for details).

- Cultural services—the river and associated riparian habitat provide wildlife and vegetation habitat and aesthetic value on Tribal lands in an otherwise arid environment.

The existing detention basins and are located east of the community of Diamond Valley. A lined channel runs through the community. These structures are designed to manage floods and provide the following ecosystem service:

- Regulating services—the existing detention dams and channel provide some measure of flood management for the community of Diamond Valley. However, they are currently in need of repair and are not functioning at full capacity.

4.3 Riparian Areas

Approximately 1.15 miles of the Santa Clara River flow through the Shivwits portion of the project area. Riparian vegetation along this stretch differs in width and density due in part to flooding and subsequent erosion (**Appendix C**, **Photographs 8**, **19**, **20**, and **21**). Where present, it is thick and consists primarily of cottonwood trees (*Populus fremontii*), tamarisk (*Tamarix* spp.), and willows (*Salix* spp.). Riparian-type native grasses, grass-like vegetation, and forbs, including cattails (*Typha* spp.), Phragmites (*Phragmites* spp.), and sedges (*Carex* spp.), are also present. Approximately 6 acres of riparian vegetation is present within the project area.

A small wetland (less than 0.5 acre) is located adjacent to the south side of the Santa Clara near the Gunlock-Old Highway 91 junction in the Shivwits portion of the project area. Within the wetland, hydric soil indicators are present, and vegetation consists of riparian and hydrophytic species including Phragmites, cattail, tamarisk, coyote willow, and narrow-lead cottonwoods. The wetland is entirely located within the ordinary high-water mark (OHWM) of the Santa Clara River and is adjacent to swiftly flowing water (Transcon 2021a).

No riparian areas are located within the Dammeron Valley and Diamond Valley portions of the project area. A Preliminary Aquatic Resource Delineation Report has been prepared for this proposed project (**Appendix E**).

4.4 Floodplain Management

The portion of the Santa Clara River within the Shivwits area is located within a FEMA Zone A floodplain. A Zone A floodplain is an area subject to inundation by the 1-percent-annual chance flood event and is generally determined using approximate methodologies (FEMA 2021). The Santa Clara River in the Shivwits site has been subjected to periodic severe flooding that has damaged adjacent stormwater drainage ditches and the agriculture area. Two drainage ditches cross the Shivwits area but are currently damaged and do not covey water to the Santa Clara River as intended (**Appendix C; Figures 6 and 7**). A pipeline that once conveyed water to the historic Tribal agriculture field is also damaged and inoperable. As a result, water has not been delivered to the field for several years.

Although not located within a designated floodplain (FEMA 2021), the Dammeron Valley and Diamond Valley sites are areas that are subject to occasional, sometimes intense flooding. These floods, while often short in duration, result in the movement of substantial sediment, resulting in local sheet, rill, and gully erosion and damage to human infrastructure (see **Section 1.2**).

Three existing detention basins are located within the Diamond Valley area (**Figure 1-3; Figure 4-1).** These basins are partially filled with sediment deposits, are otherwise damaged, and currently do not provide flood protections as was originally intended (**Appendix C, Figure C-16**). Ditches and washes that convey water during significant flood events are also damaged and in need of repair.


Figure 4-1. An existing detention basin in Diamond Valley in need of repair

4.4.1 Ecosystem Services

Agricultural lands exist within the project area. As described in Section 1.3, water from the Santa Clara River has historically been used to irrigate an adjoining Tribal agricultural field (located within the floodplain) and provide the following ecosystem service:

- Provisioning services—agricultural use of the field provided a source of food for local Tribal members. However, erosion due to floods and overland flow has damaged the field and the infrastructure necessary to provide necessary irrigation. As a result, the field has remained unused for several years.

As discussed, the existing detention basins located east of the community of Diamond Valley and the armored channel that runs through the community are designed to manage floods and provide the following ecosystem service:

- Regulating services—the existing detention dams and channel provide some measure of flood management for the community of Diamond Valley. However, they are currently in need of repair and are not functioning at full capacity.

4.5 Air Quality

The State of Utah has adopted the Federal National Ambient Air Quality Standards and Prevention of Significant Deterioration increment consumption limits to protect and preserve quality of life. The Utah Department of Environmental Quality (UDEQ) Division of Air Quality regulates sources of air pollution in the state, including minimizing fugitive dust that would be expected from construction activity, such as would occur with the proposed project.

Air quality is generally good in Washington County. The county has been designated as an attainment area for all pollutants (UDEQ 2024). Emissions are relatively small compared to more urban areas in Utah and the surrounding region. There are no significant major point sources of emissions in Washington County. The majority of emission sources are considered area sources comprised of small businesses, mobile sources (cars and trucks), and combustion sources.

4.6 U.S. Fish and Wildlife Service-Designated Threatened, Endangered, and Candidate Species

The USFWS Information for Planning and Consultation (IPaC) website was accessed in December 2021 to identify listed threatened and endangered (T&E) species and their habitat that may occur within the project area (USFWS 2021a). IPaC identified eight listed and one candidate species as potentially occurring within the project area. A further analysis of the project area determined that one additional listed species (Holmgren milkvetch) also likely occurs near the Shivwits portion of the project area (**Appendix E-3; Santa Clara Project Rare Species Evaluation**). After an evaluation of the project area, it was determined that only six species potentially occur within the project area. Habitat for the remaining four species is not found within the project area and is not discussed further in this document (**Table 4.1**). These findings were further detailed in an undated desktop evaluation conducted by Eocene Environmental Group, Inc. (Eocene; formerly Transcon Environmental, Inc.) biologists (**Appendix E**).

Table 4-1. Federally Listed and Candidate Species in the Project Area

Common Name	Scientific Name	USFWS Status	Likely to Occur within Project Area (Yes/No)
Yellow-billed cuckoo	*Coccyzus americanus*	Threatened	No
Mexican spotted owl	*Strix occidentalis lucida*	Threatened	No
Southwestern willow flycatcher	*Empidonax traillii extimus*	Endangered	Yes
Desert tortoise	*Gopherus agassizii*	Threatened	Yes
Dwarf bear-poppy	*Arctomecon humilis*	Endangered	Yes
Holmgren milkvetch	*Astragalus holmgreniorum*	Endangered	Yes
Shivwits milkvetch	*Astragalus ampullarioides*	Endangered	Yes
Jones cycladenia	*Cycladenia humilis* var. *jonesii*	Threatened	No
Siler pincushion cactus	*Pediocactus sileri*	Threatened	No
Monarch butterfly	*Danaus plexippus*	Candidate	Yes

A summary of the species analyzed in this Plan-EA is presented below.

4.6.1 Southwestern Willow Flycatcher

There are approximately 6 acres of riparian habitat found along the Santa Clara River in the Shivwits portion of the project area. This habitat extends along the river both above and below the project area. It is located along both banks of the river and consists primarily of tamarisk, cottonwoods, and willows; however, it is patchy in nature, with some areas of riparian vegetation present and other areas with limited or no riparian vegetation (**Appendix C**, **Photographs C-19** through **C-21**). The Utah Natural Heritage Program (UNHP) has documented flycatchers along the Santa Clara River within 2 miles of the Shivwits portion of the project area (UNHP 2021). No flycatchers have been documented by UNHP or the eBird website to occur within 0.5 mile of the Shivwits site (eBird 2022). It was noted in a meeting with USFWS personnel that 2 flycatcher observations were made near Gunlock Reservoir approximately 4.5 miles upstream from the Shivwits area. However, due to the spotty nature of the riparian vegetation present, potentially suitable nesting and migratory habitat is limited within the Shivwits project area. Still, flycatchers may frequent the area during migratory periods. The flycatcher was listed as an endangered species in 1995 (*FR* 1995), with critical habitat designated in 2013 (*FR* 2013).

No potential flycatcher habitat occurs within the Dammeron Valley and Diamond Valley project areas. Any riparian vegetation such as cottonwood trees is limited to individual trees or shrubs planted on private property and does not meet size or stratification requirements for the flycatcher.

4.6.2 Desert Tortoise

The tortoise was listed as a threatened species in 1990 (*FR* 1990). The project area is located within the desert tortoise Upper Virgin River Recovery Unit. Tortoises generally live in a complex topography consisting of canyons, mesas, sand dunes, and sandstone outcrops where vegetation is a transitional mixture of sagebrush scrub, creosote bush scrub, blackbrush scrub, and sandy soil communities. Tortoises within the Recovery Unit often use sandstone and lava caves instead of burrows, travel to sand dunes for laying eggs, and use other habitats for foraging (USFWS 2011a). Potential tortoise habitat within the Shivwits portion of the project area is typical of the Recovery Unit (USFWS 2011a). The terrain buffering the Shivwits portion of the project area is moderately hilly with several small washes, providing the most potential for habitat (**Appendix C**, **Photographs C-20** and **C-21**). The surface within the project area itself has been disturbed due to floods and agricultural activities. As a result, habitat here is limited.

The UNHP database documents occurrence of desert tortoises within a 0.5-mile radius of each of the three project areas (UNHP 2021). However, no potential habitat occurs within the Dammeron Valley and Diamond Valley portions of the project area due to the presence of pinyon-juniper woodland, sagebrush-dominated habitat, and urban-related disturbance.

No desert tortoise designated critical habitat occurs within the project area. The nearest designated critical tortoise habitat is in the Red Cliffs Desert Reserve located approximately 4 miles north and east of the Shivwits portion of the project area, approximately 0.1 mile south and west of the Diamond Valley portion, and 3.5 miles south of the Dammeron Valley site.

Potentially suitable habitat was evaluated by desktop analysis in May 2021 by a qualified Eocene biologist. It was determined that potential habitat existed within the Shivwits project area, primarily in the 300-foot buffer area. Subsequently, a field survey was undertaken for the entire project area. Ten-meter-wide belt transects were used to cover 100 percent of the project area (USFWS 2018). In addition to locating tortoises, the biologist looked for any type of tortoise sign (e.g., scat, burrows, track, etc.). Based on survey results, no desert tortoises or desert tortoise signs were observed within the Shivwits project area including the surrounding 300-foot buffer area. Habitat within the project area was determined to be marginal due to a lack of suitable habitat, flooding, prior agriculture activity, and the generally disturbed nature of the area.

No survey was conducted in the Dammeron Valley or Diamond Valley portions of the project area due to the lack of habitat present.

4.6.3 Dwarf Bear-Claw Poppy

The poppy was listed as an endangered species in 1979 (*FR* 1979). The USFWS currently recognizes eight individual populations restricted to approximately 9,000 acres of habitat near St. George in Washington County, Utah. The dwarf bear-claw poppy occurs within warm desert shrub communities at elevations from 2,700 to 3,300 feet above sea level (asl). The poppy grows on gypsiferous clay soils derived from various geologic members of the Moenkopi Formation, particularly the Shnabkaib (USFWS 2021b).

An Eocene biologist conducted a protocol-level dwarf bear-claw poppy survey of the Shivwits site in May 2021 (USFWS 2011b). No individual plants were located. Flooding, prior agricultural activities, and the presence of weedy species have compromised the habitat. However, potential habitat (Red Bluff habitat polygon [USFWS 2016]) occurs adjacent to the Shivwits site in the 300-foot buffer area **(Appendix B; Appendix C, Photograph C-21**).

No potential habitat is located within the Dammeron Valley and Diamond Valley sites due to existing surface disturbance and the presence of sagebrush and other woody species and pinyon/juniper woodlands. These sites are located outside of the recognized poppy habitat range.

4.6.4 Holmgren Milkvetch

The milkvetch was listed as an endangered species in 2001 *(FR* 2001), with critical habitat designated in 2006 (FR 2006). Holmgren milkvetch occurs at elevations between 2,480 and 2,999 feet asl. It is typically found on the skirt edges of hill and plateau formations slightly above drainage areas. The species is most closely associated with geological layers or parent materials found within the Moenkopi formation. The Shivwits portion of the project area is located near the Holmgren milkvetch South Hills and Stucki Springs population polygons (USFWS 2006). A protocol-level survey of the Shivwits portion of the project area was conducted in May 2021, and no plants were located (USFWS 2011b). Any potential habitat within the project area is compromised due to past agricultural practices and the presence of weedy species. The soil type present (floodplain covered with river and stream deposits) is not conducive to the milkvetch. However, potential habitat is found within the 300-foot buffer area surrounding the site **(Appendix B**). The nearest designated critical habitat is located approximately 3.2 miles southeast of the Shivwits site.

No potential habitat is located within the Dammeron Valley and Diamond Valley sites due to the presence of sagebrush and other woody species and pinyon/juniper woodlands. These sites are located outside of the recognized milkvetch habitat range.

4.6.5 Shivwits Milkvetch

The milkvetch was listed as an endangered species in 2001 (*FR* 2001), with critical habitat designated in 2006 (*FR* 2006). Shivwits milkvetch is predominately found in isolated pockets of purple-hued soft clay soils found on the Chinle formation around St. George, Utah. Occupied sites are small and located between 3,018 and 4,363 feet asl. The Shivwits site is located adjacent to the Shivwits population polygon, and designated critical habitat is located less than a mile away (USFWS 2006, 2021b). In May 2021, a qualified Eocene biologist conducted a protocol-level survey on the Shivwits portion of the project area. No individual milkvetch plants were located (USFWS 2001b). The soil type required by the milkvetch is not present on the site but is located within 1 mile of the area. Potential habitat is located within the 300-foot buffer on the west side of the site (**Appendix B**; **Appendix C**, **Photograph C-21**).

No potential habitat is located within the Dammeron Valley and Diamond Valley portions of the project area due to the presence of sagebrush, other woody species, and pinyon/juniper woodlands. These sites are located outside of the recognized milkvetch habitat range.

4.6.6 Monarch Butterfly

In December 2020, the USFWS published the results of a 12-month finding, stating that listing the monarch butterfly as a T&E species is warranted but precluded by higher priority actions (*FR* 2020). Therefore, the monarch butterfly is a candidate species and not yet listed or proposed for listing.

Monarch butterflies are found in all 50 states in a variety of habitats. The key to viable habitat is fields, roadsides, open areas, wet areas, or urban gardens that contain required milkweeds (Asclepias spp.) and other flowering plants. Adult monarchs feed on the nectar of many flowers, but they breed only where the milkweed is found. Milkweed is the host plant species and without it, monarch larvae cannot develop into butterflies. Monarch butterflies utilize a variety of milkweed species (USFS 2021). The western population overwinters in coastal California. No critical habitat has been designated or is proposed for the monarch butterfly.

No specific butterfly or milkweed surveys have been conducted for this project. However, Eocene biologists did not anecdotally observe any monarch butterflies or milkweed plants when surveying for other species. Surveys for milkweed will be included when the biologists conduct pre-construction rare plant and animal surveys.

4.7 Vegetation (Excluding U.S. Fish and Wildlife Service-Designated Species)

Agriculture, floods, homes and other private developments, and other activities have altered the majority of the project area landscape. In the undeveloped portions of the Dammeron Valley and Diamond Valley sites, vegetation is dominated by pinyon pine (*Pinus edulis*), juniper (*Juniperus osteosperma*), and sagebrush (*Artemisia* spp.). Other species present include black brush (*Coleogyne ramosissima*), rabbitbrush (*Chrysothamnus* spp.), and pricklypear cactus (*Opuntia basilaris*). Terrestrial vegetation present at the Shivwits site includes creosote (*Larrea tridentata*), greasewood (*Sarcobatus vermiculatus*), pricklypear cactus, and rabbitbrush. Other species that are common to the general area and likely occur within the Dammeron Valley, Diamond Valley, and Shivwits sites include white bursage (*Ambrosia dumosa*), Mormon tea (*Ephedra nevadensis*), desert holly (*Atriplex hymenelytra*), brittlebush (*Encelia farinosa*), desert globemallow (*Sphaeralcea ambigua*), sego lily (*Calochortus nuttallii*), scarlet paintbrush (*Castilleja* spp.), desert trumpet (*Eriogonum inflatum*), cholla

(*Opuntia* spp.), Utah yucca (*Yucca utahensis*), wild onion (*Allium* spp.), African mustard (*Malcolmia africana*), tumble mustard (*Sisymbrium altissimum*), winterfat (*Eurotia lanata*), and spiny hop sage (*Grayia spinosa*). Pinyon and juniper trees dominate the hills in the buffer zone surrounding the floodplain at the Shivwits site. In areas affected by human-related activities, non-native invasive vegetation such as Russian thistle (*Salsola* spp.), cheatgrass (*Bromus tectorum*), and red brome (*Bromus rubens*) have become established.

Riparian vegetation along the Santa Clara River consists of cottonwood trees (*Populus* spp.), tamarisk (*Tamarix* spp.), willow (Salix spp.), and various forbs and grasses.

There are 10 BLM-sensitive plant species located in Washington County, Utah (BLM 2015). Of these species, the BLM-sensitive species Virgin thistle (*Cirsium virginense*) potentially occurs within the project area (Wheeler 2021).

4.8 Noxious Weeds and Invasive Plant Species

Species on the State of Utah Designated Noxious Weed List that may occur within the project area are Scotch thistle (*Onopordum acanthium*), hoary cress (*Cardaria draba*), and tamarisk (BLM 2017; UDAF 2021). Washington County's listed noxious weeds include whorled milkweed (*Asclepias verticillata*), silverleaf nightshade (*Solanum elaeagnifolium*), halogeton (*Halogeton glomeratus*), and giant reed (*Arundo donax*). Other invasive species of concern in Washington County are cheatgrass, red brome, bull thistle (*Cirsium vulgare*), malta starthistle (*Centaurea melitensis*), Russian thistle, and silverleaf nightshade (*Solanum elaeagnifolium*) (BLM 2017). All of these species are aggressive invaders capable of dominating the landscape in a variety of soil types and vegetation communities. These species are of concern because of their ability to quickly colonize and become established on disturbed soils. These species usually germinate under a wide variety of conditions, establish quickly, produce large amounts of seeds, and out-compete native species for light, pollinators, water, and nutrients. The existing disturbed areas within the project area and the new surface disturbance resulting from project implementation could make the area susceptible to invasive species colonization.

4.9 Fish and Wildlife (Excluding U.S. Fish and Wildlife Service-Designated Species)

Fish and wildlife habitat within the project area is common to the surrounding areas in Washington County. No unique or rare habitats are present. The BLM has identified the presence of several wildlife species during preparation of EAs for projects located near the project area (BLM 2020). These species likely occur within the project area and include badger (*Taxidea taxus*), antelope ground squirrel (*Ammospermophilus leucurus*), kangaroo rat (*Dipodomys deserti*), deer mouse (*Peromyscus maniculatus*), desert woodrat (*Neotoma lepida*), Gambel's quail (*Callipepla gambelii*), mourning dove (*Zenaida macroura*), common raven (*Corvus corax*), cactus wren (*Campylorhynchus brunneicapillus*), rock wren (*Salpinctes obsoletus*), house finch (*Haemorhous mexicanus*), side-blotched lizard (*Uta stansburiana*), and western whiptail (*Cnemidophorus tigris*). Additionally, species such as red-tailed hawk (*Buteo jamaicensis*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), and mule deer (*Odocoileus hemionus*) may pass through the area.

BLM-sensitive species that may occur within the project area include Arizona toad (*Bufo microscaphus*), Great Plains toad (*Bufo cognatus*), burrowing owl (*Athene cunicularia*), ferruginous hawk (*Buteo regalis*), kit fox (*Vulpes macrotis*), Allen's big-eared bat (*Idionycteris phyllotis*), big free-tailed bat (*Nyctinomops macrotis*), fringed myotis (*Myotis thysanodes*), spotted bat (*Euderma *maculatum*), Townsend's big-eared bat (*Corynorhinus townsendii*), western red bat (*Lasiurus blossevillii*), zebra-tailed lizard (*Callisaurus draconoides*), western banded gecko (*Coleonyx variegatus*), gila monster (*Heloderma suspectum*), chuckwalla (*Sauromalus ater*), desert night lizard (*Xantusia vigilis*), sidewinder (*Crotalus cerastes*), speckled rattlesnake (*Crotalus mitchellii*), Mojave rattlesnake (*Crotalus scutulatus*), and western threadsnake (*Leptotyphlops humilis*) (BLM 2015, 2020).

The UNHP Online Species Search Report (Appendix A) identified the following additional non-Endangered Species Act-listed rare species that may occur within a 0.5- or 2-mile radius of the project area: desert sucker (*Catostomus clarkia*), Virgin spinedace (*Lepidomeda mollispinis*), flannelmouth sucker (*Catostomus latipinis*), northern leopard frog (*Lithobates pipiens*), and Smith's black-headed snake (*Tantilla hobartsmithi*) (UNHP 2021). Additionally, the UDWR identified the speckled dace (*Rhinichthys osculus*) as occurring in the Santa Clara River within the Shivwits portion of the project area (See State of Utah scoping letter found in appendix E-10). The UDWR identifies the river as important to native fish species. As part of their native fish management, the UDWR has a lease agreement with the Shivwits Band of Paiutes for water to provide flows important for restoring the historic distribution of Virgin spinedace and retaining habitat connectivity (Appendix E-10).

4.10 Migratory Birds/Bald and Golden Eagles

The USFWS IPaC project planning tool site was reviewed to identify the potential presence of migratory birds within the project area. Six migratory bird species were identified (USFWS 2021a). These birds are of particular concern because they occur on the USFWS Birds of Conservation Concern list; however, because they are not listed species, no Section 7 consultation is required. The species identified in IPaC (USFWS 2021a) include black-chinned sparrow (*Spizella atrogularis*), Cassin's finch (*Carpodacus cassinii*), Clark's grebe (*Aechmophorus clarkii*), olive-sided flycatcher (*Contopus cooperi*), pinyon jay (*Gymnorhinus cyanocephalus*), and Virginia's warbler (*Vermivora virginiae*). Additionally, the BLM has identified the following species in EAs prepared for actions near the project area: bald eagle (*Haliaeetus leucocephalus*), long-eared owl (*Asio otus*), and Lewis's woodpecker (*Melanerpes lewis*) (BLM 2020).

Suitable nesting habitat that could be utilized by a variety of migratory bird species exists within and adjacent to the project area, including pinyon-juniper woodland habitat in the Dammeron Valley and Diamond Valley portions of the project area. A large expanse of sagebrush shrub habitat that may provide suitable nesting habitat for smaller avian species also exists at these sites. This sagebrush habitat may also serve as suitable foraging for raptors and other larger species. A corridor of suitable riparian nesting habitat containing large cottonwood, Russian olive, and willow trees also exists adjacent to the Santa Clara River within the Shivwits portion of the project area. No cliff nesting habitat suitable for species such as golden eagles exists within or near the project area; however, lands surrounding the proposed project area are likely to support a variety of prey species (e.g., rabbit, rodents) and high levels of roadkill carrion which could make these lands suitable foraging habitat for golden eagles in the area. Bald and golden eagles were not identified in either the IPaC or UNHP reports but are believed to occur in the general area and have been analyzed for other projects near the project area (BLM 2017).

4.11 Social Issues

The Dammeron Valley, Diamond Valley, and Shivwits portions of the project area (Shivwits site) represent a different spectrum of socioeconomic status in Washington County.

Dammeron Valley is a small, unincorporated community located in central Washington County, Utah, with a 2020 population of 786 (World Population Review 2023). It is rural in nature with large areas of undeveloped land between homes (**Appendix B**). Dammeron Valley is among the recent developments (1976) in the County and was never part of an area settled by the original pioneer settlers. Prior to the development of the current subdivisions, the area was historically used for livestock grazing and a small amount of farming (Washington County 2012).

Diamond Valley is a small, rural, unincorporated community located adjacent to SR-18 between Dammeron Valley and St. George, Utah. Community population is not known but is estimated to be between 900 and 1,000 residents (Washington County 2012). The Diamond Valley area does not have a historical pioneer heritage. It appears to have been used primarily for ranching and livestock grazing. In the early to mid-1970s, a group of local investors began development of the Diamond Valley community, making it one of the more recent developments in Washington County. Agriculture in Diamond Valley is mainly a small amount of dry-land farming (Washington County 2012).

The approximately 28,480-acre Shivwits Reservation is located in western Washington County. The Shivwits is a sovereign Indian Tribe whose federal status was restored by Congress in 1980. In 1981, the Shivwits joined with four other Native American Bands (Cedar, Indian Peaks, Kanosh, Koosharem) to form a joint-tribal governance entity referred to as the PITU, but the Shivwits still retains its federally recognized, sovereign status. The Shivwits site is rural in nature, lacking any occupied residences, and has historically been used for agriculture. However, due to damage to the irrigation pipeline from flooding events, no planting and harvest in the area has occurred for several decades.

The Shivwits is headquartered in Ivins, Utah. The Band has an estimated enrollment of 323 persons, with an estimated 120 people living in the unincorporated community of Shivwits approximately 9 miles west of St. George on Old Highway 91 just east of the Shivwits portion of the project area. The Shivwits community includes 40 homes, a health clinic, a community center, a gas station, and a market (Wilson 2022). Economic development is an ongoing political challenge for the Band.

While not directly impacted by implementation of the proposed project, data regarding the community of Santa Clara are presented below to provide a socioeconomic view of the general project setting. The nearest large community near the Shivwits portion of the project area is Santa Clara. It is located along the Santa Clara River and was settled by Jacob Hamblin in 1854 and incorporated in 1915. The city can best be characterized as suburban in nature since many residents commute to work in St. George and other nearby business areas. Santa Clara has a rapidly growing population. The St. George metro area, of which Santa Clara is a part, was recently ranked as the fastest-growing community in the U.S. in a recent U.S. Census.

The different socioeconomic status of the reservation and the rest of Washington County is a study in contrast. **Table 4-2** presents a summary of the status of the two areas. The Washington County data includes Dammeron Valley and Diamond Valley areas.

Table 4-2. General Socioeconomic Setting of Washington County, Utah

Item	Shivwits Reservation[6,7]	Santa Clara, Utah[3]	Washington County, Utah[2, 3, 4]
Population, Employment, Households: Population	323[1]	7,924	191,226
Population, Employment, Households: Median income (dollars)	$41,250	$84,128	$65,297
Population, Employment, Households: Unemployment (Percent)	8.5	4.3[5]	2.3
Population, Employment, Households: Number of occupied households	140	2,272	61,377
Population, Employment, Households: Median value of residential units (dollars)	$83,300	$375,700	$343,700
Population, Employment, Households: Persons in poverty (Percent)	28.1	4.6	9.4
Race and Origin: White alone (Percent)	4.3	89.1	92.9
Race and Origin: Hispanic or Latino	6.6	9.0	11.3
Race and Origin: Black or African American	0.0	0.6	0.9
Race and Origin: Two or more races	6.4	3.9	2.4
Race and Origin: Native Hawaiian and other Pacific Islander alone	0.0	0.6	1.0

Item	Shivwits Reservation[6,7]	Santa Clara, Utah[3]	Washington County, Utah[2, 3, 4]
Race and Origin: American Indian and Alaska Native	88.6	0.0	1.7
Race and Origin: Asian	0.0	2.3	1.1
Race and Origin: White alone, not Hispanic, or Latino present	4.3	83.8	83.2
Education: High school graduate (percent)	47.7[1,7]	93.3	93.7
Education: Bachelor's degree or higher (percent)	7.8[1,7]	35.9	30.5

Footnote for Table 4-2:

[1] Shivwits 2022.

[2] Figures used for Washington County include the Reservation.

[3] U.S. Census 2023.

[4] U.S. Census 2021.

[5] City-Data.com. Santa Clara, Utah.

[6] U.S. Census Bureau, 2017–2021 American Community Survey 5-Year Estimates.

[7] Data are for the PITU.

4.11.1.1 Environmental Services

The social and economic status of the project area is rural in nature and primarily dependent on livestock grazing and agriculture and provides the following ecosystem services:

- Provisioning services—agricultural fields within the project area provide hay for animals and food for local consumption. The agricultural field in the Shivwits portion of the project area has not produced any provisioning services for several years due to erosion and damaged infrastructure preventing water from getting to the field. Livestock grazing is historic in the area and occurs on private and public lands and provides a source of income for local residents.

- Supporting services—limited businesses, schools, fire, and medical services and facilities are available in the Dammeron Valley and Diamond Valley communities and provide services to local residents.

4.12 Historic Properties/Cultural Resources/Native American Religious Concerns

Cultural resources include archaeological sites, historic structures, sacred sites, and traditional cultural properties (TCPs) that are important to a community's practices and beliefs and are necessary to maintain a community's cultural identity. They also include resources that have little or no historic values but do have contemporary cultural value. The National Historic Preservation Act (NHPA) of 1966, as amended (54 U.S.C. 300101), requires that federal agencies consider the effects of their actions on historic properties. The term "historic properties" refers to prehistoric or historic district, site, building, structure, or object included in or eligible for inclusion in the NRHP maintained by the Secretary of the Interior (SOI). This term includes artifacts, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the National Register criteria (36 CFR 800.16[l]).

The quality of significance in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects of State and local importance that possess integrity of location, design, setting, material, workmanship, feeling, and association and that:

A. are associated with events that have made a significant contribution to the broad patterns of our history; or

B. are associated with the lives of persons significant to our past; or

C. embody the distinctive characteristics of a type, period, or method of construction; or that represents the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. have yielded or may be likely to yield information important in prehistory or history.

Per 36 CFR800.16(d), the NRCS established the project's cultural resources Area of Potential Effects (APE) to include all potential direct and indirect effects. The Direct Effect APE consists of all proposed surface disturbance areas with a minimum of 50-meter buffers, any new access roads, and geotechnical borehole and test pit locations with associated access roads (**Geotechnical Investigation Report for Preliminary Design, Appendix E-7a, 7b, and 7c**). The surface disturbance area encompasses the three new detention basins in Dammeron Valley, the re-routing of existing flows to an adjacent routed channel on the south end of Dammeron Valley, the repair of three existing detention basins in Diamond Valley, armoring of an existing channel in Diamond Valley, armoring of portions of the south bank of the Santa Clara River on Shivwits lands, the repair and armoring of two damaged existing drainage ditches (**Figure 4-2**), pipeline installation, and necessary buffers. The Indirect Effect APE consists of the Breach Inundation Zone that is defined as the area that would be inundated in Diamond and Dammeron Valleys in the event of dam failures of the No Action and Action Alternatives, and the viewshed of Diamond and Dammeron debris basins. Maps of the cultural resources APE are found in **Appendix B**. Two redacted cultural resources inventory reports addressing the phase I borehole and test pit locations and the entire project are found in **Appendix E-8**.

Figure 4-2. Damaged drainage ditch in Shivwits area

A literature review was conducted by Eocene archaeologists to identify existing cultural resources within 0.5 mile of the APE. The results of this literature review indicate there are a total of 39 previously conducted cultural resource surveys and 65 previously recorded cultural resource sites within 0.5 mile of the project area. Of these, 13 previously conducted surveys and 7 previously identified sites were mapped as overlapping, being immediately adjacent to, or being crossed by some portion of the current project APE. Of those 7 sites, 5 are prehistoric sites that are previously determined not eligible for the NRHP, one is a historic site that is not eligible for the NRHP, and one is an historic road that has a non-contributing segment within the APE. Eocene archaeologists who meet 36 CFR 61 SOI qualification standards conducted Class II (reconnaissance) and III (intensive) cultural resources inventories of the Direct Effect APE (Transcon 2021c; Transcon 2022). The Direct Effect APE consists of approximately 587.82 acres, 245.97 acres of which are BLM St. George Field Office-managed public lands, 57.74 acres are UTLA–managed lands, and 63.17 acres are privately owned lands in Dammeron and Diamond valleys and tribal lands at the Shivwits site. A Shivwits monitor was present during the cultural resource inventories at the Shivwits site. The entirety of the APE was surveyed in 15-meter-wide transects; however, some portions of the APE were surveyed at a Class II survey level (81.87 acres) (reconnaissance only), as they are located on private property in residential neighborhoods. The Cultural Resource Fieldwork Guidelines and Standards, BLM Supplement H-8110 (BLM 2020) and the Utah State Historic Preservation Office & Antiquities Section Archaeological Compliance Guidance (Utah Division of State History 2020) were adhered to at all times during fieldwork.

As a result of the cultural resources survey, a total of 11 cultural resource sites and five IOs were located within the project APE. There are no historic buildings or built environmental resources identified within the viewshed of the Diamond and Dammeron Valley debris basins APE. A literature review of cultural resources within the breach inundation zone for Diamond and Dammeron Valleys has been prepared and is found in **Appendix E**. No cultural resources are located within the breach inundation zone. **Table 4-3** summarizes the cultural resource findings and the NRCS' determinations of site eligibility. Per 36 CFR 800.4, the NRCS consulted with the SHPO on site eligibility and the APE in letters dated August 19, 2021, and February 3, 2023, requesting concurrence on site eligibility. The SHPO concurred with site eligibility in letters dated August 20, 2021, and February 3, 2021 (**Appendix A**). The NRCS also consulted with 14 Native American Tribes on the determination of site eligibility. Refer to **Section 7.1.7** for a description of all Tribal consultation conducted.

In addition to the identification of the 11 cultural resource sites identified during the Class II and Class III cultural resources inventories, and additional cultural resource that consists of approximately 30 acres of historic agricultural fields is present within the APE. These fields were used in the early 1900s to grow various crops, and this continued for decades. However, once the buildings associated with Site 42WS6521 were no longer habitable and water was no longer available, the fields became fallow. Orchards with peach, apple, and pear trees also used to thrive at Site 42WS6521. The Bear Dance was an annual event in this area, creating cultural community-level ties. These agricultural fields have ties to the traditional, historic, and cultural continuity of the Shivwits Tribe, thus making them an important cultural resource.

Table 4-3. Cultural Resources in the Project Area

Site No.	Temporal Affiliation	Site Description	Eligibility
42WS2428	Historic	Historic road (Road from St. George to Pine Valley)	Eligible—A, non-contributing
42WS4692	Historic	Historic pipeline and suspension bridge	Not Eligible
42WS4823	Prehistoric	Prehistoric lithic scatter	Not Eligible
42WS5150	Prehistoric	Prehistoric lithic scatter	Not Eligible
42WS5151	Prehistoric	Prehistoric lithic scatter	Not Eligible
42WS5152	Prehistoric	Prehistoric artifact scatter	Not Eligible
42WS5154	Prehistoric	Prehistoric lithic scatter	Not Eligible
42WS6520	Historic	Historic irrigation ditch	Eligible—A, C, D
42WS6521	Multi-component	Multi-component prehistoric artifact scatter and historic schoolhouse/habitation complex	Eligible—A, C, D
42WS6522	Multi-component	Multi-component prehistoric and historic artifact scatter	Eligible—A, D
42WS6523	Historic	Historic flood control ditch	Eligible—A, C, D

4.12.1.1 Ecosystem Services

As discussed in their scoping letter of February 12, 2021, the Shivwits Band has sensitive cultural, historic, and traditional interests within the project area (**See Appendix E-10**). These cultural, historic, and traditional properties are described in Table 4-3 and provide the following ecosystem service:

- Cultural services—these resources provide Shivwits Band Tribal members with a spiritual sense of history and connection to their ancestors and are associated with the cultural practices, traditions, beliefs, and social institutions of the Band's traditional community.

4.13 Noise

Noise laws that may apply to the project area are provided in the Noise Control Act of 1972 (42 U.S.C. 4901 et seq.), amended by the Quiet Communities Act of 1978 (42 U.S.C. 4913), which promotes the development of state and local noise control programs. Washington County Code also includes regulations regarding noise. Ambient noise within the project area has not been measured. Therefore, no baseline is available. Generally, there are several noise sources within or near the project area. These sources include vehicle traffic, agricultural operations, and other operational noises commonly associated with rural and urban areas. Noise-sensitive receptors are those facilities, land areas, or wildlife populations that require lower noise levels for health and function. Examples include residential neighborhoods, medical facilities, schools, churches, research facilities, parks, and open space. The proposed project area in Dammeron Valley and Diamond Valley is located within and near residential neighborhoods, churches, businesses, and schools. The Shivwits project area is more rural but is located adjacent to developed roads and near some homes and local businesses.

4.14 Public Health and Safety/Hazardous Materials Waste Sites

Washington County has a history of large and destructive floods. Major flood events are shown in **Table 4-6**. FEMA has issued four flood and severe storm disaster declarations for Washington County. These occurred in 1989, 2005, 2011, and 2012 (FEMA 2024). A State of Utah publication identified over 100 flood events in Washington County between 1847 and 1981 (State of Utah 1981). Public health and safety are a concern in Washington County, where flooding has the potential to impact developed residential areas, a river, agricultural sites, trails, and other places where people are likely to visit. Floods in the Dammeron Valley and Diamond Valley areas pose human safety concerns and have damaged homes, businesses, agricultural areas, and other infrastructure. Existing drainage basin capacity is often exceeded when intensive storm events occur. Floods along the Santa Clara River within the project area have resulted in erosion and loss of agricultural opportunities. No hazardous materials waste sites are located within the project area.

Table 4-4. Major Washington County Flood Events

Flood	Date	Details
Santa Clara and Virgin River[1]	December 1861–January 1862	Began on Christmas Eve and continued for 44 days. Destroyed most of the town of Santa Clara.
Virgin River[2]	1889	Large flood destroyed the Virgin River Irrigation Dam and Canal.
Santa Clara River[1]	1932	Major damage to Winsor (Shem) Dam
Santa Clara River[1]	1938	Major damage to Winsor (Shem) Dam
Santa Clara River[1]	1955	Major damage to Winsor (Shem) Dam
Virgin River[1]	July 29, 1975	Zion National Park flood
Quail Creek Dam [1]	January 1, 1989	Flood resulted from the failure of the southwest dam on Quail Creek Reservoir and resulted in over $12 million in damage
Santa Clara and Virgin River[1]	January 10–11, 2005	Flood caused over $200 million in damage. An undetermined number of homes were destroyed.
Santa Clara River[1]	2011	Major flood that damaged the Winsor (Shem) Dam. This damage resulted in a major dam rehabilitation project sponsored by NRCS
Dammeron Valley/Diamond Valley[3]	2018	A series of intense storms resulted in the swamping of several residential homes and yards with mud and debris.
Dammeron Valley/Diamond Valley[4]	August 2022	Two storm cells passed over the area, resulting in residential flooding and inundating several areas.

Footnote for Table 4-6:

[1] Washington County Historical Society website. Accessed October 2024

[2] Archives Utah Tech University. Archives.utahtech.edu/agents/ corporate_entities/36
Website accessed October 2024

[3] The Spectrum, 2018

[4] St. George News 2022

4.14.1 Ecosystem Services

There are three existing detention basins near Diamond Valley and a channel that runs through the community. These structures provide the following ecosystem services:

- Regulating services—the detention basins and channel provide a measure of public health and safety by channeling flood waters through the community. However, these structures are in disrepair and are not effective in managing floodwaters, and the community is susceptible to catastrophic flooding.

- Provisioning services—limited fire and medical services and facilities are available in the Dammeron Valley and Diamond Valley communities and provide services to local residents.

4.15 Principles, Requirements, and Guidelines Analysis

The resources identified in **Table 3-1** and further described in this chapter were considered for their role in the ecosystem and possible services provided. Ecosystem service flows (the transmission of a service from ecosystems to people) are quantified and monetized when possible, but non-monetary and unquantified effects are also considered (see **Section 6.0**). Additional details on the ecosystem services considered are provided in the PR&G Report (**Appendix E**). Ecosystem services that are likely to be affected as a result of successful project implementation are:

- Provisioning Services—Provisioning services are tangible goods provided for direct human use and consumption
    - Water: This service will be considered through an analyses of land use, socioeconomic factors, and agriculture
- Regulating Services—Regulating services maintain a world in which it is possible for people to live, providing critical benefits that buffer against environmental catastrophe
    - Rural flood damage reduction: This service will be considered through the analyses of flood management and public health and safety
    - Water and Land Use: This service will be considered through the analyses of agricultural land use, socioeconomic factors, and water use
- Supporting Services—Supporting services are underlying processes that maintain conditions for life on earth
    - Primary production: This service is considered through the analyses of plant and animal species and their habitats and cultural resources

The ecosystem services and respective resources considered for analysis are summarized in **Table 4-7** below.

Table 4-5. Summary of Ecosystem Services and Corresponding Resource Analyses

Category	Resource
Provisioning Services	Land use
-	Socioeconomic factors
-	Agriculture
Regulating Services	Rural flood damage reduction
-	Public health and safety
-	Water and land use
-	Agricultural land use
-	Socioeconomic factors
-	Water use
Supporting Services	Plant and wildlife species
-	Cultural resources

5.0 Alternatives

5.1 Project Scoping

The primary purpose of scoping for this proposed project was to gather input from the interested public, government agencies, and Tribes/THPOs. This input included feedback on the project's purpose and need, potential alternatives, and environmental resources or issues to be addressed and to provide necessary information regarding the project. Comments were accepted both orally at a public meeting and via written submittal. The data obtained during the scoping process were used to prepare the Plan-EA. A description of the public scoping process is included in **Sections 3.0** and **7.0**. **Appendix E-10** contains a copy of the Scoping Summary Report.

As discussed in **Section 3.0**, scoping questions, comments, and concerns were requested during an initial scoping period that began on January 13, 2021, and concluded on February 12, 2021. During the scoping period, a total of 35 comments were received from the public, government agencies, and Tribes/THPOs. Public outreach will commence for a second time when the Draft Plan-EA is prepared and ready for public review and comment.

5.2 Formulation Process

The formulation of alternatives for the Santa Clara Project followed procedures outlined in the following: the NRCS NWPM (NRCS 2015) Parts 500 through 506; the NRCS National Watershed Program Handbook (NRCS 2015), Parts 600 through 606; Guidance for Conducting Analyses Under the Principles, Requirements, and Guidelines for Water- and Land-Related Resources Implementation Studies and Federal Water Resource Investments (USDA 2017); and other NRCS watershed planning policy. Potential alternatives were considered by the project team based on the ability to address the purpose and need of the project. Comments received during the scoping period were also incorporated into the formulation process for alternative analysis. In accordance with NEPA (40 CFR 1502.14), some of these initial alternatives were eliminated from further analysis due to high cost, logistics, environmental concerns, safety, or other critical factors (**Section 5.3**). Based on these considerations, this Plan-EA analyzes, in detail, the Action Alternative and the No Action Alternative.

5.3 Alternatives and Options Considered but Eliminated from Detailed Study

A full range of alternatives and options were considered for detailed study during project formulation, planning, and scoping, including alternative detention basin and ditch sites, flood walls, and removing homes and other structures. Additionally, a non-structural option was considered. After careful examination, these alternative actions were eliminated from detailed study, as they were considered infeasible, did not adequately meet the purpose and need for the project, had more adverse environmental effect, or were cost-prohibitive.

5.3.1 Other Dammeron Valley and Diamond Valley Detention Basin Sites

Other detention basin sites were evaluated in the Dammeron Valley and Diamond Valley watersheds. In Dammeron Valley, there are four tributaries that produce drainage through the community. Three of the four tributaries are proposed to have detention basins installed. The fourth and southernmost tributary was considered for a detention basin, but due to topographical constraints and the unfeasibility of placing a dam within the tributary, a detention basin at this site was eliminated from further consideration. In lieu of a fourth detention basin, a new ditch is proposed to be constructed that would direct flows from the tributary into the existing Sand Cove Wash tributary.

In Diamond Valley, two tributaries and three existing detention basins are present. Proposals to rehabilitate and improve the three existing detention basins were explored, and all three sites are being proposed. One site along Rock Hollow Wash was found suitable for stream bank erosion protection and has been proposed. No additional locations were found to be suitable for siting detention basins or drainage ditches. Therefore, no additional sites in Diamond Valley are being considered in this Plan-EA.

A floodproofing alternative was considered that would consist of the installation of flood walls, raising grade in areas, and other measures to protect occupied structures. This alternative would require extensive and invasive modifications at a very high cost estimated to be approximately $13 million (Gordon 2025) The required measures would also cut off access to residential homes and other structures. This alternative was eliminated from detailed study due to impacts from disturbance, access restrictions from proposed measures, excessive cost, and logistical issues, making it infeasible.

5.3.2 Shivwits Site

Several actions were evaluated through meetings and correspondence with the Shivwits leadership and are being proposed for the project. Other potential actions, such as constructing entirely new ditches or placing riprap beneath the OHWM, were evaluated but were determined to be more costly, not as effective, and more environmentally damaging than the Action Alternative; therefore, these actions are not considered further.

5.3.3 Non-Structural Alternative

A nonstructural alternative was evaluated. This alternative would involve the relocation of homes and businesses away from the flood zone. Structures exposed to major flooding events would be relocated or purchased and demolished. This would result in significant disturbance to families and people occupying these structures. Additionally, the cost to purchase up to 69 homes and other private structures would be exorbitant. Relocating affected properties in Dammeron Valley and Diamond Valley would be approximately $140 million (Gordon 2025). No new detention basins would be constructed, and the existing basins would not be repaired. As a result, agricultural fields would not be protected, and agricultural value loss would continue as is presently occurring. This alternative was eliminated from further study based on the environmental and social impact to people occupying structures that would be removed, uncertainties with acquisition, and exorbitant cost making this alternative infeasible. Additionally, impacts to agricultural values would continue; therefore, the identified purpose and need for the action would not be met. A nonstructural alternative would not apply to the Shivwits portion of the project area as no new structures would be constructed. The Action Alternative at this site would result in the repair of an existing pipeline and two existing ditches as well as armoring of the Santa Clara River. Those actions would also be a part of a nonstructural alternative. Because this alternative would be the same as the Action Alternative, it is not considered further as a separate alternative in this Plan-EA.

5.4 Alternatives Analyzed in Detail

An analysis of feasible alternatives is required to determine potential actions that would meet the purpose and need of the proposed project (**Section 2.0**). After careful consideration, it was determined that the Action Alternative is the only action alternative that would meet this need. Additionally, a No Action Alternative is also considered. Both alternatives are analyzed in detail.

Alternative cost estimates provide a level of detail appropriate for identifying the NEE Alternative among the alternatives considered. Project costs provided for alternatives selected for detailed study include installation and operation and maintenance (O&M) costs. Installation costs include incurred costs after the project is authorized for installation. Installation costs would incorporate, as applicable, construction, engineering, real property rights, natural resource rights, permitting, replacement, in-kind relocation payments, and project administration costs (NRCS 2015). O&M costs include materials, equipment, services, and facilities needed to operate the project and make repairs and replacements necessary to maintain structural measures in sound operating condition during the 50-year project life (NRCS 2015). A summary and comparison of project costs for alternatives included in detailed study is provided in **Section 8.0**.

5.4.1 No Action Alternative

The No Action Alternative considers the actions that would take place if no federal action or federal funding were provided for the proposed project. The SLO most likely course of action is described below.

Maintenance actions such as removing debris from existing detention basins and washes would continue. The existing environmental conditions within the project area would remain the same. These actions would cost approximately $20,000 annually (**Table 5-8**). The detention basins and associated structures in Dammeron Valley and Diamond Valley would not be constructed or repaired. Armoring of washes in Diamond Valley and along the bank of the Santa Clara River would not occur. Dammeron Valley and Diamond Valley communities would continue to experience occasional severe flash flood episodes. Water erosion would continue to occur along Rock Hollow Wash in Diamond Valley and the Santa Clara River in the Shivwits portion of the project area. Water would not be available for approximately 30 acres of agriculture land in the Shivwits area, which would not be used for crop production, as the irrigation pipeline would not be repaired.

5.4.2 Action Alternative

Implementation of the Action Alternative would authorize the following:

- The construction or repair of six detention basins in Dammeron Valley and Diamond Valley
- Provide for a new 0.35-mile ditch in Dammeron Valley to convey floodwater
- Provide 0.29 mile of armoring for Rock Hollow Wash in Diamond Valley
- Provide 0.53 mile of armoring along the Santa Clara River
- Install a 1.05-mile irrigation pipeline
- Repair 0.2 mile of two stormwater drainage ditches on Shivwits tribal lands near Ivins, Utah

The estimated cost of implementing the Action Alternative is estimated to be approximately $14,987,418 (see **Table 8-3**). Individual project components are discussed in detail in the following sections below and in **Appendix D** (**Investigation and Analysis Report**) and **Appendix E-6 (Plan of Development)**. Construction activities would take approximately 12 months to complete. Construction activities in the Shivwits area would last approximately 7 months and would occur within the overall anticipated 12-month construction time. Development of the proposed project would be compatible with the stated mission of Washington County regarding flood management (Washington County 2012).

NRCS TR-60 (Earth Dams and Reservoirs) and Utah State Rule R655-11 (Requirements of the Design, Construction, and Abandonment of Dams) would govern the design criteria for the proposed detention basins. Exact embankment design has not been developed but would be as shown in Figures 5-1 or 5-2. The hydraulic and freeboard analyses and inundation maps are found in the Preliminary Hydraulic and Freeboard Report, Santa Clara Watershed Report (**Appendix E-4a**). A Conditional Letter of Map Revision will be developed as part of the proposed project to meet FEMA requirements. When the proposed project is completed, a Letter of Map Revision will be developed to designate the 100-year floodplain to meet FEMA requirements.

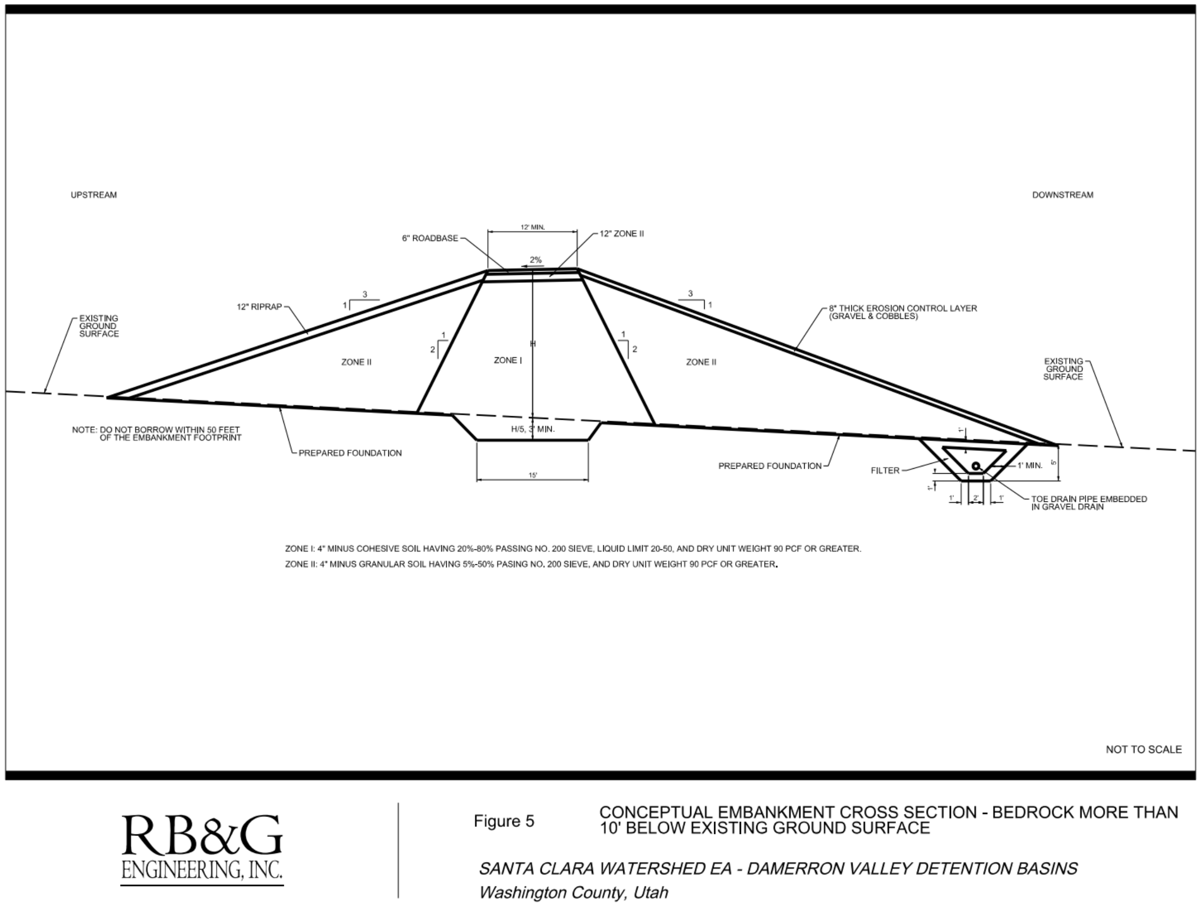

Figure 5-1. Conceptual Embankment Cross Section. (Taken from Santa Clara Watershed Detention Basins. RB&G, December 2021. Appendix E-7a)

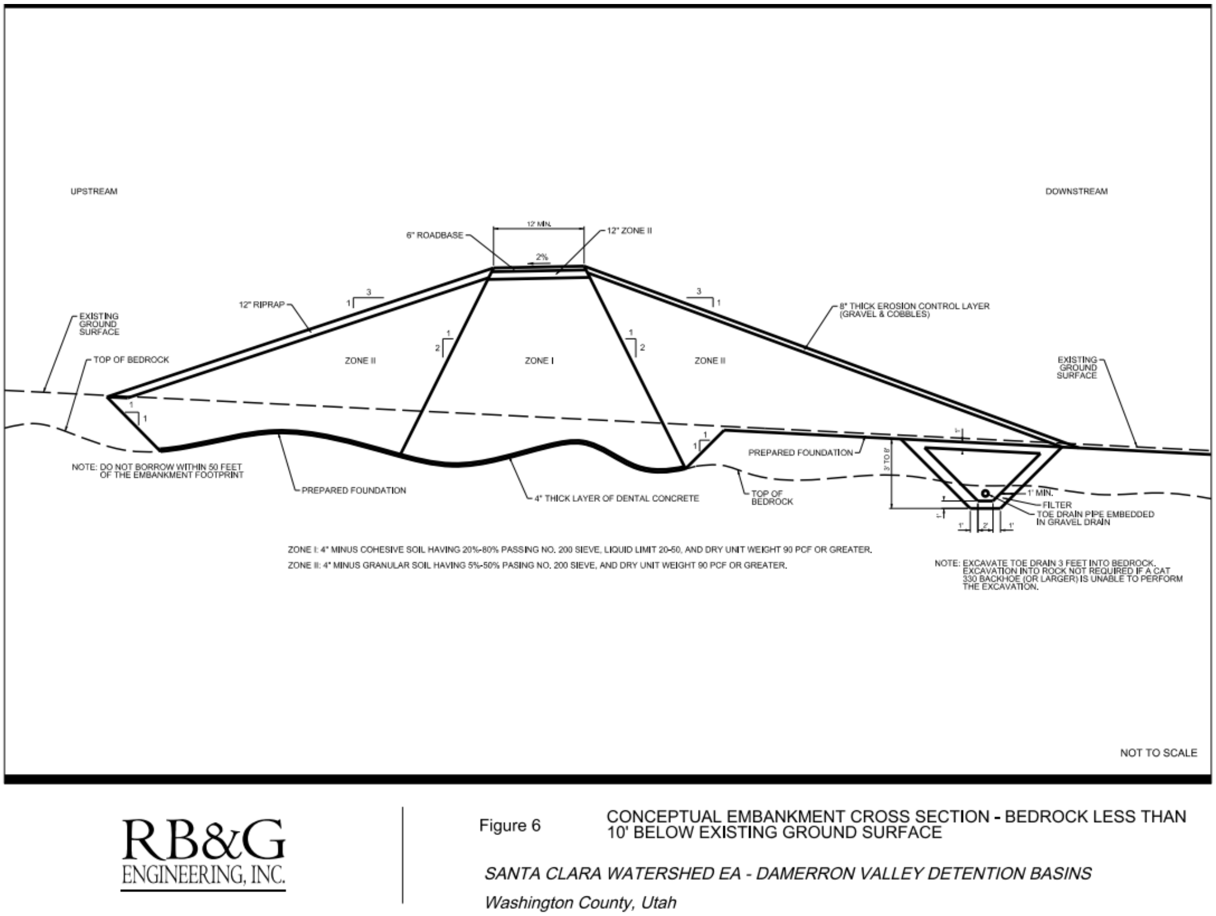

Figure 5-2. Conceptual Embankment Cross Section. (Taken from Santa Clara Watershed Detention Basins. RB&G, December 2021. Appendix E-7a)

Earthfill materials for the new and repaired detention basins would be taken from inundation areas behind the dams. Earthfill would generally include gravelly and clay soils and basalt. The earthfill embankment would consist of a low-permeable soil core and granular shell. New and repaired dam heights would be between 8 and 15 feet high. The new and repaired basins would be regulated by the State of Utah Dam Safety Program. Additional data regarding outlet pipes, tributary areas, 100-year peak flows and volume, and estimated earthwork quantity are found in an Alpha Engineering Technical Memorandum to NRCS and a Preliminary Hydrology Report (**Appendix E-5**). The BLM St. George Field Office personnel analyzed the potential impacts that would arise from soil testing activities associated with the proposed project. The resulting Categorial Exclusion environmental document is found in Appendix E.

Construction staging and access sites would be located primarily along existing roadways that would be easily accessed. Construction staging would occur within disturbed areas. The proposed detention basin areas would also be used for construction staging. Any excess soil or construction debris would be taken to an approved off-site permitted disposal location. All waste generated during construction would be properly disposed of in accordance with local, state, and federal regulations.

The hazard classification of all the detention basin dams is "high." The total population at risk is estimated to be 260 for Dammeron Valley and 488 for Diamond Valley, which is the maximum loss of life in the event of a dam failure (Appendix D).

5.4.2.1 Dammeron Valley

Dammeron Valley has four principal drainage areas. The three new detention basins (Dammeron Valley Detention Basins 1, 2, and 3) would be constructed in three of the drainage areas (**Figure 5-3**). Flow in the southernmost fourth drainage would be re-routed to an adjacent existing wash (**Figure 1.2**).15 Data specific to each proposed drainage basin is presented in **Table 5-1**. Earthwork quantities are estimated based on the existing grade surface. The design of the three detention basins would assume an average annual sediment yield of 0.5 acre-feet/mile. This value represents the upper value estimated using the Sediment Yield Classification Procedure which considered site-specific characteristics of the Dammeron Valley project drainage Basins (See **Appendix D** for details).

Figure 5-3. Proposed Dammeron Valley Detention Basin Site

As outlined in NRCS TR 210-60, the classes of dams are as follows: (1) Low Hazard Dams - Dams in rural or agricultural areas where failure may damage farm buildings, agricultural land, or township and country roads; (2) Significant Hazard Potential Dams - Dams in predominantly rural or agricultural areas where failure may damage isolated homes, main highways or minor railroads, or interrupt service of relatively important public utilities; and (3) High Hazard Potential Dams - Dams where failure may cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, main highways, or railroads. These dams are considered High Hazard Potential due to the close proximity to homes and damage that could occur to homes, roads, or infrastructure should the dams fail. The retention basins considered in this proposed action are High Hazard structures due to proximity to the infrastructure described above.

Table 5-1. Overview of the Basin Sites in Dammeron Valley

Detention Basins	Tributary Area	100-Year Peak Flow	100-Year Volume	Est. Earthwork Quantity
Dammeron 1 Detention Basin	182 acres	75 cfs	5 acre-feet	2,620 cubic yards
Dammeron 2 Detention Basin	2,286 acres	559 cfs	63 acre-feet	31,835 cubic yards
Dammeron 3 Detention Basin	470 acres	209 cfs	15 acre-feet	31,840 cubic yards

Each of the three proposed detention basins would be constructed with a low-level principal spillway conduit and an auxiliary open channel spillway. The spillway conduits and channels would be constructed on bedrock to reduce the potential for issues related to settlement and erosion. The outlet pipe would convey flows from each detention basin with a reduced inlet that would limit flows leaving each basin. The outlet pipe for Dammeron 1 detention basin would limit flows to 5 cfs, which would discharge into an existing open channel to convey the flow downstream. The combined outlet pipes for Dammeron 2 and 3 detention basins would limit flow to 25 cfs and connect downstream into a single discharge point. As outlined in NRCS TR 210-60, Part 6, the principal spillway capacity should empty at least 85 percent of the principal spillway hydrograph (PSH) routed through the retarding pool in 10 days or fewer. According to the Hydraulic and Freeboard Report, Santa Clara Watershed, prepared by Alpha Engineering (2022a**; Appendix E-4a**), Table 4 depicts the basins' uncontrolled low-level outlets flow, basin storage, and time to drain. Each of the basins is shown to drain to 90 percent of the storage volume in fewer than 10 days.

This flow would be conveyed downstream south of the Dammeron Valley community via an open channel (**Table 5-2**). The design of the basins would assume an average sediment yield of 0.5 acre-feet/mile (see **Appendix D** for a detailed analysis of sediment yields).

Table 5-2. Dammeron Valley Detention Basin Conveyance Geometry

Basin	Limited Flow	Open Channel	Culvert
Dammeron 1 Detention Basin[1]	5 cfs	2-foot depth, 1-foot base width, 2:1 banks	18 inches[1]
Dammeron 2 and 3 Detention Basins	25 cfs	3-foot depth, 2-foot base width, 2:1 banks	30 inches

Footnote for Table 5-2:

[1]Due to the constraints of the existing downstream drainage infrastructure, the principal spillway has been designed based on the downstream capacities. As outlined in NRCS TR210-60, page 6-5, "Designs using conduits with diameters less that than minimums described above must - 1) Provide trash racks designed to assure no debris will accumulate in the conduit. 2) Use the actual inside pipe dimension to develop the hydraulic performance characteristics of the principal spillway when establishing the auxiliary spillway crest

elevation described in part 7 of this TR. The above direction from TR210-60 has been met in this case allowing for conduit diameters less than the minimum, which in this case would normally be 30."

Flows from the fourth drainage area (Dammeron 4 Diversion Channel) would be conveyed by a 0.35-mile open channel to an adjacent existing drainage channel. Data for the fourth drainage area are shown in **Table 5-3**, including flows combined with the existing drainage channel.

Table 5-3. Dammeron 4 Existing Drainage Conveyance Data

Basin	Tributary Area	100-year Peak Flow	Open Channel	Culvert
Dammeron 4 Diversion Channel	1,104 acres	333 cfs	5-foot depth, 10-foot base width, 2:1 bank	Not Applicable
Dammeron 4 Diversion Channel, including existing drainage	2,404 acres	708 cfs	7-foot depth, 12-foot base width, 2:1 bank	(2) 72 inches

A toe drain would be included in each detention dam design. The toe drain would improve the safety of the dams by reducing the risk of saturation within the embankment and near-surface foundation materials (RB&G Engineering 2021). Armoring of the spillway channel would be required for the Dammeron 2 site. Depending upon the properties of the rock formations at the Dammeron 1 and 3 sites, armoring would not be required, but construction of auxiliary spillways would require excavation of rock materials. The installation cost for the Dammeron Valley portion of the project area would be approximately $7,796,690 (**Table 8-3**).

Based on the results of investigations performed for this proposed project and the intended use of the detention basins, no mitigation of liquefaction or other seismic hazards would be necessary at any of the detention dam sites (RB&G Engineering 2021).

A total of 70 acres of surface disturbance would result from construction of the three detention basins and drainage diversion. Approximately 12 months would be required to complete construction activities.

5.4.2.2 Diamond Valley

The Diamond Valley area includes four drainages. The existing Diamond Valley 1 Detention Basin would be repaired (**Figure 5-4**). This basin collects flows from three of the four Diamond Valley basins. Diamond Valley 2 and 3 Detention Basins are located upstream from Diamond Valley 1 and would also be repaired. Diamond Valley 2 collects flows from two drainages (Diamond Valley 2 and 3). Flow from the fourth and largest tributary drainage area is conveyed through the Diamond Valley community via the existing Rock Hollow Wash (Diamond Valley 4 Existing Channel) (**Appendix C**, **Photograph C-17**). Approximately 0.29 mile of this wash would be armored to better protect adjacent infrastructure (**Figure 5-5**). Details for the two detention basins to be repaired are presented in **Table 5-4** and **Table 5-5**. Details for the existing channel armoring are provided in **Table 5-6**. The installation cost for the Diamond Valley portion of the project area would be approximately $6,152,828 (**Table 8-3**).


Figure 5-4. Existing Detention Basin in Diamond Valley to be Repaired

Figure 5-5. Rock Hollow Wash in Diamond Valley

Table 5-4. Diamond Valley Basin Rehabilitation

Basin	Tributary Area	100-year Peak Flow	100-year Volume	Est. Earthwork Quantity
Diamond 1 Existing Detention Basin	575 acres	505 cfs	37 acre-feet	12,390 cubic yards (cut) 11,370 cubic yards (fill)
Diamond 2 Existing Detention Basin	597 acres	536 cfs	23 acre-feet	10,900 cubic yards (cut) 10,200 cubic yards (fill)

Table 5-5. Diamond Valley Basin Conveyance Geometry

Downstream Channel Outlet	Channel Existing Capacity	Channel Existing Geometry
Diamond 1 Existing Detention Basin	380 cfs	3-foot depth, 10-foot base width, 3:1 banks
Diamond 2 Existing Detention Basin	138 cfs	2-foot depth, 6-foot base width, 4:1 banks

Table 5-6. Diamond Valley Existing Channel Data

Existing Channel	100-year Peak Flow	Channel Existing Capacity	Channel Existing Geometry
Diamond 4 Existing Channel (Rock Hollow Wash)	2,214 cfs	3,704 cfs	12-foot depth, 10-foot base width, 1:1 banks

A total of 24 acres of surface disturbance would result from construction of the three detention basins and armoring of 0.29 mile of Red Hollow Wash. Approximately 12 months would be required to complete construction activities.

Earthwork quantities are estimated based on the existing grade surface. The design of the Diamond Valley detention basins would assume an average annual sediment yield of 0.25 acre-feet/mile (see **Appendix D** for a detailed analysis of sediment yields).

5.4.2.3 Shivwits Area

The Santa Clara River runs through the Shivwits portion of the project area and is experiencing streambank erosion due to flooding and the migrating path of the river. Additionally, two historic armored stormwater drainage ditches traverse the historic agricultural area and have been damaged due to flooding. The erosion resulting from the damaged ditches is cutting into the field (**Appendix C**, **Photographs C-6** through **C-9**). The fallow agricultural field is approximately 30 acres in size and adjacent to the Santa Clara River (**Figure 5-6).**

Figure 5-6. Agriculture Field with Santa Clara River in Background

Site development would include armoring approximately 0.53 mile of the southwest bank of the Santa Clara River to prevent further streambank erosion. The armoring would consist of the construction of a trench excavated to a depth below the anticipated scour elevation. The trench would be filled with rock armoring sized for the expected stream velocities and covered with geotextile and topsoil. This method would eliminate any disturbance within the OHWM and reduce potential impact to the adjacent riparian area. Figure 5-6 depicts a typical armoring structure that would be used.

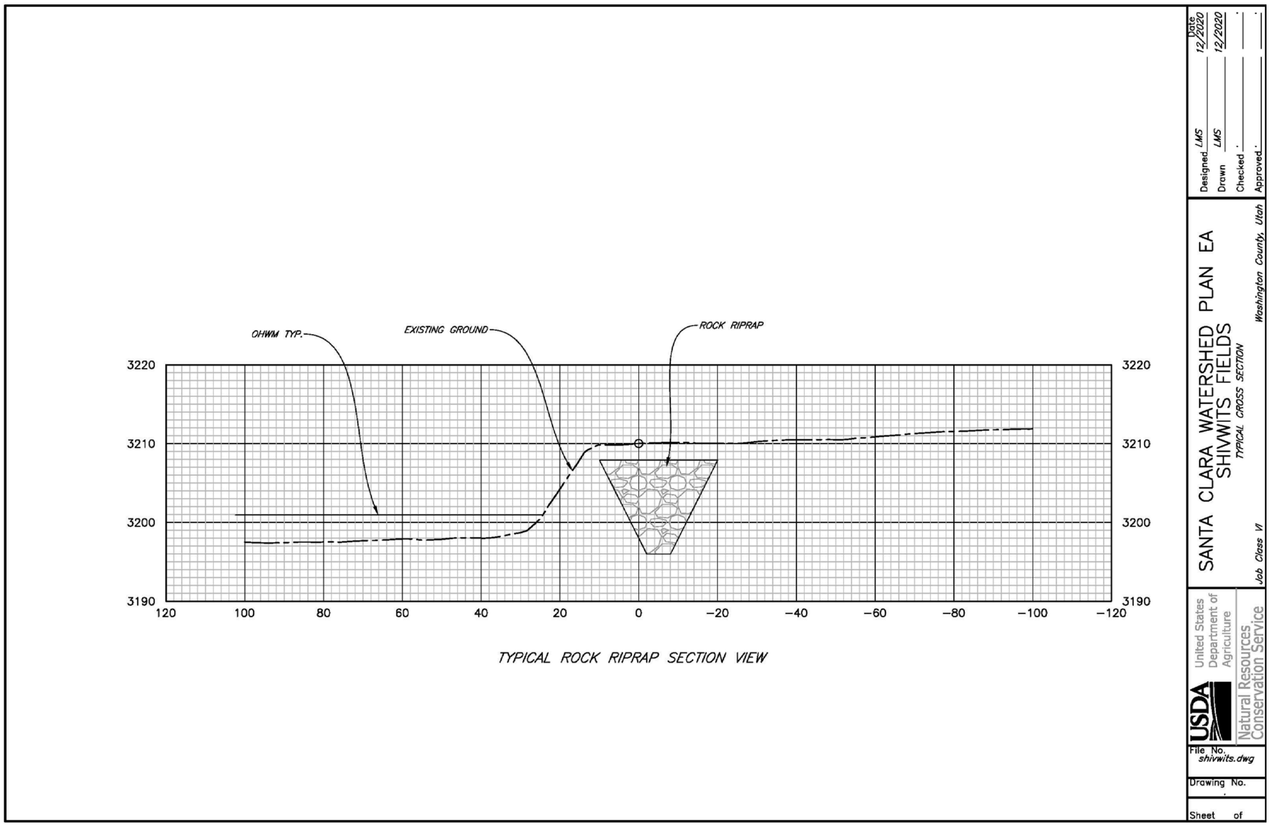

Figure 5-7. Typical Erosion Control Armoring Structure

Approximately 1.05 miles of 8-inch pipeline would be installed to irrigate the agricultural lands. The pipeline would be installed aboveground, cross the Santa Clara River by being attached to the bridge located at the northern end of the Shivwits area, and then run adjacent to Gunlock Road and Old Highway 91 to the southwest part of the area where it would access the agricultural site. Approximately 0.2 mile of the 2 existing historic stormwater drainage ditches would be repaired and re-armored. A box culvert vehicle crossing would be installed in one of the two existing artificial ditches (**Figure 1-4**). Approximately 30 acres of existing agricultural lands would be leveled to improve agriculture opportunities (**Appendix C**, **Photograph C-18**).

The project area would be accessed via existing roadways. No new access roads would be required. Construction activities and staging would stay entirely within currently disturbed areas. Any excess soil or construction debris would be taken to an off-site permitted disposal location. Any waste generated during construction would be properly disposed of in accordance with local, state, and federal regulations. The installation cost for the Shivwits portion of the project area would be approximately $1,012,400 (**Table 8-3**).

A total of 33 acres of surface disturbance would result from armoring installation, stormwater drainage ditch repair, irrigation pipeline installation (3 acres), and leveling of the agriculture field (30 acres) for future use. Approximately 7 months would be required to complete these activities. These 7 months would be embedded within the overall 12-month project development period. Additional details are provided in **Appendix D**.

5.5 Measures to Be Installed

Applicant committed environmental mitigation and protection measures including BMPS are discussed in detail in **Section 8.2**. These measures were developed to avoid or reduce potential adverse impacts that would result from project activities. These measures are incorporated as an integrated part of the Proposed Action. The measures are based on BMPs and standard operating procedures that have been employed and proven effective in similar circumstances and conditions.

5.6 National Economic Efficiency Alternative

The NEE Alternative is the alternative or combination of alternatives that reasonably maximizes the net economic benefit of the project consistent with protecting the nation's environment. The net economic benefit is the benefit attributed to the project minus the costs of the project. According to the NWPM Sections 502.2 and 505.35.b(1)(iv), when human life is potentially at risk, the NEE Alternative is defined as the federally assisted alternative with the greatest net economic benefits. For this action, the NEE Alternative is the Action Alternative.

5.7 Principles, Requirements, and Guidelines Analysis

Probable costs and an economic analysis are provided in the Economic Investigation Analysis Report (Gordon 2025) (**Appendix E**). Additional details on the PR&G analysis, trade-offs between alternatives, and risk and uncertainty are provided in the PR&G Report in Alternative E. Alternative trade-offs and ecosystem services are summarized in **Table 4-7**.

Table 5-7. PR&G Analysis Summary Trade-Off Table

Alternatives	No Action	Proposed Action
Optimizing Criteria: Locally Preferred	–	X
Optimizing Criteria: Environmentally Preferable	–	X
Optimizing Criteria: Non-structural	X	–
Optimizing Criteria: National Economic Efficiency	–	X
Guiding Principles: Healthy and Resilient Ecosystems	–	X
Guiding Principles: Sustainable Economic Development	–	X
Guiding Principles: Floodplains	–	X
Guiding Principles: Public Safety	–	X
Guiding Principles: Watershed Approach	–	X
Evaluation Framework (Ecosystem Services): **Provisioning Services**—Tangible goods provided for direct human use and consumption, such as food, fiber, water, timber, or biomass.	-	-

Alternatives	**No Action**	**Proposed Action**
Evaluation Framework (Ecosystem Services): Agriculture	Agricultural-related losses on approximately 4 acres of agricultural land in Dammeron Valley would continue due to flooding. Lack of water access and continued erosion would prohibit agricultural development on approximately 30 acres at the Shivwits site.	Agricultural-related losses in Dammeron Valley would be reduced. Water would be available for agricultural development at the Shivwits site. These actions would result in an increase of agriculture production.
Evaluation Framework (Ecosystem Services): **Regulating Services**—Maintain a world in which it is possible for people to live, providing critical benefits that buffer against environmental catastrophe. Examples include flood and disease control, water filtration, climate stabilization, or crop pollination.	-	-
Evaluation Framework (Ecosystem Services): Rural flood damage	Continued risk of substantial flood damage to infrastructure and agriculture in and around Dammeron Valley and Diamond Valley.	Reduced risk of flood damage to infrastructure and agriculture in and around Dammeron Valley and Diamond Valley.

Alternatives	No Action	Proposed Action
Evaluation Framework (Ecosystem Services): **Supporting Services**—Underlying processes maintaining conditions for life on Earth, including nutrient cycling, soil formation, and primary production.	-	-
Evaluation Framework (Ecosystem Services): Agricultural production	Approximately 30 acres of historic agricultural land on the Shivwits site would continue to not be available for agricultural use by the Tribe. Agricultural losses on approximately 4 acres of existing agricultural land in Dammeron Valley due to flooding would continue.	Historic agricultural land on the Shivwits site would be available for agricultural use by the Tribe. Agricultural losses due to flooding in the Dammeron Valley would be reduced.
Evaluation Framework (Ecosystem Services): **Cultural Services—**Make the world a place people want to live (recreational use, spiritual, aesthetic viewshed, or Tribal values).	-	-
Evaluation Framework (Ecosystem Services): Cultural/Historical Identity and Heritage	Tribal cultural use of land continues to be impacted by lack of water and erosional losses due to flooding.	Tribal traditional ecological knowledge, ceremonial use, and cultural continuity enhanced by irrigation improvements and erosion control of banks.

5.8 Summary and Comparison of Alternative Plans

The alternatives proposed for consideration and analyzed in detail in this Plan-EA have been compared against each other to discern the merits and disadvantages of each alternative. This comparison of environmental, social, and economic effects is summarized in **Table 5-8**.

Table 5-8. Resource Concerns—No Action/Action Alternative

Resource Concern	No Action Alternative	Santa Clara Watershed Project (Action Alternative)
Soils	No effects would occur from construction activities; however, damaging floods would continue at all three sites in the project area, resulting in continued soil loss.	Approximately 127 acres of surface disturbance would occur during construction activities. Conservation measures and BMPs would be implemented to reduce potential soil erosion. Long-term, the potential of soil-removing floods would be reduced. Crop production would be protected.
WOTUS	No effects would occur from construction activities; however, continued severe flooding would alter and potentially damage the Santa Clara River.	Surface disturbance resulting from project development could affect the Santa Clara River in the short term. Armoring the banks of the Santa Clara River would help protect a short stretch (approximately 0.53 mile) of that riverine ecosystem. No impacts to any WOTUS values would occur beyond the Santa Clara River.
Riparian Areas	No effects would occur from construction activities; however, riparian vegetation along the Santa Clara River would continue to be damaged by streambank erosion resulting from severe flooding.	Armoring the banks of the Santa Clara River would help protect the riparian area along a 0.53-mile stretch of the river. A small wetland located in the Shivwits portion of the project area would not be impacted.
Floodplain Management	No effects would occur from construction activities; however, the floodplain within the Shivwits site would continue to be damaged by severe flooding and erosion. Periodic severe flooding would continue in Dammeron Valley and Diamond Valley.	Floodplain management in the watershed would improve. Armoring the bank of the Santa Clara River would help protect approximately 60 acres of adjoining floodplain (30 acres of which would be used for Tribal agriculture). Repair of the stormwater ditches and irrigation pipeline would also allow for the area to be returned to agriculture activity. Severe flooding potential in Dammeron Valley and Diamond Valley would be reduced.
Air Quality	No effect	An undetermined amount of fugitive dust and other emissions would result during the anticipated 12-month construction period from equipment accessing the proposed detention basin sites located within Dammeron Valley and Diamond

Resource Concern	No Action Alternative	Santa Clara Watershed Project (Action Alternative)
		Valley. Associated activities at the Shivwits site could also produce an undetermined amount of emissions and fugitive dust. Action Alternative development would include the implementation of conservation measures and BMPs that would ensure that construction activities would not violate air quality standards.
USFWS-Designated Threatened, Endangered, and Candidate Species	No effects would occur from construction activities; however, riparian vegetation loss could continue to occur in the Shivwits portion of the project area due to stream bank erosion. This could compromise potential southwestern willow flycatcher habitat on approximately 0.53 mile. This potential impact would be negligible in scope due to limited habitat present.	Three listed plant species and two listed animal species were identified as potentially occurring within the Shivwits portion of the project area or within the surrounding 300-foot buffer. One candidate insect species was also identified as potentially occurring within the overall project area. Surveys did not locate any listed or candidate species within the project area. Implementation of applicant-committed BMPs would mitigate any potential effects to any listed species.
Vegetation (excluding USFWS-designated species)	No effects would occur due to construction activities; however, some minor but an undetermined amount of vegetation loss would occur resulting from continued severe flooding.	Construction activities would result in the disturbance of approximately 127 acres of native plant species' habitat. Anthropogenic related actions have disturbed much of this area. Applicant-committed conservation measures and BMPs would help reclaim disturbed areas. Abundant habitat exists adjacent to the project area, and project implementation would not result in significant loss of native vegetation habitat availability/quality.

Resource Concern	No Action Alternative	Santa Clara Watershed Project (Action Alternative)
Noxious Weeds and Invasive Plant Species	No effects would occur due to construction activities; however, noxious weeds and invasive plant species would continue to dominate the floodplain in the Shivwits area and other disturbed sites within the project area.	Construction activities would expose disturbed areas to some invasive growth. Conservation measures and BMPs would be implemented to minimize the spread of invasive plants, including the reseeding of disturbed areas per NRCS and BLM guidelines.
Fish and Wildlife (excluding USFWS-designated species)	No effect would occur due to construction activities; however, habitat could be lost due to continued flooding and erosion.	Increased noise and human presence during the approximately 12-month construction period could force some wildlife from the area. Abundant habitat exists adjacent to the project area, and project implementation would not result in significant loss of individual species or habitat availability/quality. Armoring the Santa Clara River would help preserve approximately 0.53 mile of riparian habitat. Because armoring would be installed above the OHWM, aquatic species within the river should not be impacted.
Migratory Birds/Bald and Golden Eagles	No effect would occur due to construction activities; however, habitat could be lost due to continued flooding and erosion.	Construction activities may disturb migratory bird and eagle habitat in the short term. Conservation measures and BMPs would be implemented to minimize any direct impacts to the species. However, if construction activities become necessary during the general migratory bird breeding/nesting season (April through August), nest abandonment and loss of young within the project area could result. Abundant foraging habitat (sagebrush, scrub, agricultural fields, etc.) exists in the vicinity of the proposed project area. No reduction of overall available foraging habitat is anticipated.
Human Environment: Social Issues	No effects would result from construction activities; however, damage to human infrastructure in	Project development would improve local socioeconomic conditions by an undetermined amount by reducing the potential for destructive floods in Dammeron Valley and Diamond Valley and

Resource Concern	No Action Alternative	Santa Clara Watershed Project (Action Alternative)
	Dammeron Valley and Diamond Valley and continued loss of potential agriculture benefits in the Shivwits portion of the project area would continue due to flooding and erosion.	by providing opportunity for agriculture in the Shivwits portion of the project. Human safety would be improved.
Human Environment: Historic Properties/Cultural Resources/Native American Religious Concerns	No effects would occur due to construction activities; however, flooding and erosion would continue to damage the historic stormwater drainage ditches (components of 42WS6521 and 42WS6523) in the Shivwits portion of the project area. The lack of a functioning pipeline and continued erosion in the historic agricultural field would continue to render this area unsuitable for agricultural use.	Based on the results of two Class III cultural resource surveys, the project would result in No Adverse Effects to historic properties. No adverse Native American religious concerns were identified by Tribes during consultation, pursuant to Executive Order 13007, 13175, and the American Indian Religious Freedom Act. This site is of historic, cultural, and ceremonial importance to the Tribe and they are supportive of the project. The Action Alternative would benefit the 30-acre historic agricultural field at the Shivwits Site and provide traditional knowledge and cultural traditions opportunities for the Tribe.
Human Environment: Hazardous Materials	No effect.	A remote potential exists for short-term effects resulting from the accidental release of hazardous materials associated with construction equipment. BMPs and federal, state, and local laws and regulations pertaining to pollution and contamination of the environment would be implemented. No hazardous materials sites are found within or near the project area.
Human Environment: Noise	No effect.	Construction activities would have a short-term, temporary noise impact, especially in the communities of Dammeron Valley and Diamond Valley. The effects would be minimal by the anticipated short duration 12-month of construction and implementation of BMPs.

Resource Concern	No Action Alternative	Santa Clara Watershed Project (Action Alternative)
Human Environment: Public Health and Safety	No effects would result from construction activities; however, occasional severe flooding would continue to harm human infrastructure, including homes and other buildings.	Development of the detention basins would reduce the potential for damage to human infrastructure and the potential for loss of life.

Table 5-9. Installation Costs—No Action/Action Alternative

Item	No Action Alternative	Santa Clara Watershed Project (Action Alternative)
Construction cost	$0	$13,079,995
Other costs	$0	$363,875
Total project cost (Installation cost)	$0	$14,987,418
Cost sharing (NRCS)	$0	$14,987,418
Cost sharing (SLO)	$0	$0

Table 5-10. NEE Account—No Action/Action Alternative

Item	No Action Alternative	Santa Clara Watershed Project (Action Alternative)
Average annual installation cost	$0	$541,600
Annual O&M cost	$20,000	$703,742
Total annual cost	$20,000	$841,134
Total annual benefit	$0	$3,747,048
Annual net economic benefit	$0	$3,043,306
Benefit-cost ratio	0.0	4.26

6.0 Environmental Consequences

6.1 Introduction

The NRCS has a responsibility under NEPA to identify and analyze potential effects on the human environment that may result from implementation of the alternative plans. This Plan-EA analyzes a No Action and Action Alternative. This section discusses the potential effects of implementation of each of the alternatives on the resources described in **Section 4.0**.

The following describes the types of effects and impact analysis used in this section (NRCS 2015):

- Direct Effect: Impacts caused by implementation of an Action Alternative that would occur at the same time and place

- Indirect Effect: Impacts caused by an action that are later in time, or farther removed in distance, but are still reasonably foreseeable

- Cumulative Effect: The impact on the environment that would result from the incremental impact of implementation of the Action Alternative when added to other past, present, and reasonably foreseeable future actions regardless of the agency (federal or non-federal) or person undertaking such other action. Duration of impacts is considered as follows: Short-term impacts would not occur beyond the anticipated 12-month construction period

- Long-term impacts would extend for the anticipated 50-year duration of the project and until successful reclamation has occurred

- Temporary impacts are impacts that are not lasting and will allow the affected resource to return or be restored to its previous (pre-project) state

Permanent impacts are those in which the affected resource will not return to its previous state within one's lifetime. The spatial definition for the cumulative effects includes Washington County, particularly the area around Dammeron Valley, Diamond Valley, and adjacent Shivwits lands.

The intensity of impacts are defined as follows:

- Negligible: The impact is the lowest level of detection. No noticeable changes to the resource would occur, and any impacts would be at or below the level of detection. If detected, the impacts would be considered slight. For adverse impacts, mitigation measures would not be necessary

- Minor: The impact is slight but detectable. Changes to the resource would be measurable, although the changes would be small and localized. For negative impacts, mitigation measures would not be necessary

- Moderate: The impact is readily apparent. Changes to the impacted resource would be measurable, may have appreciable consequences, and would be noticeable. For negative impacts, mitigation measures may be necessary

- Substantial: A large, measurable effect to the resource from the alternative actions. Mitigation measures would be needed to offset adverse effects and could be extensive and complicated to implement

6.2 Soils

See **Section 4.1** for a discussion of existing soils within the project area.

6.2.1 No Action Alternative

No effects beyond those currently occurring within the project area would result from the implementation of the No Action Alternative. The project area would continue to be subject to occasional severe flooding. These floods would continue to damage the local human infrastructure, including homes and other buildings, agriculture fields, and the riparian area along the Santa Clara River. In the Diamond Valley site, this issue would be exacerbated because many of the existing detention basins have limited functionality and need repair. The project area would continue to experience sheet, rill, and gully erosion resulting from these flash floods on approximately 57 acres within Dammeron and Diamond valleys. Approximately 63 acres would continue to be susceptible to flooding and erosion in the Shivwits area. An undetermined amount of sediment would also continue to be deposited into the river resulting from flood events.

6.2.2 Action Alternative

Construction or repair of the six detention basins at the Dammeron Valley and Diamond Valley sites would result in approximately 94 acres of surface disturbance during the 12-month construction period. Soil loss would be primarily in the form of fugitive dust, particularly during windy days or from high-precipitation events. The application of the applicant-committed conservation and protection measures and BMPs identified in **Section 8.2** would reduce, but not completely eliminate, this potential soil loss. The project area receives limited rain during the summer months; therefore, any revegetation efforts that would reduce potential soil loss would likely require several growing seasons to be fully successful. Once the detention basins are completed or stabilized, any long-term soil loss would be further reduced. Therefore, while the overall amount of soil loss would be undetermined, due to the limited amount of surface disturbance and the implementation of applicant-committed conservation measures, the loss would be localized and negligible.

Installation or repair of the six detention basins would reduce the potential for severe erosional flooding or sediment deposition in local agriculture fields on approximately 57 acres. This would result in an undetermined reduction of potential loss of agriculture crops.

Approximately 33 acres of surface disturbance would result from project installation in the Shivwits portion of the project area. Repair of the two stormwater drainage ditches and pipeline and riprap installation would disturb approximately 3 acres of land surface. Approximately 30 acres of the adjoining floodplain would be disturbed due to land leveling and renewed agricultural use. These activities would generally occur in areas that have been used for roads, agriculture, and other human-related activities for several years. No pristine areas would be affected. Riprap installation would be installed in areas disturbed by severe flooding and would help hold stream bank soil in place on approximately 0.53 mile. This installation would occur along a bend in the river that is eroding into the adjoining floodplain. Repair of the two stormwater drainage ditches (approximately 0.2 mile) and seeding of the agriculture area would also result in a reduction of soil loss. Successful installation of the armoring, repair of the two stormwater drainage ditches, and seeding would reduce soil loss on approximately 60 acres of the adjoining floodplain (30 acres of which would be used for agriculture). As a result, soil loss from construction and seeding activities at this site would be negligible.

Because various land uses and occasional flooding have disturbed the majority of the three sites within the project area, development of a biological crust in the area is limited. Therefore, loss of biological crusts resulting from implementation of the Action Alternative would be negligible.

6.3 WOTUS

See **Section 4.2** for a discussion of existing WOTUS resources located within the project area.

6.3.1 No Action Alternative

Implementation of the No Action Alternative would not have any impact on existing WOTUS values (Santa Clara River) located within the project area beyond that already occurring due to flooding events. Severe flooding could continue to damage the river in the Shivwits area by depositing sediment and other materials and eroding the riverbank. These effects would be localized and confined to the project area. No WOTUS values are present in the Dammeron and Diamond Valley portions of the project area. Implementation of the No Action Alternative would not affect ecosystem services associated with WOTUS.

6.3.2 Action Alternative

The Santa Clara River is the only WOTUS located within the project area. The only construction activity proposed for this site would be the armoring of approximately 0.53 mile of the Santa Clara River. Construction and repair of the six detention basins would reduce the amount of floodwater carried by the washes by an undetermined amount, thus potentially reducing erosion and the amount of sediment and other material entering the Santa Clara River that could affect river water quality, especially during flood events. The riprap along the Santa Clara River would be installed above the OHWM and disturb approximately 1.5 acres. In the long-term, armoring would result in stream bank stabilization and reduce erosion sediment and other material movement. The extent of this protection would be localized and not extend beyond the armoring installation areas.

Implementation of applicant-committed mitigation and conservation measures and BMPs would reduce potential impacts and result in negligible effects to the river. Impacts may include short-term increases in sediment load in surface water during the 12-month construction period. Water quality and quantity in the Santa Clara River would be improved by an undetermined but minor amount due to the short length of the armoring (0.53 mile).

Because armoring along the Santa Clara River would be installed outside of the OHWM, any adverse effects to any WOTUS resource would be limited.

6.4 Riparian Areas

See **Section 4.3** for a discussion of riparian values located within the project area.

6.4.1 No Action Alternative

Erosion of the Santa Clara River streambank would continue to occur from severe flooding events along the bend in the river located within the project area. The potential for riparian zone stabilization and protection would be foregone on approximately 0.53 mile. No riparian vegetation exists within the Dammeron Valley and Diamond Valley portions of the project area.

A small wetland (less than 0.5 acre) is located within the project area near the Santa Clara River. It would not be affected by implementation of the No Action Alternative.

6.4.2 Action Alternative

Less than 0.5 acre of riparian habitat would be disturbed resulting from installation of 0.53 mile of riprap along the Santa Clara River. This vegetation loss would be short term until riparian vegetation becomes re-established. Long-term benefits to the riparian corridor health would be anticipated, as the armoring would protect the riparian area from further erosion. While the extent of this protection would be limited to the 0.53 mile of riparian habitat, it would be important, as it would be installed at a bend in the river where streambank erosion is occurring. No riparian areas are located within the Dammeron Valley and Diamond Valley portions of the project area; therefore, construction work in these two areas would not affect any riparian or wetland values.

A small wetland (less than 0.5 acre) near the Santa Clara River is located outside of any areas that would be disturbed resulting from project development and would not be affected by implementation of the Action Alternative.

Implementation of the Action Alternative would improve WOTUS–related ecosystem services in the following ways:

- Provisioning services—water from the Santa Clara River would be made available to historic Tribal agricultural land (approximately 30 acres) through the repair of the pipeline accessing the field. Erosional damage to the field would be reduced by the repair of the two drainage ditches and the armoring of the south bank of the river.

- Cultural services—the land surrounding the Santa Clara River, including the agricultural field, has religious, cultural, and historic Tribal values. These values would be better managed by the availability of water to the agricultural field and reduction of erosion from the river-related and overland erosion through the installation of the armoring and the repair of the drainage ditches.

- Cultural services—the Santa Clara River would continue to provide habitat for aquatic and riparian species as well as aesthetic value on Tribal lands in an otherwise arid environment.

- Regulating services—repair of the Diamond Valley detention basins and channel would help protect the community from continuing catastrophic flood damage. Construction of the new detention basins in Dammeron Valley would help protect that community from continued catastrophic flooding.

6.5 Floodplain Management

See **Section 4.4** for a discussion of floodplain management within the project area.

6.5.1 No Action Alternative

Implementation of the No Action Alternative would not change current floodplain management within the Shivwits portion of the project area. However, the approximately 63-acre floodplain adjacent to the Santa Clara River would continue to be eroded by periodic severe flooding of the river and from the two inoperable drainage ditches. No designated floodplains are located within the Dammeron Valley and Diamond Valley portions of the project area. However, periodic severe flooding would continue in these areas, potentially damaging existing infrastructure and up to 4 acres of agricultural land. Other infrastructure, including State Highway 18, residential roads, culverts, etc. would continue to be subject to damaging floods. Implementation of the No Action Alternative would not change existing ecosystem services associated with floodplain management.

6.5.2 Action Alternative

Implementation of the Action Alternative would improve floodplain management within the project area portion of the watershed. Increased protection of 0.53 mile of FEMA Zone A floodplain located adjacent to the Santa Clara River in the Shivwits portion of the project area would result in less erosion along the river. The adjacent floodplain has also eroded over time due to periodic severe flooding from the river and from the two nonfunctioning drainage ditches. The installation of 0.53 mile of armoring along a bend in the river and repair of the drainage ditches would reduce the potential for continued streambank erosion and loss of adjoining floodplain. Protection of the 63-acre floodplain would provide the opportunity for historic Tribal agriculture to be restored to approximately 30 acres of the area. Repair of approximately 0.2 mile of stormwater drainage ditches in the Shivwits area would also reduce erosion of the floodplain.

Although not located within a designated floodplain hazard zone (FEMA 2021), the Dammeron Valley and Diamond Valley areas are subject to occasional, sometimes severe flooding (see discussion in **Section 1.0** and **photographs** in **Appendix C**). These flood events, while often short in duration, can result in the movement of substantial sediment. Local sheet, rill, and gully erosion and damage to human infrastructure result. Damage to local infrastructure has occurred from past floods (See Appendix C). Construction and repair of six detention basins in the area would reduce the significance of flooding within this area and reduce the potential for crop loss and damage to human infrastructure. Approximately 748 people, 69 homes, 4 acres of agricultural land, and roads and highways would benefit from the increased protection from a 100-year storm event. State Highway 18 and local residential roads and culverts would receive additional protection.

The capacity of the detention basins and channels would be based on the 100-year storm event and incorporate a low-level outlet at the base elevation of the individual dams. The low-level outlet peak flows would be designed based on downstream capacities of existing drainage infrastructure and in coordination with Washington County (Alpha 2022a). Principal spillways for each detention basin will be used to safely convey large storm events without causing damage to the dam structures (Alpha 2022b).

Implementation of the Action Alternative would comply with and support the Washington County Flood Control Ordinance by reducing the potential for damaging flooding, and it would improve human safety within the flood inundation areas (Washington County 2004).

6.5.2.1 Ecosystem Services

Floodplain management-related ecosystem services would be enhanced as follows:

- Provisioning services—the use of the agricultural field resulting from implementation of the Action Alternative would provide an additional source of locally provided food for Tribal members.

6.5.2.2 Air Quality

See **Section 4.5** for a discussion of air quality located within the project area.

6.5.3 No Action Alternative

Implementation of the No Action Alternative would not have any direct or indirect impacts to existing air quality within the project area. Continued anticipated flooding events would not affect air quality within the project area.

6.5.4 Action Alternative

Construction activities would temporarily emit several air pollutants, including PM10 (particulate matter) emissions. Other pollutants PM2.5 (fine particulate matter), carbon monoxide, sulfur oxides, nitrous oxides, mobile source air toxics, and greenhouse gases would be generated from heavy-duty diesel engines used by the construction equipment. Localized fugitive dust would result from on-site construction activities and from equipment accessing or leaving the project area. This effect would be short-term in duration and would not extend beyond the anticipated 12-month construction period. Implementation of the applicant-committed conservation and protection measures and BMPs identified in **Section 8.2** would reduce but not completely eliminate fugitive dust. Emissions from trucks and construction equipment powered by heavy-duty diesel engines would be temporary and concentrated around the construction sites. No long-term, operational-related effects to local air quality would occur beyond the 12-month construction period. It is not expected that construction activities would violate any ambient air quality standards, contribute to a potential air quality violation, or expose sensitive species or humans to concentrated pollutants. Implementation of the proposed project would adhere to all applicable federal, state, or local air quality standards. Therefore, any localized, short-term effects to air quality would be negligible.

6.6 U.S. Fish and Wildlife Service-Designated Threatened, Endangered, and Candidate Species

See **Section 4.6** for a discussion of listed threatened, endangered, and candidate species that potentially occur within the project area.

6.6.1 No Action Alternative

Implementation of the No Action Alternative would not have any direct or indirect impacts on USFWS-designated threatened, endangered, or candidate plant and animal species found within or near the project area. Periodic severe flooding would continue along the Santa Clara River, potentially damaging approximately 0.53 mile of riparian habitat. No threatened or endangered species or their habitat is located within the Dammeron Valley or Diamond Valley portions of the project area.

6.6.2 Action Alternative

Implementation of the Action Alternative would result in the temporary disturbance of less than 0.5 acre of potential southwestern willow flycatcher riparian habitat during the 7-month construction period. If a pre-construction survey identifies potential nests, construction activities would be scheduled to avoid the flycatcher breeding/nesting season (April 15 through August 31). Because construction activities would occur outside of the breeding/nesting season, indirect effects such as noise would not impact the flycatcher. Additionally, potential flycatcher habitat within the project area is marginal due to the limited and spotty nature of the riparian vegetation located along this portion of the Santa Clara River; therefore, project construction/maintenance activity would result in negligible adverse effects to the flycatcher or its habitat. Implementation of applicant-committed environmental protection measures discussed in **Section 8.2** would further reduce any potential impact to the species.

For the long-term, installation of armoring would stabilize the stream bank and associated riparian vegetation on 0.53 mile. This would help maintain potential habitat for the flycatcher. However, this would be minor in scope, as stabilization would be limited to less than 0.5 acre of riparian habitat.

Protocol-level surveys of the Shivwits portion of the project area did not locate the presence of any desert tortoise, dwarf bear-claw poppy, Holmgren milkvetch, or Shivwits milkvetch species or their habitat. Any potential habitat for these species within the Shivwits site has been compromised due to land surface disturbance resulting from flooding, road development, and past agriculture-related activities. Therefore, no direct impacts to these species would occur. Potential habitat for all four species is found within the 300-foot buffer surrounding the Shivwits site. Implementation of BMPs identified in **Section 8.2** would reduce any potential indirect impacts, such as dust. Therefore, no measurable impacts would occur to any of the listed species potentially occurring near the Shivwits site. As a result, a may affect but not likely to adversely affect determination has been made for these species. The USFWS has concurred with this determination (USFWS 2022).

The candidate species, monarch butterfly, may pass through the project area. No milkweed habitat has been observed within the area, and no loss of butterfly habitat is anticipated. Therefore, project implementation would not jeopardize the continued existence of the butterfly.

No federally-listed or candidate species or their habitat is present within the Dammeron Valley and Diamond Valley sites; therefore, project development at these two sites would have no effect on any of the species or their habitat.

6.7 Vegetation (Excluding U.S. Fish and Wildlife Service-Designated Species)

See **Section 4.7** for a discussion of native vegetation that potentially occurs within the project area.

6.7.1 No Action Alternative

Implementation of the No Action Alternative would not have any impacts on non-listed native plant species within the project area beyond that already occurring. Periodic severe flooding would continue to potentially damage native plant species communities.

6.7.2 Action Alternative

Implementation of the proposed project would result in the direct surface disturbance of approximately 127 acres of vegetation. The majority of this disturbance would occur in areas already altered due to flooding and human-related activity such as agriculture and residential development. Still, construction activities would result in the removal of some native vegetation. Native vegetation that would be lost would include sagebrush, rabbitbrush, mixed pinyon-juniper woodland, saltbush, winterfat, and other desert shrub-type vegetation as described in **Section 4.7**. These species are common to southern Utah. Therefore, disturbance of approximately 127 acres and the implementation of applicant-committed conservation measures would result in a negligible loss of native vegetation and would not affect the overall vitality of any of the individual species. Because disturbance areas would be reclaimed and re-vegetated following construction, any native vegetation loss would not be long term.

The potential exists that the BLM-sensitive plant species Virgin thistle may occur within the Shivwits portion of the project area (Wheeler 2021). The Dammeron Valley and Diamond Valley sites are not considered to be Virgin thistle habitat, as the species is generally restricted to hanging gardens in sandstone cliffs, saline seeps, and stream terraces (Welsh et al. 2008). No surveys have been conducted specifically for this species. However, due to the limited extent of projected surface disturbance (33 acres) within the Shivwits portion of the project area and because the majority of the disturbance would occur in areas already modified by flooding and human activity, it is unlikely that Virgin thistle would be affected by project implementation. The remaining 10 BLM-sensitive plant species found in Washington County have not been identified within the project area (UNHP 2021; Wheeler 2021).

6.8 Noxious Weeds and Invasive Species

See **Section 4.8** for a discussion of noxious weeds and invasive plant species that potentially occur within the project area.

6.8.1 No Action Alternative

Implementation of the No Action Alternative would not impact noxious weeds and invasive plant species within the project area. Noxious weeds and invasive plant species would continue to become established on areas disturbed by severe flooding.

6.8.2 Action Alternative

The majority of the surface area within the project area has been disturbed, and noxious weeds and invasive plant species are already present. Therefore, construction activities in these areas would not significantly contribute to the spread of these species in these areas. Overall, implementation of the Action Alternative would result in approximately 127 acres of surface disturbance resulting from construction activities. These areas would continue to be susceptible to noxious weed and invasive plant species invasion and establishment. BMPs identified in **Section 8.2** would be implemented during and following construction to reduce the spread of noxious weeds/invasive plant species. Non-desirable plant species establishment would be managed by cleaning equipment prior to delivery to the project site, reseeding disturbed areas with native plant species, and routine monitoring after construction completion. Construction and restoration sites would be maintained on a regular basis to prevent the establishment of these species. Due to limited amount surface disturbance (approximately 127 acres) and implementation of BMPs, potential impacts would be minimal.

6.9 Fish and Wildlife (Excluding U.S. Fish and Wildlife Service-Designated Species)

See **Section 4.9** for a discussion of native fish and wildlife species that potentially occur within the project area.

6.9.1 No Action Alternative

Implementation of the No Action Alternative would not have any direct or indirect impacts on non-listed fish and wildlife species or their habitat located within the project area. Periodic intensive flooding would continue to alter wildlife habitat.

6.9.2 Action Alternative

Increased noise and human presence during the 12-month construction period (including a 7-month construction period in the Shivwits area) could force some wildlife as identified in **Section 4.9** from the project area. Abundant habitat exists adjacent to the project area, and project implementation would not result in significant loss of individual species or overall habitat availability and quality. Armoring the Santa Clara River would help preserve approximately 0.53 mile of riparian and aquatic species habitat. Because armoring would be installed above the OHWM, aquatic species within the river should not be affected during the anticipated 7-month construction period. Any potential noise or human-related impacts would be short-term and not extend beyond the 12-month construction period. Because only approximately 127 acres of surface disturbance would occur, any physical loss of habitat would be localized and minor in nature.

Approximately 20 BLM- and State-sensitive species as described in **Section 4.9** potentially occur within or near the project area. These species were identified in BLM environmental documents prepared for actions near the project area (BLM 2020). The UNHP Online Species Search Report identified 5 additional sensitive species that could occur within 2 miles of the project area, mostly within the Santa Clara River ecosystem (UNHP 2021). No surveys have been conducted specifically for this project. As discussed above for wildlife, any potential noise or human-related impacts would be short-term and would not extend beyond the 12-month construction period. Because limited surface disturbance would occur (approximately 127 acres), any physical loss of habitat would be localized and minor in nature. No alteration or disturbance of the Santa Clara River itself would occur; therefore, sensitive species found within the river ecosystem would not be harmed. The resulting stabilization of the system would benefit these species in the long term. No Action Alternative related actions would lead to the need to consider listing any of these sensitive species as threatened or endangered.

6.10 Migratory Bird Species/Bald and Golden Eagles

See **Section 4.10** for a discussion of migratory bird species and bald and golden eagles that potentially occur within the project area.

6.10.1 No Action Alternative

Implementation of the No Action Alternative would not have any direct or indirect impacts on migratory birds/bald and golden eagles that may occur within the project area.

6.10.2 Action Alternative

Access of the USFWS IPaC site identified the presence of six migratory bird species potentially occurring within the project area. Project construction may result in these migratory bird and eagle species being disturbed or displaced. No nests have been located within the project area. Because the amount of surface disturbance would be small and temporary (approximately 127 acres), it is not anticipated that a significant loss of habitat would occur, and the birds could disperse into abundant surrounding habitat. While disturbance and displacement impacts could occur during the 12-month construction period, these impacts would be minimized by implementation of BMPs (see **Section 8.2**) such as timing work outside of the breeding and nesting season and conducting nest surveys prior to initiation of work. As a result, development of the proposed project would be minor and localized.

Nest surveys would be required if the need arose for construction during the general migratory bird breeding/nesting season (April 15 through August 31). Construction during this time could result in abandonment and loss of young if occupied nests were present. This loss would be limited in scope (127 acres) and construction duration (12 months).

6.11 Social Issues

See **Section 4.11** for a discussion of the local socioeconomic status of the Dammeron Valley, Diamond Valley, and Shivwits sites within the project area.

6.11.1 No Action Alternative

Implementation of the No Action Alternative would not have any direct impacts on the existing socioeconomic status within the project area. However, costs and damages associated with continued flooding events would cause undetermined socioeconomic challenges in the long term. Agricultural development potential on 30 acres in the Shivwits area would be foregone. Implementation of the No Action Alternative would not change any existing ecosystem services associated with social issues.

6.11.2 Action Alternative

Installation and repair of six detention basins in the Dammeron Valley and Diamond Valley areas would result in a reduction of severe flooding episodes. As a result, loss or damage to agriculture (57 acres) and other human infrastructure would decrease. Agriculture production would increase, and financial losses from damage to homes and other structures would be reduced. These socioeconomic changes would be undetermined but would be local in scope and not extend beyond the boundaries of the project area.

Armoring the Santa Clara River, installing the pipeline, and repairing the drainage ditches would allow for the reintroduction of 30 acres of agriculture on approximately 60 acres of floodplain adjacent to the river. Use of this area for agriculture would provide an additional local but likely minor food source. This socioeconomic change would not extend beyond the boundaries of the project area. Refer to **Appendix D** for additional information regarding the cultural, social, environmental, and economic benefits of the reintroduction of 30 acres of agricultural land to the Shivwits.

Estimated annual net economic benefits are estimated at $3,043,306 (**Table S-3**; **Table 8-8**; Gordon 2025).

6.11.3 Ecosystem Services

As discussed in Section 4.11, the social and economic status of the project area is rural and primarily dependent on livestock grazing and agriculture. Social ecosystem services management would be enhanced as follows:

- Provisioning services—agricultural and livestock fields within the project area provide hay for animals and food for local consumption and would receive an increased level of protection from catastrophic flooding. The agricultural field in the Shivwits portion of the project area has not produced any provisioning services for several years due to erosion and damaged infrastructure preventing water from getting to the field. Repair of this infrastructure would allow the field to be once again used for agricultural purposes. Livestock grazing is a historic use in the area that occurs on private and public lands and provides a source of income for local residents. This ecosystem service would also receive a measure of additional protection from implementation of the Action Alternative.

- Supporting services—limited businesses, schools, fire, and medical services and facilities are located in the Dammeron Valley and Diamond Valley communities. They would receive an increased measure of protection from flooding from the repair or construction of the detention basins and channel.

6.12 Historic Properties/Cultural Resources/Native American Religious Concerns

See **Section 4.12** for a discussion of historic properties and cultural resources that potentially occur within the project area.

6.12.1 No Action Alternative

Implementation of the No Action Alternative would not have any direct impacts on any historic properties or cultural resources located within the Dammeron Valley and Diamond Valleys portions of the project area as no construction activities would occur. A literature review of the Breach Inundation Zone APE for Diamond and Dammeron Valley identified no historic architectural resources that would be affected by potential dam breaches. Continued flooding and streambank erosion along the portion of the Santa Clara River located within the project area would continue to damage the two NRHP–eligible historic stormwater drainage ditches (Sites 42WS6521 and 42WS6523) (**Appendix C**: **Photographs 6** and **7**). Implementation of the No Action Alternative would continue to render the agricultural field in the Shivwits portion of the project area unusable due to the lack of an operating pipeline. The Shivwits Tribe plans to reincorporate this field into their cultural practices, which would be difficult with no pipeline installation. Implementation of the No Action alternative would not change existing ecosystem services associated with floodplain management.

6.12.2 Action Alternative

Project implementation would adversely affect a historic property if it alters any characteristic that qualifies the property for NRHP inclusion. As outlined in 36 CFR 800.5, factors considered in determining whether a proposed project would have adverse effects to historic properties include the extent or degree to which its implementation would result in:

1) Damage to, or loss of, a site of archaeological, tribal, or historical value that is listed, or eligible for listing, in the NRHP;

2) Loss or degradation of a TCP or sacred site, or if the property or site is made inaccessible for future use;

3) Disturbance to any human remains, including those interred outside formal cemeteries;

4) Isolation of cultural resources from the context considered significant; and

5) An effect to project elements that would be out of character with the property or site and its setting.

Two Class II/III (reconnaissance/intensive pedestrian) surveys of the cultural resources (Phase I and Phase II) Direct APE conducted by Eocene archaeologists resulted in the identification of seven previous sites, four new sites, and five IOs being located and recorded. Of these resources, per 36 CFR 800.4(2), the NRCS, in consultation with the SHPO/THPOs/Tribes and the BLM, determined that five sites are Eligible for the NRHP: one historic site is Eligible under Criterion A (42WS2428); three sites are Eligible under Criteria A, C, and D (42WS6520, 42WS6521, and 42WS6523); and one multi-component site is Eligible under Criteria A and D (42WS6522). All Eligible sites within the Shivwits area of the project (42WS6520, 42WS6521, 42WS6522, and 42WS6523) would be crossed on their edges by the installation of a pipeline, bank riprap, or ditch riprap. A full-time archaeological and tribal monitor would present for all ground-disturbing activities. Site 42WS2428 (historic road from St. George to Pine Valley) has been heavily disturbed/destroyed and almost entirely reclaimed by vegetation in one crossing; it has lost all historic format in another crossing, and all elements of the segment are non-contributing to the overall eligibility of the site within the project APE. Although it is a non-contributing segment, no construction elements would occur within the site boundaries. The Shivwits project area encompasses all historic properties that would be crossed by project components. **Table 6-1** summarizes the historic properties located within the Shivwits portion of the project area and site protection/avoidance measures.

Table 6-1. Cultural Effects Recommendations (Shivwits Site)

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Site Protective or Avoidance Measures
42WS 6520	Historic canal	Eligible—A, C, D	Pipeline	Crosses northwest edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
-	-	-	-	Enters site boundary at one other location	Contributing	No Adverse Effect	–
42WS 6521	Multi-component habitation complex	Eligible A, C, D	Pipeline	Crosses west edge of site, with nearby features	Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
-	-	-	Ditch Rip Rap	Within north edge of site in area of prior disturbance (erosion); will repair eroded channel without impacting intact masonry	Non-Contributing	No Adverse Effect. Beneficial Effect: protects historic masonry ditch from erosion from Santa Clara River	–

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Site Protective or Avoidance Measures
42WS 6522	Multi-component artifact scatter	Eligible—A, D	Pipeline	Crosses south edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
-	-	-	Bank Rip Rap	Crosses north edge of site, within area of no surface observations	Contributing	No Adverse Effect	–
42WS 6523	Historic flood control ditch	Eligible—A, C, D	Pipeline	Crosses at south end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect. Beneficial Effect: protects historic masonry ditch from erosion from Santa Clara River	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Site Protective or Avoidance Measures
-	-	-	Ditch Rip Rap	Within center of site, within area of prior disturbance (erosion); will repair eroded channel without impacting intact masonry and protect ditch from further erosion	Non-Contributing	No Adverse Effect	–
N/A	N/A	N/A	Land Leveling	No sites within the proposed land leveling area (previously disturbed area)	N/A	N/A	–

The remaining six sites and all five IOs are determined Not Eligible for listing on the NRHP under any Criteria, and although they may located be within the watershed area and potentially affected by water build-up, development would occur outside of these sites, and they would not be affected by implementation of the proposed project. There are no historic buildings or built environmental resources within the APE that would be visually affected by the construction of the proposed Diamond and Dammeron Valley debris basins. Based on these findings and implementation of the site protection and avoidance measures described in **Table 6-1**, per 36 CFR 800.5(b), the NRCS, through consultation with SHPO/THPO/Tribes/BLM, determined that implementation of the proposed project would result in No Adverse Effect to Historic Properties. The SHPO concurred with the determination of effects in a letter dated February 3, 2023. Refer to **Sections 7.1.5** and **7.1.7** for a detailed discussion of SHPO and tribal consultation and concurrence. The NRCS also consulted with 14 Native American Tribes on the determination of project effects. Refer to **Section 7.1.7** for a detailed description of all Tribal consultation conducted. Refer to **Appendix A** for all NHPA Section 106 consultation letters.

Within the Breach Inundation Zone APE for Diamon and Dammeron Valleys, a total of four previously identified cultural resource sites and three IOs are located within or crossed by APE (42WS2428, 42WS5150, 42WS5151, and 42WS5152). Of these four sites, one (42WS2428) is Eligible for listing on the NRHP under Criterion A, but the segment within the APE is non-contributing to the overall eligibility of the site, and the remaining three sites (42WS5150, 42WS5151, and 42WS5152) and all three IOs are Not Eligible for the NRHP under any Criteria. Additionally, 42WS5151 is no longer considered an archaeological site, as it has been destroyed by the construction of Homestead Drive and a residential property.

An additional cultural resource present within the project area are the long fallow agricultural fields, approximately 30 acres in size. These fields were used in the early 1900s to grow various crops, and this continued for decades. However, once the buildings associated with Site 42WS6521 were no longer habitable and water was no longer available, the fields became fallow. Orchards with peach, apple, and pear trees also used to thrive at Site 42WS6521. The Bear Dance was an annual event in this area, creating cultural community-level ties. These agricultural fields have ties to the traditional, historic, and cultural continuity of the Shivwits Tribe, thus making them an important cultural resource. The Action Alternative would return water to these fields and benefit the Shivwits in allowing them to practice their traditional agriculture and bring back cultural traditions that used to be practiced (i.e., the Bear Dance) to this area.

If any previously undetected or unreported cultural features or deposits are encountered during future project-related activities, these activities must be discontinued in the immediate area of the feature(s) and an NRCS (and BLM or SITLA, where appropriate) archaeologist or Tribal Chairperson must be notified to evaluate their nature and significance (see **Section 8.2** for applicant-committed environmental protection and BMP measures). On Private land, post-review discovery procedures outlined in the NRCS Prototype Programmatic Agreement shall be followed.

6.12.3 Ecosystem Services

As discussed in their scoping letter of February 12, 2021, the Shivwits Band has sensitive cultural, historic, and traditional interests within the Shivwits portion of the project area (**See Appendix E-10**). Ecosystem services values provided by historic properties and cultural resources would be enhanced by implementation of the Action Alternative as follows:

- Cultural services—these resources provide Shivwits Band Tribal members with a spiritual sense of history and connection to their ancestors. They are also associated with the cultural practices, traditions, beliefs, and social institutions of the Band's traditional community. Implementation of the Action Alternative would aid in the protection and management of resources by reducing the potential of flooding events that could damage these resources.

6.13 Hazardous Materials

6.13.1 No Action Alternative

Implementation of the No Action Alternative would not have any impact on the project area resulting from the use of hazardous materials during the 12-month construction period that would occur during the proposed action. Continued severe flooding could result in fuel, solvents, etc. stored in residential buildings being carried through and beyond the project area. No hazardous material sites are found within the project area.

6.13.2 Action Alternative

Construction activities would involve the use of substances considered hazardous, such as fuels, adhesives, and solvents. Inadvertent spills of these substances could runoff or percolate into the soil. In the absence of following BMPs identified in this document, local community water quality could be affected. However, implementation of BMPs would make this potential impact unlikely.

In the unlikely event of an accident, any spills would be promptly cleaned up and disposed of appropriately according to applicable state and federal regulations. If a fuel/oil or other hazardous material spill occurs, actions would be taken to minimize the amount and spread of spill material. Measures would include straw bale plugs, earthen berms, or use of other absorbent materials. If necessary, soil remediation would be conducted and would include the removal of contaminated soils to an approved bioremediation facility. Soil samples would be taken to verify the success of the site remediation. In addition, the construction contractor would be required to follow any other local, state, or federal regulations related to the use, handling, storing, transporting, and disposing of hazardous materials. As a result of the implementation of the applicant-committed conservation measures and BMPs (**Section 8.2**), any hazardous material spills would be minor and short-term in duration.

6.14 Noise

See **Section 4.13** for a discussion of noise sources that occur within the project area.

6.14.1 No Action Alternative

Implementation of the No Action Alternative would not result in additional noise sources within the project area.

6.14.2 Action Alternative

Increased localized noise levels would be evident during the 12-month construction period, especially in the Dammeron Valley and Diamond Valley communities. Specifically, the use of heavy equipment could be a nuisance to nearby residential and agricultural property owners. The implementation of applicant-committed mitigation and conservation measures and BMPs (see **Section 8.2**) would reduce but not eliminate anticipated increased noise levels. These noise levels would be localized and short-term and would not extend past the 12-month construction period. Therefore, short-term noise impacts would be minor based on the duration of construction, implementation of BMPs, and adherence to noise programs/regulations.

6.15 Cumulative Effects

Cumulative effects result from “the incremental impact of an action when added to other past, present, or reasonably foreseeable actions regardless of what agency (federal or non-federal) or person undertakes such other actions” (40 CFR 1508.7). This section of the Plan-EA evaluates potential impacts to the environment that may result from implementation of the proposed project when added to other past, present, and reasonably foreseeable future actions. The following projects in the area are currently occurring or have recently been completed and may result in cumulative effects when combined with the proposed project.

6.15.1 Past, Present, and Reasonably Foreseeable Actions

6.15.1.1 Shem Dam Rehabilitation/Gunlock Reservoir/Baker Dam Reservoir

The Shem Dam site is located approximately 0.2 mile upstream from the Shivwits portion of the project area. The purpose of this project was to repair an existing damaged dam to meet NRCS and State of Utah dam safety regulations, current engineering standards, and Bureau of Indian Affairs dam safety requirements. The completed project is stabilizing the movement of sediment in the Santa Clara River (NRCS 2014a). Two other structures are located upstream from the project area. Gunlock Reservoir and State Park is located approximately 5 river miles upstream. It was constructed in 1970 for irrigation and flood control and is a popular recreation area. Baker Dam Reservoir was constructed in 1950 for irrigation water storage and is located approximately 19 river miles upstream from the project area. It is popular for fishing and other outdoor recreation activities.

6.15.1.2 Northern Corridor

This proposed highway would extend approximately 4 miles from Washington Parkway on its east end to Red Hills Parkway on its west end. Potential impacts to the listed and candidate species resulting from development of this highway would be cumulative to those discussed for the proposed project. An EIS for the corridor has been completed but construction has not yet begun.

6.15.1.3 New Power Transmission Lines

The installation of new transmission lines has been a continuing activity in Washington County and is necessary to meet an ever-increasing energy and communication demand. Any impacts to listed and candidate species resulting from project implementation would be cumulative to those resulting from transmission line installation.

6.15.1.4 Public Roads

It is anticipated that public use of existing roads in or near the project area would continue to increase in the foreseeable future. The demand for new roads would increase as well. Noise and dust resulting from increased road construction and use would affect listed plant and animal species, including those thought to occur near the project area. Pollination of native plant species, including the federally listed dwarf bear-claw poppy and Holmgren and Shivwits milkvetches, could be affected. Increased noise levels could cause other species, including the southwestern willow flycatcher, to temporarily or permanently disperse from the area. New road installation and use would result in the continued fragmentation and loss of endangered and candidate species' habitat. Impacts resulting from implementation of the Action Alternative would be cumulative to those occurring from public road use and development.

6.15.1.5 Lake Powell Pipeline

The proposed Lake Powell Pipeline would transport water from Lake Powell through an approximately 140-mile, buried pipeline to Washington and Kane counties, Utah. At full capacity, the project would deliver 82,249 acre-feet of water per year to Washington County. This proposed project is currently being analyzed in an EIS. Social and environmental impacts that would result from pipeline construction and use would add to those projected to occur from the implementation of the Action Alternative.

6.15.1.6 Continued Population Growth and Urban Expansion in Washington County

Washington County is one of the fastest-growing areas in the U.S. (The Spectrum 2023). The demand for housing and other infrastructure continues to increase. Impacts associated with these developments would affect listed plant and animal species. As the population increases, increased demand for homes, businesses, and recreation, such as hiking and off-highway vehicle use,would impact threatened, endangered, and candidate species habitat. The impacts resulting from these activities wouldbe cumulative to those anticipated from the proposed project.

6.16 Cumulative Effects Summary

6.16.1 No Action Alternative

Implementation of the No Action Alternative would not result in any cumulative effects to natural or human resources located within the project area above those currently occurring as previously described. No additional measurable effects to past, present, or reasonably foreseeable actions would be anticipated. Severe flooding would continue to occur. It is unlikely that the floodplain adjacent to the Santa Clara River on Tribal lands would be used for agriculture in the foreseeable future. As a result, potential socioeconomic opportunities would be lost. Safety and infrastructure concerns associated with occasional severe flooding would continue. Diamond Valley and Dammeron Valley would continue to experience population and infrastructure growth and development. Open private UTLA lands and BLM–administered public lands are available for development. Washington County is one of the fastest-growing counties in the state, and that growth is anticipated to continue for the foreseeable future. Other growth-related actions such as transmission line and road construction and use would continue to be developed to meet anticipated growth in the area.

6.16.2 Action Alternative

Fifteen natural and human resources would likely experience effects that could be cumulative to the existing and reasonably foreseeable actions discussed above. Impacts resulting from development of the proposed project would be cumulative to these actions but would be negligible to minor in scope due to limited surface disturbance, limited duration of construction activities, and implementation of applicant-committed conservation and mitigation measures and BMPs.

6.16.2.1 Soils

Approximately 127 acres of surface disturbance would result in an undetermined amount of soil loss, primarily during the approximately 12-month construction period. While the amount of soil loss would be minor, it would be cumulative to soil loss resulting from other reasonably foreseeable actions near the proposed project area such as continued urban development.

6.16.2.2 WOTUS

Riprap installation along 0.53 mile of the Santa Clara River would reduce the amount of erosion occurring in this portion of the river. Project implementation would cumulatively support other NRCS and BLM projects, such as the Shem Dam Rehabilitation, in the management of the Santa Clara River. No other WOTUS values are located within the project area.

6.16.2.3 Riparian Areas

The disturbance associated with approximately 0.53 mile of armoring along the San Juan River would be in addition to other nearby actions in riparian areas on the Santa Clara River such as the Shem Dam project. However, while minor, short-term disturbance would occur, the long-term effects of this action would be cumulative to these projects in the overall management and protection of riparian values along the river.

6.16.2.4 Floodplains Management

Implementation of the Action Alternative would help protect the approximately 60-acre floodplain adjacent to the Santa Clara River. It would also provide agriculture opportunities on approximately 30 acres of the floodplain. These actions would be cumulative to other reasonably foreseeable activities in Washington County to protect floodplains. The restoration of agriculture activities would offset loss of agriculture lands in other areas of the County. However, this restoration would be minor in scope.

6.16.2.5 Air Quality

Emissions from construction equipment and fugitive dust would occur during the 12-month construction period. However, implementation of applicant-committed conservation and mitigation measures and BMPs would reduce the amount of emissions and no air quality violations would be anticipated. Any cumulative effects to other projects would be short term and negligible.

6.16.2.6 U.S. Fish and Wildlife Service Threatened, Endangered, and Candidate Species

Nearly all projects that occur within Washington County affect one or more USFWS-listed species. Five listed and one candidate species were identified as potentially occurring within or near the project area. No significant effects to any of these species are anticipated from project development because surface disturbance generally would not occur within identified habitat. However, any potential habitat disturbance or indirect effects such as noise or dust would be cumulative to habitat effects resulting from other actions. This cumulative effect would be negligible to minor in scope due to the limited amount of potential habitat loss.

6.16.2.7 Vegetation (Excluding U.S. Fish and Wildlife Service-Designated Species)

Approximately 127 acres of surface disturbance would occur from project development. This surface disturbance would be cumulative to the surface disturbance resulting from the other actions that have occurred, are presently occurring, or may occur in the reasonably foreseeable future near the project area. These actions would include urban infrastructure such as new homes and other buildings, new roads, new transmission lines, and more. The cumulative impact would be minor in scope, as applicant-committed conservation/protection measures and BMPs would be implemented to reduce the scope of the surface disturbance.

6.16.2.8 Noxious Weeds and Invasive Plant Species

Noxious weeds and invasive plant species are an ongoing resource management concern in Washington County. These species generally accompany surface-disturbing activities in the County, including the proposed project. Conservation and mitigation measures and BMPs help reduce but do not eliminate weed and invasive plant species establishment. Proposed project development would result in approximately 127 acres of surface disturbance. These effects would be cumulative to other reasonably foreseeable surfacing-disturbing actions that would be susceptible to noxious weed and invasive plant species establishment.

6.16.2.9 Fish and Wildlife (Excluding U.S. Fish and Wildlife Service-Designates Species)

Short-term effects to fish and wildlife, including approximately 127 acres of surface disturbance, increased noise, and human presence, would occur during the 12-month construction period. These effects would be cumulative to actions that have occurred or are presently occurring near the project area. Due to the short duration of construction activities, limited surface disturbance, and abundance of adjoining habitat, these effects would be minor, and any cumulative effects would be negligible.

6.16.2.10 Migratory Bird Species/Bald and Golden Eagles

Six migratory bird species were identified as potentially occurring within the project area. Implementation of applicant-committed conservation and mitigation measures and BMPs, such as timing restrictions, would reduce any potential impacts to these species. Any cumulative effects would be negligible.

6.16.2.11 Social Issues

Proposed project development would result in an undetermined improvement in socioeconomic conditions by reducing potential crop loss and infrastructure damage in Dammeron Valley and Diamond Valley and provide agriculture opportunities on the approximately 30 acres of floodplain adjacent to the Santa Clara River. These actions, while limited in scope, would be cumulative to other activities in the area.

6.16.2.12 Historic Properties/Cultural Resources/Native American Religious Concerns

Based on the results of Class III surveys, the NRCS has determined that project development will result in No Adverse Effect to Historic Properties. Eligible cultural resource sites located within the Shivwits portion of the project area will be crossed on their edges by pipeline installation and riprap installation. An archaeological and tribal monitor will be present during construction activities within 15 meters of each site boundary to ensure that no impacts would occur. In addition, an inadvertent discovery plan will be prepared, there will be a pre-construction meeting, and all Eligible site boundaries will be flagged with a 15-foot buffer. These mitigation measures have been consulted on with SHPO, Tribes, and THPOs during the Section 106 process (**Appendix A**). Implementation of the Action Alternative would continue work to restore the Shivwits portion of the project area to agricultural use. Shivwits Tribal people would be able to once again use the area to grow traditional crops and orchards. The Shivwits Band strongly supports the Proposed Action (see Shivwits Tribal letter of support in Appendix A). Therefore, implementation of the Proposed Action would result in a positive cumulative effect to the Tribe and Tribal lands by making additional lands available for agricultural use.

6.16.2.13 Hazardous Materials

Construction activities could involve the use of substances considered to be hazardous such as fuels, adhesives, and solvents. A slight potential exists that inadvertent spills of these substances could run off or percolate into the ground affecting soil or groundwater on a localized basis. Any spills would be promptly and properly cleaned up and disposed of according to appropriate state and federal regulations. As a result of the implementation of applicant-committed conservation and mitigation measures and BMPs, any hazardous material spills would be minor and short term in duration and would not result in any cumulative impacts to other actions in the area. No hazardous material sites are found within the project area. Implementation of the Action Alternative would not result in any cumulative effects associated with hazardous material sites.

6.16.2.14 Noise

Increased noise levels would be evident during the 12-month construction period, especially in the Dammeron Valley and Diamond Valley communities. Specifically, the use of heavy equipment could be a nuisance to nearby property owners. The application of applicant-committed conservation and mitigation measures and BMPs would reduce but not eliminate anticipated increased noise levels. Because these impacts are localized and would not extend beyond the 12-month construction period, project-related noise would not cumulatively contribute on a long-term basis to other actions in the area.

6.16.2.15 Public Health and Safety

Construction and repair of the six detention basins would result in improved public health and safety by reducing the potential for severe and damaging floods in the Dammeron Valley and Diamond Valley areas. While localized, this impact would be long-term in duration and contribute cumulatively to other actions being taken to improve the health and safety of local residents.

The anticipated increase in construction-related traffic during the 12-month construction period could increase the potential of highway-related accidents. This potential would be remote, would not exist beyond the construction period, and would not cumulatively add to other actions in the area on a long-term basis.

6.16.3 Risk and Uncertainty

A 50-year project life was assumed for the proposed project in calculating costs and economic evaluations. As with any long-term project, estimating costs and benefits involves a degree of risk and uncertainty. Information can be uncertain, including errors in measurements and climatic changes that could alter rainfall storm events. Assumptions were made based on the best available information. Unit costs are based on current market prices based on similar projects. Economic factors that cannot be predicted could increase project cost. Economic benefits are based on values of floodplain property, infrastructure, agricultural land use, etc.

6.17 Irreversible and Irretrievable Commitment of Resources

NEPA requires that an environmental analysis includes the identification of any irreversible and irretrievable commitments of resources which would be involved in the Proposed Action should it be implemented. Irreversible and irretrievable resource commitments are related to the use of nonrenewable resources and the effects this use could have on future generations. Irreversible effects primarily result from the use of specific resources that cannot be replaced within a reasonable time frame. Irretrievable resource commitments involve the loss in value of a resource that could not be restored as a result of implementing the proposed action.

6.17.1 No Action Alternative

Resources irreversibly or irretrievably lost through implementation of the No Action Alternative are not quantifiable. However, it can be assumed that the following effects would occur. Implementation of this alternative would result in continued severe flooding in the Dammeron Valley and Diamond Valley areas. Any loss of soil, agriculture land or crops, or other human infrastructure including residential homes would be irretrievable. Economic opportunities resulting from agriculture land use that would be lost would be foregone. Soil lost from the floodplain along the Santa Clara River within the Shivwits portion of the project area would not be recoverable. Potential agricultural opportunities within the 30-acre historic agricultural field would also be foregone.

6.17.2 Action Alternative

Any soil loss resulting from the approximately 127 acres of surface-disturbing activities would not be reclaimed. Any historic or cultural resources damaged or lost resulting from construction could not be reclaimed. Therefore, they would be lost. An unquantifiable amount of fossil fuels, labor, and construction materials (e.g., cement, aggregate, and bituminous material) would be expended during the 12-month construction period. Additionally, labor and natural resources would be used in the fabrication and preparation of construction materials. These materials are generally not retrievable. As the above analysis depicts, these commitments of resources would be minor in scope. Construction would also require a one-time expenditure of federal, state, and local funds that would not be retrievable.

7.0 Consultation, Coordination, and Public Participation

7.1 Consultation and Coordination

7.1.1 U.S. Fish and Wildlife Service

Informal consultation with the USFWS has been ongoing, consisting primarily of virtual meetings, telephone calls, and written correspondence. The USFWS IPaC and Environmental Conservation Online System websites were accessed to determine the potential presence of listed T&E species within or near the project area (USFWS 2021a, 2021b). IPaC identified seven listed and one candidate species as potentially occurring within the project area. An analysis of the project area determined that one additional listed species (Holmgren milkvetch) also likely occurs near the Shivwits portion of the project area (**Table 4.1**). After an evaluation of the project area, it was determined that 5 listed and 1 candidate species potentially occur within the project area or within the surrounding 300-foot buffer area (southwestern willow flycatcher, desert tortoise, dwarf bear-claw poppy, Holmgren milkvetch, Shivwits milkvetch, and monarch butterfly). Habitat for the remaining 4 species is not found within the project area or the 300-foot buffer area. A BA was prepared and submitted to the USFWS on June 9, 2022. As a result of the coordination and analysis conducted for this Plan-EA, it has been determined that implementation of the proposed project May Affect but is Not Likely Adversely Affect the listed species or their designated critical habitat and would not likely jeopardize the continued existence of the monarch butterfly. These determinations resulted from a careful evaluation of the project area. The USFWS concurred with these findings by memorandum dated July 7, 2022 (USFWS 2022). Consultation with the USFWS will continue throughout project development. Additionally, a letter was submitted to the USFWS on May 14, 2024, inviting the USFWS to submit reports or investigations regarding wildlife resources that should be considered and to participate in the preparation of the Plan-EA per Section 12 of Public Law 83-566.

7.1.2 U.S. Army Corps of Engineers

USACE has jurisdiction on WOTUS under Section 404 of the Clean Water Act (CWA). USACE has been consulted regarding WOTUS that have been identified as occurring within the project area. An Aquatic Resource Delineation Report has been prepared for USACE review and approval. Contact with USACE has been ongoing and will continue throughout project development as necessary. Consultation with the USACE is ongoing. It is assumed that the Santa Clara River is a WOTUS. Project sponsors are waiting for a final determination on the ditches, washes, and wetlands. It is unlikely that they are WOTUS as water is only found in them in response to flood events.

7.1.3 Bureau of Land Management

As a cooperating agency, the BLM has been involved in all aspects of the proposed project development. The BLM prepared an EA Categorical Exclusion to address geotechnical soil testing activities at the Dammeron Valley and Diamond Valley detention basin sites. The document is found in **Appendix E-11** and on the BLM E-Planning Website. The analysis contained in this Plan-EA will serve as the BLM EA on any approvals required by the agency. The BLM action is to decide whether to approve a ROW on the BLM-administered public lands portion of the project area.

7.1.4 Utah Natural Heritage Program (Utah Division of Wildlife Resources)

The UNHP Online Species Online webpage was accessed to determine the potential presence of rare (listed and non-listed) plant and animal species within or near the project area. The site identified species within a 0.5- and 2-mile radius of the project area. Nine species were identified as being within the radius. Written correspondence with the UNHP rare plant conservation coordinator resulted in the determination that an additional rare plant species, Virgin thistle, could also occur near the project area. Coordination with UNHP will continue as necessary throughout project development. These species are discussed in **Sections 4.7** and **4.9**.

7.1.5 Utah State Historic Preservation Office

Two Class III Cultural Resources Inventory Reports have been completed: NRCS's Santa Clara Watershed Plan-EA Project—Phase I: Borehole and Test Pit Locations (U21TN0316) and NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project (U21TN0317). As part of NHPA Section 106 compliance, the reports were submitted to the Utah SHPO for concurrence with the APE and determinations of site eligibility and project effects. Per 36 CFR 800.4, the NRCS consulted on the Phase I APE, site eligibility and determination of No Adverse Effect to Historic Properties in a letter dated August 19, 2021, and the Utah SHPO concurred in a letter dated August 20, 2021. NRCS consulted on Phase II APE, site eligibility and determination of No Adverse Effect to Historic Properties in a letter dated February 3, 2023 (**Appendix A**), and the Utah SHPO concurred with site eligibility and a determination of No Adverse Effect to Historic Properties in a letter dated February 3, 2023. In the event that cultural/archaeological resources or human remains/funerary objects are found during construction activities, all activities would stop, and the appropriate agencies would be notified according to NRCS protocol, as detailed in the NRCS Prototype Programmatic Agreement. SHPO consultation letters can be found in **Appendix A**.

7.1.6 Utah Trust Lands Administration

UTLA is a cooperating agency in this effort. Contact has been maintained with the local UTLA office throughout the project development process. A permit or letter of permission would be required prior to any surface-disturbing activities occurring on SITLA-administered lands. This Plan-EA would serve as UTLA's environmental documentation for this action. UTLA has accepted a request to be a cooperating agency on this project.

7.1.7 Tribal

Tribes who hold ancestral land, traditional use, and/or traditional cultural property claims in and near the project area were identified using as a baseline the National Park Service's Native American Graves Protection and Repatriation Act Native American Consultation Database, through which any federally recognized Tribe could identify those counties in Utah where they had consultation interests. The Tribal list for this project was supplemented with the BLM St. George Field Office's Native American consultation list. The Bureau of Indian Affairs and the Utah Division of Indian Affairs websites were also used as sources. During scoping, the NRCS reached out to the assembled list of Tribes asking of any additional Tribes that should be contacted. **Table 7-1** lists the record of Tribal Consultations. Consultation letters are found in Appendix A. The Shivwits Band of Paiutes cooperating agency acceptance letter is located in Appendix E.

Table 7-1. NRCS Record of Tribal Consultations

–	Project/Reason for Initiating Consultation: Santa Clara Watershed Plan-EA (NEPA)												
–	Program: NRCS Watershed and Flood Prevention Operations Program												
Tribe Information			**Consultation Initiated[1]**		**Cultural Resource Report Consultation Packages[2]**			**Consultation Follow Up[2]**				**Tribe Cons Status (Date)**
Federally Recognized Tribe	**Contact Name**	**Address**	**Letter Date**	**Response**	**NRCS Mailed to Tribe[3]**	**Received by Tribe[3,4]**	**Tribe Response**	**Follow Up #1 Type (Date)**	**Response #1 Type (Date): Response**	**Follow Up #2 Type (Date)**	**Response #2 Type (Date)**	
Cedar Band of Paiutes	Delice Tom (Chairwoman, past)	P.O. Box 235 Cedar City, Utah 84721	1/13/2021	None	8/19/2021	X	None	NA	-	-	-	-
	Travis Parashonts (Chairperson, current)	600 North 100 East Cedar City, Utah 84721	1/23/2023	None	1/23/2023	X	None	Phone (01/16/2024); (435) 586-9433 Left message	None	Phone (1/31/2024); (435) 586-9433 Left Message	None	No response
Chemehuevi Indian Tribe	Charles Wood (Chairman)	P.O. Box 1976 Havasu Lake, California 92363	1/13/2021	None	8/19/2021 1/23/2023	X	None	Phone (1/16/2024) (760)-858-4219 Left message	None	Phone (1/31/2024); (760) 858-4219 (Left Message	None	No response
Hopi Tribe of Arizona	Stewart B. Koyiyumptewa (THPO)	P.O. Box 123 Kykotsmovi, Arizona 86039	1/13/2021	Letter (2/10/2021) Request consultation if adverse effects	8/19/2021 1/23/2023	X	Letters (8/27/2021) Concur	Email (08/25/2023)	None	Phone (1/16/2024); (928) 734-3615 Left message	None	Concur (08/27/2021; No response)

–	Project/Reason for Initiating Consultation: Santa Clara Watershed Plan-EA (NEPA)											
–	Program: NRCS Watershed and Flood Prevention Operations Program											
Tribe Information			**Consultation Initiated**[1]		**Cultural Resource Report Consultation Packages**[2]			**Consultation Follow Up**[2]				**Tribe Cons Status (Date)**
Federally Recognized Tribe	**Contact Name**	**Address**	**Letter Date**	**Response**	**NRCS Mailed to Tribe**[3]	**Received by Tribe**[3,4]	**Tribe Response**	**Follow Up #1 Type (Date)**	**Response #1 Type (Date): Response**	**Follow Up #2 Type (Date)**	**Response #2 Type (Date)**	
	Timothy Nuvangyaoma (Chairman)		1/13/2021	None	8/19/2021 1/23/2023	X	None	-	None	NA	NA	
Indian Peaks Band of Paiutes	Tamara Borchardt-Slayton (Chairperson)	P.O. Box 2062 Cedar City, Utah 84721	-	-	8/19/2021 1/23/2023	X	None	Phone (01/16/2024) (435) 691-3946 Left message	None	Phone (1/31/2024) (435) 691-3946 Left message	None	No response
Kaibab Band of Paiute Indians of the Kaibab Indian Reservation	Daniel Bullets (Environmental Program Director)	HC65, Box 2 Fredonia, Arizona 86022	1/13/2021	None	8/19/2021 1/23/2023	X	None	Email (8/25/2023)	Email (8/28/2023): No concerns, glad to hear working with Shivwits Band	Phone (1/09/2024); (928) 643-6278	No concerns, defer to PITU	Defer to PITU (8/28/2023)
	Ona Segundo (Chairwoman, past)		1/13/2021	None	8/19/2021 1/23/2023	X	None	Email (8/25/2023) rolandm@kaibabpaiute-nsn.gov	None	NA	-	
	Roland Maldonado		-	-	-	-	-	-	-	Phone (1/09/2024);	No concerns,	

–	Project/Reason for Initiating Consultation: Santa Clara Watershed Plan-EA (NEPA)											
–	Program: NRCS Watershed and Flood Prevention Operations Program											
Tribe Information			**Consultation Initiated**[1]		**Cultural Resource Report Consultation Packages**[2]			**Consultation Follow Up**[2]				**Tribe Cons Status (Date)**
Federally Recognized Tribe	**Contact Name**	**Address**	**Letter Date**	**Response**	**NRCS Mailed to Tribe**[3]	**Received by Tribe**[3,4]	**Tribe Response**	**Follow Up #1 Type (Date)**	**Response #1 Type (Date): Response**	**Follow Up #2 Type (Date)**	**Response #2 Type (Date)**	
	(Chairman, current)									(928) 643-7245	defer to Shivwits	
	Ganivan Timcan (Southern Paiute Consortium)		1/13/2021	None	8/19/2021 1/23/2023	X	None		None	-	-	
Kanosh Band of Paiutes	Darlene Arrum (Chairwoman, past)	P.O. Box 116 Kanosh, Utah 84637	1/13/2021	None	8/19/2021 1/23/2023	X	None	Email (8/25/2023) darleneparrum@gmail.com	None	No listed phone number	None	No response
Koosharem Band of Paiutes	LaTosha Mayo (Chairwoman, past)	P.O. Box 205 Richfield, Utah 84107	1/13/2021	None	8/19/2021 1/23/2023	X	None	NA	NA	-	-	No response
	Toni Kanosh (Chairwoman, current)		-	-	8/19/2021 1/23/2023	X	None	Email (8/25/2023) koosharem@utahpaiutes.org	None	Phone (1/09/2024); (435) 896-2823; Not in Service	None	

–	Project/Reason for Initiating Consultation: Santa Clara Watershed Plan-EA (NEPA)
–	Program: NRCS Watershed and Flood Prevention Operations Program

Tribe Information			**Consultation Initiated**[1]		**Cultural Resource Report Consultation Packages**[2]			**Consultation Follow Up**[2]				**Tribe Cons Status (Date)**
Federally Recognized Tribe	**Contact Name**	**Address**	**Letter Date**	**Response**	**NRCS Mailed to Tribe**[3]	**Received by Tribe**[3,4]	**Tribe Response**	**Follow Up #1 Type (Date)**	**Response #1 Type (Date): Response**	**Follow Up #2 Type (Date)**	**Response #2 Type (Date)**	
Las Vegas Tribe of Paiute Indians of the Las Vegas Colony	Curtis Anderson (Chairman, past)	One Paiute Drive Las Vegas, Nevada 89106	1/13/2021	None	8/19/2021	X	None	-	-	-	-	No response
	Ramona Salazar		1/13/2021	None	8/19/2021 1/23/2023	X	None	-	-	-	-	
	Daryn Pete (Chairwoman, present)		-	-	8/19/2021	X	None	Email (8/25/2023) dpete@lvpaiute.com	None	Phone (1/09/2024); (702) 386-3926; Left message	None	
	Benny Tso (Chairman, past)		-	-	8/19/2021 1/23/2023	X	None	-	-	-	-	
Moapa Band of Paiute Indians of the Moapa River Reservation, Nevada	Greg Anderson (Chairman, past)	P.O. Box 340 Moapa, Nevada 89025	1/13/2021	None	8/19/2021 1/23/2023	X	None	Email (8/25/2023) chair.mbop@moapabandofpaiutes.org	None	-	None	Concur (9/23/2021)

–	Project/Reason for Initiating Consultation: Santa Clara Watershed Plan-EA (NEPA)											
–	Program: NRCS Watershed and Flood Prevention Operations Program											
Tribe Information			**Consultation Initiated[1]**		**Cultural Resource Report Consultation Packages[2]**			**Consultation Follow Up[2]**				**Tribe Cons Status (Date)**
Federally Recognized Tribe	**Contact Name**	**Address**	**Letter Date**	**Response**	**NRCS Mailed to Tribe[3]**	**Received by Tribe[3,4]**	**Tribe Response**	**Follow Up #1 Type (Date)**	**Response #1 Type (Date): Response**	**Follow Up #2 Type (Date)**	**Response #2 Type (Date)**	
	Darren Daboda (THPO)		1/13/2021	None	8/19/2021 1/23/2023	X	None	Email (8/25/2023) moapathpo@moapabandofpaiutes.org	None	Phone (1/16/2024); (702) 865-2787; Left message	Asked if new road access was covered by survey. NRCS said yes.	
	Shandoah (Shanan) Anderson (Cultural Manager) (former)		1/13/2021	None	8/19/2021 1/23/2023	X	Email (09/23/2021): Concur	Email (8/25/2023) moapacultural@moapabandofpaiutes.org	Shanan left position	NA	NA	
	Laura Parry (Chairwoman, current)		-	-	8/19/2021 1/23/2023	X	None	-	None	-	-	
Navajo Nation	Richard Begay (THPO)	P.O. Box 7440 Window Rock, Arizona 86515	1/13/2021	Email (2/10/2021) No TCPS; no addt'l consultation needed.	8/19/2021 1/23/2023	X	None	NA	None	NA	Per email on 2/10/2021, project may proceed, no additional	Project may proceed

–	Project/Reason for Initiating Consultation: Santa Clara Watershed Plan-EA (NEPA)												
–	Program: NRCS Watershed and Flood Prevention Operations Program												
Tribe Information			**Consultation Initiated[1]**		**Cultural Resource Report Consultation Packages[2]**			**Consultation Follow Up[2]**				**Tribe Cons Status (Date)**
Federally Recognized Tribe	**Contact Name**	**Address**	**Letter Date**	**Response**	**NRCS Mailed to Tribe[3]**	**Received by Tribe[3,4]**	**Tribe Response**	**Follow Up #1 Type (Date)**	**Response #1 Type (Date): Response**	**Follow Up #2 Type (Date)**	**Response #2 Type (Date)**	
											consultation needed.	
	Jonathan Nez (President, past)		1/13/2021	None	8/19/2021	X	None	NA	None	-	-	
	Buu Nygren (President, current)		-	-	1/23/2023	-	None	NA	None	-	-	
PITU	Dorena Martineau (Cultural Resource Director, past)	440 North Paiute Drive Cedar City, Utah 84721	1/13/2021	None	8/19/2021 1/23/2023	X	Letter (9/8/2021) Concur; Email letter (02/16/2023): Concur	NA	-	-	-	Concur (9/8/2021 and 2/16/2023)
Pueblo of Zuni	Kurt Dongoske (THPO)	P.O. Box 339 Zuni, New Mexico 87327	1/13/2021	None	8/19/2021 1/23/2023	X	None	CC Email (8/28/2023) kdongoske@cableone.net	None	Phone (1/16/2024) (928) 289-925; Left message	None	No response

–	Project/Reason for Initiating Consultation: Santa Clara Watershed Plan-EA (NEPA)												
–	Program: NRCS Watershed and Flood Prevention Operations Program												
Tribe Information			**Consultation Initiated[1]**		**Cultural Resource Report Consultation Packages[2]**			**Consultation Follow Up[2]**				**Tribe Cons Status (Date)**	
Federally Recognized Tribe	**Contact Name**	**Address**	**Letter Date**	**Response**	**NRCS Mailed to Tribe[3]**	**Received by Tribe[3,4]**	**Tribe Response**	**Follow Up #1 Type (Date)**	**Response #1 Type (Date): Response**	**Follow Up #2 Type (Date)**	**Response #2 Type (Date)**		
	Val R. Panteah, Sr. (Governor, past)		1/13/2021	None	8/19/2021 1/23/2023	X	None	NA	-	-	-	No response	
	Arden Kucate (Governor, current)		1/13/2021	None	8/19/2021	X	None	Email (8/28/2023) arden.kucate@ashiwi.org	None	-	-	No response	
San Juan Southern Paiute Tribe	Carlene Yellowhair (President, past)	P.O. Box 2950 Tuba City, Arizona 86045	1/13/2021	None	8/19/2021	X	None	-	-	-	-	No response	
San Juan Southern Paiute Tribe	Johnny Lehi Jr. (President, past)	P.O. Box 2950 Tuba City, Arizona 86045	1/13/2021	None	8/19/2021 1/23/2023	X	None	Email (8/28/2023) J.lehijr@sanjuanpaiute-nsn.gov	None	Phone (1/16/2024); (928) 212-9794; Left message with new President Candelora Lehi	None	No response	
Shivwits Band of Paiute Indians	Carmen Clark (Chairwoman)	6060 West 3650 North	1/13/2021	None	8/19/2021	X	None	Report Consultation Package	None	-	-	Cooperating Agency	

–	Project/Reason for Initiating Consultation: Santa Clara Watershed Plan-EA (NEPA)												
–	Program: NRCS Watershed and Flood Prevention Operations Program												
Tribe Information			**Consultation Initiated[1]**		**Cultural Resource Report Consultation Packages[2]**			**Consultation Follow Up[2]**				**Tribe Cons Status (Date)**
Federally Recognized Tribe	**Contact Name**	**Address**	**Letter Date**	**Response**	**NRCS Mailed to Tribe[3]**	**Received by Tribe[3,4]**	**Tribe Response**	**Follow Up #1 Type (Date)**	**Response #1 Type (Date): Response**	**Follow Up #2 Type (Date)**	**Response #2 Type (Date)**	
		Ivins, Utah 84738						Phase II (1/23/2023)				consultation ongoing
	Hope Silvas (Chairperson)		-	-	8/19/2021 Email 1/13/2022 Draft Phase II Report	X	Email (2/11/2022) Request Zoom meeting (corr. In App. A)	Report Consultation Package Phase II (1/23/2023)	None	-	-	
Ute Indian Tribe of the Uintah & Ouray Reservation, Utah	Luke Duncan (Chairman, past)	P.O. Box 190 Fort Duchesne, Utah 84026	01/13/2021	None	8/19/2021	X	None	Email (8/25/2023) luked@utetribe.com	None	NA	None	Defer to PITU
	Betsy Chapoose (THPO)		1/13/2021	None	8/19/2021 1/23/2023	X	None	Email (8/25/2023) betsyc@uteTribe.com	None	Phone (1/16/2024); (435) 722-5141	No concerns, will defer to PITU	
	Julius Murray (Chairman, current)		1/13/2021	None	8/19/2021 1/23/2023	X	None	Email (8/28/2023)	None	Phone (1/16/2024); (435) 722-	None	

–	Project/Reason for Initiating Consultation: Santa Clara Watershed Plan-EA (NEPA)												
–	Program: NRCS Watershed and Flood Prevention Operations Program												
Tribe Information			**Consultation Initiated[1]**		**Cultural Resource Report Consultation Packages[2]**			**Consultation Follow Up[2]**				**Tribe Cons Status (Date)**	
Federally Recognized Tribe	**Contact Name**	**Address**	**Letter Date**	**Response**	**NRCS Mailed to Tribe[3]**	**Received by Tribe[3,4]**	**Tribe Response**	**Follow Up #1 Type (Date)**	**Response #1 Type (Date): Response**	**Follow Up #2 Type (Date)**	**Response #2 Type (Date)**		
								juliusm@utetribe.com		5141, left message			

[1] Tribe consultation was initiated as part of the Scoping process and is documented in a Scoping Summary Report included in **Appendix E-10**.

[2] Documentation is included below the Table.

[3] An addendum to the Cultural Resource Survey was made after it was provided to the Tribes and a second letter was sent to all Tribes with the updated Cultural Resource Survey. The first letter and second letter mailed and received dates are included.

[4] Date of receipt of mail delivery to Tribe.

Concurrent with the scoping period, and as part of Section 106 of the NHPA, Executive Order 13007, 13175, and the American Indian Religious Freedom Act, the NRCS reached out to 14 federally-recognized Tribes/THPOs regarding known historic properties or places of traditional religious and cultural importance near the project area (**Appendix A**). The tribal scoping letter was submitted on January 13, 2021. Letters were submitted to the Shivwits Band of Paiutes, Kanosh Band of Paiutes, Cedar Band of Paiutes, Ute Indian Tribe of the Uintah and Ouray Reservation, the Paiute Indian Tribe of Utah, the Kaibab Band of Paiute Indians of the Kaibab Indian Reservation, the Koosharem Band of Paiutes, the Moapa Band of Paiute Indians of the Moapa River Reservation, the Las Vegas Tribe of Paiute Indians of the Las Vegas Colony, the Navajo Nation, the Pueblo of Zuni, the Hopi Tribe, San Juan Southern Paiute Tribe of Arizona, and Chemehuevi Indian Tribe. The Navajo Nation responded in an email dated February 10, 2021, stating that they had no known TCPs within the project area and that the project may proceed without further consultation. The Hopi Tribe responded in a letter dated February 10, 2021, requesting consultation in the event that cultural resources are identified that may be adversely affected. Discussions and formal consultation with the Shivwits have been ongoing during development of this Plan-EA. The Shivwits were also consulted via telephone on multiple occasions during development of the content of cultural resources site forms for specific sites on Shivwits land in order to fully represent the Shivwits' preferred information in the site descriptions. Two Cultural Resources Inventory Reports (Phase I and Phase II) were completed as a result of intensive cultural resources inventories, and a Shivwits monitor was present during both inventories. Per 36 CFR 800.4, the NRCS consulted with the same 14 Tribes/THPOs as above for concurrence on-site eligibility and project effects. Per 36 CFR800.4, the NRCS consulted on the Phase I report APE, site eligibility and project effects in a letter dated August 19, 2021.The Moapa Band of the Paiute Tribe concurred with Phase I of the project on September 23. 2021. The PITU concurred with Phase I of the project via letter on September 8, 2021. The Hopi Tribe concurred with Phase I of the project on August 27, 2021.

The NRCS emailed a draft copy of the Phase II report to the Shivwits for review on January 13, 2022. In an email on February 11, 2022, Hope Silvas, the Chairperson, requested a Zoom meeting to discuss the results of the Phase II report. A Zoom meeting was held on February 18, 2022, and was an open discussion of proposed project measures and sites found. A draft copy of the Phase II report was also emailed to Garry Cantley, BIA Regional Archaeologist, on February 16, 2022 (Appendix A). The BIA Responded via email on March 2, 2022, with minor comments and no issue with site eligible or project effects.

Per 36 CFR800.4, the NRCS consulted on the final Phase II report APE, site eligibility and project effects, in a letter dated February 3, 2023. The Paiute Indian Tribe concurred with Phase II of the project via letter on February 16, 2023. Informal telephone and email dialogue with the Shivwits is continuing throughout the development of the Plan-EA. All formal consultation letters are included in **Appendix A**.

Additionally, in a letter dated February 16, 2021, the Shivwits accepted the request to be a cooperating agency in the project. The Shivwits are supportive of the proposed project as it would provide an opportunity to grow traditional crops and restore other traditional activities. In a letter dated August 3, 2023, the Tribe stated that, "This project is key to assisting the Shivwits Band in restoring our agriculture, increasing irrigate efficiency, passing down our traditional knowledge to our youth, and continuing our cultural traditions."

7.1.8 Sponsoring Local Organization

Washington County is the SLO for the project. Financial assistance for the project was requested from the NRCS through Standard Form 424—Application for Federal Assistance. Coordination between the SLO, NRCS, and other agencies is ongoing. Meetings were conducted throughout the planning and process to discuss the project measures and identify potential concerns. The SLO has reviewed and participated in the development of the Preliminary Draft and Draft Plan-EA.

7.1.9 Utah Division of Water Rights Dam Safety

Utah Dam Safety has jurisdiction over dams in the state, and new dams must meet Utah Division of Administrative Rules regulations (UDAR 2018). Utah Dam Safety has been involved project development and has been invited to review and comment on the Draft Plan-EA.

7.1.10 Private Landowners

Private landowners have been contacted through multiple media channels, including mailings, remote scoping meetings, postings of notifications in post offices and newspapers, and a NRCS website. A total of 106 initial mailings announcing a public scoping meeting were sent out on January 11, 2021. The mailing list will be updated as necessary throughout the project. An online public meeting was held on January 27, 2021. A question-and-answer session followed a presentation and description of the proposed project. Thirty-five comments were received during the scoping period. NRCS maintains a website that discusses the project and provides information on scheduled public events. Private landowners and other interested publics will continue to be involved through various notices (mailings, emails, etc.) as the project progresses.

7.2 Public Participation

7.2.1 Public Participation Plan

A Public Outreach Plan was completed and published in January 2021 (Transcon 2021b). The plan describes outreach activities to engage individual agencies, Tribes/THPOs, and interested members of the public regarding the project. At the conclusion of the project, Eocene will produce a Scoping Summary Report, which will summarize the outreach efforts described in this Plan and will include all comments received and issues raised.

7.2.2 Project Scoping

A public scoping process was conducted to identify relevant resources and environmental concerns to be analyzed in detail and to determine which ones could be eliminated from detailed study. A list of resource concerns was compiled for the project as outlined in the NWPM Section 501.24 B (NRCS 2015) and from input provided by the public or agencies during the scoping process.

The public was notified of the proposed project through multiple channels, including landowner notification, newspaper notices, an online public meeting, and the maintenance of an NRCS website. A public scoping meeting was held via Zoom on January 27, 2021. The meeting provided an opportunity for the public and various agencies to express any specific comments and concerns regarding the proposed project. The scoping period concluded on February 12, 2021. A total of 35 public comments, 2 agency comments, and 4 tribal comments were received. A Scoping Summary

Report was prepared that provides details of the scoping process, including public and agency comments received (**Appendix A**).

Potential resource issues/concerns and their relevancy to the Action Alternative are summarized in **Table S-4**. These are also analyzed in detail in **Section 6.0** of this Plan-EA. Resource issues determined not relevant to the Action Alternative have been eliminated from detailed study (see **Table 3-1**).

Ongoing discussions and consultations have been conducted with federal, tribal, state, and other agencies throughout the Plan-EA process. Those consulted or otherwise contacted include the USFWS, USACE, BLM St. George Field Office, UDWR, SHPO, UDWRe, Washington County, individual Tribes/THPOs, and private landowners.

7.2.3 Public Outreach

Table 7-2 summarizes the project's public outreach activities. The public was provided with opportunities to comment on the project. The Santa Clara Watershed Project Scoping Summary Report details public outreach efforts for the project (**Appendix E-10**, **Scoping Summary Report**).

Table 7-2. Public Outreach Activities

Date	Purpose	Type
January 11, 2021	Public notification	155 mailings were sent to landowners in Dammeron Valley and Diamond Valley.
January 13, 2021	Tribal outreach	Letters were sent to 14 Tribes/THPOs. Fact sheets were also included.
Ongoing	NRCS website	The NRCS maintains a public webpage that includes basic project data, the fact sheet, and instructions for submitting comments. A recording of the public meeting has been posted on the website.
January 13 and 20, 2021	Newspaper notices	A project summary and public meeting information were posted in the local newspaper, The Spectrum.
January 27, 2021	Online public meeting	The virtual public meeting included an identification of project background, location, and information on the environmental review process. A question-and-answer session followed. Comments were encouraged.

Date	Purpose	Type
January 10, 2021	Agency outreach	29 project fact sheets were sent to individuals at federal, state, and local agencies. Fact sheets were also sent to elected officials.
Final Plan-EA Outreach		
TBD	–	–
–	–	–

7.2.4 Agency Involvement

Twenty-nine federal, state, and local agencies were contacted during the scoping period that commenced on January 13, 2021, and concluded on February 12, 2021. Three agencies submitted comments. These were the Office of the Governor, Public Lands Policy Coordinating Office, and SITLA. Their comments are included in the Scoping Summary Report (**Appendix E-10**). No agencies have disapproved of the project.

Consultation with the USFWS had been ongoing throughout the Plan-EA preparation process. A BA has been prepared and submitted. The USFWS has reviewed the document and has concurred with the effects determinations presented in the BA.

As a cooperating agency, BLM St. George Field Office personnel have participated in bi-weekly planning meetings and have provided input and information that has been incorporated into the various documents associated with this project.

USACE has been consulted regarding WOTUS. An Aquatic Resource Delineation Report has been prepared for USACE review and approval.

Cooperating agencies are the BLM, Shivwits, and SITLA.

7.2.5 Agency Plan-Environmental Assessment Review

Will be prepared following the Draft Plan-EA comment period.

7.2.6 Plan-Environmental Assessment Public Comment

This will be completed following the public comment.

7.2.7 Final Plan-Environmental Assessment and Finding of No Significant Impact

This will be completed before the Final Plan-EA is published.

8.0 Action Alternative

8.1 Rationale for Action Alternative Selection

Alternatives were formulated following procedures outlined in the NWPM (NRCS 2015), National Watershed Program Handbook (NRCS 2014b), Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (USWRC 1983), and other NRCS watershed planning policies. As discussed in **Section 2.0** (Purpose and Need), the need exists to provide for enhanced flood control and improved water distribution in Washington County, Utah. Successful project development would increase public protection and rural resiliency. Residents within the project area currently experience occasional, sometimes severe flooding, and existing irrigation water distribution is not meeting user needs.

Existing structures are old, only partially functional, and have limited ability to control floods. Implementation of the Action Alternative would protect residents, homes, properties, the local watershed, and other infrastructure within Dammeron Valley and Diamond Valley and on Shivwits tribal lands. A more efficient irrigation system resulting in increased water availability would be provided along with erosion protection along the Santa Clara River. Flooding in this area has resulted in erosion of a historic agriculture field and damaged an irrigation pipeline. In addition to flood management, armoring along the river would also improve fish and wildlife habitat, including potential habitat for the endangered southwestern willow flycatcher on 0.53 mile of riparian habitat.

In total, the proposed project would provide improved flood protection in the affected communities for approximately 748 people, 69 homes, roads/highways, and approximately 57 acres of agricultural lands. An additional 30 acres of land would be made available for agricultural development. Due to the public benefits described above, the Action Alternative for the project was also determined to be the NEE Alternative.

Implementation of the Action Alternative would meet eligible program purposes as described in Title 390-National Watershed Manual 500.3 Eligible Purposes.

8.2 Applicant-Committed Environmental Protection Measures and Best Management Practices

The proposed project would include the construction of three detention basins in dry washes east of Dammeron Valley, the rerouting of existing flows to an adjacent channel on the south end of Dammeron Valley, the repair of three existing detention basins in Diamond Valley, armoring of an existing channel in Diamond Valley, and armoring portions of the south bank of the Santa Clara River near the junction of Gunlock Road and Old Highway 91. Two existing drainage ditches accessing the Santa Clara River would also be repaired and armored, and a pipeline would be installed to provide irrigation water to approximately 30 acres of the floodplain for agricultural purposes.

The following are applicant-committed mitigation and protection measures that would be implemented as part of the proposed project and would improve flood protection, agricultural water management, and watershed protection. The impact analysis in **Section 6.0** assumes that all of these measures would be fully implemented during construction and maintenance of the proposed project.

8.2.1 General Measures

The following general measures will be implemented:

- Implementation of the Action Alternative will comply with all applicable federal and state laws and regulations, as well as local zoning and building ordinances during all phases of the project
- Construction activities will be limited to the smallest extent practicable within the project area
- During construction activities, vehicle parking and material stockpiles will be located within designated staging areas
- Construction personnel will adhere to state and BLM fire prevention and suppression requirements
- Construction personnel will have fire tools and extinguishers available at all times
- BLM and local agency BMPs, including water application when needed, will be used to control fugitive dust levels during surface-disturbing activities
- In order to control stormwater discharges, BMPs will be used as needed, including material handling and temporary storage procedures that minimize exposure of potential pollutants to stormwater, spill prevention and response, sediment and erosion controls, and physical stormwater controls
- Prior to initiation of construction activities, all project personnel will attend environmental training led by a qualified biologist approved by the USFWS and the BLM. The training will identify T&E species potentially occurring in the project area and the appropriate course of action if such a species is encountered. Applicant-committed conservation and protection measures to avoid and minimize potential adverse impacts will be discussed
- Disturbance of natural vegetation will be limited to the extent necessary to complete the project to reduce the impact to native plant species and ground-nesting pollinators
- Areas of disturbance will be re-vegetated with native shrubs, forbs, and grasses as determined by the BLM and local agencies

8.2.2 Soils (Upland Erosion and Sedimentation)

- No ground disturbance will occur during or immediately following precipitation events or under any wet conditions that would create deep ruts
- Upon completion of construction activities, the disturbed areas will be recontoured to minimize erosion and compaction, restore natural ground cover, reestablish plant growth, and allow natural surface drainage
- Silt fences, straw bales, and/or other appropriate BMPs will be used to minimize erosion of disturbed areas if needed

8.2.3 Air Quality

- Appropriate emission control devices on all construction equipment will be required
- Only properly operating, well-maintained construction equipment will be used
- Water or an approved dust suppressant/soil binder will be applied to disturbed areas, as necessary, to reduce fugitive dust and to limit visual and air quality impacts
- Watering or covering loads to reduce emissions during material transportation/handling will be used, as necessary
- A stabilized construction entrance (track-out pad), wheel washers, and/or other similar BMPs at construction site access points will be provided to reduce track-out of site materials onto the adjacent roadway network
- Material stockpiles will be watered, as necessary, to prevent windblown dust
- Vegetation cover will be established in disturbed areas as soon as possible to reduce windblown dust

8.2.4 Water (Surface Water Quality)

- No project activities or related disturbance will occur within any wetlands or below the OHWM of any jurisdictional ephemeral, intermittent, or perennial stream
- In order to control stormwater discharges, BMPs will be used as required, including material handling and temporary storage procedures that minimize exposure of potential pollutants to stormwater, spill prevention and response, sediment and erosion controls, and physical stormwater controls
- A Stormwater Pollution Prevention Plan (SWPPP) will be prepared and adhered to during construction
- Fueling of vehicles and equipment will be prohibited within 100 feet of any riparian areas

8.2.5 Vegetation (Excluding U.S. Fish and Wildlife Service-Designated Species)

- The applicant will remove only the minimum amount of vegetation necessary for construction or maintenance activities
- Where seeding is required, the applicant will use a BLM- and NRCS-approved, weed-free, native seed mix
- Established cottonwood trees in riparian areas would be left in place for fish and wildlife habitat

8.2.6 Noxious Weeds and Invasive Plant Species

- A detailed weed control plan will be provided to the BLM, NRCS, and local agencies for approval before construction begins
- All equipment will be cleaned of soils, seeds, vegetation matter, and other debris prior to entering or reentering the project area
- Vegetation will be monitored periodically for potential establishment of noxious weeds or other undesirable plant species. If needed, the applicant will be responsible for weed control in disturbed areas within the project area, including consultation with the authorized officer and/or local authorities in determining acceptable weed control methods
- The applicant will follow BLM and NRCS regulations pertaining to control of noxious weeds; use of herbicides also would comply with BLM and NRCS requirements
- Post-construction period weed control will be the responsibility of Washington County
- Any use of herbicides will comply with federal and state requirements

8.2.7 U.S. Fish and Wildlife Service Threatened, Endangered, and Candidate Species

8.2.7.1 Southwestern Willow Flycatcher

The following measures related to the federally listed southwestern willow flycatcher will be implemented:

- No construction activities will occur within 0.25 mile of suitable habitat for southwestern willow flycatcher within the nesting season (April 15 through August 31) unless a permitted surveyor conducts species surveys according to USFWS southwestern willow flycatcher survey protocol and no nests or individuals are detected
- If construction schedules are unexpectedly changed, additional consultation with the BLM and USFWS will be necessary to discuss the ability to work within parts of those spatial and seasonal buffers
- If determined necessary by the USFWS, Washington County will restore disturbed southwestern willow flycatcher habitat to equal or better condition than that lost or disturbed through construction or maintenance activities. The specific areas to be mitigated will be determined by the USFWS, the BLM, and other involved parties

8.2.7.2 Desert Tortoise

The following measures related to the federally listed desert tortoise will be implemented:

- Suitable habitat with potential for desert tortoise will be surveyed according to USFWS protocol by a qualified biologist (who has taken the mandatory desert tortoise survey training) within 1 year prior to construction (USFWS 2018)

- If a desert tortoise is encountered in the project area during construction, the animal will not be approached or handled, and all nearby project activities will be halted. The USFWS will be notified, and construction activities will not recommence until the USFWS provides approval

- To reduce the potential for running over desert tortoises, vehicle and equipment speeds will not exceed 20 miles per hour in the project area

- The underside of any parked vehicles and equipment will be checked for desert tortoises seeking shelter prior to moving the vehicle or equipment

- To prevent entrapment of wildlife during construction, all open pits and trenches will be monitored throughout the construction day

- At the beginning of the construction day and before they are filled, pits and trenches will be inspected for trapped tortoises. If any animals are found, they will be moved out of harm's way by a qualified biologist approved by the USFWS

8.2.7.3 Dwarf Bear-Claw Poppy, Holmgren Milkvetch, and Shivwits Milkvetch

The following measures related to the federally-listed dwarf bear-claw poppy, Holmgren milkvetch, and Shivwits milkvetch will be implemented:

- USFWS protocol-level surveys will be conducted within 1 year prior to construction for federally-listed plant species in order to identify occupied and potential habitat and develop protective measures

- Ground-disturbing activities will not occur within 300 feet of any dwarf bear-claw poppy during its flowering season (mid-April through May) unless authorized by BLM and USFWS botanists. A survey conducted in 2021 did not locate any dwarf bear-claw poppies within the project area

- If Holmgren milkvetch and Shivwits milkvetch are determined to be present, ground-disturbing activities will not occur within 300 feet during their flowering season (April through June) unless authorized by BLM and USFWS botanists. A survey conducted in 2021 did not locate either species within the project area

- The project area will be watered as needed (at least three times per day when dry conditions are present) within 300 feet of dwarf bear-claw poppy, Holmgren milkvetch, and Shivwits milkvetch locations to keep dust down and limit any adverse impacts to the plants, especially if construction must occur during the flowering season

8.2.7.4 Monarch Butterfly (Candidate Species)

- Native milkweed (Asclepias spp.) and pollinator-friendly plant species will be included in reclamation seed mixes per BLM and USFWS guidance

- Disturbance of milkweed habitat will be avoided to the extent possible

8.2.8 Fish and Wildlife (Excluding U.S. Fish and Wildlife Service-designated Species)

- To prevent entrapment of wildlife during construction, all open pits or trenches will be monitored throughout the construction day

- Excavated holes more than 2 feet deep will be covered at the close of each day or provided with one or more escape ramps. Alternatively, fencing may be erected around open pits or trenches

- Before pits or trenches are filled, they will be inspected for trapped animals. If any animals are found, they will be moved out of harm's way by a qualified biologist approved by the UDWR or NRCS

- No rodenticides will be used on the project site

8.2.9 Migratory Birds/Bald and Golden Eagles

- Where possible, construction activities involving habitat alteration and noise will occur outside of Utah's migratory bird primary nesting season (April 1 through July 15). In Utah, the migratory bird nesting season can extend from January 1 through August 31 (especially for raptors); therefore, a pre-construction survey by a qualified biologist (less than 7 to 10 days prior to when work begins on the project site) will be conducted for nesting birds. After such surveys are performed, the applicant will not conduct any additional disturbance during the avian breeding season without first conducting another avian survey

- If an active nest is identified, the BLM biologist will be notified, and a no-activity buffer (ranging from 100 feet to 1 mile, depending on species) will be established around the nest site and remain in place until the young have fledged and/or the nest becomes inactive (USFWS 2002). After August 31, no further avian surveys will be required until the next year

- Activities will comply with Utah BLM BMPs for Raptors and Their Associated Habitats in Utah (BLM 2006). Project activities will not occur within recommended spatial and seasonal buffers for raptors unless otherwise approved by the BLM and local agencies. If existing topography limits line of sight between an active nest and construction activities, spatial and seasonal buffers may be reduced

8.2.10 Riparian Areas

- No mature riparian trees will be removed during construction activities unless approved by the UDWR and NRCS

- No machinery will be allowed in the Santa Clara River

8.2.11 Historic Properties/Cultural Resources

- Shivwits Site: All Eligible site boundaries will be flagged, a pre-construction meeting will be held to train construction personnel on cultural resources, and a full-time archaeological and tribal monitor will be present for all ground-disturbing activities within 15-meters of each Eligible site boundary

- If cultural resources are discovered during construction activities, all ground-disturbing activities within 50 feet of the discovery shall cease, the NRCS (and BLM or SITLA, where appropriate) archaeologist will be notified, and the post-review discovery procedures with be followed, as outlined in the Prototype Programmatic Agreement between the NRCS and SHPO

- If the applicant revises the location of any ground-disturbing activities that will impact areas beyond those previously surveyed and analyzed in this Plan-EA, the applicant shall notify the NRCS and per 36 CFR 800.8(C)(5), the NRCS shall notify the Advisory Council on Historic Preservation and all consulting parties that supplemental environmental documents will be prepared in compliance with NEPA and that the procedures in 36 CFR 800.3 through 36 CFR 800.6 will be followed as necessary. A new cultural resources evaluation—with background research, Class III survey (as needed), and evaluation of visual resource concerns—will be conducted. The NRCS (and BLM or SITLA, where applicable) archaeologist will be consulted

- If human remains/funerary objects are discovered under any circumstances, all work in the immediate vicinity (100 feet) will immediately halt, and the Washington County Sherriff, the NRCS (and BLM or SITLA, where applicable) archaeologist, and the Utah State History's Human Remains Program will be contacted

- Procedures outlined in the Prototype Programmatic Agreement between the NRCS and SHPO shall be followed

- Construction personnel will be instructed to be observant for cultural/historic objects and to follow the post-review discovery procedures

- Training will be conducted by an archaeologist approved by the NRCS

8.2.12 Visual Resources

- Visible structures (including metal structures) will be painted or otherwise treated to not be shiny or reflective. Facilities will be of a color that blends into the surrounding landscape (no bright colors such as red, yellow, or orange will be used)

- Areas disturbed during construction activities will be restored to pre-construction conditions. This will be accomplished by grading to match natural contours and stabilizing through establishment of ground cover. These areas will be re-established by seeding with an herbaceous plant seed mixture and revegetation with NRCS-approved plant species to match the surrounding native plant community

8.2.13 Traffic

- Signs will be posted in local communities regarding the schedule for construction at the proposed sites

- Construction haul trucks will utilize caution and maintain safe travel speeds and distances

8.2.14 Noise

- Construction noise levels will be minimized to the extent possible with proper maintenance of construction equipment and the use of approved noise mufflers

8.2.15 Hazardous Materials and Wastes

- The NRCS requires that contractors comply with all federal, state, and local laws/regulations pertaining to pollution and contamination of the environment to prevent pollution of surface water, groundwater, soil, and air with any hazardous materials
- Construction sites, staging areas, and access roads will be kept orderly during construction
- Refuse and trash, including stakes and flags, will be removed and properly disposed of on a regular basis
- Portable toilets will be used on-site and maintained on a regular schedule
- No oil or fuel will be drained on the ground; oils or chemicals will be hauled to an approved site for disposal
- Diesel fuel, hydraulic fluids, and engine oil products will be the only hazardous material liquids used on-site
- All toxic substances (e.g., oil, gas, antifreeze) will be stored in closed containers at all times. Accidental spills will be cleaned up immediately
- A hazardous materials spill kit that is appropriate for the solvents involved in the O&M of vehicles and machinery used during the project will be kept on-site during construction
- The BLM, NRCS, and other regulatory agencies will be immediately contacted in the event of a fuel/oil or hazardous material spill. Actions will be taken to minimize the amount and spread of the spilled material, including using straw bale plugs, earthen berms, and absorbent materials. If necessary, soil remediation will be conducted, including the removal of contaminated soils to an approved facility and soil sampling to verify successful site remediation
- Washington County will be responsible for compliance with applicable local, state, and federal regulations related to the use, handling, storing, transporting, and disposing of hazardous materials on non-federal lands

8.2.16 Public Health

- During construction, all personnel will be required to conform to contractor safety procedures. All personnel will be adequately trained to perform their tasks

- Heavy equipment will be outfitted with Occupational Safety and Health Administration-required safety devices such as backup warnings and seat belts

- Hard hats, safety boots, ear/eye protection, and other personal safety equipment will be used on-site

- All accidents and injuries will be reported to the appropriate contractor safety officer

8.2.17 Fire Prevention and Protection

- Construction staff will adhere to BLM and local fire prevention and suppression requirements; allconstruction personnel will have fire tools and extinguishers available at all times

8.2.18 Construction Site Restoration

- A detailed restoration plan (revegetation and long-term weed management) will be provided to the NRCS for approval before construction. Seed would be distributed in a manner required by the NRCS (e.g., hand broadcast seeding; covering the seed with a rake or a device pulled by an all-terrain vehicle)

- All temporary ground disturbance areas will be restored to the original contours and revegetated following construction

- Where seeding is required, the applicant will use a BLM- and NRCS-approved, weed-free, native seed mix

- Soil removed during construction will be reused. Topsoil will be kept separated from subsoil to preserve the seed bank

- Vegetation removal will be kept to the minimum amount necessary

8.2.19 Compensatory Mitigation Measures

No compensatory mitigation would be required for the Action Alternative.

8.2.20 Mitigation Commitments

The applicant-committed mitigation and environmental protection measures and BMPs identified in **Section 8.2** are considered part of the proposed project. The impact analysis in **Section 6.0** and summarized above assumes that all of these measures would be fully implemented. No compensatory mitigation would be required for the Action Alternative.

8.3 8.3 Permits and Compliance

The federal, tribal, state, and local permits and compliance actions described in this section would be required for development of the Action Alternative. A Watershed Agreement and a Memorandum of Understanding (MOU) shall be completed and signed by the NRCS and SLO prior to the obligation of construction funds for the Project.

8.3.1 Federal

8.3.1.1 NRCS

This Plan-EA has been prepared under the authority of the NRCS Watershed and Flood Prevention Operations Program, which authorizes funding to help urban and rural communities protect, improve, and develop land resources in watersheds up to 250,000 acres in size. During the NHPA Section 106 consultation process, the NRCS determined that the project would result in No Adverse Effect to Historic Properties, and the Utah SHPO concurred with this determination.

8.3.1.2 U.S. Fish and Wildlife Service

The project area has been evaluated for the potential occurrence of federally-listed threatened, endangered, or candidate plant and animal species or their habitat. The USFWS IPaC site was accessed, and a BA (**Appendix A**) has been completed for the proposed project. Six federally-listed and candidate species were identified as potentially occurring within or near the project area. It was determined that no species would be adversely affected by project development. The USFWS has concurred with this determination, and no permits would be required for this project.

8.3.1.3 U.S. Army Corps of Engineers

A USACE jurisdictional determination should be made for potential WOTUS within the project area. Section 404 permitting would be required if waters are determined to be jurisdictional. Consultation with the USACE is ongoing. To date, the only identified WOTUS in the project area is the Santa Clara River. It is unlikely that the ditches or washes in the project are WOTUS because they only carry water in response to precipitation events and are dry the remainder of the time. A small wetland in the Shivwits portion of the project area would not be affected by project development. The USACE is currently assessing findings from a delineation report prepared for this project, and further Section 401/404 permitting requirements will be determined at a later date; they will be based on the total amount of impact to any CWA jurisdictional delineations. Bureau of Land Management

The BLM has federal approval authority on public lands they administer. The BLM has agreed to be a cooperating agency in the preparation of the Plan-EA. This Plan-EA will serve as the necessary environmental documentation for actions located on BLM-administered public lands and requiring BLM approval. The BLM federal action is to respond to Washington County's application to issue a ROW grant to install or make repairs to the structures located on public lands as established by the BLM's statutory and regulatory responsibilities regarding ROWs under the Federal Land Policy and Management Act of 1976 (43 CFR 2800).

8.3.1.4 Farm Production and Conservation (FPAC) Business Center

The FPAC is responsible for financial management, budgeting, human resources, information technology, acquisitions/procurement, customer experience, internal controls, risk management, strategic and annual planning, and other similar activities for the FPAC Mission Area and its component agencies, including the NRCS.

8.3.2 Tribal

8.3.2.1 Shivwits Band of Paiute Indians

The Shivwits is a federally recognized Tribe and has tribal approval authority on the reservation. The Tribe has agreed to be a cooperating agency in the preparation of this Plan-EA. This Plan-EA will also serve as the necessary environmental documentation of actions located on Shivwits land and requiring Shivwits administration approval. The Shivwits tribal action is to grant access to Washington County to install or make repairs to the structures located on the reservation. The Shivwits Land Use Plan identifies the Shivwits portion of the project area as potential agricultural land (Shivwits 1999).

8.3.3 State of Utah

8.3.3.1 Utah Division of Water Rights

Approval will be required for the final design report, construction drawings, and specifications by the Utah State assistant engineer.

8.3.3.2 Utah Division of Water Quality

Under Section 401 of the CWA, approval will be required so that the project does not violate state water quality standards. Certification is obtained as part of the USACE Section 404 Permit review process. Under Section 402 of the CWA, a Utah Pollutant Discharge Elimination System Stormwater General Permit for Construction Activities is required for construction activities that disturb more than 1 acre and discharge pollutants to surface waters. An SWPPP will be developed, including submitting a Notice of Intent to the Utah Division of Water Quality.

8.3.3.3 Utah State Historic Preservation Office

If, during construction, previously unidentified cultural resources or human remains/funerary objects are discovered, work would be stopped, and an NRCS archaeologist (or BLM or SITLA, where appropriate) must be consulted to evaluate their nature and significance. Procedures for discoveries outlined in the USDA-NRCS State-Level Prototype Programmatic Agreement would be followed.

8.3.3.4 Utah Division of Oil, Gas, and Mining

If riprap is obtained from a source that does not have an existing mining permit, a mining operations permit would be required to mine the riprap.

8.3.3.5 Utah Department of Environmental Quality

A Utah Pollutant Discharge Elimination System Construction General Permit is required for construction activities that disturb more than 1 acre and discharge pollutants to surface waters. An SWPPP would be developed, including submitting a Notice of Intent to the UDEQ. A 401 Water Quality Certification Application may also need to be completed for project measures.

8.3.3.6 Utah Dam Safety

Approval will be required for the final design report, construction drawings, and specifications by the Utah State assistant engineer.

8.3.3.7 Utah Trust Lands Administration

An easement would be required prior to any surface-disturbing activities occurring on lands administered by the UTL administration. This Plan-EA would serve as the UTLA's environmental documentation for this action.

8.3.4 Local

A Watershed Agreement and an MOU would be completed and signed by the NRCS and Washington County prior to the obligation of construction funds for development of the proposed project.

Any additional county and local permits required for this proposed project would be obtained prior to construction.

8.4 Installation and Financing

8.4.1 Planned Sequence of Installation

Washington County would obtain all approvals and permits for the project prior to beginning construction activities. These may take up to 1 year to obtain. The three separate project sites (Dammeron Valley, Diamond Valley, and the Shivwits site) would be developed independently and would not be dependent on each other for sequence of development.

Dammeron Valley and Diamond Valley: Construction work at these two sites would occur over an approximate 12-month period. Work would be completed in late fall to early spring to avoid winter runoff and the summer monsoon season.

Shivwits Site: Construction would occur over an approximate 7-month period between September 1 and April 1 to avoid disturbance to potential sensitive bird nesting habitat. The action would occur within the overall 12-month development period assumed for the overall project.

8.4.2 Responsibilities

The 1963 Watershed Work Plan identifies the responsibilities of NRCS for this project. The roles and responsibilities for NRCS and Washington County, the SLO, would continue in accordance with this Plan-EA, the Watershed Agreement, and the MOU. NRCS is responsible for leading the planning efforts and providing engineering support, Washington County is responsible for environmental permits and construction implementation, and NRCS and Washington County are responsible for the project design. NRCS would assist Washington County during construction by providing oversight and certifying completion of the project.

8.4.3 Contracting

Activities associated with the Action Alternative received from NRCS funding mechanisms would be procured using awarded contracts. Washington County would oversee and administer construction of the project in coordination with NRCS.

8.4.4 Real Property and Relocations

Property within the project area is located on private, tribal, BLM, and UTLA lands (**Figures 1.5**, **1.6**, and **1.7**). Easements for proposed developments (including egress/ingress), future O&M activities, or property acquisition would need to be obtained.

8.4.5 Financing

This watershed plan must be authorized before funding may be made available for project operations. The NRCS would provide funding from the Watershed Protection and Flood Prevention Act (PL 83-566, as amended by PL 106-472) at the percentages identified in **Table 8-1**. Federal assistance varies by project-authorized purpose, and alternative measures include purposes of flood prevention, watershed protection, public recreation, and agricultural water management. Washington County is responsible for providing the remaining non-federally funded portions of the project (**Table 8-2**).

Table 8-1. Cost-Shareable Items Operation, Maintenance, and Replacement Cost by Project Increment (Dollars)

Works of Improvement	%[2]	NRCS	%[2]	Sponsors	Total
Construction Costs	100%	$13,079,995	0%	$0	$13,079,995
Engineering Technical Assistance Costs[3]	100%	$1,019,616	0%	$0	$1,019,616
Project Administration Costs [1]	100%	$504,808	0%	$0	$504,808
Subtotal	–	$14,604,418	–	$0	$14,604,418
Cost-Shareable and Non-Cost-Shareable Total	99%	$14,604,418	2%	$357,500	$14,961,918

Footnote for Table 8-1:

[1] The sponsors and NRCS will each bear the costs of project administration that each incurs.

[2] As per NWPM Section 500.42 and Figure 500-E2. PL-566, cost share rates depend on the authorized purposes of the particular watershed plan. For flood prevention measures, PL-566 pays 100 percent of construction and engineering. Installation of compensatory mitigation is considered part of the construction of the flood control measure (per text between Figures 500-E1 and 500-E2). Real property rights acquisition is 100 percent sponsor cost for most PL-566 activities. However, acquisition of property rights for mitigation and recreation may be cost-shared (see referenced sections).

[3] Cost-sharable at 100 percent NRCS if sponsor hires engineering for structure design. Not cost-shareable if sponsor's engineering is for elements required for real property rights (road improvements, power line modification, livestock water supply line, etc.).

Source: Economic Investigation and Analysis Report. Santa Clara Watershed Plan. Hal Gordon, May 2025

Table 8-2. Non-Cost-Shareable Items Operation, Maintenance, and Replacement Cost by Project Increment (Dollars)

Works of Improvement	%[2]	NRCS	%[2]	Sponsors	Total
Construction Costs	0%	$0	100%	$288,100	$288,100
Engineering Costs	0%	$0	100%	$2,600	$2,600
Real Property Landrights[3]	0%	$0	100%	$65,000	$65,000
Mitigation	0%	$0	100%	$0	$0
Permits	0%	$0	100%	$1,800	$1,800
Project Administration Costs [1]	0%	$0	100%	$0	$0
Subtotal	–	$0	-	$357,500	$357,500
Cost-Shareable and Non-Cost-Shareable Total	99%	$14,604,418	2%	$357,500	$14,961,918

Footnote for Table 8-2:

[1] The sponsors and NRCS will each bear the costs of project administration that each incurs.

[2] As per NWPM Section 500.42 and Figure 500-E2. PL-566, cost share rates depend on the authorized purposes of the particular watershed plan. For flood prevention measures, PL-566 pays 100 percent of construction and engineering. Installation of compensatory mitigation is considered part of the construction of the flood control measure (per text between Figures 500-E1 and 500-E2). Real property rights acquisition is 100 percent sponsor cost for most PL-566 activities. However, acquisition of property rights for mitigation and recreation may be cost-shared (see referenced sections).

[3] Construction elements required to satisfy real property rights are also 100 percent sponsor cost.

Source: Economic Investigation and Analysis Report. Santa Clara Watershed Plan. Hal Gordon, May 2025

Funding for O&M of facilities after construction would be derived from normal revenues from Washington County. This O&M cost would be budgeted annually so that the structures are maintained in good condition.

8.5 Operation and Maintenance

Operation includes the administration, management, and performance of other actions needed to keep the proposed Santa Clara Watershed Project safe and functioning as planned. Maintenance includes performance of work, preventing deterioration, and repairing damage or replacement of structures if one or more of their components fail. Damage to any of the completed structures caused by normal deterioration, droughts, flooding caused by rainfall in excess of design, or vandalism are considered maintenance. Maintenance would include both routine and as-needed measures.

Measures in this plan would be operated and maintained by Washington County with technical assistance from appropriate federal, state, and local agencies in accordance with their delegated authority. A specific O&M Plan would be prepared using the NRCS National O&M Manual (NRCS 2003). Washington County's liability for O&M would extend throughout the actual life of the structure.

An O&M Agreement would be developed prior to construction that would provide for inspections, reports, and procedures for performing the maintenance items. The agreement will include specific provisions for retention, use, and disposal of property acquired or improved with PL 83-566 assistance. The term of this new O&M Agreement will be for the life expectancy of the project. The O&M costs after construction would be approximately $162,142 annually (Dammeron Valley $76,869; Diamond Valley $84,783; Shivwits Area $490) as shown in **Table 8-3**.

The structures would be inspected by Washington County on a regularly scheduled basis and during, or immediately following, major storms, earthquakes, or other occurrences that may adversely affect the structures and appurtenant works.

Table 8-3. Estimated Average Annual Costs for Alternatives (Dollars)[1]

Evaluation Unit	Amortization of Installation Cost	Operation, Maintenance, & Replacement	Total
Dammeron Valley	$281,800	$76,869	$358,669
Diamond Valley	$222,300	$84,783	$307,083
Shivwits Area	$36,600	$490	$37,090
Grand Total	$540,700	$162,142	$702,842

Footnote for Table 8-3:

[1] Discount rate 2.5 percent with a 51-year period of analysis. Price base 2022.

Source: Economic Investigation and Analysis Report. Santa Clara Watershed Plan. Hal Gordon, May 2025

8.6 Costs

The installation cost estimate for the Action Alternative (NEE Alternative) is $14,970,418, as identified in **Table 8-4**. Economic tables have been included to present information relevant to the costs and benefits of the Action Alternative and NEE Alternative. Structural tables have been included to present the relevant structural information pertinent to the design of the Action Alternative. The costs for the Action Alternative are conceptual-level cost estimates only, with an estimated range of accuracy at ±30 percent. Detailed structural designs and construction cost estimates would be prepared for the project during the final design phase and prior to the start of the competitive bidding process. The final cost of the project would be the price received from the winning construction bid plus or minus the amount of contract modifications. Assessments, considerations, and calculations are based on a 51-year evaluation period and a discount rate of 2.5 percent (Federal Water Resources FY 2023 discount rate). The estimated installation cost in **Table 8-4** documents land status upon which the project structures reside, as well as federal and non-federal funding sources, respectively.

Table 8-4. (Economic Table 1). Economic Estimated Installation Costs Santa Clara Watershed Project (Dollars)[1]

Installation Cost Items–	PL-83-566 Funds Estimated Cost	Other Funds Estimated Cost	Total Estimated Cost
Dammeron Valley Site[1]	$7,724,290	$72,400	$7,796,690
Diamond Valley Site[1]	$6,130,328	$22,500	$6,152,828
Shivwits Site[1]	$758,925	$261,975	$1,020,900
Project Total	$14,613,543	$356,875	$14,970,418

Footnote for Table 8-4:

[1] Price Base 2022.

Source: Economic Investigation and Analysis Report. Santa Clara Watershed Plan. Hal Gordon, May 2025

The estimated cost distribution shown in **Table 8-5** depicts the estimated installation cost distribution between PL 83-566 funds and the costs borne by Washington County for the three project sites.

Table 8-5. (Economic Table 2). Economic Estimated Cost Distribution[1]—Water Resource Project Measures Santa Clara Watershed Project (Dollars)

Installation Cost Items[2]	Dammeron	Diamond	Shivwits	Total Project
PL-83-566 Funds: Construction Costs	$6,896,688	$5,473,508	$728,925	$13,099,121
PL-83-566 Funds: Engineering Technical Assistance Costs	$551,735	$437,881	$22,500	$1,012,116
PL-83-566 Funds: Project Administration Costs	$275,868	$218,940	$7,500	$502,308
Total PL-83-566 Costs	$7,724,291	$6,130,329	$758,925	$14,613,545
Other Funds: Construction Costs	$6,000	$20,000	$242,975	$268,975
Other Funds: Engineering Costs	$600	$2,000	$7,500	$10,100
Other Funds: Real Property Land Rights	$65,000	$0	$0	$65,000
Other Funds: Permits	$800	$500	$500	$1,800
Other Funds: Mitigation	$0	$0	$8,500	$8,500
Other Funds: Project Administration Costs	$0	$0	$2,500	$2,500
Total Other Funds	$72,400	$22,500	$261,975	$356,875
Total Project Cost	$7,796,690	$6,152,828	$1,020,900	$14,970,418

Installation Cost Items[2]	Dammeron	Diamond	Shivwits	Total Project
Amortized Costs[1]	$281,800	$222,300	$36,900	$541,000
Annual OM&R	$76,869	$84,783	$490	$162,142
Total Annual Costs	$358,669	$307,083	$37,390	$703,142

Footnote for Table 8-5:

[1] Discount rate 2.5 percent with a 51-year period of analysis. Price base 2022.

[2] All costs towards the Project Purpose of Flood Prevention.

Source: Economic Investigation and Analysis Report. Santa Clara Watershed Plan. Hal Gordon, May 2025

Table 8-6 depicts the estimated average annual NEE costs amortized over the period of analysis (51 years).

Table 8-6. (Economic Table 4). Estimated Average Annual NEE Costs Santa Clara Watershed, Utah (Dollars)[1]

Project Sites	Amortization of Installation Cost	Operation, Maintenance, Replacement Cost	Total
Dammeron Valley Site	$281,800	$76,869	$358,669
Diamond Valley Site	$222,300	$84,783	$307,083
Shivwits Site	$36,900	$490	$37,390
Total	$541,000	$162,142	$703,142

Footnote for Table 8-6:

[1] Discount rate 2.5 percent with a 51-year period of analysis. Price base 2022.

Source: Economic Investigation and Analysis Report. Santa Clara Watershed Plan. Hal Gordon, May 2025

Table 8-7 summarizes the results of the flood damage reduction benefits analysis conducted for this project. **Table 8-8** provides a summary of annual watershed protection damage reduction benefits. Implementation of the Action Alternative would reduce projected flood damages (up to and including a 100-year storm event) and restore agricultural lands.

Table 8-7. (Economic Table 5). Estimated Average Annual Flood Damage Reduction Benefits Santa Clara Watershed Project (Dollars)[1]

(Dammeron Valley, Diamond Valley, Shivwits Site) Item	(Average Annual Damages Without Project) Ag Related	(Average Annual Damages Without Project) Non-Ag Related	(Average Annual Damages with Project) Ag Related	(Average Annual Damages with Project) Non-Ag Related	(Average Annual Benefits) Ag Related	(Average Annual Benefits) Non-Ag Related
Floodwater Damage: Structures, Contents, Vehicles	$0	$3,061,847	$0	$80,909	$0	$2,980,938
Floodwater Damage: Roads	$0	$2,182	$0	$0	$0	$2,182
Floodwater Damage: Crop and Pasture	$363	$0	$3	$0	$360	$0
Floodwater Damage: Subtotal	$363	$3,064,029	$3	$80,909	$360	$2,983,120
Sediment/Erosion Damage: Sediment Deposition	$25	$844	$5	$40	$20	$804
Sediment/Erosion Damage: Floodplain Scour	$147	$8,231	$11	$138	$136	$8,093
Sediment/Erosion Damage: Road and Bridge	$0	$0	$0	$0	$0	$0
Sediment/Erosion Damage: Urban	$0	$0	$0	$0	$0	$0
Sediment/Erosion Damage: Subtotal	$172	$9,076	$16	$178	$156	$8,897
Indirect Damage	$0	$0	$0	$0	$0	$0
Grand Total	$535	$3,073,104	$20	$81,087	$516	$2,992,017

Footnote for Table 8-6:

[1] Discount rate 2.5 percent with a 51-year period of analysis. Price bases 2022.

Source: Economic Investigation and Analysis Report. Santa Clara Watershed Plan. Hal Gordon, May 2025

Table 8-8. (Economic Table 5A). Estimated Average Annual Flood Damage Reduction Benefits Summary Santa Clara Watershed Project (Dollars)[1]

Item	Damage Reduction Benefit
Floodwater Damage: Structures, Contents, Vehicles	$2,980,938
Floodwater Damage: Roads	$2,182
Floodwater Damage: Crops and Pasture	$360
Floodwater Damage Subtotal	$2,983,480
Sediment/Erosion Damage: Sediment Deposition	$824
Sediment/Erosion Damage: Flood Plain Scour	$8,230
Sediment/Erosion Damage: Road and Bridge	$0
Sediment/Erosion Damage: Urban	$0
Sediment/Erosion Damage Subtotal	$9,053
Indirect Damage	$0
Total	$2,992,533

Footnote for Table 8-7:

[1] Price base: 2021. Calculated using FY 2022 Water Resources Discount Rate (2.5 percent), annualized over 50 years, and 51-year period of analysis. Prepared June 2023.

Source: Economic Investigation and Analysis Report. Santa Clara Watershed Plan. Hal Gordon, May 2025

Table 8-9 summarizes the benefits and costs of the project and documents the overall benefit to cost ratio of the proposed improvements. It is recognized that the benefit-cost ratio for the Shivwits portion of the project area is not favorable financially. However, the Shivwits Band strongly supports implementing the Proposed Action. In a letter of support dated August 3, 2023 (Appendix A), the Band stated that the Proposed Project is vital for the benefit of the Shivwits culturally, socially, and economically. The letter identifies several of these benefits including making the area once again available for traditional agricultural crops and orchards. The Band plans to bring back the Bear Dance that was once held in the area. In summary, the Band concluded that the Proposed Action would "…extend further than simply restoring agricultural fields, and will strengthen Shivwits cultural connections, revitalizing it as a gathering area, and connecting our younger generations with the elders. This project is key to assisting the Shivwits Band in restoring our agriculture, increasing irrigation efficiency, passing down our traditional knowledge to our youth, and continuing our cultural traditions. It is paramount that the Santa Clara Watershed Plan-EA move forward given the significant social, cultural, and economic benefits that it provides to the Shivwits Band."

Table 8-9. (Economic Table 6). Comparison of Annual NEE Benefits and Costs Santa Clara Watershed Project (Dollars)[1]

–	Average Annual Costs[3]	Average Annual Benefits[2]	Benefit-Cost Ratio	Net Benefits
Dammeron Alt 1	$358,669	$1,074,410	3.00	$715,741
Diamond Alt 1	$307,083	$1,917,963	6.25	$1,610,880
Shivwits Alt 1	$37,390	$160	0.0043	-$37,230
Grand Total	**$703,142**	**$2,992,533**	**4.26**	**$2,289,391**

Footnote for Table 8-8:

[1]Discount rate 2.5 percent with a 51-year period of analysis. Price base 2022.

[2]Taken from **Table 8-4**.

[3]Taken from **Tables 8-5** and **8-6**.

Source: Economic Investigation and Analysis Report. Santa Clara Watershed Plan. Hal Gordon, May 2025

8.7 Structural Tables

Structural data evaluating the proposed measures in the Preferred Alternative, including structures with planned storage capacity and channel work are found in Tables 8-10 and 8-11.

Table 8-10. Structural Data – Dammeron Valley Dams with Planned Storage Capacity (Santa Clara Watershed) (Utah)[1]

Item	Unit	Structure No.	Total
Class of Structure	-	Dammeron 1	High
-	-	Dammeron 2	High
-	-	Dammeron 3	High
Seismic Zone	-	Dammeron 1	U-2
-	-	Dammeron 2	U-2
-	-	Dammeron 3	U-2
Uncontrolled Drainage Area	Square Miles	N/A	-
Controlled Drainage Area	Square Miles	Dammeron 1	0.284
-	-	Dammeron 2	3.572
-	-	Dammeron 3	0.734
Total Drainage Area	Square Miles	Dammeron 1	0.3
-	-	Dammeron 2	3.6
-	-	Dammeron 3	0.7

Item	Unit	Structure No.	Total
Runoff Curve No. (1-day) (AMC II)	-	Dammeron 1	86.8
-	-	Dammeron 2	83.9
-	-	Dammeron 3	87.9
Time of Concentration (Tc)	Hours	Dammeron 1	0.20
-	-	Dammeron 2	1.66
-	-	Dammeron 3	0.62
Elevation Top Dam	Feet	Dammeron 1	4,694.5
-	-	Dammeron 2	4,700.2
-	-	Dammeron 3	4,700.2
Elevation Crest Auxiliary Spillway	Feet	Dammeron 1	4,691.5
-	-	Dammeron 2	4,697.0
-	-	Dammeron 3	4,697.0
Elevation Crest Low Stage Inlet	Feet	Dammeron 1	4,678.0
-	-	Dammeron 2	4,667.0
-	-	Dammeron 3	4,675.0
Auxiliary Spillway Type		Dammeron 1	Earth
-	-	Dammeron 2	Earth
-	-	Dammeron 3	Earth
Auxiliary Spillway Bottom Width	Feet	Dammeron 1	90
-	-	Dammeron 2	450
-	-	Dammeron 3	450
Auxiliary Spillway Exit Slope	Percent	-	-
Maximum Height of Dam	Feet	Dammeron 1	33.5
-	-	Dammeron 2	38
-	-	Dammeron 3	38
Volume of Fill	Cubic Yards	Dammeron 1	2,620
-	-	Dammeron 2	31,835
-	-	Dammeron 3	31,840
Total Capacity	Acre-Feet	Dammeron 1	26

Item	Unit	Structure No.	Total
-	-	Dammeron 2	392
-	-	Dammeron 3	392
Beneficial Use	Acre-Feet	N/A	
Floodwater Retarding	Acre-Feet	Dammeron 1	21
-	-	Dammeron 2	312
-	-	Dammeron 3	312
Between High and Low Stage	Acre-Feet	Dammeron 1	21
-	-	Dammeron 2	312
-	-	Dammeron 3	312
Principal Spillway Design	-	-	-
Rainfall Volume (10-day)	Inches	Dammeron 1	6.53
-	-	Dammeron 2	7.15
-	-	Dammeron 3	6.43
Runoff Volume (10-day)	Acre-Feet	Dammeron 1	80
-	-	Dammeron 2	1,013
-	-	Dammeron 3	188
Capacity of Low Stage (max.)	Cubic Feet per Second	Dammeron 1	5
-	-	Dammeron 2	25
-	-	Dammeron 3	25
Capacity of High Stage (max.)	Cubic Feet per Second	Dammeron 1	1,199.0
-	-	Dammeron 2	7,124.0
-	-	Dammeron 3	7,124.0
Dimensions of Conduit	Inches	Dammeron 1	30
-	-	Dammeron 2	30
-	-	Dammeron 3	30
Type of Conduit	-	Dammeron 1	Steel
-	-	Dammeron 2	Steel
-	-	Dammeron 3	Steel
Frequency Operation-Auxiliary Spillway	-	-	Maximum

Item	Unit	Structure No.	Total
Auxiliary Spillway Hydrograph	-	-	-
Rainfall Volume	Inches	Dammeron 1	4.91
-	-	Dammeron 2	4.37
-	-	Dammeron 3	4.90
Runoff Volume	Acre-Feet	Dammeron 1	55.0
-	-	Dammeron 2	516.0
-	-	Dammeron 3	133.0
Storm Duration	Hours	Dammeron 1	6
-	-	Dammeron 2	6
-	-	Dammeron 3	6
Velocity of Flow (Vc)	Feet per Second		
Max. Reservoir Water Surface Elevation	Feet	Dammeron 1	4,693.1
-	-	Dammeron 2	4,698.2
-	-	Dammeron 3	4,689.7
Freeboard Hydrograph	-	-	-
Rainfall Volume	Inches	Dammeron 1	11.73
-	-	Dammeron 2	9.30
-	-	Dammeron 3	11.73
Runoff Volume	Acre-Feet	Dammeron 1	161
-	-	Dammeron 2	1,408
-	-	Dammeron 3	382
Storm Duration	Hours	Dammeron 1	6
-	-	Dammeron 2	6
-	-	Dammeron 3	6
Max. Reservoir Water Surface Elevation	Feet	Dammeron 1	4,694.4
-	-	Dammeron 2	4,700.2
-	-	Dammeron 3	4,700.2
Capacity Equivalents	-	-	-
Sediment Volume	Acre-Feet	Dammeron 1	5
-	-	Dammeron 2	65
-	-	Dammeron 3	15

Item	Unit	Structure No.	Total
Floodwater Retarding Volume	Acre-Feet	Dammeron 1	21
-	-	Dammeron 2 & 3	312
Beneficial Volume	Acre-Feet	N/A	-

Footnote for Table 8-10:

[1] Data in this table provided by Alpha Engineering, February 2025.

Table 8-11. Structural Data – Diamond Valley Dams with Planned Storage Capacity (Santa Clara Watershed) (Utah)[1]

Item	Unit	Structure No.	Total
Class of Structure	-	Diamond 1	High
-	-	Diamond 2	High
-	-	Diamond 3	High
Seismic Zone	-	Diamond 1	U-2
-	-	Diamond 2	U-2
-	-	Diamond 3	U-2
Uncontrolled Drainage Area	Square Mile	N/A	-
Controlled Drainage Area	Square Mile	Diamond 1	0.9
-	-	Diamond 2	0.9
-	-	Diamond 3	0.6
Total Drainage Area	Square Mile	Diamond 1	0.9
-	-	Diamond 2	0.9
-	-	Diamond 3	0.6
Runoff Curve No. (1-day) (AMC II)	-	Diamond 1	87.8
-	-	Diamond 2	85.8
-	-	Diamond 3	88.9
Time of Concentration (Tc)	Hours	Diamond 1	0.67
-	-	Diamond 2	0.66
-	-	Diamond 3	0.47
Elevation Top Dam	Feet	Diamond 1	4556.0
-	-	Diamond 2	4600.0

Item	Unit	Structure No.	Total
-	-	Diamond 3	4607.0
Elevation Crest Auxiliary Spillway	Feet	Diamond 1	4556.0
-	-	Diamond 2	4600.0
-	-	Diamond 3	4607.0
Elevation Crest Low Stage Inlet	Feet	Diamond 1	4540.0
-	-	Diamond 2	4585.0
-	-	Diamond 3	4595.0
Auxiliary Spillway Type	-	Diamond 1	Earth
-	-	Diamond 2	Earth
-	-	Diamond 3	Earth
Auxiliary Spillway Bottom Width	Feet	Diamond 1	150
-	-	Diamond 2	130
-	-	Diamond 3	100
Auxiliary Spillway Exit Slope	Percent	-	-
Maximum Height of Dam	Feet	Diamond 1	12
-	-	Diamond 2	19
-	-	Diamond 3	15
Volume of Fill	Cubic Yards	Diamond 1	11,370
-	-	Diamond 2	10,200
-	-	Diamond 3	3,185
Total Capacity	Acre-Feet	Diamond 1	61
-	-	Diamond 2	27
-	-	Diamond 3	14
Beneficial Use	Acre-Feet	N/A	
Floodwater Retarding	Acre-Feet	Diamond 1	51
-	-	Diamond 2	13
-	-	Diamond 3	8
Between High and Low Stage	Acre-Feet	Diamond 1	51
-	-	Diamond 2	13

Item	Unit	Structure No.	Total
-	-	Diamond 3	8
Principal Spillway Design	-	-	-
Rainfall Volume (10-day)	Inches	Diamond 1	6.54
-	-	Diamond 2	6.78
-	-	Diamond 3	6.64
Runoff Volume (10-day)	Acre-Feet	Diamond 1	246
-	-	Diamond 2	246
-	-	Diamond 3	171
Capacity of Low Stage (max.)	Cubic Feet per Second	Diamond 1	120
-	-	Diamond 2	10.0
-	-	Diamond 3	10.0
Capacity of High Stage (max.)	Cubic Feet per Second	Diamond 1	3,296
-	-	Diamond 2	2,538
-	-	Diamond 3	2,078
Dimensions of Conduit	Inches	Diamond 1	30
-	-	Diamond 2	30
-	-	Diamond 3	30
Type of Conduit	-	Diamond 1	Steel
-	-	Diamond 2	Steel
-	-	Diamond 3	Steel
Frequency Operation-Auxiliary Spillway	-	-	Maximum
Auxiliary Spillway Hydrograph	-	-	-
Rainfall Volume	Inches	Diamond 1	4.91
-	-	Diamond 2	4.94
-	-	Diamond 3	4.91
Runoff Volume	Acre-Feet	Diamond 1	171
-	-	Diamond 2	163
-	-	Diamond 3	118
Storm Duration	Hours	Diamond 1	6

Item	Unit	Structure No.	Total
-	-	Diamond 2	6
-	-	Diamond 3	6
Max. Reservoir Water Surface Elevation	Feet	Diamond 1	4558.1
-	-	Diamond 2	4601.8
-	-	Diamond 3	4608.9
Freeboard Hydrograph	-	-	-
Rainfall Volume	Inches	Diamond 1	11.73
-	-	Diamond 2	11.73
-	-	Diamond 3	11.73
Runoff Volume	Acre-Feet	Diamond 1	490
-	-	Diamond 2	478
-	-	Diamond 3	331
Storm Duration	Hours	Diamond 1	6
-	-	Diamond 2	6
-	-	Diamond 3	6
Max. Reservoir Water Surface Elevation	Feet	Diamond 1	4560.0
-	-	Diamond 2	4604.0
-	-	Diamond 3	4611.0
Capacity Equivalents	-	-	-
Sediment Volume	Acre-Feet	Diamond 1	10
-	-	Diamond 2	11
-	-	Diamond 3	4
Floodwater Retarding Volume	Acre-Feet	Diamond 1	51
-	-	Diamond 2	13
-	-	Diamond 3	8
Beneficial Volume	Acre-Feet	N/A	-

Footnote for Table 8-11:

[1] Data in this table provided by Alpha Engineering, February 2025.

Table 8-12. Structural Table – Channel Work – Dammeron Valley New Channel (Santa Clara Watershed) (Utah)

Channel Name	Dammeron 1 Detention Basin
Channel Dimensions	2-foot depth, 1-foot base width, 2:1 banks
Station	general design along length of channel
Drainage Area (mi^2)	0.284
() Year Frequency Design Discharge (ft^3/s)	(100-Year) 298
Water Surface Elevation (msl)	varies along channel (4658-4646)
Hydraulic Gradient (ft/ft)	0.008
Gradient (ft/ft)	0.008
Bottom Width (ft)	1
Elevation (ft)	4,657–4,645
Side Slope	2:1
n Value (aged)	0.05
n Value (as built)	0.05
Velocity (aged) ft/s	~3.33
Velocity (as built) ft/s	~3.33
Excavation Volume yd^3	80
Type of Work	establishment of new channel including necessary stabilization measures
Existing Channel Type	N/A
Present Flow Condition	ephemeral

9.0 References

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10.0 List of Preparers

Table 10-1 identifies the people who participated in the preparation of this Plan-EA.

Table 10-1. List of Preparers

Name	Title (Years of Experience)	Education	Other
NRCS: Norm Evenstad	Water Resources Specialist (30-plus years - RET)	B.S., Geology	Utah P.G.
NRCS: Derek Hamilton	Wildlife Biologist (15-plus years)	M.S., Environmental Science	-
NRCS: Lance Smith	Engineer (15-plus-years)	B.S., Civil Engineering	Utah P.E.
NRCS: Tara Hoffmann	Archaeologist (15-plus years)	M.A., Archaeology	Utah BLM & Statewide Principal Investigator
NRCS: Kyle Wheeler	Water Resources Planner (2 years)	B.S., Biology/Range	–
BLM: Shawnna Dao	Realty Specialist	–	–
BLM: Hayden Houston	Planning and Environmental Coordinator	–	–
BLM: Katherine Chiasson	Planning and Environmental Coordinator		
BLM: Susan Griffith	Reality Specialist	–	–
Eocene: Brian Parker	Biologist/Project Manager (12 years)	B.S., Biology	-
Eocene: Jacob Norlin	Project Manager (1.5 years)	B.S., Biology; B.S., Animal Ecology	M.A.T. Science Education; M.ed. Educational Leadership
Eocene: Lara Schick	Project Management/Biologist (17 years)	B.A., Environmental Studies; M.S. Wildlife and Fisheries	–

Name	Title (Years of Experience)	Education	Other
Eocene: Ronald Bolander	Senior Environmental Planner (42-plus years)	M.S., Botany	-
Eocene: Lindsey M. Evenson	Archaeologist (10-plus years)	M.A., Cultural Resource Management	Utah BLM & Statewide Principal Investigator
Eocene: Jennifer Bannick	Archaeologist (7-plus years)	B.A., Archaeology	-
Eocene: Natalie Noland	Technical Editor (10 years)	B.A., English	-
Eocene: Maggie Draper	Technical Editor (4-plus years	B.A., English	-
Eocene: David Sims	GIS Supervisor (5 years)	M.S., GIS	-
Eocene: Davey Dobbs	Senior Environmental Planner (14 years)	M.S., Urban Planning	-
Washington County: Todd Edwards	Washington County Public Works Director (36 years)	B.S., Civil Engineering	–
Alpha Engineering, Inc.: Glen Carnahan	Professional Civil Engineer (23 years)	B.S., Civil Engineering	Licensed Professional Engineer, Utah 4855703-2202, Nevada 21126
Alpha Engineering, Inc.: Brent Gardner	Managing Principal (44-plus years)	B.S., Civil Engineering	Licensed Professional Engineer, Utah and Arizona 167981-2202
Alpha Engineering, Inc.: Todd Gardner	Professional Civil Engineer (17 years)	B.S., Civil Engineering	Licensed Professional Engineer, Utah 8215989-2202
Alpha Engineering, Inc.: Hal Gordon	Economist (35 years)	M.S. Agricultural Economics	–
RB&G Engineering, Inc.: Brad Price	Senior Geotechnical Engineer (45-plus years)	B.S. Civil Engineering	Licensed Professional Engineer, Utah

Name	Title (Years of Experience)	Education	Other
RB&G Engineering, Inc.: Brandon Horrocks	Geotechnical Engineer (13-plus years)	B.S. Civil Engineering	Licensed Professional Engineer, Utah and Nevada
RB&G Engineering, Inc.: Michael Hansen	Professional Geologist (37 years)	B.G. Engineering Geology	Utah P.G.

11.0 Distribution List

This section lists federal, state, and local government agencies, businesses, and other organizations that were included on the project distribution list for scoping notice and Notice of Availability (NOA) for the Draft Plan-EA. The NOA for the Final Plan-EA was sent to all state and federal agencies in the distribution list and to all other parties that had expressed interest in the project to date.

An NOA for the Draft Plan-EA will be distributed to the following government agencies/staff and organizations.

11.1 Federal Government

BLM

Bureau of Reclamation

EPA

USACE

USFWS

NRCS

11.2 State Government

U.S. Representatives

U.S. Senators

Utah State Representatives

State Senator

Utah Division of Water Rights

SITLA

Utah Public Land Policy Coordination Office

Utah Department of Transportation

Utah Department of Agriculture

Utah Department of Public Safety

Utah Department of Community and Culture

Utah Division of Forestry, Fire, and State Lands

Utah Department of Environmental Quality

Utah Division of Wildlife Resources

Utah Department of Heritage and Arts

Utah Reclamation, Mitigation, and Conservation Commission

Utah Natural Heritage Program

Utah Department of Natural Resources

11.3 Local Government

Washington County

Town of Santa Clara

Dammeron Valley Community

Diamond Valley Community

11.4 Tribes/Tribal Historic Preservation Offices

Shivwits Band of Paiutes

Kanosh Band of Paiute Indians

Ute Indian Tribe of the Uintah and Ouray Reservation

Cedar Band of Paiute Indians

Paiute Indian Tribe of Utah

Hopi Tribe

Koosharem Band of Paiute Indians

Chemehuevi Indian Tribe

Navajo Nation

Pueblo of Zuni

Moapa Band of Paiute Indians of the Moapa River Reservation

Las Vegas Tribe of Paiute Indians of the Las Vegas Colony

Kaibab Band of Paiute Indians of the Kaibab Indian Reservation

San Juan Southern Paiute Tribe of Arizona

11.5 Businesses and Organizations

11.6 Private Parties

The names and addresses of private parties, such as affected landowners, who will receive notice of the Draft Plan-EA are not listed in this section for privacy.

12.0 Acronyms, Abbreviations, and Short Forms

APE	area of potential effect
asl	above sea level
BA	Biological Assessment
BLM	Bureau of Land Management
BMPs	Best Management Practices
CFR	Code of Federal Regulations
cfs	cubic feet per second
CWA	Clean Water Act
DR	Decision Record
EA	Environmental Assessment
EIS	Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FONSI	Finding of No Significant Impact
IO	isolated occurrence
IPaC	Information for Planning and Consultation System
MOU	Memorandum of Understanding
NEE	National Economic Efficiency
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NOA	Notice of Availability
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWPM	National Watershed Program Manual
O&M	operation and maintenance
OHWM	ordinary high-water mark

PITU	Paiute Indian Tribe of Utah
PL	Public Law
PR&G	Principles, Requirements, and Guidelines
RMP	Resource Management Plan
ROW	right-of-way
SHPO	State Historic Preservation Office
SITLA	School and Institutional Trust Lands Administration
SLO	Sponsoring Local Organization
SWPPP	Stormwater Pollution Prevention Plan
T&E	threatened and endangered
TCP	traditional cultural property
THPO	Tribal Historic Preservation Office
UDEQ	Utah Department of Environmental Quality
UDWR	Utah Division of Wildlife Resources
UDWRe	Utah Division of Water Resources
UNHP	Utah Natural Heritage Program
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
WOTUS	Waters of the U.S.

Appendix A

Comments, Responses, and Consultation

BIOLOGICAL RESOURCES CONSULTATION

United States Department of Agriculture

May 14, 2024

George Weekley
Field Supervisor, Utah Field Office
U.S. Fish and Wildlife Service
2369 West Orton Circle, Suite 50
West Valley City, UT 84119

RE: Santa Clara Watershed Plan-Environmental Assessment (Plan-EA)
Section 12 Notification--Public Law 83-566

Dear George Weekley:

The Natural Resources Conservation Service (NRCS) is currently preparing the Santa Clara Watershed Plan-EA for flood protection and agricultural water management measures in Washington County, Utah. In accordance with Section 12 of the Watershed Protection and Flood Prevention Act, Public Law 83-566 (U.S.C. Section 1008), this letter serves to notify the U.S. Fish and Wildlife Service (USFWS) that NRCS invites the USFWS to submit survey reports or investigations regarding wildlife resources that will be considered in development of the Santa Clara Watershed Plan-EA. Additionally, the NRCS welcomes USFWS participation in the preparation of the Plan-EA in accordance with Section 12 of Public Law 83-566.

Thank you for your assistance. If you have any questions, please contact Kyle Wheeler, Watershed Coordinator, at kyle.wheeler@usda.gov or 435-253-2147.

Sincerely,

Travis Mote
Acting State Conservationist

cc:
Anders Fillerup, Acting Assistant State Conservationist—Water Resources, NRCS, Salt Lake City, UT
Kyle Wheeler, Watershed Coordinator, NRCS, Richfield, UT

USDA

United States Department of Agriculture

The U.S. Fish and Wildlife Service concurs with your determination that the proposed action *may affect, and is not likely to adversely affect*:

Species: Southwestern willow flycatcher, desert tortoise, dwarf bear-claw poppy, Holmgren milkvetch, and Shivwits milkvetch

Critical Habitat: N/A

The proposed action is expected to be:

Insignificant: X Discountable: ____ Beneficial: ____

U.S. Fish and Wildlife Utah Field Supervisor

Office Code: 06E23000 Project Code: 2022-0055419

June 9, 2022

Yvette Converse
Supervisor, Utah Field Office
U.S. Fish and Wildlife Service
2369 West Orton Circle, Suite 50
West Valley City, UT 84119

RE: Santa Clara Watershed Plan-Environmental Assessment (Plan-EA)
Washington County, Utah

Dear Yvette Converse:

The Natural Resources Conservation Service (NRCS) is providing assistance to Washington County through the Watershed Protection and Flood Prevention Program to prepare the Santa Clara Watershed Plan-EA for proposed project measures in Washington County, Utah. This letter is being submitted in compliance with Section 7 of the Endangered Species Act (ESA) to document our determination of potential project effects on federally-listed species and designated critical habitat; additionally, this letter serves as a request for U.S. Fish and Wildlife Service concurrence with our determinations.

The NRCS has determined that the Santa Clara Watershed Plan-EA **may affect, but is not likely to adversely affect** the southwestern willow flycatcher (*Empidonax traillii extimus*), desert tortoise (*Gopherus agassizii*), dwarf bear-claw poppy (*Arctomecon humilis*), Holmgren milkvetch (*Astragalus holmgreniorum*), and Shivwits milkvetch (*Astragalus ampullarioides*). Furthermore, it has been determined that the project would have **no effect** on the remaining federally-listed ESA species, including critical habitat, known to occur in Washington County. Please find the enclosed Biological Assessment that has been prepared to document the basis for our determinations and identify conservation measures for the project.

Thank you for your assistance. If you have any questions or need additional information, please contact Derek Hamilton of my staff at 801/524-4560 or derek.hamilton@usda.gov.

Sincerely,

EMILY FIFE Digitally signed by EMILY FIFE
Date: 2022.06.09 08:32:53 -06'00'

EMILY FIFE
State Conservationist

Enclosure

cc:
Derek Hamilton, Biologist/Water Resources Coordinator, NRCS, Salt Lake City, UT
Brandon Todd, Acting Area Conservationist, NRCS, Richfield, UT
Mike Marshall, District Conservationist, NRCS, Fillmore, UT

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Utah Ecological Services Field Office
2369 West Orton Circle, Suite 50
West Valley City, UT 84119-7603
Phone: (801) 975-3330 Fax: (801) 975-3331
http://www.fws.gov
http://www.fws.gov/utahfieldoffice/

In Reply Refer To: December 09, 2021
Consultation Code: 06E23000-2022-SLI-0116
Event Code: 06E23000-2022-E-00351
Project Name: Santa Clara Watershed Plan-EA

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List
- USFWS National Wildlife Refuges and Fish Hatcheries
- Migratory Birds

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Utah Ecological Services Field Office
2369 West Orton Circle, Suite 50
West Valley City, UT 84119-7603
(801) 975-3330

Project Summary

Consultation Code: 06E23000-2022-SLI-0116
Event Code: Some(06E23000-2022-E-00351)
Project Name: Santa Clara Watershed Plan-EA
Project Type: LAND - FLOODING
Project Description: The project area encompasses three separate locations in central and west-central Washington County,
Utah. These sites are Dammeron Valley, Diamond Valley, and Shivwits Band of Paiutes land near Ivins.
The Dammeron Valley and Diamond Valley portions of the project area are near Utah Highway 18,
approximately 15.5 miles and approximately 3 miles north of St. George, respectively. The Shivwits portion of the project area is located approximately 5 miles west of the community of Ivins adjacent to Old Highway 91 and Gunlock Road junction (Figure 1). The Diamond Valley portion of the project is located within Sections 1, 8, 9, 16, and 21 of Township 40 South, Range 16 West on the Saddle Mountain 7.5-minute U.S. Geological Survey (USGS) quadrangle map (USGS 2021). The Dammeron Valley portion of the project is located within Sections 1, 2, and 35 of Township 41 South, Range 16 West on the Veyo 7.5-minute USGS quadrangle map (USGS 2021). The Shivwits portion of the project is located within Sections 28 and 33 of Township 41 South, Range 17 West on the Shivwits 7.5-minute USGS quadrangle map (USGS 2021).

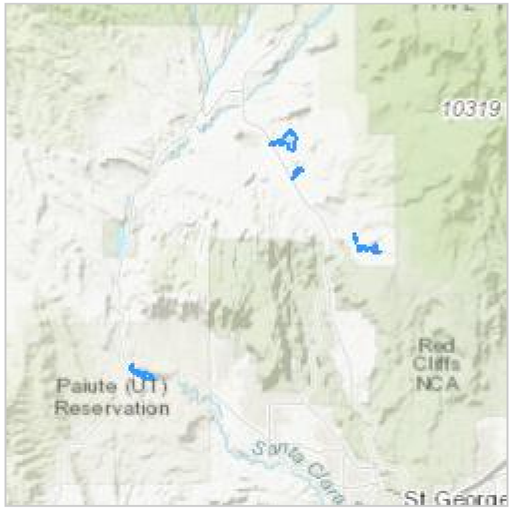
Washington County is proposing to install and reestablish a series of detention basins in Dammeron Valley and Diamond Valley in Washington County, Utah, and provide armoring along the Santa Clara River on Shivwits tribal land near Ivins, Utah. The detention basins and armoring would provide flood protection to the local communities and a Shivwits tribal farming area.

The project would include the construction of three detention basins on dry washes east of Dammeron
Valley, the re-routing of existing flows to an adjacent routed channel on the south end of Dammeron Valley, the potential construction of an alternative detention basin and the re-establishment of three existing detention basins in Diamond Valley, armoring and protection of an existing channel in Diamond Valley, armoring portions of the south bank of the Santa Clara River just west of the Shivwits tribal community near Shem Dam, and armoring of two man-made ditches leading to the Santa Clara River in the Shivwits section of the project area. Additional measures that may be installed in the Shivwits portion of the project area include a new water pipeline that would be hung on the existing Gunlock Road bridge structure over the Santa Clara River and extend to areas

within the project and greenhouse. It should be noted that all proposed actions being designed would be limited to occur within the boundaries displayed on map provided within this report.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@37.3110723,-113.6612586454248,14z



Counties: Washington County, Utah

Endangered Species Act Species

There is a total of 9 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Birds

NAME	STATUS
Mexican Spotted Owl *Strix occidentalis lucida* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/8196	Threatened
Southwestern Willow Flycatcher *Empidonax traillii extimus* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/6749	Endangered
Yellow-billed Cuckoo *Coccyzus americanus* Population: Western U.S. DPS There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/3911	Threatened

Reptiles

NAME	STATUS
Desert Tortoise *Gopherus agassizii* Population: Wherever found, except AZ south and east of Colorado R., and Mexico There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/4481	Threatened

Insects

NAME	STATUS
Monarch Butterfly *Danaus plexippus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9743	Candidate

Flowering Plants

NAME	STATUS
Dwarf Bear-poppy *Arctomecon humilis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/5492	Endangered
Jones Cycladenia *Cycladenia humilis var. jonesii* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/3336	Threatened
Shivwits Milk-vetch *Astragalus ampullarioides* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/5840	Endangered
Siler Pincushion Cactus *Pediocactus (=Echinocactus,=Utahia) sileri* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/3607	Threatened

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

USFWS National Wildlife Refuge Lands And Fish Hatcheries

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS OR FISH HATCHERIES WITHIN YOUR PROJECT AREA.

Migratory Birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Black-chinned Sparrow *Spizella atrogularis* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9447	Breeds Apr 15 to Jul 31
Cassin's Finch *Carpodacus cassinii* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9462	Breeds May 15 to Jul 15
Clark's Grebe *Aechmophorus clarkii* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Jun 1 to Aug 31

NAME	BREEDING SEASON
Olive-sided Flycatcher *Contopus cooperi* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/3914	Breeds May 20 to Aug 31
Pinyon Jay *Gymnorhinus cyanocephalus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9420	Breeds Feb 15 to Jul 15
Virginia's Warbler *Vermivora virginiae* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9441	Breeds May 1 to Jul 31

Probability Of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence ( )

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

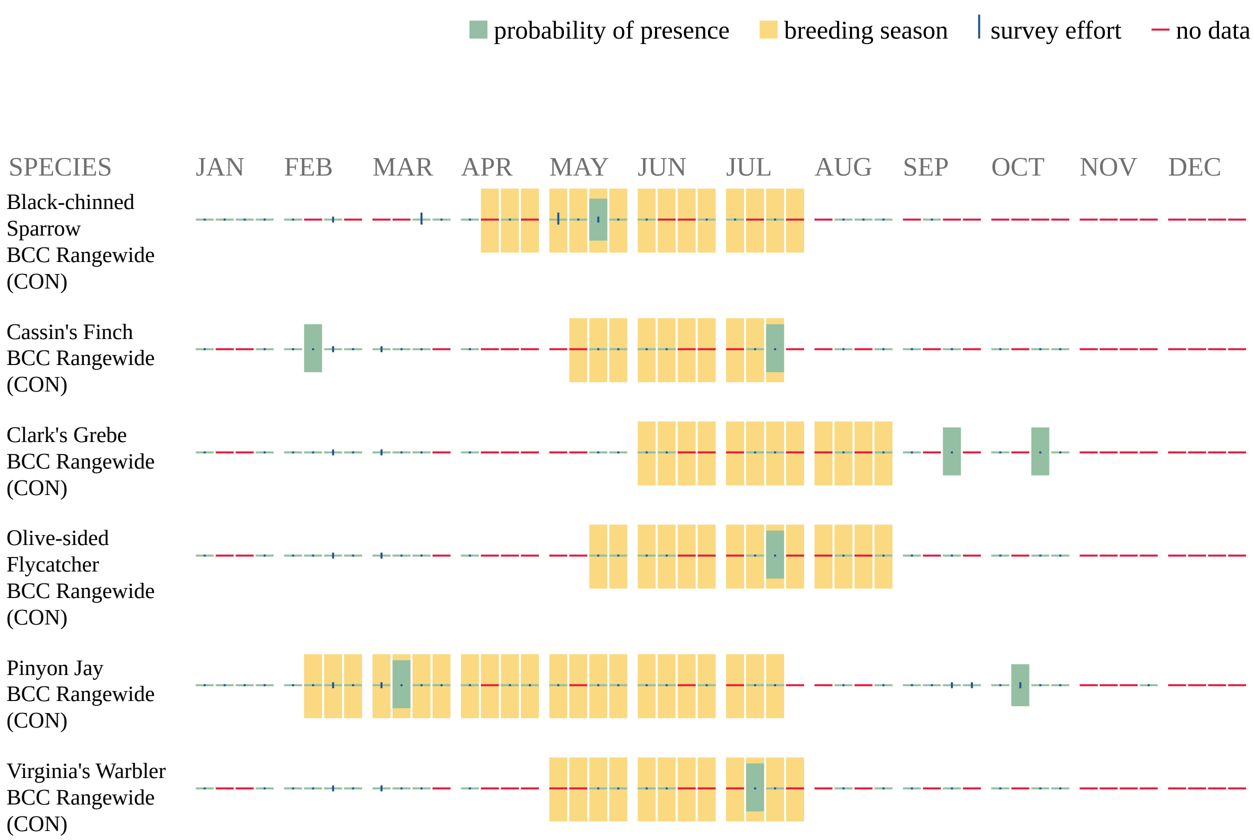
1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ( )
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php

- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

Migratory Birds FAQ

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the AKN Phenology Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?
To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?
Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects
For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?
If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Utah Division of Wildlife Resources
Utah Natural Heritage Program
1594 W. North Temple
PO Box 146301
Salt Lake City, UT 84116

Report Number: 12745
October 12, 2021

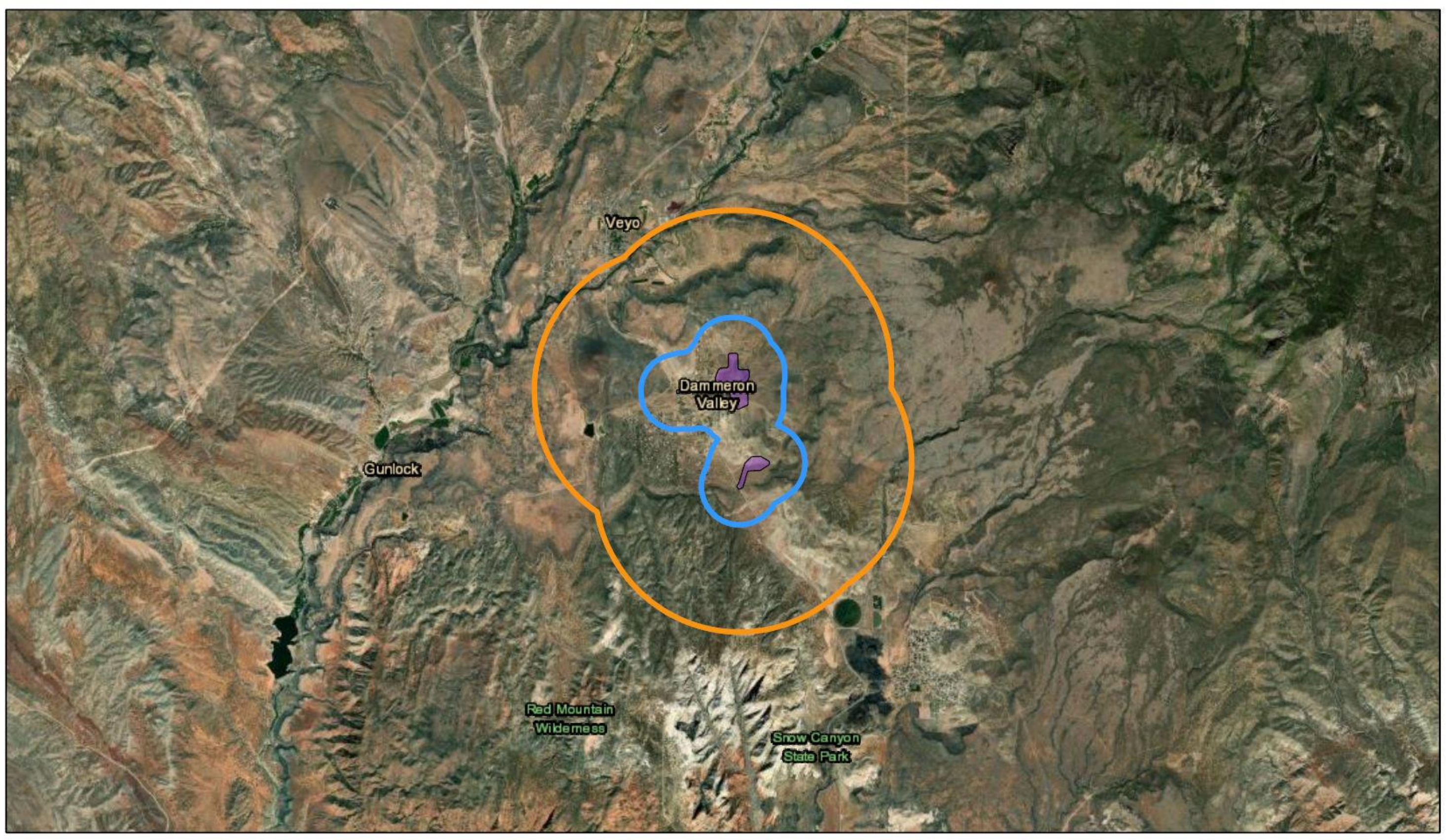
Utah Natural Heritage Program Online Species Search Report

Project Information

Project Name
Santa Clara Watershed Plan-EA Project

Project Description
Watershed Assessment

Location Description
Dammeron Valley



October 12, 2021

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Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

Animals within a ½ mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
Gila Monster	Heloderma suspectum	SGCN		
Mojave Desert Tortoise	Gopherus agassizii	SGCN	LT	2009

Plants within a ½ mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
No Species Found				

Animals within a 2 mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
American White Pelican	Pelecanus erythrorhynchos	SGCN		
Arizona Toad	Anaxyrus microscaphus	SGCN		2003
Desert Sucker	Catostomus clarkii	SGCN		1992
Gila Monster	Heloderma suspectum	SGCN		
Mojave Desert Tortoise	Gopherus agassizii	SGCN	LT	2009
Virgin Spinedace	Lepidomeda mollispinis	SGCN		1992

Plants within a 2 mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
No Species Found				

Definitions

State Status

SGCN	Species of greatest conservation need listed in the Utah Wildlife Action Plan

U.S. Endangered Species Act

LE	A taxon that is listed by the U.S. Fish and Wildlife Service as "endangered" with the probability of worldwide extinction
LT	A taxon that is listed by the U.S. Fish and Wildlife Service as "threatened" with becoming endangered
LE;XN	An "endangered" taxon that is considered by the U.S. Fish and Wildlife Service to be "experimental and nonessential" in its designated use areas in Utah
C	A taxon for which the U.S. Fish and Wildlife Service has on file sufficient information on biological vulnerability and threats to justify it being a "candidate" for listing as endangered or threatened
PT/PE	A taxon "proposed" to be listed as "endangered" or "threatened" by the U.S. Fish and Wildlife Service

Disclaimer

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The UDWR provides no warranty, nor accepts any liability, occurring from any incorrect, incomplete, or misleading data, or from any incorrect, incomplete, or misleading use of these data.

The results are a query of species tracked by the Utah Natural Heritage Program, which includes all species listed under the U.S. Endangered Species Act and species on the Utah Wildlife Action Plan. Other significant wildlife values might also be present on the designated site. Please contact UDWR's regional habitat manager if you have any questions.

For additional information about species listed under the Endangered Species Act and their Critical Habitats that may be affected by activities in this area or for information about Section 7 consultation under the Endangered Species Act, please visit https://ecos.fws.gov/ipac/ or contact the U.S. Fish and Wildlife Service Utah Ecological Services Field Office at (801) 975-3330 or utahfieldoffice_esa@fws.gov.

Please contact our office at (801) 538-4759 or habitat@utah.gov if you require further assistance.

Your project is located in the following UDWR region(s): Southern region

Report generated for:
Erica Wightman
Transcon Environmental
579 Galena Park
Draper, UT 84020
(801) 367-0885
ewightman@transcon.com

Utah Division of Wildlife Resources
Utah Natural Heritage Program
1594 W. North Temple
PO Box 146301
Salt Lake City, UT 84116

Report Number: 12746
October 12, 2021

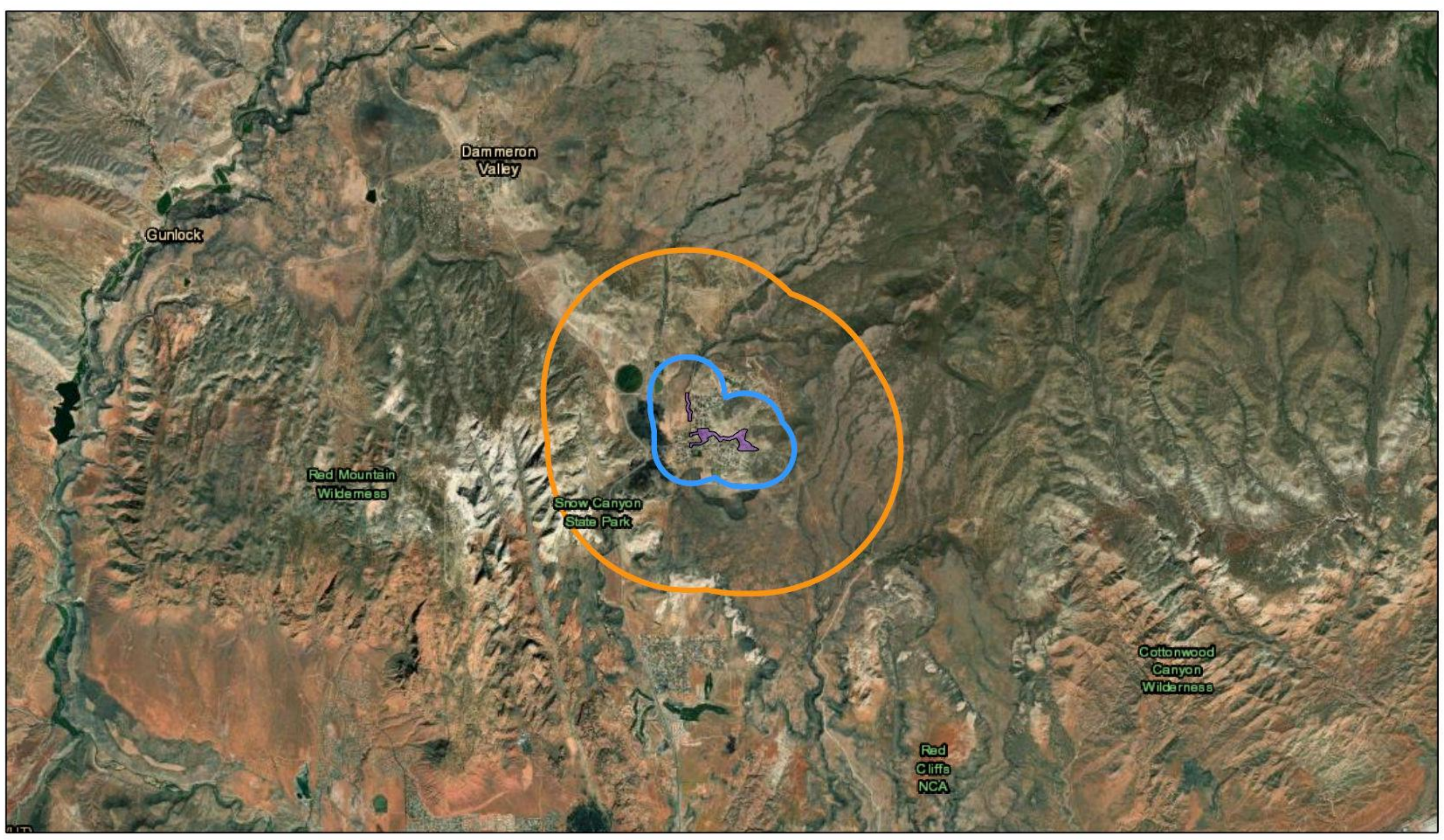
Utah Natural Heritage Program Online Species Search Report

Project Information

Project Name
Santa Clara Watershed Plan-EA Project

Project Description
Watershed Assessment

Location Description
Diamond Valley



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Animals within a ½ mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
Mojave Desert Tortoise	Gopherus agassizii	SGCN	LT	2007

Plants within a ½ mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
No Species Found				

Animals within a 2 mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
Gila Monster	Heloderma suspectum	SGCN		
Mojave Desert Tortoise	Gopherus agassizii	SGCN	LT	2007

Plants within a 2 mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
No Species Found				

Definitions

State Status

SGCN	Species of greatest conservation need listed in the Utah Wildlife Action Plan

U.S. Endangered Species Act

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LE;XN	An "endangered" taxon that is considered by the U.S. Fish and Wildlife Service to be "experimental and nonessential" in its designated use areas in Utah
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PT/PE	A taxon "proposed" to be listed as "endangered" or "threatened" by the U.S. Fish and Wildlife Service

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Please contact our office at (801) 538-4759 or habitat@utah.gov if you require further assistance.

Your project is located in the following UDWR region(s): Southern region

Report generated for:
Erica Wightman
Transcon Environmental
579 Galena Park
Draper, UT 84020
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ewightman@transcon.com

Utah Division of Wildlife Resources
Utah Natural Heritage Program
1594 W. North Temple
PO Box 146301
Salt Lake City, UT 84116

Report Number: 12747
October 12, 2021

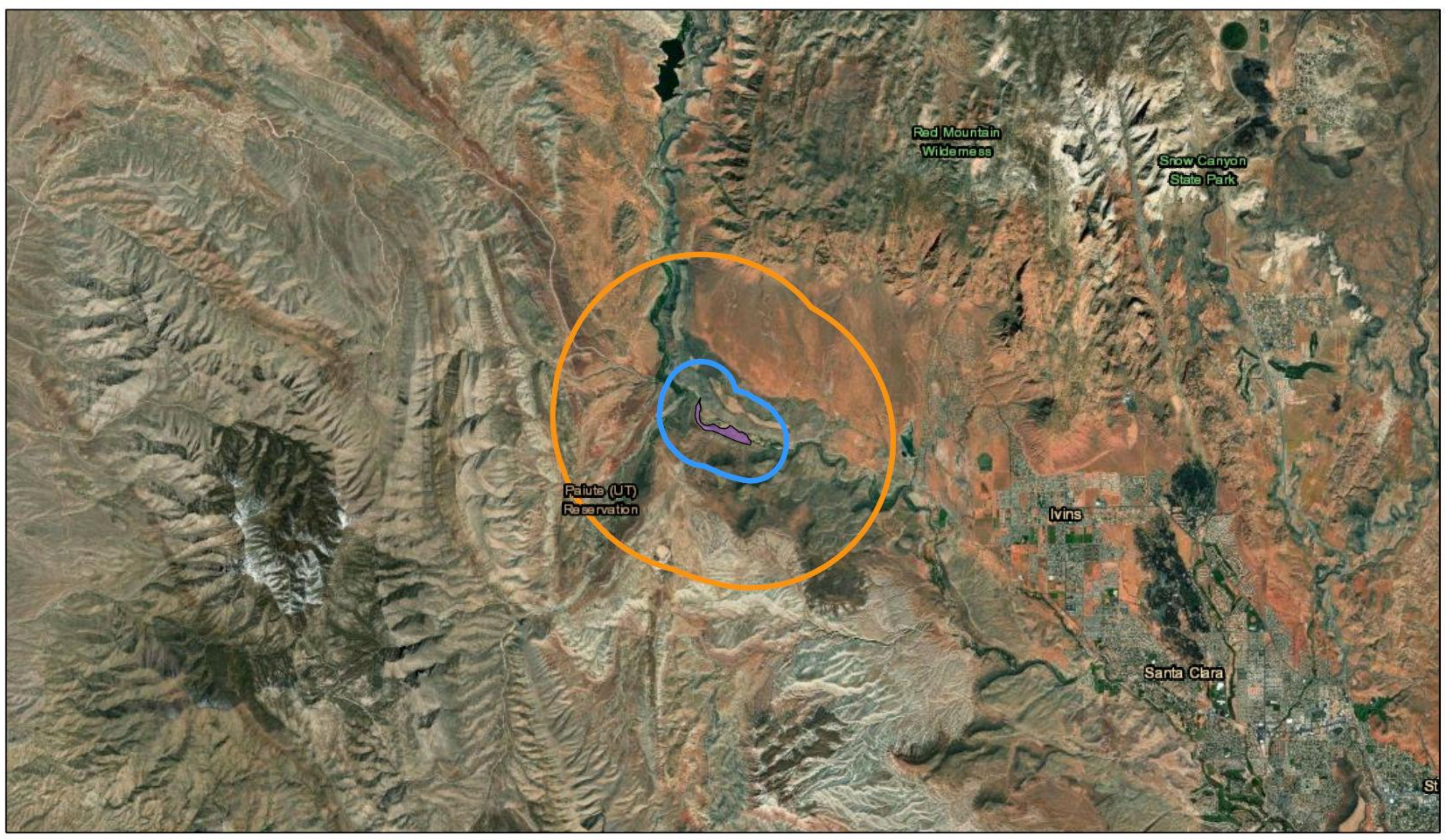
Utah Natural Heritage Program Online Species Search Report

Project Information

Project Name
Santa Clara Watershed Plan-EA Project

Project Description
Watershed Assessment

Location Description
Shivwits



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Animals within a ½ mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
Arizona Toad	Anaxyrus microscaphus	SGCN		1999
Desert Sucker	Catostomus clarkii	SGCN		2012
Mojave Desert Tortoise	Gopherus agassizii	SGCN	LT	1995
Virgin Spinedace	Lepidomeda mollispinis	SGCN		2012

Plants within a ½ mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
Shivwits Milkvetch	Astragalus ampullarioides		LE	2000

Animals within a 2 mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
Arizona Toad	Anaxyrus microscaphus	SGCN		1999
Desert Sucker	Catostomus clarkii	SGCN		2012
Flannelmouth Sucker	Catostomus latipinnis	SGCN		1942
Gila Monster	Heloderma suspectum	SGCN		1980
Mojave Desert Tortoise	Gopherus agassizii	SGCN	LT	2000
Southwestern Willow Flycatcher	Empidonax traillii extimus	SGCN	LE	1996
Virgin Spinedace	Lepidomeda mollispinis	SGCN		2012
Yuma Myotis	Myotis yumanensis	SGCN		1996

Plants within a 2 mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
Shivwits Milkvetch	Astragalus ampullarioides		LE	2000

Definitions

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The UDWR provides no warranty, nor accepts any liability, occurring from any incorrect, incomplete, or misleading data, or from any incorrect, incomplete, or misleading use of these data.

The results are a query of species tracked by the Utah Natural Heritage Program, which includes all species listed under the U.S. Endangered Species Act and species on the Utah Wildlife Action Plan. Other significant wildlife values might also be present on the designated site. Please contact UDWR's regional habitat manager if you have any questions.

For additional information about species listed under the Endangered Species Act and their Critical Habitats that may be affected by activities in this area or for information about Section 7 consultation under the Endangered Species Act, please visit https://ecos.fws.gov/ipac/ or contact the U.S. Fish and Wildlife Service Utah Ecological Services Field Office at (801) 975-3330 or utahfieldoffice_esa@fws.gov.

Please contact our office at (801) 538-4759 or habitat@utah.gov if you require further assistance.

Your project is located in the following UDWR region(s): Southern region

Report generated for:
Erica Wightman
Transcon Environmental
579 Galena Park
Draper, UT 84020
(801) 367-0885
ewightman@transcon.com

PHASE II SECTION 106 CONSULTATION

Spencer J. Cox
Governor

Deidre M. Henderson
Lieutenant Governor

Jill Remington Love
Executive Director
Utah Department of Cultural and Community Engagement

Utah SHPO

Christopher Merritt
State Historic Preservation Officer
Utah State Historic Preservation Office

February 3, 2023

Trisha Cracroft
Acting State Conservationist
Natural Resources Conservation Service
125 South State Street, Room 4010
Salt Lake City, Utah 84138-1100

RE: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah

For future correspondence, please reference Case No.

Dear Trisha,

The Utah State Historic Preservation Office received your submission and request for our comment on the above-referenced undertaking on February 03, 2023.

We concur with your determinations of eligibility and effect for this undertaking.

This letter serves as our comment on the determinations you have made within the consultation process specified in §36CFR800.4. If you have questions, please contact me at 801-245-7263 or by email at cmerritt@utah.gov.

Sincerely,

Christopher W. Merritt
State Historic Preservation Officer

NRCS RECORD OF TRIBAL CONSULTATIONS

Project/Reason for Initiating Consultation: Santa Clara Watershed Plan-EA (NEPA)

Program: NRCS Watershed and Flood Prevention Operations Program

Tribe Information			Consultation Initiated[1]		Cultural Resource Report Consultation Packages[2]			Consultation Follow Up[2]				Tribe Cons Status (Date)
Federally Recognized Tribe	Contact Name	Address	Letter Date	Response	NRCS Mailed to Tribe[3]	Received by Tribe[3,4]	Tribe Response	Follow Up #1 Type (Date)	Response #1 Type (Date): Response	Follow Up #2 Type (Date)	Response #2 Type (Date)	
Cedar Band of Paiutes	Delice Tom (Chairwomen, past)	P.O. Box 235 Cedar City, Utah 84721	01/13/2021	None	8/19/2021	X	None	NA	-	-	-	-
	Travis Parashonts (Chairperson, current)	600 North 100 East Cedar City, UT 84721	01/23/2023	None	1/23/2023	X	None	Phone 01/16/2024; (435) 586-9433 Left message	None	Phone 01/31/2024; (435) 586-9433 Left Message	None	No response
Chemehuevi Indian Tribe	Charles Wood (Chairman)	P.O. Box 1976 Havasu Lake, California 92363	01/13/2021	None	8/19/2021 1/23/2023	X	None	Phone 01/16/2024 (760)-858-4219 Left message	None	Phone 01/31/2024; (760) 858-4219 (Left Message	None	No response
Hopi Tribe of Arizona	Stewart B. Koyiyumptewa (THPO)	P.O. Box 123 Kykotsmovi, Arizona 86039	01/13/2021	Letter (02/10/2021) Request consultation if adverse effects	8/19/2021 1/23/2023	X	Letters (8/27/2021) Concur	Email 08/25/2023)	None	Phone (1/16/2024); (928) 734-3615 Left message	None	Concur (08/27/2021; No response
	Timothy Nuvangyaoma (Chairman)		01/13/2021	None	8/19/2021 1/23/2023	X	None	-	None	NA	NA	
Indian Peaks Band of Paiutes	Tamara Borchardt-Slayton (Chairperson)	P.O. Box 2062 Cedar City, Utah 84721	-	-	8/19/2021 1/23/2023	X	None	Phone (01/16/2024) (435) 691-3946 Left message	None	Phone (01/31/2024) (435) 691-3946 Left message	None	No response
Kaibab Band of Paiute Indians of the Kaibab Indian Reservation	Daniel Bullets (Environmental Program Director)	HC65, Box 2 Fredonia, Arizona 86022	01/13/2021	None	8/19/2021 1/23/2023	X	None	Email (8/25/2023)	Email (08/28/2023): No concerns, glad to hear working with Shivwits Band	Phone (01/09/2024); (928) 643-6278	No concerns, defer to PITU	Defer to PITU (8/28/2023)
	Ona Segundo (Chairwomen, past)		01/13/2021	None	8/19/2021 1/23/2023	X	None	Email (8/25/2023) rolandm@kaibabpaiute-nsn.gov	None	NA	-	
	Roland Maldonado (Chairman, current)		-	-	-	-	-	-	-	Phone (01/09/2024); (928) 643-7245	No concerns, defer to Shivwits	

	Ganivan Timcan (Southern Paiute Consortium)		01/13/2021	None	8/19/2021 1/23/2023	X	None		None	-	-	
Kanosh Band of Paiutes	Darlene Arrum (Chairwoman, past)	P.O. Box 116 Kanosh, Utah 84637	01/13/2021	None	8/19/2021 1/23/2023	X	None	Email (8/25/2023) darleneparrum@gmail.com	None	No listed phone number	None	No response
Koosharem Band of Paiutes	LaTosha Mayo (Chairwoman, past)	P.O. Box 205 Richfield, Utah 84107	01/13/2021	None	8/19/2021 1/23/2023	X	None	NA	NA	-	-	No response
	Toni Kanosh (Chairwomen, current)		-	-	8/19/2021 1/23/2023	X	None	Email (08/25/2023) koosharem@utahpaiutes.org	None	Phone (01/09/2024); (435) 896-2823; Not in Service	None	
Las Vegas Tribe of Paiute Indians of the Las Vegas Colony	Curtis Anderson (Chairman, past)	One Paiute Drive Las Vegas, Nevada 89106	01/13/2021	None	8/19/2021	X	None	-	-	-	-	No response
	Ramona Salazar		01/13/2021	None	8/19/2021 1/23/2023	X	None	-	-	-	-	
	Daryn Pete (Chairwoman, present)		-	-	8/19/2021	X	None	Email (8/25/2023) dpete@lvpaiute.com	None	Phone (01/09/2024); (702) 386-3926; Left message	None	
	Benny Tso (Chairman, past)		-	-	8/19/2021 1/23/2023	X	None	-	-	-	-	
Moapa Band of Paiute Indians of the Moapa River Reservation, Nevada	Greg Anderson (Chairman, past)	P.O. Box 340 Moapa, Nevada 89025	01/13/2021	None	8/19/2021 1/23/2023	X	None	Email (8/25/2023) chair.mbop@moapabandofpaiutes.org	Non	-	None	Concur (09/23/2021)
	Darren Daboda (THPO)		01/13/2021	None	8/19/2021 1/23/2023	X	None	Email (8/25/2023) moapathpo@moapabandofpaiutes.org	None	Phone 01/16/2024; (702) 865-2787; Left message	Asked if new road access was covered by survey. NRCS said yes.	
	Shandoah (Shanan) Anderson (Cultural Manager) (former)		01/13/2021	None	8/19/2021 1/23/2023	X	Email (09/23/2021): Concur	Email (8/25/2023) moapacultural@moapabandofpaiutes.org	Shanan left position	NA	NA	
	Laura Parry (Chairwomen, current)		-	-	8/19/2021 1/23/2023	X	None	-	None	-	-	
Navajo Nation	Richard Begay (THPO)	P.O. Box 7440 Window Rock, Arizona 86515	01/13/2021	Email (2/10/2021) No TCPS; no addt'l consultation needed.	8/19/2021 1/23/2023	X	None	NA	None	NA	Per email on 2/10/2021, project may proceed, no additional consultation needed.	Project may proceed

	Jonathan Nez (President, Past)		01/13/2021	None	8/19/2021	X	None	NA	None	-	-	
	Buu Nygren (President, Current)		-	-	1/23/2023	-	None	NA	None	-	-	
Paiute Indian Tribe of Utah (PITU)	Dorena Martineau (Cultural Resource Director, Past)	440 North Paiute Drive Cedar City, Utah 84721	01/13/2021	None	8/19/2021 1/23/2023	X	Letter (9/8/2021) Concur; Email letter (02/16/2023): Concur	NA	-	-	-	Concur (9/8/2021 and 2/16/2023)
Pueblo of Zuni	Kurt Dongoske (THPO)	P.O. Box 339 Zuni, New Mexico 87327	01/13/2021	None	8/19/2021 1/23/2023	X	None	CC Email (8/28/2023) kdongoske@cableone.net	None	Phone (01/16/2024) (928) 289-925; Left message	None	No response
	Val R. Panteah, Sr. (Governor, past)		01/13/2021	None	8/19/2021 1/23/2023	X	None	NA	-	-	-	No response
	Arden Kucate (Governor, current)		01/13/2021	None	8/19/2021	X	None	Email (8/28/2023) arden.kucate@ashiwi.org	None	-	-	No response
San Juan Southern Paiute Tribe	Carlene Yellowhair (President, past)	P.O. Box 2950 Tuba City, Arizona 86045	01/13/2021	None	8/19/2021	X	None	-	-	-	-	No response
	Johnny Lehi Jr. (President, past)		01/13/202	None	8/19/2021 1/23/2023	X	None	Email (8/28/2023) J.lehijr@sanjuanpaiute-nsn.gov	None	Phone (01/16/2024) 928-212-9794; Left message with new President Candelora Lehi	None	No response
Shivwits Band of Paiute Indians	Carmen Clark (Chairwomen)	6060 West 3650 North Ivins, Utah 84738	01/13/2021	None	8/19/2021	X	None	Report Consultation Package Phase II (1/23/2023)	None	-	-	Cooperating Agency-consultation ongoing
	Hope Silvas (Chairperson)		-	-	8/19/2021 Email 1/13/2022 Draft Phase II Report	X	Email (2/11/2022) Request Zoom meeting (corr. In App. A)	Report Consultation Package Phase II (1/23/2023)	None	-	-	
Ute Indian Tribe of the Uintah & Ouray Reservation, Utah	Luke Duncan (Chairman, past)	P.O. Box 190 Fort Duchesne, Utah 84026	01/13/2021	None	8/19/2021	X	None	Email (8/25/2023) luked@utetribe.com	None	NA	None	Defer to PITU
	Betsy Chapoose (THPO)		01/13/2021	None	8/19/2021 1/23/2023	X	None	Email (8/25/2023) betsyc@uteTribe.com	None	Phone (01/16/2024) (435) 722-5141	No concerns, will defer to PITU	
	Julius Murray (Chairman, current)		01/13/2021	None	8/19/2021 1/23/2023	X	None	Email (8/28/2023) juliusm@utetribe.com	None	Phone (01/16/2024) (435) 722-5141, left message	None	

Notes: Cons = Consultation, THPO = Tribal Historic Preservation Officer

1 – Tribe consultation was initiated as part of the Scoping process and is documented in the Scoping Report included in Appendix A.

2 – Documentation is included below the Table.

3 – An addendum to the Cultural Resource Survey was made after it was provided to the Tribes and a second letter was sent to all Tribes with the updated Cultural Resource Survey. The first letter and second letter mailed and received dates are included.

4 – Date of receipt of mail delivery to Tribe.

January 23, 2023

Christopher Merritt, PhD
State Historic Preservation Officer
Utah Division of State History
300 Rio Grande Avenue
Salt Lake City, Utah 84101-1182

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Dr. Merritt:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*, and associated data. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

The Phase II Area of Potential Effects (APE) encompasses Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The APE acreage totals 587.82 acres, including 296.38 acres that was previously surveyed in Phase I, and 291.44 acres of new survey in Phase II. Of this, 245.97 acres falls on land administered by the Bureau of Land Management (BLM), St. George Field Office, 57.74 acres are on lands managed by the Utah School and Institutional Trust Lands Administration (SITLA), 220.94 acres are on Private land, and 63.17 acres are on the Shivwits Reservation. The NRCS is acting as the lead federal agency for the purposes of Section 106 consultation, which will also cover SITLA's responsibilities under Utah Code Annotated Section 9-8-404. The BLM is a cooperating agency.

An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. in two field sessions from May 17–21, 2021, and May 24–28, 2021. As a result of the survey, it was determined that a total of 11 cultural resource sites are located within the project APE. Of these 11 sites, four sites were previously reported separately under Phase I of the Project and were not updated as part of this report (42WS2428, 42WS5150, 42WS5151,42WS5154 [see U21TN0316]). Site (42WS2428: *Road from St. George to Pine Valley*) is determined Eligible for listing on the National

United States Department of Agriculture

Register of Historic Places (NRHP) under Criterion A for its association with significant historic events (but the segment within the APE is determined non-contributing), and three sites (42WS5150, 42WS5151, and 42WS5152) are determined Not Eligible for the NRHP under any Criteria. Additionally, the NRCS has determined Site 42WS5151 to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property. No construction elements are occurring within the boundaries of these sites.

Three previously recorded sites were identified within the project APE during the new survey (42WS4692: historic pipeline and suspension bridge, 42WS4823: prehistoric lithic scatter, and 42WS5154: prehistoric lithic scatter). Four new cultural resource sites were identified as a result of this survey (42WS6520: historic irrigation ditch, 42WS6521: historic Shivwits school and multi-component, 42WS6522: multicomponent, and 42WS6523: historic flood control ditch). The NRCS has determined that Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all eligible for the NRHP. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154), are determined Not Eligible for NRHP listing under any Criteria.

Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

TABLE 1
SANTA CLARA WATERSHED PLAN-EA PROJECT
CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Mitigation*
42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
				Enters site boundary at one other location	Contributing	No Adverse Effect	
42WS6521	Multi-component habitation complex	Eligible A, C,	Pipeline	Crosses W edge of site, with nearby features	Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an
			Ditch Rip Rap	Within N edge of site in area of prior disturbance (erosion); will repair eroded	Non-Contributing	No Adverse Effect	

TABLE 1 SANTA CLARA WATERSHED PLAN-EA PROJECT CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)							
Site No.	**Site Type**	**Eligibility**	**Project Component**	**Impacts**	**Status**	**Effects**	**Mitigation***
				channel without impacting intact masonry			inadvertent discovery plan prior to construction.
42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Bank Rip Rap	Crosses N edge of site, within area of no surface observations	Contributing	No Adverse Effect	
42WS6523	Historic flood control ditch	Eligible - A, C, D	Pipeline	Crosses at S end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Ditch Rip Rap	Within center of site, within area of prior disturbance (erosion); will repair eroded channel without impacting intact masonry and protect ditch from further erosion	Non-Contributing	No Adverse Effect	
N/A	N/A	N/A	Land Leveling	No sites within the proposed land leveling area (previously disturbed area)	N/A	N/A	N/A
*Note: both an archaeological and Tribal monitor will be present for all ground disturbing activities within the Shivwits area of the project.							

Based on the monitoring and avoidance measures for the four NRHP- Eligible sites located on the Shivwits APE proposed in Table 1, and that the additional three newly recorded sites are determined ineligible for the NRHP, the NRCS has determined that the undertaking will result in ***no adverse effect to historic properties***. Additionally, as previously stated, no construction activities will take place within the site boundaries of the four previously reported on sites (refer to U21TN0316). The NRCS requests your concurrence for the determination of project effects and site eligibility. If you have any questions, comments, or concerns, please contact Tara S. Hoffmann, State Cultural Resources Specialist, at 801-524-4556, or tara.hoffmann@usda.gov, at your convenience.

Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
Tara Hoffmann, State Cultural Resources specialist, NRCS, Salt Lake City, UT
Brandon Todd, ASTC-Field Operations, NRCS, Richfield, UT
Lynn Kitchen, District Conservationist, NRCS, Cedar City, UT
Norm Evenstad, Assistant State Conservationist Water Resources, NRCS, Salt Lake City, UT
Derek Hamilton, Water Resources Coordinator, NRCS, Salt Lake City, UT
Amber Van Alfen, Archaeologist, BLM, Color County District, St. George, UT
Kristine Curry, Archaeologist, SITLA, Salt Lake City, UT
Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

From:	Hoffmann, Tara - FPAC-NRCS, UT
To:	Stewart Koyiyumptewa
Subject:	NRCS Santa Clara Watershed Plan-EA follow-up
Date:	Friday, August 25, 2023 5:02:00 PM
Attachments:	U21TN0316 HopiTHPO Concur.pdf Hopi_Consult.pdf U21TN0317.pdf

Stewart,

Hope you're doing well. I'm reaching out about one of our watershed projects near Santa Clara, Utah. We last mailed consultation letters in January of this year, and I wanted to check again to see if the Hopi had any concerns regarding the Santa Clara Watershed Plan-EA. I have attached the cultural resources report and second consultation letter. The first consultation we sent was in 2021 for geotechnical bore hole and test pit locations and we did receive concurrence on that part of the project (attached). This main part of the project in located partially on Shivwits Paiute land, and the rest is on BLM/State/Private in Diamond and Dammeron Valleys in south-central. The majority of the eligible cultural resources sites are on Shivwits, and we have been working with them closely throughout this project as one component is bringing irrigation water back to a historic agricultural field.

Please let us know within 30 days if the Hopi have any concerns, TCPS or other cultural resources that need to be take into account as we continue in our development of the Plan-EA. Also let us know if you concur with our determinations of site eligibility and project effects. Thanks again you for your continued involvement and support on all of our projects. I welcome any questions, comments or concerns and can provide any specific site forms you'd like for this project.

Cheers,

Tara

Tara S. Hoffmann, MA
State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

From:	Daniel Bulletts
To:	Hoffmann, Tara - FPAC-NRCS, UT
Subject:	Re: [Take care when opening attachments] NRCS Santa Clara Watershed Plan-EA
Date:	Monday, August 28, 2023 10:11:16 AM

Hello,
Thank you for reaching out to the Kaibab Paiute Band of Paiute Indians Cultural Resource department. I have reviewed all the attached documents and do not have any questions or comments regarding this project. Good to hear you are working closely with the Shivwitt's Band.

Take care and keep me in the loop on any other projects you may be working on these days.

On Fri, Aug 25, 2023 at 2:51 PM Hoffmann, Tara - FPAC-NRCS, UT <tara.hoffmann@usda.gov> wrote:

> Hello Daniel,
>
> Hope you're doing well. I'm reaching out about one of our watershed projects near Santa Clara. We last mailed letters in January of this year, and I wanted to check again to see if the Kaibab had any concerns regarding the Santa Clara Watershed Plan-EA. I have attached the cultural resources report and initial consultation letter. This project in located partially on Shivwits land, and the rest is on BLM/SITLA/Private in Diamond and Dammeron Valleys. The majority of the eligible cultural resources sites are on Shivwits, and we have been working with them closely throughout this project as one component is bringing irrigation water back to a historic agricultural field.
>
> Please let me know within 30 days if the Kaibab have any concerns, TCPS or other cultural resources that need to be take into account as we continue in our development of the Plan-EA. Thanks again you for your continued involvement and support on all of our projects. Hope I get to work with you again soon.
>
> Cheers,
>
> Tara
>
> Tara S. Hoffmann, MA
>
> State Cultural Resources Specialist/Tribal Liaison

> USDA Natural Resources Conservation Service
>
> Salt Lake City, UT
>
> 385.258.1266
>
>

--
Daniel Bulletts
Southern Paiute Consortium/Cultural Resource Director
Kaibab Band of Paiute Indians
HC 65 Box 02
Fredonia AZ 86022
928-643-6278

From:	Hoffmann, Tara - FPAC-NRCS, UT
To:	rolandm@kaibabpaiute-nsn.gov
Subject:	NRCS Santa Clara Watershed Plan-EA
Date:	Friday, August 25, 2023 3:53:00 PM
Attachments:	U21TN0317.pdf Segundo_Consult.pdf

Dear Ms. Segundo,

Hope you're doing well. I'm reaching out about one of our watershed projects near Santa Clara. We last mailed letters in January of this year, and I wanted to check again to see if the Kaibab had any concerns regarding the Santa Clara Watershed Plan-EA. I have attached the cultural resources report and initial consultation letter. This project in located partially on Shivwits land, and the rest is on BLM/SITLA/Private in Diamond and Dammeron Valleys. The majority of the eligible cultural resources sites are on Shivwits, and we have been working with them closely throughout this project as one component is bringing irrigation water back to a historic agricultural field.

Please let me know within 30 days if the Kaibab have any concerns, TCPS or other cultural resources that need to be take into account as we continue in our development of the Plan-EA. Thanks again you for your continued involvement and support on all of our projects. Hope I get to work with you again soon.

Cheers,

Tara

Tara S. Hoffmann, MA
State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

From: Hoffmann, Tara - FPAC-NRCS, UT
To: Daniel Bulletts
Subject: NRCS Santa Clara Watershed Plan-EA
Date: Friday, August 25, 2023 3:50:00 PM
Attachments: U21TN0317.pdf
Bulletts_Consult.pdf

Hello Daniel,

Hope you're doing well. I'm reaching out about one of our watershed projects near Santa Clara. We last mailed letters in January of this year, and I wanted to check again to see if the Kaibab had any concerns regarding the Santa Clara Watershed Plan-EA. I have attached the cultural resources report and initial consultation letter. This project in located partially on Shivwits land, and the rest is on BLM/SITLA/Private in Diamond and Dammeron Valleys. The majority of the eligible cultural resources sites are on Shivwits, and we have been working with them closely throughout this project as one component is bringing irrigation water back to a historic agricultural field.

Please let me know within 30 days if the Kaibab have any concerns, TCPS or other cultural resources that need to be take into account as we continue in our development of the Plan-EA. Thanks again you for your continued involvement and support on all of our projects. Hope I get to work with you again soon.

Cheers,

Tara

Tara S. Hoffmann, MA
State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

From:	Hoffmann, Tara - FPAC-NRCS, UT
To:	darleneparrum@gmail.com
Subject:	NRCS Santa Clara Watershed Project
Date:	Monday, August 28, 2023 10:37:00 AM
Attachments:	Arrum_Consult.pdf U21TN0317.pdf

Ms. Arrum,

Hope you're doing well. I'm reaching out about one of our watershed projects near Santa Clara, Utah. We last mailed consultation letters in January of this year, and I wanted to check again to see if the Kanosh Band had any concerns regarding the Santa Clara Watershed Plan-EA. I have attached the cultural resources report and consultation letter. This part of the project in located partially on Shivwits Paiute land, and the rest is on BLM/State/Private in Diamond and Dammeron Valleys in south-central Utah. The majority of the eligible cultural resources sites are on Shivwits, and we have been working with them closely throughout this project as one component is bringing irrigation water back to a historic agricultural field.

Please let us know within 30 days if the Kanosh have any concerns, TCPS or other cultural resources that need to be take into account as we continue in our development of the Plan-EA. Also let us know if you concur with our determinations of site eligibility and project effects. Thanks again you for your continued involvement and support on all of our projects. I welcome any questions, comments or concerns and can provide any specific site forms you'd like for this project.

Cheers,

Tara

Tara S. Hoffmann, MA
State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

From:	Hoffmann, Tara - FPAC-NRCS, UT
To:	koosharem@utahpaiutes.org
Subject:	NRCS Santa Clara Watershed Plan-EA
Date:	Friday, August 25, 2023 3:43:00 PM
Attachments:	Koosharem_Consult.pdf U21TN0317.pdf

Dear Ms. Kanosh,

I'm writing as a follow-up consultation to one of our watershed projects near Santa Clara. We last mailed letters in January of this year, and I wanted to check again to see if the Koosharem Band had any concerns regarding the Santa Clara Watershed Plan-EA. I have attached the cultural resources report and initial consultation letter (which was mailed to your predecessor). This project in located partially on Shivwits land, and the rest is on BLM/SITLA/Private in Diamond and Dammeron Valleys. The project is proposing to build two debris basins in Diamond and Dammeron Valleys for flood control and then also install an irrigation pipeline on Shivwits to return water to their now dry agricultural fields. The majority of the eligible cultural resources sites are on Shivwits, and we have been working with them closely throughout this project as one component is bringing irrigation water back to the historic agricultural field.

Please let me know within 30 days if the Koosharem Band has any concerns, TCPS or other cultural resources we need to take into account as we continue in our development of the Plan-EA.

Hope all is well.

Cheers,

Tara

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State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

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State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

From:	Hoffmann, Tara - FPAC-NRCS, UT
To:	dpete@lvpaiute.com
Subject:	NRCS Santa Clara Watershed Plan-EA
Date:	Friday, August 25, 2023 4:10:00 PM
Attachments:	U21TN0317.pdf Pete_Consult.pdf

Dear Ms. Pete,

I'm writing as a follow-up consultation to one of the Natural Resources Conservation Service's Watershed Plan-Environmental Assessment projects near Santa Clara, Utah. We had previously consulted with your predecessor but are continuing our efforts and want to make sure we take into account any new concerns that may have arisen since our last consultation efforts. I have attached a formal consultation letter and copy of the cultural resources report that has been completed for this project. As a summary, this project proposes to build two debris basins near Dammeron and Diamond Valleys in south-central Utah and also construct an irrigation pipeline on Shivwits Paiute land to restore irrigation water to an historic agricultural field. Part of the project is on BLM, State and Private, and a small portion on Shivwits. Of the cultural resources sites identified, the majority of eligible ones are on Shivwits, and we have been working closely with them throughout this project.

Please let us know within 30 days if the Las Vegas Tribe has any concerns, TCPS or other cultural resources we need to take into account as we continue in our development of the Plan-EA. And also if you concur with site eligibility and project effects. Please reach out if you have any questions at all or would like to arrange a meeting.

Cheers,

Tara

Tara S. Hoffmann, MA
State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

From:	Hoffmann, Tara - FPAC-NRCS, UT
To:	chair.mbop@moapabandofpaiutes.org
Cc:	moapathpo@moapabandofpaiutes.org
Subject:	FW: NRCS Santa Clara Watershed Plan-EA follow up
Date:	Friday, August 25, 2023 4:32:00 PM
Attachments:	Anderson_Consult.pdf U21TN0317.pdf

Mr. Daboda and Mr. Anderson,

I emailed Shanan but found out she is no longer with the cultural department. I'm following up about an NRCS project and wanted to see if the Moapa Band has any concerns or questions. Me email below to Shanan summarizes the project and I have attached our previous formal consultation letter (one was also sent to you, Darren). Also attached is the cultural resources report.

Shanan,

I'm writing as a follow-up consultation to one of our watershed projects near Santa Clara, Utah. Our last communication was between you and Marcel about Phase I of this project (Borehole and Test Pit locations), but we did finish the second cultural resources phase and send a consultation letter in January (see attached). I wanted to make sure that the Moapa Band didn't have any concerns regarding the results of this survey, the determination of site eligibility and project effects (we did make a determination of "No Adverse Effect"). I have also attached the cultural resources report. The second phase of this project in located partially on Shivwits land, and the rest is on BLM/State/Private in south-central Utah. Washington County is proposing to build two debris basins in Diamond and Dammeron Valleys for flood control and then also install an irrigation pipeline on Shivwits to return water to their now dry agricultural fields. The majority of the eligible cultural resources sites are on Shivwits, and I have been working with them very closely, as well as our engineers to make sure they are involved in all aspects of the project including site identification, monitoring, and designing the pipeline too.

Please let me know within 30 days if the Moapa Band has any concerns, TCPS, other cultural resources we need to take into account as we continue in our development of the Plan-EA. And also if you concur with site eligibility and project effects. I have also cc'd Darren to keep the THPO involved as well. Any question at all, please let me know.

Cheers,

Tara

Tara S. Hoffmann, MA
State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

From:	Hoffmann, Tara - FPAC-NRCS, UT
To:	moapacultural@moapabandofpaiutes.org
Cc:	moapathpo@moapabandofpaiutes.org
Subject:	NRCS Santa Clara Watershed Plan-EA follow up
Date:	Friday, August 25, 2023 4:22:00 PM
Attachments:	U21TN0317.pdf Anderson_Consult.pdf

Shanan,

I'm writing as a follow-up consultation to one of our watershed projects near Santa Clara, Utah. Our last communication was between you and Marcel about Phase I of this project (Borehole and Test Pit locations), but we did finish the second cultural resources phase and send a consultation letter in January (see attached). I wanted to make sure that the Moapa Band didn't have any concerns regarding the results of this survey, the determination of site eligibility and project effects (we did make a determination of "No Adverse Effect"). I have also attached the cultural resources report. The second phase of this project in located partially on Shivwits land, and the rest is on BLM/State/Private in south-central Utah. Washington County is proposing to build two debris basins in Diamond and Dammeron Valleys for flood control and then also install an irrigation pipeline on Shivwits to return water to their now dry agricultural fields. The majority of the eligible cultural resources sites are on Shivwits, and I have been working with them very closely, as well as our engineers to make sure they are involved in all aspects of the project including site identification, monitoring, and designing the pipeline too.

Please let me know within 30 days if the Moapa Band has any concerns, TCPS, other cultural resources we need to take into account as we continue in our development of the Plan-EA. And also if you concur with site eligibility and project effects. I have also cc'd Darren to keep the THPO involved as well. Any question at all, please let me know!

Cheers,

Tara

Tara S. Hoffmann, MA
State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

From:	Hoffmann, Tara - FPAC-NRCS, UT
To:	arden.kucate@ashiwi.org
Cc:	kdongoske@cableone.net
Subject:	NRCS Santa Clara Watershed Project follow-up
Date:	Monday, August 28, 2023 4:12:00 PM
Attachments:	U21TN0317.pdf Dongoske_Consult.pdf Kucate_Consult.pdf

Dear Mr. Kucate,

I'm writing as a follow-up consultation to one of the Natural Resources Conservation Service's Watershed Plan-Environmental Assessment projects near Santa Clara, Utah. We had previously consulted with your predecessor but are continuing our efforts and want to make sure we take into account any new concerns that may have arisen since our last consultation efforts. I have attached a formal consultation letter and copy of the cultural resources report that has been completed for this project. As a summary, this project proposes to build two debris basins near Dammeron and Diamond Valleys in south-central Utah and also construct an irrigation pipeline on Shivwits Paiute land to restore irrigation water to an historic agricultural field. Part of the project is on BLM, State and Private, and a small portion on Shivwits. Of the cultural resources sites identified, the majority of eligible ones are on Shivwits, and we have been working closely with them throughout this project.

Please let us know within 30 days if the Pueblo of Zuni has any concerns, TCPS or other cultural resources we need to take into account as we continue in our development of the Plan-EA. And also if you concur with site eligibility and project effects. Please reach out if you have any questions at all or would like to arrange a meeting.

Cheers,

Tara

Tara S. Hoffmann, MA
State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

From:	Hoffmann, Tara - FPAC-NRCS, UT
To:	J.lehijr@sanjuanpaiute-nsn.gov
Subject:	NRCS Santa Clara Watershed Project
Date:	Monday, August 28, 2023 3:02:00 PM
Attachments:	U21TN0317.pdf Lehi_Consult.pdf

Mr. Lehi, Jr.,

Hope you're doing well. I'm reaching out about one of our watershed projects near Santa Clara, Utah. We last mailed consultation letters in January of this year, and I wanted to check again to see if the San Juan Southern Paiute Tribe had any concerns regarding the Santa Clara Watershed Plan-EA. I have attached the cultural resources report and consultation letter. This part of the project in located partially on Shivwits Paiute land, and the rest is on BLM/State/Private in Diamond and Dammeron Valleys in south-central Utah. The majority of the eligible cultural resources sites are on Shivwits, and we have been working with them closely throughout this project as one component is bringing irrigation water back to a historic agricultural field.

Please let us know within 30 days if the San Juan Southern Paiute have any concerns, TCPS or other cultural resources that need to be take into account as we continue in our development of the Plan-EA. Also let us know if you concur with our determinations of site eligibility and project effects. Thanks again you for your continued involvement and support on all of our projects. Please let me know if you have any questions.

Cheers,

Tara

Tara S. Hoffmann, MA
State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

From:	Hoffmann, Tara - FPAC-NRCS, UT
To:	betsyc@uteTribe.com
Subject:	NRCS Santa Clara Watershed Plan-EA follow-up consultation
Date:	Friday, August 25, 2023 3:36:00 PM
Attachments:	Ute_Consult.pdf U21TN0317.pdf
Importance:	High

Betsy,

I'm writing as a follow-up consultation to one of our watershed projects near Santa Clara. We last mailed letters in January of this year, and I wanted to check again to see if the Ute Tribe had any concerns regarding the Santa Clara Watershed Plan-EA. I have attached the cultural resources report and initial consultation letter. This project in located partially on Shivwits land, and the rest is on BLM/SITLA/Private in Diamond and Dammeron Valleys. The majority of the eligible cultural resources sites are on Shivwits, and we have been working with them closely throughout this project as one component is bringing irrigation water back to a historic agricultural field.

Please let me know within 30 days if the Ute has any concerns, TCPS or other cultural resources we need to be take into account as we continue in our development of the Plan-EA. Thank you for your continued involvement and support.

Hope all is well.

Cheers,

Tara

Tara S. Hoffmann, MA
State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

From:	Hoffmann, Tara - FPAC-NRCS, UT
To:	luked@utetribe.com
Subject:	NRCS Santa Clara Watershed Plan-EA follow-up consultation
Date:	Friday, August 25, 2023 3:36:00 PM
Attachments:	U21TN0317.pdf Duncan_Consult.pdf

Mr. Duncan,

I'm writing as a follow-up consultation to one of our watershed projects near Santa Clara. We last mailed letters in January of this year, and I wanted to check again to see if the Ute Tribe had any concerns regarding the Santa Clara Watershed Plan-EA. I have attached the cultural resources report and initial consultation letter. This project in located partially on Shivwits land, and the rest is on BLM/SITLA/Private in Diamond and Dammeron Valleys. The majority of the eligible cultural resources sites are on Shivwits, and we have been working with them closely throughout this project as one component is bringing irrigation water back to a historic agricultural field.

Please let me know within 30 days if the Ute has any concerns, TCPS or other cultural resources we need to be take into account as we continue in our development of the Plan-EA. Thank you for your continued involvement and support.

Hope all is well.

Cheers,

Tara

Tara S. Hoffmann, MA
State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

THE PAIUTE INDIAN TRIBE OF UTAH

440 North Paiute Drive • Cedar City, Utah 84721 • (435) 586-1112 • Fax (435) 867-2659

February 16, 2023

Trisha Cracroft/Acting State Conservationist
Natural Resources Conservation Service
125 South State St., Room 4010
Salt Lake City, Utah 84138

Dear Ms. Cracroft,

SUBJECT: ***UDSH Project Number: U21TN0317, Washington County, Utah***

The Paiute Indian Tribe of Utah is in receipt of your correspondence dated January 23, 2023 and has reviewed the material and do not have any objections pertaining to the above-named project. Currently we are not aware of cultural resource sites, practices, or locations of importance in the tribe's traditional religions or culture.
As you are aware the tribe supports the identification and avoidance of prehistoric sites and traditional cultural properties. The tribe concurs with your determination of eligibility and effort for this undertaking, this letter serves as our comment on the determinations you have made.

The Paiute Indian Tribe of Utah sincerely appreciates your accomplishments and consideration you and your staff have made to consult with the tribe.

Sincerely,

Dorena Martineau/Cultural Resource Director
Paiute Indian Tribe of Utah
440 North Paiute Drive
Cedar City, Utah 84721
P 435-586-1112
E dmartineau@pitu.gov W www.utahpaiutes.org

January 23, 2023

Ms. Betsy Chapoose, THPO
Cultural Rights Protection Department
Ute Indian Tribe of the Uintah & Ouray Reservation
P.O. Box 190
Fort Duchesne, Utah 84026

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Ms. Chapoose:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*, and associated data. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

The Phase II Area of Potential Effects (APE) encompasses Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The APE acreage totals 587.82 acres, including 296.38 acres that was previously surveyed in Phase I, and 291.44 acres of new survey in Phase II. Of this, 245.97 acres falls on land administered by the Bureau of Land Management (BLM), St. George Field Office, 57.74 acres are on lands managed by the Utah School and Institutional Trust Lands Administration (SITLA), 220.94 acres are on Private land, and 63.17 acres are on the Shivwits Reservation. The NRCS is acting as the lead federal agency for the purposes of Section 106 consultation, which will also cover SITLA's responsibilities under Utah Code Annotated Section 9-8-404. The BLM is a cooperating agency.

An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. in two field sessions from May 17–21, 2021, and May 24–28, 2021. As a result of the survey, it was determined that a total of 11 cultural resource sites are located within the project APE. Of these 11 sites, four sites were previously reported separately under Phase I of the Project and were not updated as part of this report (42WS2428, 42WS5150, 42WS5151,42WS5154 [see U21TN0316]). Site (42WS2428: *Road from St. George to Pine Valley*) is determined Eligible for listing on the National

Register of Historic Places (NRHP) under Criterion A for its association with significant historic events (but the segment within the APE is determined non-contributing), and three sites (42WS5150, 42WS5151, and 42WS5152) are determined Not Eligible for the NRHP under any Criteria. Additionally, the NRCS has determined Site 42WS5151 to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property. No construction elements are occurring within the boundaries of these sites.

Three previously recorded sites were identified within the project APE during the new survey (42WS4692: historic pipeline and suspension bridge, 42WS4823: prehistoric lithic scatter, and 42WS5154: prehistoric lithic scatter). Four new cultural resource sites were identified as a result of this survey (42WS6520: historic irrigation ditch, 42WS6521: historic Shivwits school and multi-component, 42WS6522: multicomponent, and 42WS6523: historic flood control ditch). The NRCS has determined that Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all eligible for the NRHP. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154), are determined Not Eligible for NRHP listing under any Criteria.

Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

TABLE 1
SANTA CLARA WATERSHED PLAN-EA PROJECT
CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Mitigation*
42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
				Enters site boundary at one other location	Contributing	No Adverse Effect	
42WS6521	Multi-component habitation complex	Eligible A, C,	Pipeline	Crosses W edge of site, with nearby features	Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an
			Ditch Rip Rap	Within N edge of site in area of prior disturbance (erosion); will repair eroded	Non-Contributing	No Adverse Effect	

TABLE 1 SANTA CLARA WATERSHED PLAN-EA PROJECT CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)							
Site No.	**Site Type**	**Eligibility**	**Project Component**	**Impacts**	**Status**	**Effects**	**Mitigation***
				channel without impacting intact masonry			inadvertent discovery plan prior to construction.
42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Bank Rip Rap	Crosses N edge of site, within area of no surface observations	Contributing	No Adverse Effect	
42WS6523	Historic flood control ditch	Eligible - A, C, D	Pipeline	Crosses at S end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Ditch Rip Rap	Within center of site, within area of prior disturbance (erosion); will repair eroded channel without impacting intact masonry and protect ditch from further erosion	Non-Contributing	No Adverse Effect	
N/A	N/A	N/A	Land Leveling	No sites within the proposed land leveling area (previously disturbed area)	N/A	N/A	N/A
*Note: both an archaeological and Tribal monitor will be present for all ground disturbing activities within the Shivwits area of the project.							

Based on the monitoring and avoidance measures for the four NRHP- Eligible sites located on the Shivwits APE proposed in Table 1, and that the additional three newly recorded sites are determined ineligible for the NRHP, the NRCS has determined that the undertaking will result in ***no adverse effect to historic properties***. Additionally, as previously stated, no construction activities will take place within the site boundaries of the four previously reported on sites (refer to U21TN0316). The NRCS requests your

concurrence for the determination of project effects and site eligibility. If you have any questions, comments, or concerns, please contact Tara S. Hoffmann, State Cultural Resources Specialist, at 801-524-4556, or tara.hoffmann@usda.gov, at your convenience.

Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
Tara Hoffmann, State Cultural Resources specialist, NRCS, Salt Lake City, UT
Brandon Todd, ASTC-Field Operations, NRCS, Richfield, UT
Lynn Kitchen, District Conservationist, NRCS, Cedar City, UT
Norm Evenstad, Assistant State Conservationist Water Resources, NRCS, Salt Lake City, UT
Derek Hamilton, Water Resources Coordinator, NRCS, Salt Lake City, UT
Amber Van Alfen, Archaeologist, BLM, Color County District, St. George, UT
Kristine Curry, Archaeologist, SITLA, Salt Lake City, UT
Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

January 23, 2023

Darren Daboda, THPO
Moapa Band of Paiutes
1 Lincoln Street
PO Box 340
Moapa, NV 89025

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Mr. Daboda:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*, and associated data. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

The Phase II Area of Potential Effects (APE) encompasses Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The APE acreage totals 587.82 acres, including 296.38 acres that was previously surveyed in Phase I, and 291.44 acres of new survey in Phase II. Of this, 245.97 acres falls on land administered by the Bureau of Land Management (BLM), St. George Field Office, 57.74 acres are on lands managed by the Utah School and Institutional Trust Lands Administration (SITLA), 220.94 acres are on Private land, and 63.17 acres are on the Shivwits Reservation. The NRCS is acting as the lead federal agency for the purposes of Section 106 consultation, which will also cover SITLA's responsibilities under Utah Code Annotated Section 9-8-404. The BLM is a cooperating agency.

An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. in two field sessions from May 17–21, 2021, and May 24–28, 2021. As a result of the survey, it was determined that a total of 11 cultural resource sites are located within the project APE. Of these 11 sites, four sites were previously reported separately under Phase I of the Project and were not updated as part of this report (42WS2428, 42WS5150, 42WS5151,42WS5154 [see U21TN0316]). Site (42WS2428: *Road from St. George to Pine Valley*) is determined Eligible for listing on the National

Register of Historic Places (NRHP) under Criterion A for its association with significant historic events (but the segment within the APE is determined non-contributing), and three sites (42WS5150, 42WS5151, and 42WS5152) are determined Not Eligible for the NRHP under any Criteria. Additionally, the NRCS has determined Site 42WS5151 to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property. No construction elements are occurring within the boundaries of these sites.

Three previously recorded sites were identified within the project APE during the new survey (42WS4692: historic pipeline and suspension bridge, 42WS4823: prehistoric lithic scatter, and 42WS5154: prehistoric lithic scatter). Four new cultural resource sites were identified as a result of this survey (42WS6520: historic irrigation ditch, 42WS6521: historic Shivwits school and multi-component, 42WS6522: multicomponent, and 42WS6523: historic flood control ditch). The NRCS has determined that Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all eligible for the NRHP. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154), are determined Not Eligible for NRHP listing under any Criteria.

Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

TABLE 1
SANTA CLARA WATERSHED PLAN-EA PROJECT
CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Mitigation*
42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
				Enters site boundary at one other location	Contributing	No Adverse Effect	
42WS6521	Multi-component habitation complex	Eligible A, C,	Pipeline	Crosses W edge of site, with nearby features	Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an
			Ditch Rip Rap	Within N edge of site in area of prior disturbance (erosion); will repair eroded	Non-Contributing	No Adverse Effect	

TABLE 1 SANTA CLARA WATERSHED PLAN-EA PROJECT CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)							
Site No.	**Site Type**	**Eligibility**	**Project Component**	**Impacts**	**Status**	**Effects**	**Mitigation***
				channel without impacting intact masonry			inadvertent discovery plan prior to construction.
42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Bank Rip Rap	Crosses N edge of site, within area of no surface observations	Contributing	No Adverse Effect	
42WS6523	Historic flood control ditch	Eligible - A, C, D	Pipeline	Crosses at S end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Ditch Rip Rap	Within center of site, within area of prior disturbance (erosion); will repair eroded channel without impacting intact masonry and protect ditch from further erosion	Non-Contributing	No Adverse Effect	
N/A	N/A	N/A	Land Leveling	No sites within the proposed land leveling area (previously disturbed area)	N/A	N/A	N/A
*Note: both an archaeological and Tribal monitor will be present for all ground disturbing activities within the Shivwits area of the project.							

Based on the monitoring and avoidance measures for the four NRHP- Eligible sites located on the Shivwits APE proposed in Table 1, and that the additional three newly recorded sites are determined ineligible for the NRHP, the NRCS has determined that the undertaking will result in ***no adverse effect to historic properties***. Additionally, as previously stated, no construction activities will take place within the site boundaries of the four previously reported on sites (refer to U21TN0316). The NRCS requests your

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Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
Tara Hoffmann, State Cultural Resources specialist, NRCS, Salt Lake City, UT
Brandon Todd, ASTC-Field Operations, NRCS, Richfield, UT
Lynn Kitchen, District Conservationist, NRCS, Cedar City, UT
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Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

USDA

United States Department of Agriculture

January 23, 2023

Kurt Dongoske, RPA
Director/Tribal Historic Preservation Officer
Zuni Heritage & Historic Preservation
P.O. Box 339
Zuni, New Mexico 87327

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Mr. Dongoske:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*, and associated data. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

The Phase II Area of Potential Effects (APE) encompasses Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The APE acreage totals 587.82 acres, including 296.38 acres that was previously surveyed in Phase I, and 291.44 acres of new survey in Phase II. Of this, 245.97 acres falls on land administered by the Bureau of Land Management (BLM), St. George Field Office, 57.74 acres are on lands managed by the Utah School and Institutional Trust Lands Administration (SITLA), 220.94 acres are on Private land, and 63.17 acres are on the Shivwits Reservation. The NRCS is acting as the lead federal agency for the purposes of Section 106 consultation, which will also cover SITLA's responsibilities under Utah Code Annotated Section 9-8-404. The BLM is a cooperating agency.

An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. in two field sessions from May 17–21, 2021, and May 24–28, 2021. As a result of the survey, it was determined that a total of 11 cultural resource sites are located within the project APE. Of these 11 sites, four sites were previously reported separately under Phase I of the Project and were not updated as part of this report (42WS2428, 42WS5150, 42WS5151,42WS5154 [see U21TN0316]). Site (42WS2428: *Road from St. George to Pine Valley*) is determined Eligible for listing on the National

Register of Historic Places (NRHP) under Criterion A for its association with significant historic events (but the segment within the APE is determined non-contributing), and three sites (42WS5150, 42WS5151, and 42WS5152) are determined Not Eligible for the NRHP under any Criteria. Additionally, the NRCS has determined Site 42WS5151 to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property. No construction elements are occurring within the boundaries of these sites.

Three previously recorded sites were identified within the project APE during the new survey (42WS4692: historic pipeline and suspension bridge, 42WS4823: prehistoric lithic scatter, and 42WS5154: prehistoric lithic scatter). Four new cultural resource sites were identified as a result of this survey (42WS6520: historic irrigation ditch, 42WS6521: historic Shivwits school and multi-component, 42WS6522: multicomponent, and 42WS6523: historic flood control ditch). The NRCS has determined that Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all eligible for the NRHP. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154), are determined Not Eligible for NRHP listing under any Criteria.

Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

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Site No.	**Site Type**	**Eligibility**	**Project Component**	**Impacts**	**Status**	**Effects**	**Mitigation***
				channel without impacting intact masonry			inadvertent discovery plan prior to construction.
42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
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42WS6523	Historic flood control ditch	Eligible - A, C, D	Pipeline	Crosses at S end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
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Based on the monitoring and avoidance measures for the four NRHP- Eligible sites located on the Shivwits APE proposed in Table 1, and that the additional three newly recorded sites are determined ineligible for the NRHP, the NRCS has determined that the undertaking will result in ***no adverse effect to historic properties***. Additionally, as previously stated, no construction activities will take place within the site boundaries of the four previously reported on sites (refer to U21TN0316). The NRCS requests your

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Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
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Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

January 23, 2023

Stewart B. Koyiyumptewa, THPO
Hopi Tribe of Arizona
Hopi Cultural Preservation Office
P.O Box 123
Kykotsmovi, Arizona 86039

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Mr. Koyiyumptewa:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*, and associated data. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

The Phase II Area of Potential Effects (APE) encompasses Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The APE acreage totals 587.82 acres, including 296.38 acres that was previously surveyed in Phase I, and 291.44 acres of new survey in Phase II. Of this, 245.97 acres falls on land administered by the Bureau of Land Management (BLM), St. George Field Office, 57.74 acres are on lands managed by the Utah School and Institutional Trust Lands Administration (SITLA), 220.94 acres are on Private land, and 63.17 acres are on the Shivwits Reservation. The NRCS is acting as the lead federal agency for the purposes of Section 106 consultation, which will also cover SITLA's responsibilities under Utah Code Annotated Section 9-8-404. The BLM is a cooperating agency.

An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. in two field sessions from May 17–21, 2021, and May 24–28, 2021. As a result of the survey, it was determined that a total of 11 cultural resource sites are located within the project APE. Of these 11 sites, four sites were previously reported separately under Phase I of the Project and were not updated as part of this report (42WS2428, 42WS5150, 42WS5151,42WS5154 [see U21TN0316]). Site (42WS2428: *Road from St. George to Pine Valley*) is determined Eligible for listing on the National

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Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

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CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Mitigation*
42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
				Enters site boundary at one other location	Contributing	No Adverse Effect	
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42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
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42WS6523	Historic flood control ditch	Eligible - A, C, D	Pipeline	Crosses at S end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
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Based on the monitoring and avoidance measures for the four NRHP- Eligible sites located on the Shivwits APE proposed in Table 1, and that the additional three newly recorded sites are determined ineligible for the NRHP, the NRCS has determined that the undertaking will result in ***no adverse effect to historic properties***. Additionally, as previously stated, no construction activities will take place within the site boundaries of the four previously reported on sites (refer to U21TN0316). The NRCS requests your

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Sincerely,

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Enclosure

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Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

January 23, 2023

Shanandoah (Shanan) Anderson
Cultural Manager
Moapa Band of Paiute Indians of the Moapa River Indian Reservation
P.O. Box 340
Moapa, Nevada 89025-0340

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Mr. Anderson

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

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42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
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Enclosure

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Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

January 23, 2023

Ms Darlene Arrum
Chairwoman
PO Box 116
Kanosh, UT 84637

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Ms Arrum:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

The Phase II Area of Potential Effects (APE) encompasses Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The APE acreage totals 587.82 acres, including 296.38 acres that was previously surveyed in Phase I, and 291.44 acres of new survey in Phase II. Of this, 245.97 acres falls on land administered by the Bureau of Land Management (BLM), St. George Field Office, 57.74 acres are on lands managed by the Utah School and Institutional Trust Lands Administration (SITLA), 220.94 acres are on Private land, and 63.17 acres are on the Shivwits Reservation. The NRCS is acting as the lead federal agency for the purposes of Section 106 consultation, which will also cover SITLA's responsibilities under Utah Code Annotated Section 9-8-404. The BLM is a cooperating agency.

An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. in two field sessions from May 17–21, 2021, and May 24–28, 2021. As a result of the survey, it was determined that a total of 11 cultural resource sites are located within the project APE. Of these 11 sites, four sites were previously reported separately under Phase I of the Project and were not updated as part of this report (42WS2428, 42WS5150, 42WS5151,42WS5154 [see U21TN0316]). Site (42WS2428: *Road from St. George to Pine Valley*) is determined Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events

(but the segment within the APE is determined non-contributing), and three sites (42WS5150, 42WS5151, and 42WS5152) are determined Not Eligible for the NRHP under any Criteria. Additionally, the NRCS has determined Site 42WS5151 to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property. No construction elements are occurring within the boundaries of these sites.

Three previously recorded sites were identified within the project APE during the new survey (42WS4692: historic pipeline and suspension bridge, 42WS4823: prehistoric lithic scatter, and 42WS5154: prehistoric lithic scatter). Four new cultural resource sites were identified as a result of this survey (42WS6520: historic irrigation ditch, 42WS6521: historic Shivwits school and multi-component, 42WS6522: multicomponent, and 42WS6523: historic flood control ditch). The NRCS has determined that Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all eligible for the NRHP. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154), are determined Not Eligible for NRHP listing under any Criteria.

Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

TABLE 1
SANTA CLARA WATERSHED PLAN-EA PROJECT
CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Mitigation*
42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
				Enters site boundary at one other location	Contributing	No Adverse Effect	
42WS6521	Multi-component habitation complex	Eligible A, C,	Pipeline	Crosses W edge of site, with nearby features	Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent
			Ditch Rip Rap	Within N edge of site in area of prior disturbance (erosion); will repair eroded channel without	Non-Contributing	No Adverse Effect	

TABLE 1 SANTA CLARA WATERSHED PLAN-EA PROJECT CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)							
Site No.	**Site Type**	**Eligibility**	**Project Component**	**Impacts**	**Status**	**Effects**	**Mitigation***
				impacting intact masonry			discovery plan prior to construction.
42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Bank Rip Rap	Crosses N edge of site, within area of no surface observations	Contributing	No Adverse Effect	
42WS6523	Historic flood control ditch	Eligible - A, C, D	Pipeline	Crosses at S end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Ditch Rip Rap	Within center of site, within area of prior disturbance (erosion); will repair eroded channel without impacting intact masonry and protect ditch from further erosion	Non-Contributing	No Adverse Effect	
N/A	N/A	N/A	Land Leveling	No sites within the proposed land leveling area (previously disturbed area)	N/A	N/A	N/A
*Note: both an archaeological and Tribal monitor will be present for all ground disturbing activities within the Shivwits area of the project.							

Based on the monitoring and avoidance measures for the four NRHP- Eligible sites located on the Shivwits APE proposed in Table 1, and that the additional three newly recorded sites are determined ineligible for the NRHP, the NRCS has determined that the undertaking will result in ***no adverse effect to historic properties***. Additionally, as previously stated, no construction activities will take place within the site boundaries of the four previously reported on sites (refer to U21TN0316). The NRCS requests your concurrence for the determination of project effects and site eligibility.

United States Department of Agriculture

If you have any questions, comments, or concerns, please contact Tara S. Hoffmann, State Cultural Resources Specialist, at 801-524-4556, or tara.hoffmann@usda.gov, at your convenience.

Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
Tara Hoffmann, State Cultural Resources specialist, NRCS, Salt Lake City, UT
Brandon Todd, ASTC-Field Operations, NRCS, Richfield, UT
Lynn Kitchen, District Conservationist, NRCS, Cedar City, UT
Norm Evenstad, Assistant State Conservationist Water Resources, NRCS, Salt Lake City, UT
Derek Hamilton, Water Resources Coordinator, NRCS, Salt Lake City, UT
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Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

USDA

United States Department of Agriculture

January 23, 2023

Mr. Daniel Bullets
Kaibab Band of Paiute Indians of the Kaibab Indian Reservation
Cultural Preservation Office
HC65, Box 2
Fredonia, Arizona 86022

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Mr. Bullets:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

The Phase II Area of Potential Effects (APE) encompasses Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The APE acreage totals 587.82 acres, including 296.38 acres that was previously surveyed in Phase I, and 291.44 acres of new survey in Phase II. Of this, 245.97 acres falls on land administered by the Bureau of Land Management (BLM), St. George Field Office, 57.74 acres are on lands managed by the Utah School and Institutional Trust Lands Administration (SITLA), 220.94 acres are on Private land, and 63.17 acres are on the Shivwits Reservation. The NRCS is acting as the lead federal agency for the purposes of Section 106 consultation, which will also cover SITLA's responsibilities under Utah Code Annotated Section 9-8-404. The BLM is a cooperating agency.

An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. in two field sessions from May 17–21, 2021, and May 24–28, 2021. As a result of the survey, it was determined that a total of 11 cultural resource sites are located within the project APE. Of these 11 sites, four sites were previously reported separately under Phase I of the Project and were not updated as part of this report (42WS2428, 42WS5150, 42WS5151,42WS5154 [see U21TN0316]). Site (42WS2428: *Road from St. George to Pine Valley*) is determined Eligible for listing on the National

Register of Historic Places (NRHP) under Criterion A for its association with significant historic events (but the segment within the APE is determined non-contributing), and three sites (42WS5150, 42WS5151, and 42WS5152) are determined Not Eligible for the NRHP under any Criteria. Additionally, the NRCS has determined Site 42WS5151 to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property. No construction elements are occurring within the boundaries of these sites.

Three previously recorded sites were identified within the project APE during the new survey (42WS4692: historic pipeline and suspension bridge, 42WS4823: prehistoric lithic scatter, and 42WS5154: prehistoric lithic scatter). Four new cultural resource sites were identified as a result of this survey (42WS6520: historic irrigation ditch, 42WS6521: historic Shivwits school and multi-component, 42WS6522: multicomponent, and 42WS6523: historic flood control ditch). The NRCS has determined that Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all eligible for the NRHP. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154), are determined Not Eligible for NRHP listing under any Criteria.

Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

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Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Mitigation*
				channel without impacting intact masonry			inadvertent discovery plan prior to construction.
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Enclosure

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Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

January 23, 2023

Ms. Carmen Clark
Cultural Resources
Shivwits Band of Paiute Indians
Paiute Indian Tribe of Utah
6060 West 3650 North
Ivins, Utah 84738

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Ms. Clark:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

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USDA

United States Department of Agriculture

January 23, 2023

Mr. Luke Duncan
Chairman
Ute Indian Tribe of the Uintah & Ouray Reservation, Utah
P.O. Box 190
Fort Duchesne, Utah 84026

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

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Three previously recorded sites were identified within the project APE during the new survey (42WS4692: historic pipeline and suspension bridge, 42WS4823: prehistoric lithic scatter, and 42WS5154: prehistoric lithic scatter). Four new cultural resource sites were identified as a result of this survey (42WS6520: historic irrigation ditch, 42WS6521: historic Shivwits school and multi-component, 42WS6522: multicomponent, and 42WS6523: historic flood control ditch). The NRCS has determined that Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all eligible for the NRHP. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154), are determined Not Eligible for NRHP listing under any Criteria.

Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

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CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)</th></tr>
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USDA

United States Department of Agriculture

TABLE 1 SANTA CLARA WATERSHED PLAN-EA PROJECT CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)							
Site No.	**Site Type**	**Eligibility**	**Project Component**	**Impacts**	**Status**	**Effects**	**Mitigation***
				channel without impacting intact masonry			inadvertent discovery plan prior to construction.
42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Bank Rip Rap	Crosses N edge of site, within area of no surface observations	Contributing	No Adverse Effect	
42WS6523	Historic flood control ditch	Eligible - A, C, D	Pipeline	Crosses at S end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Ditch Rip Rap	Within center of site, within area of prior disturbance (erosion); will repair eroded channel without impacting intact masonry and protect ditch from further erosion	Non-Contributing	No Adverse Effect	
N/A	N/A	N/A	Land Leveling	No sites within the proposed land leveling area (previously disturbed area)	N/A	N/A	N/A
*Note: both an archaeological and Tribal monitor will be present for all ground disturbing activities within the Shivwits area of the project.							

Based on the monitoring and avoidance measures for the four NRHP- Eligible sites located on the Shivwits APE proposed in Table 1, and that the additional three newly recorded sites are determined ineligible for the NRHP, the NRCS has determined that the undertaking will result in ***no adverse effect to historic properties***. Additionally, as previously stated, no construction activities will take place within the site boundaries of the four previously reported on sites (refer to U21TN0316). The NRCS requests your

United States Department of Agriculture

concurrence for the determination of project effects and site eligibility. If you have any questions, comments, or concerns, please contact Tara S. Hoffmann, State Cultural Resources Specialist, at 801-524-4556, or tara.hoffmann@usda.gov, at your convenience.

Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
Tara Hoffmann, State Cultural Resources specialist, NRCS, Salt Lake City, UT
Brandon Todd, ASTC-Field Operations, NRCS, Richfield, UT
Lynn Kitchen, District Conservationist, NRCS, Cedar City, UT
Norm Evenstad, Assistant State Conservationist Water Resources, NRCS, Salt Lake City, UT
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Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

January 23, 2023

Mr. Johnny Lehi, Jr.
President
San Juan Southern Paiute Tribe of Arizona
50 South Main Street, Suite 201
P.O. Box 2950
Tuba City, Arizona 86045

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Mr. Lehi:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

The Phase II Area of Potential Effects (APE) encompasses Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The APE acreage totals 587.82 acres, including 296.38 acres that was previously surveyed in Phase I, and 291.44 acres of new survey in Phase II. Of this, 245.97 acres falls on land administered by the Bureau of Land Management (BLM), St. George Field Office, 57.74 acres are on lands managed by the Utah School and Institutional Trust Lands Administration (SITLA), 220.94 acres are on Private land, and 63.17 acres are on the Shivwits Reservation. The NRCS is acting as the lead federal agency for the purposes of Section 106 consultation, which will also cover SITLA's responsibilities under Utah Code Annotated Section 9-8-404. The BLM is a cooperating agency.

An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. in two field sessions from May 17–21, 2021, and May 24–28, 2021. As a result of the survey, it was determined that a total of 11 cultural resource sites are located within the project APE. Of these 11 sites, four sites were previously reported separately under Phase I of the Project and were not updated as part of this report (42WS2428, 42WS5150, 42WS5151,42WS5154 [see U21TN0316]). Site

(42WS2428: *Road from St. George to Pine Valley*) is determined Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events (but the segment within the APE is determined non-contributing), and three sites (42WS5150, 42WS5151, and 42WS5152) are determined Not Eligible for the NRHP under any Criteria. Additionally, the NRCS has determined Site 42WS5151 to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property. No construction elements are occurring within the boundaries of these sites.

Three previously recorded sites were identified within the project APE during the new survey (42WS4692: historic pipeline and suspension bridge, 42WS4823: prehistoric lithic scatter, and 42WS5154: prehistoric lithic scatter). Four new cultural resource sites were identified as a result of this survey (42WS6520: historic irrigation ditch, 42WS6521: historic Shivwits school and multi-component, 42WS6522: multicomponent, and 42WS6523: historic flood control ditch). The NRCS has determined that Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all eligible for the NRHP. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154), are determined Not Eligible for NRHP listing under any Criteria.

Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

TABLE 1
SANTA CLARA WATERSHED PLAN-EA PROJECT
CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Mitigation*
42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
				Enters site boundary at one other location	Contributing	No Adverse Effect	
42WS6521	Multi-component habitation complex	Eligible A, C,	Pipeline	Crosses W edge of site, with nearby features	Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction
			Ditch Rip Rap	Within N edge of site in area of prior disturbance (erosion); will	Non-Contributing	No Adverse Effect	

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Site No.	**Site Type**	**Eligibility**	**Project Component**	**Impacts**	**Status**	**Effects**	**Mitigation***
				repair eroded channel without impacting intact masonry			meeting, and an inadvertent discovery plan prior to construction.
42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Bank Rip Rap	Crosses N edge of site, within area of no surface observations	Contributing	No Adverse Effect	
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N/A	N/A	N/A	Land Leveling	No sites within the proposed land leveling area (previously disturbed area)	N/A	N/A	N/A
*Note: both an archaeological and Tribal monitor will be present for all ground disturbing activities within the Shivwits area of the project.							

Based on the monitoring and avoidance measures for the four NRHP- Eligible sites located on the Shivwits APE proposed in Table 1, and that the additional three newly recorded sites are determined ineligible for the NRHP, the NRCS has determined that the undertaking will result in ***no adverse effect to historic properties***. Additionally, as previously stated, no construction activities will take place within the site

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Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
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Brandon Todd, ASTC-Field Operations, NRCS, Richfield, UT
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Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

United States Department of Agriculture

January 23, 2023

Mr. Glenn Lodge, Chairman
Chemehuevi Indian Tribe
1990 Palo Verde Drive
P.O. Box 1976
Havasu Lake, CA 92363

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Mr. Lodge:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

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42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
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42WS6521	Multi-component habitation complex	Eligible A, C,	Pipeline	Crosses W edge of site, with nearby features	Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an
			Ditch Rip Rap	Within N edge of site in area of prior disturbance (erosion); will repair eroded	Non-Contributing	No Adverse Effect	

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				channel without impacting intact masonry			inadvertent discovery plan prior to construction.
42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
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42WS6523	Historic flood control ditch	Eligible - A, C, D	Pipeline	Crosses at S end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
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Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
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Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

United States Department of Agriculture

January 23, 2023

Ms. Dorena Martineau
Paiute Indian Tribe of Utah
440 North Paiute Drive
Cedar City, Utah 84721

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Ms. Martineau:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

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TABLE 1
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CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Mitigation*
42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
				Enters site boundary at one other location	Contributing	No Adverse Effect	
42WS6521	Multi-component habitation complex	Eligible A, C,	Pipeline	Crosses W edge of site, with nearby features	Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent
			Ditch Rip Rap	Within N edge of site in area of prior disturbance (erosion); will repair eroded channel without	Non-Contributing	No Adverse Effect	

TABLE 1 SANTA CLARA WATERSHED PLAN-EA PROJECT CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)							
Site No.	**Site Type**	**Eligibility**	**Project Component**	**Impacts**	**Status**	**Effects**	**Mitigation***
				impacting intact masonry			discovery plan prior to construction.
42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Bank Rip Rap	Crosses N edge of site, within area of no surface observations	Contributing	No Adverse Effect	
42WS6523	Historic flood control ditch	Eligible - A, C, D	Pipeline	Crosses at S end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Ditch Rip Rap	Within center of site, within area of prior disturbance (erosion); will repair eroded channel without impacting intact masonry and protect ditch from further erosion	Non-Contributing	No Adverse Effect	
N/A	N/A	N/A	Land Leveling	No sites within the proposed land leveling area (previously disturbed area)	N/A	N/A	N/A
*Note: both an archaeological and Tribal monitor will be present for all ground disturbing activities within the Shivwits area of the project.							

Based on the monitoring and avoidance measures for the four NRHP- Eligible sites located on the Shivwits APE proposed in Table 1, and that the additional three newly recorded sites are determined ineligible for the NRHP, the NRCS has determined that the undertaking will result in ***no adverse effect to historic properties***. Additionally, as previously stated, no construction activities will take place within the site boundaries of the four previously reported on sites (refer to U21TN0316). The NRCS requests your concurrence for the determination of project effects and site eligibility.

United States Department of Agriculture

If you have any questions, comments, or concerns, please contact Tara S. Hoffmann, State Cultural Resources Specialist, at 801-524-4556, or tara.hoffmann@usda.gov, at your convenience.

Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
Tara Hoffmann, State Cultural Resources specialist, NRCS, Salt Lake City, UT
Brandon Todd, ASTC-Field Operations, NRCS, Richfield, UT
Lynn Kitchen, District Conservationist, NRCS, Cedar City, UT
Norm Evenstad, Assistant State Conservationist Water Resources, NRCS, Salt Lake City, UT
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Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

USDA

United States Department of Agriculture

January 23, 2023

Ms. LaTosha Mayo, Chairwoman
Koosharem Band of Paiutes
P.O. Box 205
Richfield, Utah 84701

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Ms. Mayo:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

The Phase II Area of Potential Effects (APE) encompasses Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The APE acreage totals 587.82 acres, including 296.38 acres that was previously surveyed in Phase I, and 291.44 acres of new survey in Phase II. Of this, 245.97 acres falls on land administered by the Bureau of Land Management (BLM), St. George Field Office, 57.74 acres are on lands managed by the Utah School and Institutional Trust Lands Administration (SITLA), 220.94 acres are on Private land, and 63.17 acres are on the Shivwits Reservation. The NRCS is acting as the lead federal agency for the purposes of Section 106 consultation, which will also cover SITLA's responsibilities under Utah Code Annotated Section 9-8-404. The BLM is a cooperating agency.

An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. in two field sessions from May 17–21, 2021, and May 24–28, 2021. As a result of the survey, it was determined that a total of 11 cultural resource sites are located within the project APE. Of these 11 sites, four sites were previously reported separately under Phase I of the Project and were not updated as part of this report (42WS2428, 42WS5150, 42WS5151,42WS5154 [see U21TN0316]). Site (42WS2428: *Road from St. George to Pine Valley*) is determined Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events

(but the segment within the APE is determined non-contributing), and three sites (42WS5150, 42WS5151, and 42WS5152) are determined Not Eligible for the NRHP under any Criteria. Additionally, the NRCS has determined Site 42WS5151 to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property. No construction elements are occurring within the boundaries of these sites.

Three previously recorded sites were identified within the project APE during the new survey (42WS4692: historic pipeline and suspension bridge, 42WS4823: prehistoric lithic scatter, and 42WS5154: prehistoric lithic scatter). Four new cultural resource sites were identified as a result of this survey (42WS6520: historic irrigation ditch, 42WS6521: historic Shivwits school and multi-component, 42WS6522: multicomponent, and 42WS6523: historic flood control ditch). The NRCS has determined that Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all eligible for the NRHP. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154), are determined Not Eligible for NRHP listing under any Criteria.

Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

TABLE 1
SANTA CLARA WATERSHED PLAN-EA PROJECT
CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Mitigation*
42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
				Enters site boundary at one other location	Contributing	No Adverse Effect	
42WS6521	Multi-component habitation complex	Eligible A, C,	Pipeline	Crosses W edge of site, with nearby features	Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent
			Ditch Rip Rap	Within N edge of site in area of prior disturbance (erosion); will repair eroded channel without	Non-Contributing	No Adverse Effect	

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Based on the monitoring and avoidance measures for the four NRHP- Eligible sites located on the Shivwits APE proposed in Table 1, and that the additional three newly recorded sites are determined ineligible for the NRHP, the NRCS has determined that the undertaking will result in ***no adverse effect to historic properties***. Additionally, as previously stated, no construction activities will take place within the site boundaries of the four previously reported on sites (refer to U21TN0316). The NRCS requests your concurrence for the determination of project effects and site eligibility.

United States Department of Agriculture

If you have any questions, comments, or concerns, please contact Tara S. Hoffmann, State Cultural Resources Specialist, at 801-524-4556, or tara.hoffmann@usda.gov, at your convenience.

Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
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Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

United States Department of Agriculture

January 23, 2023

Mr. Timothy L. Nuvangyaoma
Chairman
Hopi Tribe Chairman's Office
P.O. Box 123
Kykotsmovi, Arizona 86039

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Mr. Nuvangyaoma:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

The Phase II Area of Potential Effects (APE) encompasses Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The APE acreage totals 587.82 acres, including 296.38 acres that was previously surveyed in Phase I, and 291.44 acres of new survey in Phase II. Of this, 245.97 acres falls on land administered by the Bureau of Land Management (BLM), St. George Field Office, 57.74 acres are on lands managed by the Utah School and Institutional Trust Lands Administration (SITLA), 220.94 acres are on Private land, and 63.17 acres are on the Shivwits Reservation. The NRCS is acting as the lead federal agency for the purposes of Section 106 consultation, which will also cover SITLA's responsibilities under Utah Code Annotated Section 9-8-404. The BLM is a cooperating agency.

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Site No.	**Site Type**	**Eligibility**	**Project Component**	**Impacts**	**Status**	**Effects**	**Mitigation***
42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
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				channel without impacting intact masonry			inadvertent discovery plan prior to construction.
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Enclosure

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Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

United States Department of Agriculture

January 23, 2023

Mr. Buu Nygren
President
Navajo Nation Office of the President
P.O. Box 7440
Window Rock, Arizona 86515
(928) 871-6352

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

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boundaries of the four previously reported on sites (refer to U21TN0316). The NRCS requests your concurrence for the determination of project effects and site eligibility. If you have any questions, comments, or concerns, please contact Tara S. Hoffmann, State Cultural Resources Specialist, at 801-524-4556, or tara.hoffmann@usda.gov, at your convenience.

Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
Tara Hoffmann, State Cultural Resources specialist, NRCS, Salt Lake City, UT
Brandon Todd, ASTC-Field Operations, NRCS, Richfield, UT
Lynn Kitchen, District Conservationist, NRCS, Cedar City, UT
Norm Evenstad, Assistant State Conservationist Water Resources, NRCS, Salt Lake City, UT
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Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

January 23, 2023

Val R. Panteah, Sr., Governor
Pueblo of Zuni
P.O. Box 339
Zuni, New Mexico 87327

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Mr. Panteah:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

The Phase II Area of Potential Effects (APE) encompasses Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The APE acreage totals 587.82 acres, including 296.38 acres that was previously surveyed in Phase I, and 291.44 acres of new survey in Phase II. Of this, 245.97 acres falls on land administered by the Bureau of Land Management (BLM), St. George Field Office, 57.74 acres are on lands managed by the Utah School and Institutional Trust Lands Administration (SITLA), 220.94 acres are on Private land, and 63.17 acres are on the Shivwits Reservation. The NRCS is acting as the lead federal agency for the purposes of Section 106 consultation, which will also cover SITLA's responsibilities under Utah Code Annotated Section 9-8-404. The BLM is a cooperating agency.

An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. in two field sessions from May 17–21, 2021, and May 24–28, 2021. As a result of the survey, it was determined that a total of 11 cultural resource sites are located within the project APE. Of these 11 sites, four sites were previously reported separately under Phase I of the Project and were not updated as part of this report (42WS2428, 42WS5150, 42WS5151,42WS5154 [see U21TN0316]). Site (42WS2428: *Road from St. George to Pine Valley*) is determined Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events

(but the segment within the APE is determined non-contributing), and three sites (42WS5150, 42WS5151, and 42WS5152) are determined Not Eligible for the NRHP under any Criteria. Additionally, the NRCS has determined Site 42WS5151 to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property. No construction elements are occurring within the boundaries of these sites.

Three previously recorded sites were identified within the project APE during the new survey (42WS4692: historic pipeline and suspension bridge, 42WS4823: prehistoric lithic scatter, and 42WS5154: prehistoric lithic scatter). Four new cultural resource sites were identified as a result of this survey (42WS6520: historic irrigation ditch, 42WS6521: historic Shivwits school and multi-component, 42WS6522: multicomponent, and 42WS6523: historic flood control ditch). The NRCS has determined that Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all eligible for the NRHP. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154), are determined Not Eligible for NRHP listing under any Criteria.

Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

TABLE 1
SANTA CLARA WATERSHED PLAN-EA PROJECT
CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Mitigation*
42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
				Enters site boundary at one other location	Contributing	No Adverse Effect	
42WS6521	Multi-component habitation complex	Eligible A, C,	Pipeline	Crosses W edge of site, with nearby features	Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent
			Ditch Rip Rap	Within N edge of site in area of prior disturbance (erosion); will repair eroded channel without	Non-Contributing	No Adverse Effect	

TABLE 1 SANTA CLARA WATERSHED PLAN-EA PROJECT CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)							
Site No.	**Site Type**	**Eligibility**	**Project Component**	**Impacts**	**Status**	**Effects**	**Mitigation***
				impacting intact masonry			discovery plan prior to construction.
42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Bank Rip Rap	Crosses N edge of site, within area of no surface observations	Contributing	No Adverse Effect	
42WS6523	Historic flood control ditch	Eligible - A, C, D	Pipeline	Crosses at S end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Ditch Rip Rap	Within center of site, within area of prior disturbance (erosion); will repair eroded channel without impacting intact masonry and protect ditch from further erosion	Non-Contributing	No Adverse Effect	
N/A	N/A	N/A	Land Leveling	No sites within the proposed land leveling area (previously disturbed area)	N/A	N/A	N/A
*Note: both an archaeological and Tribal monitor will be present for all ground disturbing activities within the Shivwits area of the project.							

Based on the monitoring and avoidance measures for the four NRHP- Eligible sites located on the Shivwits APE proposed in Table 1, and that the additional three newly recorded sites are determined ineligible for the NRHP, the NRCS has determined that the undertaking will result in ***no adverse effect to historic properties***. Additionally, as previously stated, no construction activities will take place within the site boundaries of the four previously reported on sites (refer to U21TN0316). The NRCS requests your concurrence for the determination of project effects and site eligibility.

United States Department of Agriculture

If you have any questions, comments, or concerns, please contact Tara S. Hoffmann, State Cultural Resources Specialist, at 801-524-4556, or tara.hoffmann@usda.gov, at your convenience.

Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
Tara Hoffmann, State Cultural Resources specialist, NRCS, Salt Lake City, UT
Brandon Todd, ASTC-Field Operations, NRCS, Richfield, UT
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Kristine Curry, Archaeologist, SITLA, Salt Lake City, UT
Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

United States Department of Agriculture

January 23, 2023

Travis Parashonts
Chairperson
600 North 100 East
Cedar City, UT 84721

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Mr. Parashonts:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

The Phase II Area of Potential Effects (APE) encompasses Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The APE acreage totals 587.82 acres, including 296.38 acres that was previously surveyed in Phase I, and 291.44 acres of new survey in Phase II. Of this, 245.97 acres falls on land administered by the Bureau of Land Management (BLM), St. George Field Office, 57.74 acres are on lands managed by the Utah School and Institutional Trust Lands Administration (SITLA), 220.94 acres are on Private land, and 63.17 acres are on the Shivwits Reservation. The NRCS is acting as the lead federal agency for the purposes of Section 106 consultation, which will also cover SITLA's responsibilities under Utah Code Annotated Section 9-8-404. The BLM is a cooperating agency.

An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. in two field sessions from May 17–21, 2021, and May 24–28, 2021. As a result of the survey, it was determined that a total of 11 cultural resource sites are located within the project APE. Of these 11 sites, four sites were previously reported separately under Phase I of the Project and were not updated as part of this report (42WS2428, 42WS5150, 42WS5151,42WS5154 [see U21TN0316]). Site (42WS2428: *Road from St. George to Pine Valley*) is determined Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events

(but the segment within the APE is determined non-contributing), and three sites (42WS5150, 42WS5151, and 42WS5152) are determined Not Eligible for the NRHP under any Criteria. Additionally, the NRCS has determined Site 42WS5151 to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property. No construction elements are occurring within the boundaries of these sites.

Three previously recorded sites were identified within the project APE during the new survey (42WS4692: historic pipeline and suspension bridge, 42WS4823: prehistoric lithic scatter, and 42WS5154: prehistoric lithic scatter). Four new cultural resource sites were identified as a result of this survey (42WS6520: historic irrigation ditch, 42WS6521: historic Shivwits school and multi-component, 42WS6522: multicomponent, and 42WS6523: historic flood control ditch). The NRCS has determined that Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all eligible for the NRHP. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154), are determined Not Eligible for NRHP listing under any Criteria.

Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

TABLE 1
SANTA CLARA WATERSHED PLAN-EA PROJECT
CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Mitigation*
42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
				Enters site boundary at one other location	Contributing	No Adverse Effect	
42WS6521	Multi-component habitation complex	Eligible A, C,	Pipeline	Crosses W edge of site, with nearby features	Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent
			Ditch Rip Rap	Within N edge of site in area of prior disturbance (erosion); will repair eroded channel without	Non-Contributing	No Adverse Effect	

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Site No.	**Site Type**	**Eligibility**	**Project Component**	**Impacts**	**Status**	**Effects**	**Mitigation***
				impacting intact masonry			discovery plan prior to construction.
42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Bank Rip Rap	Crosses N edge of site, within area of no surface observations	Contributing	No Adverse Effect	
42WS6523	Historic flood control ditch	Eligible - A, C, D	Pipeline	Crosses at S end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Ditch Rip Rap	Within center of site, within area of prior disturbance (erosion); will repair eroded channel without impacting intact masonry and protect ditch from further erosion	Non-Contributing	No Adverse Effect	
N/A	N/A	N/A	Land Leveling	No sites within the proposed land leveling area (previously disturbed area)	N/A	N/A	N/A
*Note: both an archaeological and Tribal monitor will be present for all ground disturbing activities within the Shivwits area of the project.							

Based on the monitoring and avoidance measures for the four NRHP- Eligible sites located on the Shivwits APE proposed in Table 1, and that the additional three newly recorded sites are determined ineligible for the NRHP, the NRCS has determined that the undertaking will result in ***no adverse effect to historic properties***. Additionally, as previously stated, no construction activities will take place within the site boundaries of the four previously reported on sites (refer to U21TN0316). The NRCS requests your concurrence for the determination of project effects and site eligibility.

United States Department of Agriculture

If you have any questions, comments, or concerns, please contact Tara S. Hoffmann, State Cultural Resources Specialist, at 801-524-4556, or tara.hoffmann@usda.gov, at your convenience.

Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
Tara Hoffmann, State Cultural Resources specialist, NRCS, Salt Lake City, UT
Brandon Todd, ASTC-Field Operations, NRCS, Richfield, UT
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Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

January 23, 2023

Laura Parry
Chairwoman
Moapa Band of Paiute Indians of the Moapa River Indian
Reservation, Nevada
P.O. Box 340
Moapa, Nevada 89025-0340

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Ms. Parry:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

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USDA

United States Department of Agriculture

(42WS2428: *Road from St. George to Pine Valley*) is determined Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events (but the segment within the APE is determined non-contributing), and three sites (42WS5150, 42WS5151, and 42WS5152) are determined Not Eligible for the NRHP under any Criteria. Additionally, the NRCS has determined Site 42WS5151 to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property. No construction elements are occurring within the boundaries of these sites.

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Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

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				repair eroded channel without impacting intact masonry			meeting, and an inadvertent discovery plan prior to construction.
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Acting State Conservationist

Enclosure

cc: (w/o encl)
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Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

January 23, 2023

Ms. Ramona Salazar
Las Vegas Tribe of Paiute Indians of the Las Vegas Indian Colony
One Paiute Drive
Las Vegas, Nevada 89106

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Ms. Salazar

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

The Phase II Area of Potential Effects (APE) encompasses Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The APE acreage totals 587.82 acres, including 296.38 acres that was previously surveyed in Phase I, and 291.44 acres of new survey in Phase II. Of this, 245.97 acres falls on land administered by the Bureau of Land Management (BLM), St. George Field Office, 57.74 acres are on lands managed by the Utah School and Institutional Trust Lands Administration (SITLA), 220.94 acres are on Private land, and 63.17 acres are on the Shivwits Reservation. The NRCS is acting as the lead federal agency for the purposes of Section 106 consultation, which will also cover SITLA's responsibilities under Utah Code Annotated Section 9-8-404. The BLM is a cooperating agency.

An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. in two field sessions from May 17–21, 2021, and May 24–28, 2021. As a result of the survey, it was determined that a total of 11 cultural resource sites are located within the project APE. Of these 11 sites, four sites were previously reported separately under Phase I of the Project and were not updated as part of this report (42WS2428, 42WS5150, 42WS5151,42WS5154 [see U21TN0316]). Site (42WS2428: *Road from St. George to Pine Valley*) is determined Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events

(but the segment within the APE is determined non-contributing), and three sites (42WS5150, 42WS5151, and 42WS5152) are determined Not Eligible for the NRHP under any Criteria. Additionally, the NRCS has determined Site 42WS5151 to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property. No construction elements are occurring within the boundaries of these sites.

Three previously recorded sites were identified within the project APE during the new survey (42WS4692: historic pipeline and suspension bridge, 42WS4823: prehistoric lithic scatter, and 42WS5154: prehistoric lithic scatter). Four new cultural resource sites were identified as a result of this survey (42WS6520: historic irrigation ditch, 42WS6521: historic Shivwits school and multi-component, 42WS6522: multicomponent, and 42WS6523: historic flood control ditch). The NRCS has determined that Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all eligible for the NRHP. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154), are determined Not Eligible for NRHP listing under any Criteria.

Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

TABLE 1
SANTA CLARA WATERSHED PLAN-EA PROJECT
CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Mitigation*
42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
				Enters site boundary at one other location	Contributing	No Adverse Effect	
42WS6521	Multi-component habitation complex	Eligible A, C,	Pipeline	Crosses W edge of site, with nearby features	Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent
			Ditch Rip Rap	Within N edge of site in area of prior disturbance (erosion); will repair eroded channel without	Non-Contributing	No Adverse Effect	

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TABLE 1 SANTA CLARA WATERSHED PLAN-EA PROJECT CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)							
Site No.	**Site Type**	**Eligibility**	**Project Component**	**Impacts**	**Status**	**Effects**	**Mitigation***
				impacting intact masonry			discovery plan prior to construction.
42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Bank Rip Rap	Crosses N edge of site, within area of no surface observations	Contributing	No Adverse Effect	
42WS6523	Historic flood control ditch	Eligible - A, C, D	Pipeline	Crosses at S end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Ditch Rip Rap	Within center of site, within area of prior disturbance (erosion); will repair eroded channel without impacting intact masonry and protect ditch from further erosion	Non-Contributing	No Adverse Effect	
N/A	N/A	N/A	Land Leveling	No sites within the proposed land leveling area (previously disturbed area)	N/A	N/A	N/A
*Note: both an archaeological and Tribal monitor will be present for all ground disturbing activities within the Shivwits area of the project.							

Based on the monitoring and avoidance measures for the four NRHP- Eligible sites located on the Shivwits APE proposed in Table 1, and that the additional three newly recorded sites are determined ineligible for the NRHP, the NRCS has determined that the undertaking will result in ***no adverse effect to historic properties***. Additionally, as previously stated, no construction activities will take place within the site boundaries of the four previously reported on sites (refer to U21TN0316). The NRCS requests your concurrence for the determination of project effects and site eligibility.

If you have any questions, comments, or concerns, please contact Tara S. Hoffmann, State Cultural Resources Specialist, at 801-524-4556, or tara.hoffmann@usda.gov, at your convenience.

Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
Tara Hoffmann, State Cultural Resources specialist, NRCS, Salt Lake City, UT
Brandon Todd, ASTC-Field Operations, NRCS, Richfield, UT
Lynn Kitchen, District Conservationist, NRCS, Cedar City, UT
Norm Evenstad, Assistant State Conservationist Water Resources, NRCS, Salt Lake City, UT
Derek Hamilton, Water Resources Coordinator, NRCS, Salt Lake City, UT
Amber Van Alfen, Archaeologist, BLM, Color County District, St. George, UT
Kristine Curry, Archaeologist, SITLA, Salt Lake City, UT
Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

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United States Department of Agriculture

January 23, 2023

Ms. Ona Segundo
Chairwoman
Kaibab Band of Paiute Indians of the Kaibab Indian Reservation
Tribal Affairs Building
HC65, Box 2
Fredonia, Arizona 86022

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Ms. Segundo:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

The Phase II Area of Potential Effects (APE) encompasses Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The APE acreage totals 587.82 acres, including 296.38 acres that was previously surveyed in Phase I, and 291.44 acres of new survey in Phase II. Of this, 245.97 acres falls on land administered by the Bureau of Land Management (BLM), St. George Field Office, 57.74 acres are on lands managed by the Utah School and Institutional Trust Lands Administration (SITLA), 220.94 acres are on Private land, and 63.17 acres are on the Shivwits Reservation. The NRCS is acting as the lead federal agency for the purposes of Section 106 consultation, which will also cover SITLA's responsibilities under Utah Code Annotated Section 9-8-404. The BLM is a cooperating agency.

An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. in two field sessions from May 17–21, 2021, and May 24–28, 2021. As a result of the survey, it was determined that a total of 11 cultural resource sites are located within the project APE. Of these 11 sites, four sites were previously reported separately under Phase I of the Project and were not updated as part of this report (42WS2428, 42WS5150, 42WS5151,42WS5154 [see U21TN0316]). Site

(42WS2428: *Road from St. George to Pine Valley*) is determined Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events (but the segment within the APE is determined non-contributing), and three sites (42WS5150, 42WS5151, and 42WS5152) are determined Not Eligible for the NRHP under any Criteria. Additionally, the NRCS has determined Site 42WS5151 to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property. No construction elements are occurring within the boundaries of these sites.

Three previously recorded sites were identified within the project APE during the new survey (42WS4692: historic pipeline and suspension bridge, 42WS4823: prehistoric lithic scatter, and 42WS5154: prehistoric lithic scatter). Four new cultural resource sites were identified as a result of this survey (42WS6520: historic irrigation ditch, 42WS6521: historic Shivwits school and multi-component, 42WS6522: multicomponent, and 42WS6523: historic flood control ditch). The NRCS has determined that Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all eligible for the NRHP. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154), are determined Not Eligible for NRHP listing under any Criteria.

Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

TABLE 1
SANTA CLARA WATERSHED PLAN-EA PROJECT
CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Mitigation*
42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
				Enters site boundary at one other location	Contributing	No Adverse Effect	
42WS6521	Multi-component habitation complex	Eligible A, C,	Pipeline	Crosses W edge of site, with nearby features	Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction
			Ditch Rip Rap	Within N edge of site in area of prior disturbance (erosion); will	Non-Contributing	No Adverse Effect	

TABLE 1 SANTA CLARA WATERSHED PLAN-EA PROJECT CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)							
Site No.	**Site Type**	**Eligibility**	**Project Component**	**Impacts**	**Status**	**Effects**	**Mitigation***
				repair eroded channel without impacting intact masonry			meeting, and an inadvertent discovery plan prior to construction.
42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Bank Rip Rap	Crosses N edge of site, within area of no surface observations	Contributing	No Adverse Effect	
42WS6523	Historic flood control ditch	Eligible - A, C, D	Pipeline	Crosses at S end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
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N/A	N/A	N/A	Land Leveling	No sites within the proposed land leveling area (previously disturbed area)	N/A	N/A	N/A
*Note: both an archaeological and Tribal monitor will be present for all ground disturbing activities within the Shivwits area of the project.							

Based on the monitoring and avoidance measures for the four NRHP- Eligible sites located on the Shivwits APE proposed in Table 1, and that the additional three newly recorded sites are determined ineligible for the NRHP, the NRCS has determined that the undertaking will result in ***no adverse effect to historic properties***. Additionally, as previously stated, no construction activities will take place within the site

boundaries of the four previously reported on sites (refer to U21TN0316). The NRCS requests your concurrence for the determination of project effects and site eligibility. If you have any questions, comments, or concerns, please contact Tara S. Hoffmann, State Cultural Resources Specialist, at 801-524-4556, or tara.hoffmann@usda.gov, at your convenience.

Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
Tara Hoffmann, State Cultural Resources specialist, NRCS, Salt Lake City, UT
Brandon Todd, ASTC-Field Operations, NRCS, Richfield, UT
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Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

USDA

United States Department of Agriculture

January 23, 2023

Ms. Hope Silvas
Chairwoman
Shivwits Band of Paiute Indians, Paiute Indian Tribe of Utah
6060 West 3650 North
Ivins, Utah 84738

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Ms. Silvas:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

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United States Department of Agriculture

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Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
Tara Hoffmann, State Cultural Resources specialist, NRCS, Salt Lake City, UT
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Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

United States Department of Agriculture

January 23, 2023

Mr. Ganivan Timcan
Southern Paiute Consortium
Kaibab Band of Paiute Indians of the Kaibab Indian Reservation
Cultural Preservation Office
HC65, Box 2
Fredonia, Arizona 86022

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Mr. Timcan:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

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An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. in two field sessions from May 17–21, 2021, and May 24–28, 2021. As a result of the survey, it was determined that a total of 11 cultural resource sites are located within the project APE. Of these 11 sites, four sites were previously reported separately under Phase I of the Project and were not updated as part of this report (42WS2428, 42WS5150, 42WS5151,42WS5154 [see U21TN0316]). Site

(42WS2428: *Road from St. George to Pine Valley*) is determined Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events (but the segment within the APE is determined non-contributing), and three sites (42WS5150, 42WS5151, and 42WS5152) are determined Not Eligible for the NRHP under any Criteria. Additionally, the NRCS has determined Site 42WS5151 to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property. No construction elements are occurring within the boundaries of these sites.

Three previously recorded sites were identified within the project APE during the new survey (42WS4692: historic pipeline and suspension bridge, 42WS4823: prehistoric lithic scatter, and 42WS5154: prehistoric lithic scatter). Four new cultural resource sites were identified as a result of this survey (42WS6520: historic irrigation ditch, 42WS6521: historic Shivwits school and multi-component, 42WS6522: multicomponent, and 42WS6523: historic flood control ditch). The NRCS has determined that Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all eligible for the NRHP. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154), are determined Not Eligible for NRHP listing under any Criteria.

Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

TABLE 1
SANTA CLARA WATERSHED PLAN-EA PROJECT
CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Mitigation*
42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
				Enters site boundary at one other location	Contributing	No Adverse Effect	
42WS6521	Multi-component habitation complex	Eligible A, C,	Pipeline	Crosses W edge of site, with nearby features	Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction
			Ditch Rip Rap	Within N edge of site in area of prior disturbance (erosion); will	Non-Contributing	No Adverse Effect	

TABLE 1 SANTA CLARA WATERSHED PLAN-EA PROJECT CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)							
Site No.	**Site Type**	**Eligibility**	**Project Component**	**Impacts**	**Status**	**Effects**	**Mitigation***
				repair eroded channel without impacting intact masonry			meeting, and an inadvertent discovery plan prior to construction.
42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Bank Rip Rap	Crosses N edge of site, within area of no surface observations	Contributing	No Adverse Effect	
42WS6523	Historic flood control ditch	Eligible - A, C, D	Pipeline	Crosses at S end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Ditch Rip Rap	Within center of site, within area of prior disturbance (erosion); will repair eroded channel without impacting intact masonry and protect ditch from further erosion	Non-Contributing	No Adverse Effect	
N/A	N/A	N/A	Land Leveling	No sites within the proposed land leveling area (previously disturbed area)	N/A	N/A	N/A
*Note: both an archaeological and Tribal monitor will be present for all ground disturbing activities within the Shivwits area of the project.							

Based on the monitoring and avoidance measures for the four NRHP- Eligible sites located on the Shivwits APE proposed in Table 1, and that the additional three newly recorded sites are determined ineligible for the NRHP, the NRCS has determined that the undertaking will result in ***no adverse effect to historic properties***. Additionally, as previously stated, no construction activities will take place within the site

boundaries of the four previously reported on sites (refer to U21TN0316). The NRCS requests your concurrence for the determination of project effects and site eligibility. If you have any questions, comments, or concerns, please contact Tara S. Hoffmann, State Cultural Resources Specialist, at 801-524-4556, or tara.hoffmann@usda.gov, at your convenience.

Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
Tara Hoffmann, State Cultural Resources specialist, NRCS, Salt Lake City, UT
Brandon Todd, ASTC-Field Operations, NRCS, Richfield, UT
Lynn Kitchen, District Conservationist, NRCS, Cedar City, UT
Norm Evenstad, Assistant State Conservationist Water Resources, NRCS, Salt Lake City, UT
Derek Hamilton, Water Resources Coordinator, NRCS, Salt Lake City, UT
Amber Van Alfen, Archaeologist, BLM, Color County District, St. George, UT
Kristine Curry, Archaeologist, SITLA, Salt Lake City, UT
Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

January 23, 2023

Mr. Benny Tso
Las Vegas Tribe of Paiute Indians of the Las Vegas Indian Colony
One Paiute Drive
Las Vegas, Nevada 89106

Reference: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah (U21TN0317)

Dear Mr. Tso:

Enclosed are a cultural resources report titled *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah*. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Concurrence from your office for Phase I, with a determination of no adverse effect, was received on August 20, 2021 (Case No. 21-1778).

The Phase II Area of Potential Effects (APE) encompasses Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The APE acreage totals 587.82 acres, including 296.38 acres that was previously surveyed in Phase I, and 291.44 acres of new survey in Phase II. Of this, 245.97 acres falls on land administered by the Bureau of Land Management (BLM), St. George Field Office, 57.74 acres are on lands managed by the Utah School and Institutional Trust Lands Administration (SITLA), 220.94 acres are on Private land, and 63.17 acres are on the Shivwits Reservation. The NRCS is acting as the lead federal agency for the purposes of Section 106 consultation, which will also cover SITLA's responsibilities under Utah Code Annotated Section 9-8-404. The BLM is a cooperating agency.

An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. in two field sessions from May 17–21, 2021, and May 24–28, 2021. As a result of the survey, it was determined that a total of 11 cultural resource sites are located within the project APE. Of these 11 sites, four sites were previously reported separately under Phase I of the Project and were not updated as part of this report (42WS2428, 42WS5150, 42WS5151,42WS5154 [see U21TN0316]). Site (42WS2428: *Road from St. George to Pine Valley*) is determined Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events

(but the segment within the APE is determined non-contributing), and three sites (42WS5150, 42WS5151, and 42WS5152) are determined Not Eligible for the NRHP under any Criteria. Additionally, the NRCS has determined Site 42WS5151 to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property. No construction elements are occurring within the boundaries of these sites.

Three previously recorded sites were identified within the project APE during the new survey (42WS4692: historic pipeline and suspension bridge, 42WS4823: prehistoric lithic scatter, and 42WS5154: prehistoric lithic scatter). Four new cultural resource sites were identified as a result of this survey (42WS6520: historic irrigation ditch, 42WS6521: historic Shivwits school and multi-component, 42WS6522: multicomponent, and 42WS6523: historic flood control ditch). The NRCS has determined that Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all eligible for the NRHP. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154), are determined Not Eligible for NRHP listing under any Criteria.

Given the amount of ground disturbance within the Shivwits Project Area, and sites identified, the NRCS will be working closely with the Shivwits Band to ensure no sites are adversely affected. Table 1 summarizes the sites identified within the Shivwits Project Area APE, the project component within the site boundary (ie, pipeline, rip rap), the impacts from proposed project elements, and mitigation to avoid any adverse effects. Enclosed site forms with site maps provide more detailed annotation of proposed project component locations within site boundaries. Additionally, for all Eligible sites in the Shivwits area of the project, a pre-construction meeting will be held, an inadvertent discovery plan will be prepared and provided to construction personnel and Tribal and archaeological monitors, and an archaeological and Tribal monitor will be present for all ground disturbance within 15 meters of each Eligible site boundary. Finally, all Eligible site boundaries will be flagged prior to construction with at least a 15-meter buffer.

TABLE 1
SANTA CLARA WATERSHED PLAN-EA PROJECT
CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)

Site No.	Site Type	Eligibility	Project Component	Impacts	Status	Effects	Mitigation*
42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
				Enters site boundary at one other location	Contributing	No Adverse Effect	
42WS6521	Multi-component habitation complex	Eligible A, C,	Pipeline	Crosses W edge of site, with nearby features	Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent
			Ditch Rip Rap	Within N edge of site in area of prior disturbance (erosion); will repair eroded channel without	Non-Contributing	No Adverse Effect	

TABLE 1 SANTA CLARA WATERSHED PLAN-EA PROJECT CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)							
Site No.	**Site Type**	**Eligibility**	**Project Component**	**Impacts**	**Status**	**Effects**	**Mitigation***
				impacting intact masonry			discovery plan prior to construction.
42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Bank Rip Rap	Crosses N edge of site, within area of no surface observations	Contributing	No Adverse Effect	
42WS6523	Historic flood control ditch	Eligible - A, C, D	Pipeline	Crosses at S end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Ditch Rip Rap	Within center of site, within area of prior disturbance (erosion); will repair eroded channel without impacting intact masonry and protect ditch from further erosion	Non-Contributing	No Adverse Effect	
N/A	N/A	N/A	Land Leveling	No sites within the proposed land leveling area (previously disturbed area)	N/A	N/A	N/A
*Note: both an archaeological and Tribal monitor will be present for all ground disturbing activities within the Shivwits area of the project.							

Based on the monitoring and avoidance measures for the four NRHP- Eligible sites located on the Shivwits APE proposed in Table 1, and that the additional three newly recorded sites are determined ineligible for the NRHP, the NRCS has determined that the undertaking will result in ***no adverse effect to historic properties***. Additionally, as previously stated, no construction activities will take place within the site boundaries of the four previously reported on sites (refer to U21TN0316). The NRCS requests your concurrence for the determination of project effects and site eligibility.

United States Department of Agriculture

If you have any questions, comments, or concerns, please contact Tara S. Hoffmann, State Cultural Resources Specialist, at 801-524-4556, or tara.hoffmann@usda.gov, at your convenience.

Sincerely,

TRISHA CRACROFT
Acting State Conservationist

Enclosure

cc: (w/o encl)
Tara Hoffmann, State Cultural Resources specialist, NRCS, Salt Lake City, UT
Brandon Todd, ASTC-Field Operations, NRCS, Richfield, UT
Lynn Kitchen, District Conservationist, NRCS, Cedar City, UT
Norm Evenstad, Assistant State Conservationist Water Resources, NRCS, Salt Lake City, UT
Derek Hamilton, Water Resources Coordinator, NRCS, Salt Lake City, UT
Amber Van Alfen, Archaeologist, BLM, Color County District, St. George, UT
Kristine Curry, Archaeologist, SITLA, Salt Lake City, UT
Lara Schick, Project Manager/Biologist, Transcon Environmental, Cedar City, UT
Garry Cantley, Regional Archaeologist, BIA, Phoenix, AZ

From:	Hoffmann, Tara - NRCS, Salt Lake City, UT
To:	Hope Silvas
Subject:	RE: [External Email]Re: Draft Cultural Resources Report for the NRCS Santa Clara Watershed Project
Date:	Monday, February 14, 2022 2:07:00 PM
Attachments:	image001.png

Yes, that works great for me. Here is a Zoom invite- I blocked out 2 hours, for as much time as needed, my day is open. Look forward to talking to everyone.

Join Zoom Meeting
https://us05web.zoom.us/j/82286428324?pwd=SHFiNTZ3enI2ekN2WGZLdjQ4VlJZQT09

Meeting ID: 822 8642 8324
Passcode: cultural

Tara S. Hoffmann, MA
State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

From: Hope Silvas <justhopesilvas@gmail.com>
Sent: Monday, February 14, 2022 1:26 PM
To: Hoffmann, Tara - NRCS, Salt Lake City, UT <tara.hoffmann@usda.gov>
Subject: Re: [External Email]Re: Draft Cultural Resources Report for the NRCS Santa Clara Watershed Project

Can we do Friday the 18th at 1pm?

Sent from my iPhone

> On Feb 11, 2022, at 10:18 AM, Hoffmann, Tara - NRCS, Salt Lake City, UT <tara.hoffmann@usda.gov> wrote:
>
> Hope,
>
> My schedule is fairly open next week except for Thursday, and zoom would work. What day/time is best for the Council?
>
> Tara
>
> Tara S. Hoffmann, MA

State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

From: Hope Silvas <justhopesilvas@gmail.com>
Sent: Friday, February 11, 2022 9:49 AM
To: Hoffmann, Tara - NRCS, Salt Lake City, UT <tara.hoffmann@usda.gov>
Subject: [External Email]Re: Draft Cultural Resources Report for the NRCS Santa Clara Watershed Project

Good Morning Tara, the Shivwits Band Council has requested a meeting possibly by zoom at your earliest convenience on the findings of your report.

On Thu, Jan 13, 2022 at 12:39 PM Hoffmann, Tara - NRCS, Salt Lake City, UT <tara.hoffmann@usda.gov> wrote:

> Travis and Carmen,
>
> Transcon has finished a draft of the cultural resources report and site forms for the Santa Clara Watershed Plan- EA Project. I still have to do a detailed review of all the documents, but if you and other councilmembers would like to review the report and site forms, all of the documents are available here:
>
> U21TN0317_SHPO Package_draft.
>
> I can also print out hard copies and mail them if that's easier. There is BLM land involved on this project too, so you can just focus on the Shivwits part of the report if you like. Also, if there is any information you'd like to add to the sites found on Shivwits land, for instance the schoolhouse and what it later became, we can include that. Or if you'd like wording changed, or some information not included either in the report or on site forms, we can make that happen.
>
> I know Covid has ramped up yet again, but I can always make a trip to you to go over things in person, either at a Band meeting or separately.
>
> Hope all is well,
>
> Tara

Tara S. Hoffmann, MA
State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

From:	Cantley, Garry
To:	Hoffmann, Tara - NRCS, Salt Lake City, UT
Subject:	Re: [EXTERNAL] Draft cultural report for NRCS project on Shivwits
Date:	Wednesday, March 2, 2022 11:31:04 AM
Attachments:	image001.png

Tara,
Sounds like a very interesting project.
No issue with eligibility or effect.
Take or leave our comments, which are very minor:

Section 10, page 1: Usually, the first time the common name of a species is written, the scientific name is also given. Suggest "…the endangered southwestern willow flycatcher (Empidonax traillii extimus)…"
Section 10, page 1: "The entire project area (Phase I and Phase II) encompasses 587.82 acres and includes…"
Section 12, page 2: Results of lit review and previously conducted cultural resource surveys sections list 13 previously conducted surveys, but Table B-2 lists 14

Our only other comment is that we wish you the best of luck in successful completion of the project.

Garry J. Cantley
Regional Archeologist
BIA Western Regional Office
2600 North Central Avenue, Suite 400
Phoenix, Arizona 85004-3008
(602) 379-6750
(602) 240-8447 direct
(602) 418-8503 cell
Regular day off is 2nd Friday of each pay period.

From: Hoffmann, Tara - NRCS, Salt Lake City, UT <tara.hoffmann@usda.gov>
Sent: Wednesday, February 16, 2022 11:38 AM
To: Cantley, Garry <Garry.Cantley@bia.gov>
Subject: [EXTERNAL] Draft cultural report for NRCS project on Shivwits

Garry,

Hope all is well. The NRCS has a watershed project that is partially on Shivwits Paiute land, and I wasn't sure if you wanted the opportunity to review the draft report. This was a last-minute thought on my part, and the Shivwits have already reviewed the report. The project is also on BLM land (and SITLA and UDOT but they declined to review). I am meeting with the Shivwits in Friday to discuss the results, and I am not yet sure exactly what their comments will entail, though I have inclinations.

There is the Shivwits Indian School (or Paiute Agency School) located within the APE, and we are definitely avoiding it, but it is clearly a sensitive subject. The school was relocated to Panguitch in 1904, and the Panguitch location has burials that have received press coverage and are currently trying to be located. The school was later relocated back to Shivwits and after it closed it continued as a Presbyterian Church and school and later a meetinghouse. I could go on and on as I've done my own independent research and spoken with the Shivwits.

But I'll cease my chatter since you may not need to read the draft. I will also send you the final copy for official Section 106 consultation. We are working closely with the Shivwits in the meantime, as the project will be protecting their land from floods and erosion, and they are a cooperating agency for the EA. This project is located just downstream from our other project at Shem Dam back in 2012. Here is a link to the report:

U21TN0317_SHPO Package_draft.

Thanks,

Tara

Tara S. Hoffmann, MA
State Cultural Resources Specialist/Tribal Liaison
USDA Natural Resources Conservation Service
Salt Lake City, UT
385.258.1266

SHIVWITS SUPPORT LETTER

August 3, 2023

Emily Fife, State Conservationist
Natural Resources Conservation Service
125 S State St
Salt Lake City,UT 84138

Dear Ms. Fife,

The NRCS' Santa Clara Watershed Plan-EA (Project) is a vital project for the benefit of Shivwits Band of Paiute Indians (Shivwits), culturally, socially, and economically. Part of the Project proposes to install rip rap along the river to stabilize the banks that erode from yearly floods. This rip rap will also protect two historic ditches that were built by our ancestors over 100 years ago when the Southern Paiute Agency Indian School began. For decades, we flood irrigated the now dry fields with these ditches, but when two dams were built north of our land upstream, the natural flow of the Santa Clara River was altered, and the flow of water into the ditches changed along with it. Therefore, it is critical to have an irrigation pipeline to supply water to our agricultural fields. The proposed pipeline is also more efficient than our previous method of flood irrigation. In 2012, we worked with the NRCS on one of the historic dams upstream, also on Shivwits land, and this Project continues that work, helping to restore the river and prevent further erosion.

With the return of water to the dry fields, we will be able to grow traditional crops such as corn, melons, and peanuts. Over 100 years ago, there used to be orchards with peach, apple, and apricot trees, as well as grape vines that the elders remember. We would like to bring those fruits back to this area. Without the pipeline, the fields remain fallow and will not support traditional crops.

Once growing traditional crops, we can bring our youth to teach them about traditional agriculture and the history of this area. The Bear Dance, which we used to hold here once a year, will be brought back as well. Thus, the benefits of the Project extend further than simply restoring agricultural fields, and will strengthen Shivwits cultural connections, revitalizing it as a gathering area, and connecting our younger generations with the elders.

This project is key to assisting the Shivwits Band in restoring our agriculture, increasing irrigation efficiency, passing down our traditional knowledge to our youth, and continuing our cultural traditions. It is paramount that the Santa Clara Watershed Plan-EA move forward given the significant social, cultural, and economic benefits that it provides to the Shivwits Band.

Sincerely,

Hope Silvas, Chairwoman
Shivwits Band of Paiute Indians

PHASE I SECTION 106 CONSULTATION

REC'D AUG 30 2021

Site No.	Affiliation	Eligibility
	St. George to Pine Valley)	
42WS5150	Prehistoric lithic scatter	Not Eligible
42WS5151	Prehistoric lithic scatter	Not Eligible
42WS5152	Prehistoric artifact scatter	Not Eligible

The NRCS recommends that the Phase I project proceed as planned with a determination of ***no adverse effect to historic properties.*** The NRCS requests your concurrence for the determination of project effects.

If you have any questions, comments, or concerns, please contact Marcel Corbeil, NRCS-South Area Cultural Resources Specialist, at 435-893-3367, or marcel.corbeil@usda.gov at your convenience.

Sincerely,

8-27-21

Emily Fife

EMILY FIFE
State Conservationist

Concur
[signature]
For
Koyiyumptewa

Enclosure

cc: (w/o encl)
Alan Atkins, ASTC - Field Operations, NRCS, Richfield, UT
Lynn Kitchen, District Conservationist, NRCS, Cedar City, UT
Norm Evenstad, ASTC - Water Resources, NRCS, Salt Lake City, UT
Derek Hamilton, Water Resources Coordinator, NRCS, Salt Lake City, UT
Leslie Warta, NEPA Environmental Compliance Specialist, NRCS, Salt Lake City, UT
Amber Van Alfen, Archaeologist, BLM, Color County District, St. George, UT
Kristine Curry, Archaeologist, SITLA, Salt Lake City, UT
Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT
Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, UT
Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

Spencer J. Cox
Governor

Deidre M. Henderson
Lieutenant Governor

Jill Remington Love
Executive Director
Utah Department of Cultural and Community Engagement

Utah Division of State History

Jennifer Ortiz
Director

Christopher Merritt
State Historic Preservation Officer

August 20, 2021

Emily Fife
State Conservationist
Natural Resources Conservation Service
125 South State Street, Room 4010
Salt Lake City, Utah 84138-1100

RE: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah (U21TN0316)

For future correspondence, please reference Case No. 21-1778

Dear Ms. Fife,

The Utah State Historic Preservation Office received your request for our comment on the above-referenced undertaking on August 19, 2021.

We concur with your determinations of eligibility and "No Adverse Effect" for this undertaking.

This letter serves as our comment on the determination you have made within the consultation process specified in §36CFR800.4. Additionally, Utah Code 9-8-404(1)(a) denotes that your agency is responsible for all final decisions regarding cultural resources for this undertaking. Our comments here are provided as specified in U.C.A. 9-8-404(3)(a)(i).

If you have questions, please contact me at 801-245-7246 or by email at sagardy@utah.gov.

Sincerely,

Savanna Agardy
Compliance Archaeologist

August 19, 2021

Christopher Merritt, PhD
State Historic Preservation Officer
Utah Division of State History
300 Rio Grande Avenue
Salt Lake City, Utah 84101-1182

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah Division of State History (UDSH) Project No. U21TN0316).

Dear Dr. Merritt:

Enclosed is a copy of a cultural resources report titled *NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah*, and associated data. The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), with assistance of Washington County, Utah as the project sponsor, is considering proposed improvements within the Santa Clara Watershed.

The proposed improvements include the construction of stream diversions and detention basins within the Dammeron and Diamond Valleys, as well as other improvements within the Shivwits Band of Paiutes lands including stream restoration, irrigation supply, and flood protection. This report encompasses Phase I of the project, which consists of geotechnical and borehole test pit locations within Dammeron and Diamond Valleys.

Phase I of the project involves lands managed by the Bureau of Land Management (BLM) St. George Field Office, and the State of Utah School and Institutional Trust Lands Administration (SITLA) as well as private lands. Phase I includes preliminary testing sites (8-inch borehole drilling and 20-foot-square test pits) to determine placement of project components. For the purposes of Section 106 consultation, the NRCS will function as the lead Federal agency.

An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. under the authority of Utah Division of State History (UDSH) Project No. U21TN0316. As a result of the inventory, it was determined that a total of four previously identified cultural resource sites are located within or crossed by the project Area of Potential Effects (APE) (42WS2428, 42WS5150, 42WS5151, and 42WS5152). No new cultural resource sites were identified as a result of this survey.

Table 1 summarizes the site identified, type, and eligibility determinations. Of these four sites, one (42WS2428) is Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events. The segments of historic road 42WS2428 within the project APE are heavily disturbed or destroyed and lack historic integrity. The remaining three sites (42WS5150, 42WS5151, and 42WS5152) are Not Eligible for the NRHP under any Criteria.

Table 1. Site summaries and NRHP eligibility recommendations.

Site No.	Affiliation	Eligibility
42WS2428	Historic road (Road from	Eligible – A

Site No.	Affiliation	Eligibility
	St. George to Pine Valley)	
42WS5150	Prehistoric lithic scatter	Not Eligible
42WS5151	Prehistoric lithic scatter	Not Eligible
42WS5152	Prehistoric artifact scatter	Not Eligible

The NRCS recommends that the Phase I project proceed as planned with a determination of ***no adverse effect to historic properties.*** The NRCS requests your concurrence for the determination of project effects.

If you have any questions, comments, or concerns, please contact Marcel Corbeil, NRCS-South Area Cultural Resources Specialist, at 435-893-3367, or marcel.corbeil@usda.gov at your convenience.

Sincerely,

Emily Fife

EMILY FIFE
State Conservationist

Enclosure

cc: (w/o encl)
Alan Atkins, ASTC - Field Operations, NRCS, Richfield, UT
Lynn Kitchen, District Conservationist, NRCS, Cedar City, UT
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Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT
Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, UT
Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

From:	Shanan Anderson
To:	Corbeil, Marcel - FPAC-NRCS, Richfield, UT
Subject:	[External Email]NRCS Santa Clara Watershed Plan-EA Project
Date:	Thursday, September 23, 2021 4:23:45 PM
Attachments:	image001.png

Marcel

In reference to: **NRCS Santa Clara Watershed Plan-EA Project-Phase I: Borehole and Test Pit Locations. Washington County, Utah (Utah State Division of State History (UDSH) Project No. U21n0316).**

The Moapa Band of Paiutes do not have any questions or comments and is in concurrence for the determination of project effects and site eligibility determinations.

Thank you for contacting the Moapa band of Paiutes.

Shanandoah Anderson
Cultural Manager
Moapa Band of Paiutes
Office: 702-865-2787 ext. 91
Cell: 702-371-7802

THE PAIUTE INDIAN TRIBE OF UTAH

440 North Paiute Drive • Cedar City, Utah 84721 • (435) 586-1112 • Fax (435) 867-2659

September 8, 2021

Emily Fife/State Conservationist
Natural Resources Conservation Service
125 South State St., Room 4010
Salt Lake City, Utah 84138

Dear Ms. Fife,

SUBJECT: ***NRCS's Santa Clara Watershed Plan-EA Project***

The Paiute Indian Tribe of Utah is in receipt of your correspondence dated August 19, 2021 and has reviewed the material and do not have any objections pertaining to the above-named project. Currently we are not aware of cultural resource sites, practices, or locations of importance in the tribe's traditional religions or culture.
As you are aware the tribe supports the identification and avoidance of prehistoric sites and traditional cultural properties. The tribe concurs with your determination of eligibility and effort for this undertaking, this letter serves as our comment on the determinations you have made.

The Paiute Indian Tribe of Utah sincerely appreciates your accomplishments and consideration you and your staff have made to consult with the tribes.

Thank You,

Dorena Martineau/Cultural Resource Director
Paiute Indian Tribe of Utah
440 North Paiute Drive
Cedar City, Utah 84721
dmartineau@utahpaiutes.org
435-586-1112

August 19, 2021

Mr. Curtis Anderson
Las Vegas Tribe of Paiute Indians of the Las Vegas Indian Colony
One Paiute Drive
Las Vegas, Nevada 89106

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Mr. Anderson:

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The proposed improvements include the construction of stream diversions and detention basins within the Dammeron and Diamond Valleys, as well as other improvements within the Shivwits Band of Paiutes lands including stream restoration, irrigation supply, and flood protection. This report encompasses Phase I of the project, which consists of geotechnical and borehole test pit locations within Dammeron and Diamond Valleys.

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Table 1 summarizes the site identified, type, and eligibility determinations. Of these four sites, one (42WS2428) is Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events. The segments of historic road 42WS2428 within the project APE are heavily disturbed or destroyed and lack historic integrity. The remaining three sites (42WS5150, 42WS5151, and 42WS5152) are Not Eligible for the NRHP under any Criteria.

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The NRCS recommends that the Phase I project proceed as planned with a determination of ***no adverse effect to historic properties.*** The NRCS requests your concurrence for the determination of project effects.

If you have any questions, comments, or concerns, please contact Marcel Corbeil, NRCS-South Area Cultural Resources Specialist, at 435-893-3367, or marcel.corbeil@usda.gov at your convenience.

Sincerely,

Emily Fife

EMILY FIFE
State Conservationist

Enclosure

cc: (w/o encl)
Alan Atkins, ASTC - Field Operations, NRCS, Richfield, UT
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Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, UT
Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Ms. Darlene Arrum
Chairwoman
Kanosh Band of Paiutes
P.O. Box 116
Kanosh, Utah 84637

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Ms. Arrum:

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Table 1 summarizes the site identified, type, and eligibility determinations. Of these four sites, one (42WS2428) is Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events. The segments of historic road 42WS2428 within the project APE are heavily disturbed or destroyed and lack historic integrity. The remaining three sites (42WS5150, 42WS5151, and 42WS5152) are Not Eligible for the NRHP under any Criteria.

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If you have any questions, comments, or concerns, please contact Marcel Corbeil, NRCS-South Area Cultural Resources Specialist, at 435-893-3367, or marcel.corbeil@usda.gov at your convenience.

Sincerely,

Emily Fife

EMILY FIFE
State Conservationist

Enclosure

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Alan Atkins, ASTC - Field Operations, NRCS, Richfield, UT
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Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, UT
Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Mr. Richard M. Begay
Tribal Historic Preservation Officer and Department Manager
Navajo Nation Historic Preservation Department
P.O. Box 4950
Window Rock, Arizona 86515

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Mr. Begay:

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If you have any questions, comments, or concerns, please contact Marcel Corbeil, NRCS-South Area Cultural Resources Specialist, at 435-893-3367, or marcel.corbeil@usda.gov at your convenience.

Sincerely,

Emily Fife

EMILY FIFE
State Conservationist

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Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Ms. Tamara Borchardt-Slayton
Chairperson
Indian Peaks Band of Paiutes
P.O. Box 2062
Cedar City, Utah 84721

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Ms. Borchardt-Slayton:

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Sincerely,

Emily Fife

EMILY FIFE
State Conservationist

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Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Mr. Daniel Bullets
Kaibab Band of Paiute Indians of the Kaibab Indian Reservation
Cultural Preservation Office
HC65, Box 2
Fredonia, Arizona 86022

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

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Emily Fife

EMILY FIFE
State Conservationist

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August 19, 2021

Ms. Betsy Chapoose
Director
Cultural Rights Protection Department
Ute Indian Tribe of the Uintah & Ouray Reservation, Utah
P.O. Box 190
Fort Duchesne, Utah 84026

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Ms. Chapoose:

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Emily Fife

EMILY FIFE
State Conservationist

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Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Ms. Carmen Clark
Shivwits Band of Paiutes
Paiute Indian Tribe of Utah
6060 West 3650 North
Ivins, Utah 84738

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Ms. Clark:

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Sincerely,

Emily Fife

EMILY FIFE
State Conservationist

Enclosure

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Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, UT
Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Mr. Kurt Dongoske, RPA.
Director and Tribal Historic Preservation Officer
P.O. Box 339
Zuni, New Mexico 87327

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Mr. Dongoske:

Enclosed is a copy of a cultural resources report titled *NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah.* The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), with assistance of Washington County, Utah as the project sponsor, is considering proposed improvements within the Santa Clara Watershed.

The proposed improvements include the construction of stream diversions and detention basins within the Dammeron and Diamond Valleys, as well as other improvements within the Shivwits Band of Paiutes lands including stream restoration, irrigation supply, and flood protection. This report encompasses Phase I of the project, which consists of geotechnical and borehole test pit locations within Dammeron and Diamond Valleys.

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Table 1 summarizes the site identified, type, and eligibility determinations. Of these four sites, one (42WS2428) is Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events. The segments of historic road 42WS2428 within the project APE are heavily disturbed or destroyed and lack historic integrity. The remaining three sites (42WS5150, 42WS5151, and 42WS5152) are Not Eligible for the NRHP under any Criteria.

Table 1. Site summaries and NRHP eligibility recommendations.

Site No.	Affiliation	Eligibility
42WS2428	Historic road (Road from St. George to Pine Valley)	Eligible – A

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The NRCS recommends that the Phase I project proceed as planned with a determination of ***no adverse effect to historic properties.*** The NRCS requests your concurrence for the determination of project effects.

If you have any questions, comments, or concerns, please contact Marcel Corbeil, NRCS-South Area Cultural Resources Specialist, at 435-893-3367, or marcel.corbeil@usda.gov at your convenience.

Sincerely,

Emily Fife

EMILY FIFE
State Conservationist

Enclosure

cc: (w/o encl)
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Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, UT
Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Mr. Luke Duncan
Chairman
Ute Indian Tribe of the Uintah & Ouray Reservation, Utah
P.O. Box 190
Fort Duchesne, Utah 84026

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Mr. Duncan:

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Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Chairperson Toni Kanosh
Koosharem Band of Paiutes
P.O. Box 205
Richfield, Utah 84701

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Chairperson Kanosh:

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Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, UT
Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

USDA

August 19, 2021

Mr. Stewart B. Koyiyumptewa
Tribal Historic Preservation Office
Hopi Cultural Preservation Office
P.O. Box 123
Kykotsmovi, Arizona 86039

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Mr. Koyiyumptewa:

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Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, UT
Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Ms. Dorena Martineau
Paiute Indian Tribe of Utah
440 North Paiute Drive
Cedar City, Utah 84721

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Ms. Martineau:

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Emily Fife

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State Conservationist

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Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

USDA

August 19, 2021

Mr. Jonathan Nez
President
Navajo Nation Office of the President
P.O. Box 7440
Window Rock, Arizona 86515

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Mr. Nez:

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August 19, 2021

Mr. Timothy Nuvangyaoma
Chairman
Hopi Cultural Chairman's Office
P.O. Box 123
Kykotsmovi, Arizona 86039

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Mr. Nuvangyaoma:

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Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Mr. Val R. Panteah, Sr.
Governor
P.O. Box 339
Zuni, New Mexico 87327

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

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Alan Atkins, ASTC - Field Operations, NRCS, Richfield, UT
Lynn Kitchen, District Conservationist, NRCS, Cedar City, UT
Norm Evenstad, ASTC - Water Resources, NRCS, Salt Lake City, UT
Derek Hamilton, Water Resources Coordinator, NRCS, Salt Lake City, UT
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Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT
Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, UT
Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Ms. Laura Parry
Chairwoman
Moapa Band of Paiute Indians of the Moapa River Reservation, Nevada
P.O. Box 340
Moapa, Nevada 89025

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Ms. Parry:

Enclosed is a copy of a cultural resources report titled *NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah.* The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), with assistance of Washington County, Utah as the project sponsor, is considering proposed improvements within the Santa Clara Watershed.

The proposed improvements include the construction of stream diversions and detention basins within the Dammeron and Diamond Valleys, as well as other improvements within the Shivwits Band of Paiutes lands including stream restoration, irrigation supply, and flood protection. This report encompasses Phase I of the project, which consists of geotechnical and borehole test pit locations within Dammeron and Diamond Valleys.

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Table 1 summarizes the site identified, type, and eligibility determinations. Of these four sites, one (42WS2428) is Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events. The segments of historic road 42WS2428 within the project APE are heavily disturbed or destroyed and lack historic integrity. The remaining three sites (42WS5150, 42WS5151, and 42WS5152) are Not Eligible for the NRHP under any Criteria.

Table 1. Site summaries and NRHP eligibility recommendations.

Site No.	Affiliation	Eligibility
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42WS5152	Prehistoric artifact scatter	Not Eligible

The NRCS recommends that the Phase I project proceed as planned with a determination of ***no adverse effect to historic properties.*** The NRCS requests your concurrence for the determination of project effects.

If you have any questions, comments, or concerns, please contact Marcel Corbeil, NRCS-South Area Cultural Resources Specialist, at 435-893-3367, or marcel.corbeil@usda.gov at your convenience.

Sincerely,

Emily Fife

EMILY FIFE
State Conservationist

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Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, UT
Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Ms. Ramona Salazar
Las Vegas Tribe of Paiute Indians of the Las Vegas Indian Colony
One Paiute Drive
Las Vegas, Nevada 89106

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Ms. Salazar:

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Table 1 summarizes the site identified, type, and eligibility determinations. Of these four sites, one (42WS2428) is Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events. The segments of historic road 42WS2428 within the project APE are heavily disturbed or destroyed and lack historic integrity. The remaining three sites (42WS5150, 42WS5151, and 42WS5152) are Not Eligible for the NRHP under any Criteria.

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Emily Fife

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Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Ms. Ona Segundo
Chairwoman
Kaibab Band of Paiute Indians of the Kaibab Indian Reservation
Tribal Affairs Building
HC65, Box 2
Fredonia, Arizona 86022

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Ms. Segundo:

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Sincerely,

Emily Fife

EMILY FIFE
State Conservationist

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Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

USDA

August 19, 2021

Chairperson Hope Silvas
Shivwits Band of Paiutes
Paiute Indian Tribe of Utah
6060 West 3650 North
Ivins, Utah 84738

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Chairperson Silvas:

Enclosed is a copy of a cultural resources report titled *NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah.* The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), with assistance of Washington County, Utah as the project sponsor, is considering proposed improvements within the Santa Clara Watershed.

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Sincerely,

Emily Fife

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Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Mr. Ganivan Timcan
Southern Paiute Consortium
Kaibab Band of Paiute Indians of the Kaibab Indian Reservation
Cultural Preservation Office
HC65, Box 2
Fredonia, Arizona 86022

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Mr. Timcan:

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Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Ms. Delice Tom
Chairperson
Cedar Band of Paiutes
600 North 100 East
P.O. Box 235
Cedar City, Utah 84721

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Ms. Tom:

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August 19, 2021

Mr. Benny Tso
Las Vegas Tribe of Paiute Indians of the Las Vegas Indian Colony
One Paiute Drive
Las Vegas, Nevada 89106

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Mr. Tso:

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Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Mr. Charles Wood
Chairman
Chemehuevi Indian Tribe
1990 Palo Verde Drive
P.O. Box 1976
Havasu Lake, California 92363

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Mr. Wood:

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An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. under the authority of Utah Division of State History (UDSH) Project No. U21TN0316. As a result of the inventory, it was determined that a total of four previously identified cultural resource sites are located within or crossed by the project Area of Potential Effects (APE) (42WS2428, 42WS5150, 42WS5151, and 42WS5152). No new cultural resource sites were identified as a result of this survey.

Table 1 summarizes the site identified, type, and eligibility determinations. Of these four sites, one (42WS2428) is Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events. The segments of historic road 42WS2428 within the project APE are heavily disturbed or destroyed and lack historic integrity. The remaining three sites (42WS5150, 42WS5151, and 42WS5152) are Not Eligible for the NRHP under any Criteria.

Table 1. Site summaries and NRHP eligibility recommendations.

Site No.	Affiliation	Eligibility
42WS2428	Historic road (Road from St. George to Pine Valley)	Eligible – A
42WS5150	Prehistoric lithic scatter	Not Eligible
42WS5151	Prehistoric lithic scatter	Not Eligible
42WS5152	Prehistoric artifact scatter	Not Eligible

The NRCS recommends that the Phase I project proceed as planned with a determination of ***no adverse effect to historic properties.*** The NRCS requests your concurrence for the determination of project effects.

If you have any questions, comments, or concerns, please contact Marcel Corbeil, NRCS-South Area Cultural Resources Specialist, at 435-893-3367, or marcel.corbeil@usda.gov at your convenience.

Sincerely,

Emily Fife

EMILY FIFE
State Conservationist

Enclosure

cc: (w/o encl)
Alan Atkins, ASTC - Field Operations, NRCS, Richfield, UT
Lynn Kitchen, District Conservationist, NRCS, Cedar City, UT
Norm Evenstad, ASTC - Water Resources, NRCS, Salt Lake City, UT
Derek Hamilton, Water Resources Coordinator, NRCS, Salt Lake City, UT
Leslie Warta, NEPA Environmental Compliance Specialist, NRCS, Salt Lake City, UT
Amber Van Alfen, Archaeologist, BLM, Color County District, St. George, UT
Kristine Curry, Archaeologist, SITLA, Salt Lake City, UT
Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT
Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, UT
Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

August 19, 2021

Ms. Carlene Yellowhair
President
San Juan Southern Paiute Tribe
P.O. Box 2950
Tuba City, Arizona 86045

Reference: NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah. (Utah State Division of State History (UDSH) Project No. U21TN0316).

Dear Ms. Yellowhair:

Enclosed is a copy of a cultural resources report titled *NRCS's Santa Clara Watershed Plan-EA Project – Phase I: Borehole and Test Pit Locations, Washington County, Utah.* The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), with assistance of Washington County, Utah as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. The proposed improvements include the construction of stream diversions and detention basins within the Dammeron and Diamond Valleys, as well as other improvements within the Shivwits Band of Paiutes lands including stream restoration, irrigation supply, and flood protection. This report encompasses Phase I of the project, which consists of geotechnical and borehole test pit locations within Dammeron and Diamond Valleys.

Phase I of the project involves lands managed by the Bureau of Land Management (BLM) St. George Field Office, and the State of Utah School and Institutional Trust Lands Administration (SITLA) as well as private lands. Phase I includes preliminary testing sites (8-inch borehole drilling and 20-foot-square test pits) to determine placement of project components. For the purposes of Section 106 consultation, the NRCS will function as the lead Federal agency.

An intensive pedestrian cultural resources inventory of the undertaking was completed by Transcon Environmental, Inc. under the authority of Utah Division of State History (UDSH) Project No. U21TN0316. As a result of the inventory, it was determined that a total of four previously identified cultural resource sites are located within or crossed by the project Area of Potential Effects (APE) (42WS2428, 42WS5150, 42WS5151, and 42WS5152). No new cultural resource sites were identified as a result of this survey.

Table 1 summarizes the site identified, type, and eligibility determinations. Of these four sites, one (42WS2428) is Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant historic events. The segments of historic road 42WS2428 within the project APE are heavily disturbed or destroyed and lack historic integrity. The remaining three sites (42WS5150, 42WS5151, and 42WS5152) are Not Eligible for the NRHP under any Criteria.

Table 1. Site summaries and NRHP eligibility recommendations.

Site No.	Affiliation	Eligibility
42WS2428	Historic road (Road from St. George to Pine Valley)	Eligible – A
42WS5150	Prehistoric lithic scatter	Not Eligible

Site No.	Affiliation	Eligibility
42WS5151	Prehistoric lithic scatter	Not Eligible
42WS5152	Prehistoric artifact scatter	Not Eligible

The NRCS recommends that the Phase I project proceed as planned with a determination of ***no adverse effect to historic properties.*** The NRCS requests your concurrence for the determination of project effects.

If you have any questions, comments, or concerns, please contact Marcel Corbeil, NRCS-South Area Cultural Resources Specialist, at 435-893-3367, or marcel.corbeil@usda.gov at your convenience.

Sincerely,

Emily Fife

EMILY FIFE
State Conservationist

Enclosure

cc: (w/o encl)
Alan Atkins, ASTC - Field Operations, NRCS, Richfield, UT
Lynn Kitchen, District Conservationist, NRCS, Cedar City, UT
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Kristine Curry, Archaeologist, SITLA, Salt Lake City, UT
Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT
Tara S. Hoffmann, State Cultural Resources Specialist, NRCS, Salt Lake City, UT
Marcel Corbeil, South Area Cultural Resources Specialist, NRCS, Richfield, UT

Shivwits Band of Paiutes

February 12, 2021

Brian Parker
Transcon Environmental
1745 S. Alma School Rd., Ste. 220
Phoenix, AZ 85210

Re: *Comments – Proposed Santa Clara Watershed Plan-EA Project*

Dear Brian:

The Shivwits Band Council, governing body of the Shivwits Band of Paiutes (Band), has received the United States Department of Agriculture's Natural Resources Conservation Service (NRCS) letter from Emily Fife dated January 13, 2021, regarding the above-referenced Project. The Shivwits Band appreciates receiving notice about this potential project and provides this written notice of its interest, initial comments, and desire to participate in the development of the Environmental Assessment (EA).

As a preliminary matter, the Band requests consultation with NRCS directly on this matter. Pursuant to Executive Order 13175 and the NRCS General Manual 410, the Shivwits Band request direct consultation with NRCS in relation to the Proposed Santa Clara Watershed Plan (Plan). The Band looks forward to meeting with NRCS representatives soon.

The Shivwits Band has existed as a sovereign Band since time immemorial on the lands underlying this Project (Subject Lands). The Band is interested and impacted because the Subject Lands are, as you know, within the Band's aboriginal and ceded territory, as well as the Band's current Reservation land held in trust by the United States government. In addition, the Shivwits Band has water rights established by U.S. Congress in Public Law 106-263, the Shivwits Band of Paiutes Water Rights Settlement Act that are impacted by the Plan. We are concerned about the stream diversions and detention basins, and want to make sure that the stream restoration, irrigation supply and flood protection plans do not harm our water rights or the related lands.

The Project Plan should not disregard or adversely impact the Band's cultural and traditional interests in the area. The Shivwits Band has culturally sensitive areas within the area impacted by the Plan, as well as historic sites. The Subject Lands are associated with the cultural practices, traditions, beliefs, and social institutions of the Band's traditional community. The Band wants to ensure that any of the proposed improvements affecting land which is part of the

Band's aboriginal territory, ceded land, and current Reservation do not disturb Band graves, artifacts, ceremonial sites, historic properties and cultural resources.

This is not an exhaustive description of Band interests or objections. Rather, we hope to generally inform NRCS of the Band's interest and concerns and look forward to providing additional information after the requested consultation.

Thank you for giving meaningful consideration to the Band's concerns. Please coordinate through our legal counsel, Mark Echo Hawk regarding this matter now. You may contact the Band at 435.922.8920 or mark@echohawk.com. The Shivwits Band Council looks forward to talking or meeting at your convenience.

Sincerely,

SHIVWITS BAND OF PAIUTES BAND COUNCIL

Carmen Clark

Carmen Clark, Chairperson

cc: Mark Echo Hawk, Shivwits Band of Paiutes Tribal Attorney

From:	Timothy Begay
To:	Hoffmann, Tara - NRCS, Salt Lake City, UT
Subject:	SANTACLARA WATERSHED PLAN-EA PROJECT
Date:	Wednesday, February 10, 2021 2:29:45 PM

Dear Ms. Hoffmann:

The Navajo Nation Heritage and Historic Preservation Department's (NNHPD) Traditional Culture Program is (TCP) in receipt of your letter regarding USDA Natural Resources Conservation Service Santa Clara Watershed plan EA Project within Washington Cunty, Utah.

After reviewing your letter and cross referencing our Traditional Cultural Properties (TCP's) database, NNHHPD-TCP has determined that there are No Navajo TCP's within the project area and you may proceed without further consultation for this project.

If you have any additional questions, concerns or would like to discuss these issues further, please don't hesitate to contact our office at (928) 871-7198 or (928) 871-7152. Thank you for your cooperation and understanding.

Sincerely,

Timothy C. Begay, Navajo Cultural Specialist
Navajo Nation Heritage and Historic Preservation Department
P.O. Box 4950
Window Rock, AZ 86515
tbegay@navajo-nsn.gov

THE HOPI TRIBE

Timothy L. Nuvangyaoma
CHAIRMAN

Clark W. Tenakhongva
VICE-CHAIRMAN

February 10, 2021

Emily Fife, State Conservationist
Attention: Tara S. Hoffmann, State Cultural Resource Specialist
Natural Resources Conservation Service
125 South State Street,Room 4010
Salt Lake City, Utah 84138

Dear Ms. Fife,

Thank you for your correspondence dated January 13, 2021, regarding the National Resources Conservation Service (NRCS) in cooperation with Washington County Utah, considering improvements within the Santa Clara Watershed, including stream diversions and detention basins within the Dammeron and Diamond Valleys and stream restoration, irrigation supply and flood protection within the Shivwits Band of Paiutes lands. The Hopi Cultural Preservation Office appreciates the NRCS's continuing solicitation of our input and your efforts to address our concerns.

The Hopi Tribe claims cultural affiliation to prehistoric cultural groups in Utah. The Hopi Cultural Preservation Office supports the identification and avoidance of prehistoric archaeological sites and we consider the prehistoric archaeological sites of our ancestors to be "footprints" and Traditional Cultural Properties.

The Hopi Cultural Preservation Office concurs that informed and valid NRCS decisions are best made when based upon scientifically derived data. We request consultation on any proposal in Utah with the potential to adversely affect prehistoric cultural resources. If the cultural resources report identifies prehistoric sites that may be adversely affected by project activities, We request ongoing consultation including being provided with copies of the cultural resources survey report and any proposed treatment plans for review and comment. Thank you for your consideration.

Respectfully,

Stewart B. Koyiyumptewa, Program Manager/THPO
Hopi Cultural Preservation Office

xc: Utah State Historic Preservation Office

United States Department of Agriculture

Natural Resources
Conservation Service

Utah State Office

125 South State Street
Room 4010
Salt Lake City, UT 84138

Ph: 801-524-4550
Fax: 844-715-4928
www.ut.nrcs.usda.gov

January X, 2021

<Address Block>

RE: Santa Clara Watershed Plan-EA Project

Dear Mr./Ms. XXXX:

The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), in coordination with Washington County, Utah as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

As designed, the proposed improvements will involve the construction of stream diversions and detention basins within the Dammeron and Diamond Valleys. The project will also involve other improvements within the Shivwits Band of Pauites lands including stream restoration, irrigation supply, and flood protection. The Area of Potential Effects is located on Bureau of Land Management (BLM), Utah School and Institutional Trust Lands Administration (SITLA), Tribal, and Private lands.

In cooperation with Washington County, USDA-NRCS is in the very early planning stages of preparing an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA) to consider and analyze potential impacts from the action. For the purposes of compliance with NEPA and Section 106 of the NHPA, USDA-NRCS is the designated lead agency. Pursuant to Section 106 of the National Historic Preservation Act (NHPA), Executive Order 13007, the American Indian Religious Freedom Act, we write to you at this time regarding the project and we welcome any information you would like to share with us regarding historic properties or places of traditional religious and cultural importance near the proposed project area that we should consider as part of our analysis. We would also appreciate your assistance in identifying any other tribes with whom we should consult on this project.

You are invited to an online virtual scoping meeting, to be held on Wednesday, January 27th, 2021 from 6:30 to 7:30 pm. The meeting is expected to be a presentation of preliminary project plans and will ask for input on potential issues USDA-NRCS should be aware of during the environmental analysis.

NRCS invites you to submit comments anytime during the open comment period starting January 13, 2021 and ending on February 12, 2021. Please refer to the enclosed flyer for instructions on submitting comments. **Comments must be received by February 12, 2021 to become part of the public record.**

We look forward to hearing from and working with you on this important project. We welcome your call if you have questions on the proposed project or if you wish to arrange a meeting. If you have any questions, comments or concerns, please contact State Cultural Resources Specialist Tara S. Hoffmann at 385-258-1266 or tara.hoffmann@usda.gov, at your earliest convenience.

Sincerely,

EMILY FIFE
NRCS State Conservationist

Encl: Project Fact Sheet/Scoping Notice

cc:

Tara S. Hoffmann, NRCS, State Cultural Resources Specialist, Salt Lake City, UT
Alan Atkins, NRCS, Assistant State Conservationist for Field Operations, Richfield, UT
Lynn Kitchen, NRCS, District Conservationist, Cedar City, UT
Norm Evenstad, NRCS, Assistant State Conservationist, Salt Lake City, UT
Derek Hamilton, NRCS, Water Resources Coordinator, Salt Lake City, UT
Leslie Warta, NRCS, Environmental Compliance Specialist, Salt Lake City, UT
Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT

January 13, 2021

Mr. Greg Anderson
Chairman
Moapa Band of Paiute Indians of the Moapa River Reservation, Nevada
P.O. Box 340
Moapa, Nevada 89025

RE: Santa Clara Watershed Plan-EA Project

Dear Mr. Anderson:

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

As designed, the proposed improvements will involve the construction of stream diversions and detention basins within the Dammeron and Diamond Valleys. The project will also involve other improvements within the Shivwits Band of Paiutes lands including stream restoration, irrigation supply, and flood protection. The Area of Potential Effects (APE) is located on Bureau of Land Management (BLM), Utah School and Institutional Trust Lands Administration (SITLA), Tribal, and Private lands.

In cooperation with Washington County, NRCS is in the very early planning stages of preparing an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA) to consider and analyze potential impacts from the action. For the purposes of compliance with NEPA and Section 106 of the National Historic Preservation Act (NHPA), NRCS is the designated lead agency. Pursuant to Section 106 of the NHPA, Executive Order 13007, the American Indian Religious Freedom Act, we write to you at this time regarding the project and we welcome any information you would like to share with us regarding historic properties or places of traditional religious and cultural importance near the proposed project area that we should consider as part of our analysis. We would also appreciate your assistance in identifying any other tribes with whom we should consult on this project.

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We look forward to hearing from and working with you on this important project. We welcome your call, if you have questions on the proposed project or if you wish to arrange a meeting. If you have any questions, comments or concerns, please contact State Cultural Resources Specialist, Tara S. Hoffmann at 385-258-1266 or tara.hoffmann@usda.gov, at your earliest convenience.

Sincerely,

Emily Fife

EMILY FIFE
NRCS State Conservationist

Encl: Project Fact Sheet/Scoping Notice

cc:

Tara S. Hoffmann, NRCS, State Cultural Resources Specialist, Salt Lake City, UT
Alan Atkins, NRCS, Assistant State Conservationist for Field Operations, Richfield, UT
Lynn Kitchen, NRCS, District Conservationist, Cedar City, UT
Norm Evenstad, NRCS, Assistant State Conservationist for Water Resources, Salt Lake City, UT
Derek Hamilton, NRCS, Water Resources Coordinator, Salt Lake City, UT
Leslie Warta, NRCS, Environmental Compliance Specialist, Salt Lake City, UT
Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT

USDA

January 13, 2021

Mr. Richard Begay
THPO and Department Manager
Navajo Nation Historic Preservation Department
P.O. Box 7440
Window Rock, Arizona 86515

RE: Santa Clara Watershed Plan-EA Project

Dear Mr. Begay:

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

As designed, the proposed improvements will involve the construction of stream diversions and detention basins within the Dammeron and Diamond Valleys. The project will also involve other improvements within the Shivwits Band of Paiutes lands including stream restoration, irrigation supply, and flood protection. The Area of Potential Effects (APE) is located on Bureau of Land Management (BLM), Utah School and Institutional Trust Lands Administration (SITLA), Tribal, and Private lands.

In cooperation with Washington County, NRCS is in the very early planning stages of preparing an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA) to consider and analyze potential impacts from the action. For the purposes of compliance with NEPA and Section 106 of the National Historic Preservation Act (NHPA), NRCS is the designated lead agency. Pursuant to Section 106 of the NHPA, Executive Order 13007, the American Indian Religious Freedom Act, we write to you at this time regarding the project and we welcome any information you would like to share with us regarding historic properties or places of traditional religious and cultural importance near the proposed project area that we should consider as part of our analysis. We would also appreciate your assistance in identifying any other tribes with whom we should consult on this project.

You are invited to an online virtual scoping meeting, to be held on Wednesday, January 27th, 2021 from 6:30 pm to 7:30 pm. The meeting is expected to be a presentation of preliminary project plans and will ask for input on potential issues NRCS should be aware of during the environmental analysis.

NRCS invites you to submit comments anytime during the open comment period starting January 13, 2021 and ending on February 12, 2021. Please refer to the enclosed flyer for instructions on submitting comments. **Comments must be received by February 12, 2021 to become part of the public record.**

We look forward to hearing from and working with you on this important project. We welcome your call, if you have questions on the proposed project or if you wish to arrange a meeting. If you have any questions, comments or concerns, please contact State Cultural Resources Specialist, Tara S. Hoffmann at 385-258-1266 or tara.hoffmann@usda.gov, at your earliest convenience.

Sincerely,

Emily Fife

EMILY FIFE
NRCS State Conservationist

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Derek Hamilton, NRCS, Water Resources Coordinator, Salt Lake City, UT
Leslie Warta, NRCS, Environmental Compliance Specialist, Salt Lake City, UT
Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT

January 13, 2021

Mr. Daniel Bullets
Kaibab Band of Paiute Indians of the Kaibab Indian Reservation
Cultural Preservation Office
HC65, Box 2
Fredonia, Arizona 86022

RE: Santa Clara Watershed Plan-EA Project

Dear Mr. Bullets:

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

As designed, the proposed improvements will involve the construction of stream diversions and detention basins within the Dammeron and Diamond Valleys. The project will also involve other improvements within the Shivwits Band of Paiutes lands including stream restoration, irrigation supply, and flood protection. The Area of Potential Effects (APE) is located on Bureau of Land Management (BLM), Utah School and Institutional Trust Lands Administration (SITLA), Tribal, and Private lands.

In cooperation with Washington County, NRCS is in the very early planning stages of preparing an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA) to consider and analyze potential impacts from the action. For the purposes of compliance with NEPA and Section 106 of the National Historic Preservation Act (NHPA), NRCS is the designated lead agency. Pursuant to Section 106 of the NHPA, Executive Order 13007, the American Indian Religious Freedom Act, we write to you at this time regarding the project and we welcome any information you would like to share with us regarding historic properties or places of traditional religious and cultural importance near the proposed project area that we should consider as part of our analysis. We would also appreciate your assistance in identifying any other tribes with whom we should consult on this project.

You are invited to an online virtual scoping meeting, to be held on Wednesday, January 27th, 2021 from 6:30 pm to 7:30 pm. The meeting is expected to be a presentation of preliminary project plans and will ask for input on potential issues NRCS should be aware of during the environmental analysis.

NRCS invites you to submit comments anytime during the open comment period starting January 13, 2021 and ending on February 12, 2021. Please refer to the enclosed flyer for instructions on submitting comments. **Comments must be received by February 12, 2021 to become part of the public record.**

We look forward to hearing from and working with you on this important project. We welcome your call, if you have questions on the proposed project or if you wish to arrange a meeting. If you have any questions, comments or concerns, please contact State Cultural Resources Specialist, Tara S. Hoffmann at 385-258-1266 or tara.hoffmann@usda.gov, at your earliest convenience.

Sincerely,

Emily Fife

EMILY FIFE
NRCS State Conservationist

Encl: Project Fact Sheet/Scoping Notice

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Derek Hamilton, NRCS, Water Resources Coordinator, Salt Lake City, UT
Leslie Warta, NRCS, Environmental Compliance Specialist, Salt Lake City, UT
Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT

January 13, 2021

Chairperson
Kanosh Band of Paiutes
P.O. Box 116
Kanosh, Utah 84637

RE: Santa Clara Watershed Plan-EA Project

Dear Chairperson:

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

As designed, the proposed improvements will involve the construction of stream diversions and detention basins within the Dammeron and Diamond Valleys. The project will also involve other improvements within the Shivwits Band of Paiutes lands including stream restoration, irrigation supply, and flood protection. The Area of Potential Effects (APE) is located on Bureau of Land Management (BLM), Utah School and Institutional Trust Lands Administration (SITLA), Tribal, and Private lands.

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We look forward to hearing from and working with you on this important project. We welcome your call, if you have questions on the proposed project or if you wish to arrange a meeting. If you have any questions, comments or concerns, please contact State Cultural Resources Specialist, Tara S. Hoffmann at 385-258-1266 or tara.hoffmann@usda.gov, at your earliest convenience.

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Emily Fife

EMILY FIFE
NRCS State Conservationist

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Derek Hamilton, NRCS, Water Resources Coordinator, Salt Lake City, UT
Leslie Warta, NRCS, Environmental Compliance Specialist, Salt Lake City, UT
Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT

USDA

January 13, 2021

Ms. Betsy Chapoose
Director
Cultural Rights Protection Department
Ute Indian Tribe of the Uintah and Ouray Reservation, Utah
P.O. Box 190
Fort Duchesne, Utah 84026

RE: Santa Clara Watershed Plan-EA Project

Dear Ms. Chapoose:

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

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Sincerely,

Emily Fife

EMILY FIFE
NRCS State Conservationist

Encl: Project Fact Sheet/Scoping Notice

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Derek Hamilton, NRCS, Water Resources Coordinator, Salt Lake City, UT
Leslie Warta, NRCS, Environmental Compliance Specialist, Salt Lake City, UT
Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT

January 13, 2021

Mr. Charles Wood
Chairman
Chemehuevi Indian Tribe
P.O. Box 1976
Havasu Lake, California 92363

RE: Santa Clara Watershed Plan-EA Project

Dear Mr. Wood:

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

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Sincerely,

Emily Fife

EMILY FIFE
NRCS State Conservationist

Encl: Project Fact Sheet/Scoping Notice

cc:

Tara S. Hoffmann, NRCS, State Cultural Resources Specialist, Salt Lake City, UT
Alan Atkins, NRCS, Assistant State Conservationist for Field Operations, Richfield, UT
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Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT

January 13, 2021

Ms. Carmen Clark
Chairwoman
Shivwits Band of Paiute Indians
Paiute Indian Tribe of Utah
6060 West 3650 North
Ivins, Utah 84738

RE: Santa Clara Watershed Plan-EA Project

Dear Ms. Clark:

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

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Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT

January 13, 2021

Mr. Curtis Anderson
Las Vegas Tribe of Paiute Indians of the Las Vegas Colony
One Paiute Drive
Las Vegas, Nevada 89106

RE: Santa Clara Watershed Plan-EA Project

Dear Mr. Anderson:

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

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January 13, 2021

Mr. Darren Deboda
Moapa Band of Paiute Indians of the Moapa River Indian Reservation, Nevada
P.O. Box 340
Moapa, Nevada 89025

RE: Santa Clara Watershed Plan-EA Project

Dear Mr. Deboda:

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

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January 13, 2021

Mr. Kurt Dongoske, RPA.
Director/Tribal Historic Preservation Officer
Zuni Heritage & Historic Preservation
P.O. Box 339
Zuni, New Mexico 87327

RE: Santa Clara Watershed Plan-EA Project

Dear Mr. Dongoske:

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

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USDA

January 13, 2021

Mr. Luke Duncan
Chairman
Ute Indian Tribe of the Uintah and Ouray Reservation, Utah
P.O. Box 190
Fort Duchesne, Utah 84026

RE: Santa Clara Watershed Plan-EA Project

Dear Mr. Duncan:

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

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January 13, 2021

Mr. Stewart B. Koyiyumptewa
Tribal Historic Preservation Officer
Hopi Tribe of Arizona
Hopi Cultural Preservation Office
P.O. Box 123
Kykotsmovi, Arizona 86039

RE: Santa Clara Watershed Plan-EA Project

Dear Mr. Koyiyumptewa:

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

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January 13, 2021

Ms. Dorena Martineau
Paiute Indian Tribe of Utah
440 North Paiute Drive
Cedar City, Utah 84721

RE: Santa Clara Watershed Plan-EA Project

Dear Ms. Martineau:

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USDA

January 13, 2021

Ms. LaTosha Mayo
Chairwoman
Koosharem Band of Paiutes
P.O. Box 205
Richfield, Utah 84107

RE: Santa Clara Watershed Plan-EA Project

Dear Ms. Mayo:

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January 13, 2021

Mr. Jonathan Nez
President
Navajo Nation Office of the President
P.O. Box 7440
Window Rock, Arizona 86515

RE: Santa Clara Watershed Plan-EA Project

Dear Mr. Nez:

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USDA

January 13, 2021

Mr. Timothy Nuvangyaoma
Chairman
Hopi Tribe of Arizona
Hopi Tribe Chairman's Office
P.O. Box 123
Kykotsmovi, Arizona 86039

RE: Santa Clara Watershed Plan-EA Project

Dear Mr. Nuvangyaoma:

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

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In cooperation with Washington County, NRCS is in the very early planning stages of preparing an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA) to consider and analyze potential impacts from the action. For the purposes of compliance with NEPA and Section 106 of the National Historic Preservation Act (NHPA), NRCS is the designated lead agency. Pursuant to Section 106 of the NHPA, Executive Order 13007, the American Indian Religious Freedom Act, we write to you at this time regarding the project and we welcome any information you would like to share with us regarding historic properties or places of traditional religious and cultural importance near the proposed project area that we should consider as part of our analysis. We would also appreciate your assistance in identifying any other tribes with whom we should consult on this project.

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We look forward to hearing from and working with you on this important project. We welcome your call, if you have questions on the proposed project or if you wish to arrange a meeting. If you have any questions, comments or concerns, please contact State Cultural Resources Specialist, Tara S. Hoffmann at 385-258-1266 or tara.hoffmann@usda.gov, at your earliest convenience.

Sincerely,

Emily Fife

EMILY FIFE
NRCS State Conservationist

Encl: Project Fact Sheet/Scoping Notice

cc:

Tara S. Hoffmann, NRCS, State Cultural Resources Specialist, Salt Lake City, UT
Alan Atkins, NRCS, Assistant State Conservationist for Field Operations, Richfield, UT
Lynn Kitchen, NRCS, District Conservationist, Cedar City, UT
Norm Evenstad, NRCS, Assistant State Conservationist for Water Resources, Salt Lake City, UT
Derek Hamilton, NRCS, Water Resources Coordinator, Salt Lake City, UT
Leslie Warta, NRCS, Environmental Compliance Specialist, Salt Lake City, UT
Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT

January 13, 2021

Ms. Ona Segundo
Chairwoman
Kaibab Band of Paiute Indians of the Kaibab Indian Reservation
Tribal Affairs Building
HC65, Box 2
Fredonia, Arizona 86022

RE: Santa Clara Watershed Plan-EA Project

Dear Ms. Segundo:

The United States Department of Agriculture Natural Resources Conservation Service (USDA), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

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Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT

January 13, 2021

Mr. Val R. Panteah, Sr.
Governor
Pueblo of Zuni
P.O. Box 339
Zuni, New Mexico 87327

RE: Santa Clara Watershed Plan-EA Project

Dear Mr. Panteah:

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

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Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT

January 13, 2021

Ms. Ramona Salazar
Las Vegas Tribe of Paiute Indians of the Las Vegas Colony
One Paiute Drive
Las Vegas, Nevada 89106

RE: Santa Clara Watershed Plan-EA Project

Dear Ms. Ramona Salazar:

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

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Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT

January 13, 2021

Mr. Ganivan Timcan
Southern Paiute Consortium
Kaibab Band of Paiute Indians of the Kaibab Indian Reservation
Cultural Preservation Office
HC65, Box 2
Fredonia, Arizona 86022

RE: Santa Clara Watershed Plan-EA Project

Dear Mr. Timcan:

The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), in coordination with Washington County, Utah; USDA-NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

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Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT

January 13, 2021

Ms. Delice Tom
Chairwoman
Cedar Band of Paiutes
P.O. Box 235
Cedar City, Utah 84721

RE: Santa Clara Watershed Plan-EA Project

Dear Ms. Tom:

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Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT

January 13, 2021

Ms. Carlene Yellowhair
President
P.O. Box 2950
Tuba City, Arizona 86045

RE: Santa Clara Watershed Plan-EA Project

Dear Ms. Yellowhair:

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), in coordination with Washington County, Utah; NRCS as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Improvements under consideration will address flood control and protection, agricultural demands, public safety risks, while enhancing species habitat. See the enclosed Project Fact Sheet for information about project features.

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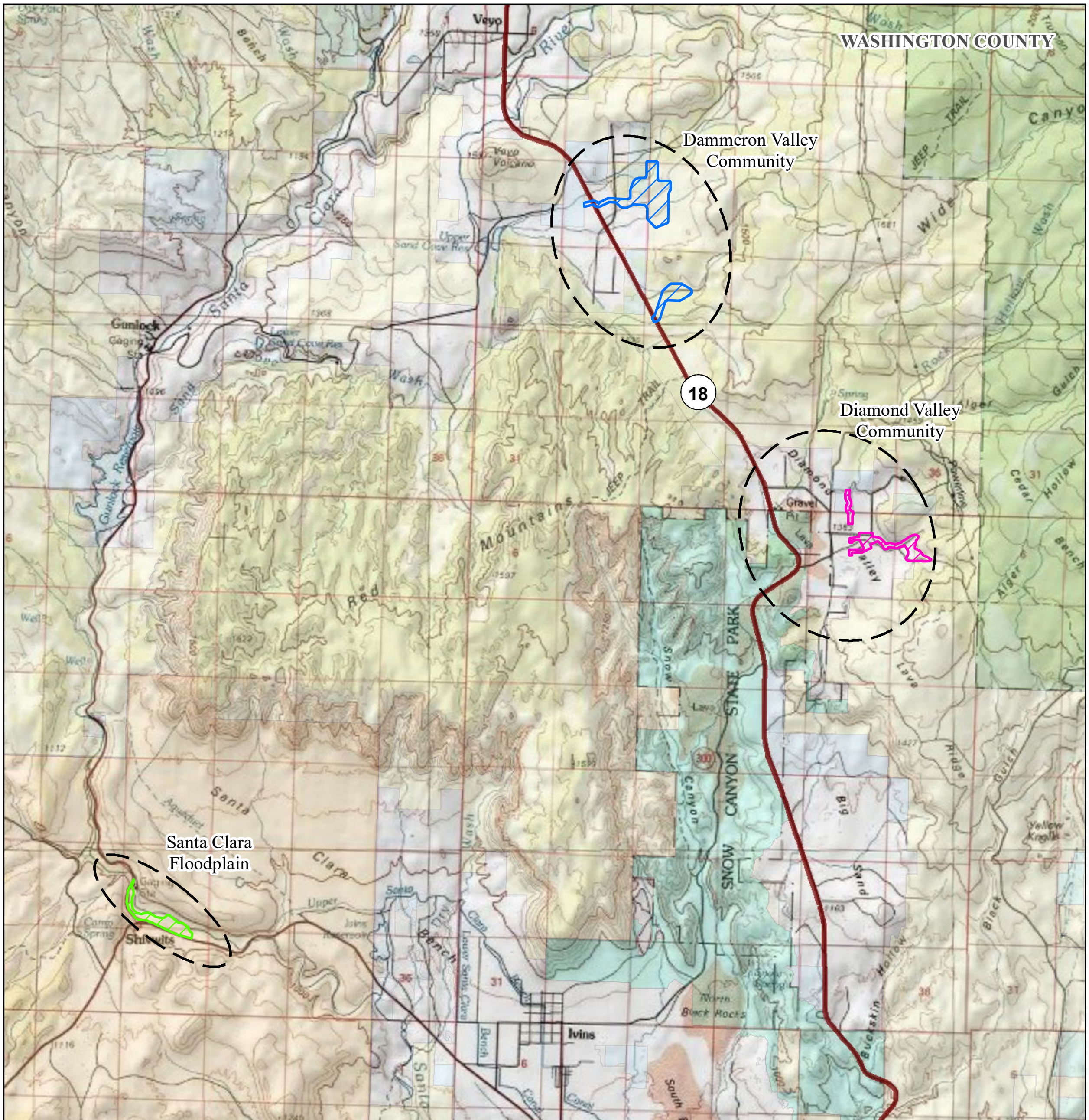
Brian Parker, Environmental Coordinator, Transcon Environmental, Cedar City, UT

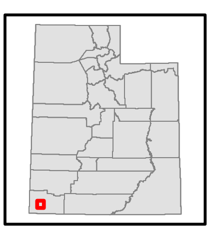
Tribe	Office/Department	Person of Contact	Title/Position	Street Address	City	State	Zip	CC w/ Enclosure	Notes
Hopi Tribe	Hopi Tribe Chairman's Office	Mr. Timothy L. Nuvangyaoma	Chairman	P.O. Box 123	Kykotsmovi	AZ	86039	No	N/A
Hopi Tribe	Hopi Culture Preservation Office	Stewart B. Koyiyumpetewa	THPO	P.O. Box 123	Kykotsmovi	AZ	86039	No	N/A
Cedar Band of Paiutes	N/A	Ms. Delice Tom	Chariperson	600 N 100 East, P.O. Box 205	Richfield	UT	84701		
Chemehuevi Indian Tribe	N/A	Mr. Charles Wood	Chairman	1990 Palo Verde Drive, P.O. Box 1976	Havasu Lake	CA	92363		
Kaibab Band of Paiute Indians	Cultural Preservation Office	Mr. Daniel Bullets		HC65, Box 2	Fredonia	AZ	86022	No	
Kaibab Band of Paiute Indians	Southern Paiute Consortium	Ms. Ona Segundo		Tribal Affairs Building, HC65, Box 2	Fredonia	AZ	86022	No	N/A
Kaibab Band of Paiute Indians	N/A	Ms. Ona Segundo	Chairwoman	Tribal Affairs Building, HC65, Box 2	Fredonia	AZ	86022	No	N/A
Kanosh Band of Paiutes	N/A		Chairperson	P.O. Box 116	Kanosh	UT	84637		
Koosharem Band of Paiuts	N/A	Ms. LaTosha Mayo	Chairwoman	P.O. Box 205	Richfield	UT	84701		
Las Vegas Tribe of Paiute Indians of the Las Vegas Colony	N/A	Mr. Curtis Anderson	Chairman	One Paiute Drive	Las Vegas	NV	89106	No	N/A
Las Vegas Tribe of Paiute Indians of the Las Vegas Colony	N/A	Ms. Ramona Salazar		One Paiute Drive	Las Vegas	NV	89106	No	N/A
Moapa Band of Paiute Indians	N/A	Mr. Greg Anderson	Chairman	P.O. Box 340	Moapa	NV	89025	Yes; include Mr. Darren Deboda's	N/A
Moapa Band of Paiute Indians	N/A	Mr. Darren Deboda	N/A	P.O. Box 340	Moapa	NV	89025	Yes; include w/ Mr. Greg Anderson's	
Navajo Nation	Navajo Nation Office of the President	Mr. Jonathan Nez	President	P.O. Box 7440	Window Rock	AZ	86515	Yes; include Mr. Richard Begaye's	N/A
Navajo Nation	Navajo Nation Historic Preservation Department	Mr. Richard M. Begay	THPO and Department Manager	P.O. Box 4950	Window Rock	AZ	86515	Yes; include w/ Mr. Russel Begaye's	
Paiute Indian Tribe of Utah	N/A	Ms. Dorena Martineau		440 North Paiute Drive	Cedar City	UT	84721	No	N/A
Pueblo of Zuni	N/A	Mr. Val Panteah, Sr.	Governor	P.O. Box 339	Zuni	NM	87327	No	N/A
Pueblo of Zuni	N/A	Dr. Kurt Dongoske	Director and Tribal Historic Preservation Officer	P.O. Box 1149	Zuni	NM	87327	No	N/A
San Juan Southern Paiute Tribe of Arizona	N/A	Ms. Carlene Yellowhair	President	50 South Main Street, Suite 201, P.O. Box 2950	Tuba City	AZ	86045	No	Send email: c.yellowhair@sanjuanpaiute-NSN.gov
Shivwits Band of Paiute Indians	N/A	Ms. Carmen Clark	Chairwoman	6060 West 3650 North	Ivins	UT	84738		
Ute Indian Tribe of the Uintah and Ouray Reservation	N/A	Mr. Luke Duncan	Chairman	P.O. Box 190	Fort Duchesne	UT	84026	No	N/A
Ute Indian Tribe of the Uintah and Ouray Reservation	Cultural Rights Protection Department	Ms. Betsy Chapoose	Director	P.O. Box 190	Fort Duchesne	UT	84026	No	N/A

Appendix B

Project Maps

9/18/2024 Document Path: G:\Projects\AlphaD38_05_Santa_Clara_Watershed_EA\Map_Files\MXD\Project_Overview_MXD\Santa_Clara_EA_Overview_Update.mxd





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Legend

- Dammeron Valley Project Area
- Diamond Valley Project Area
- Shivwits Project Area
- Affected Area
- Snow Canyon State Park
- BLM
- Private
- SITLA
- Tribal
- UDWR
- USFS

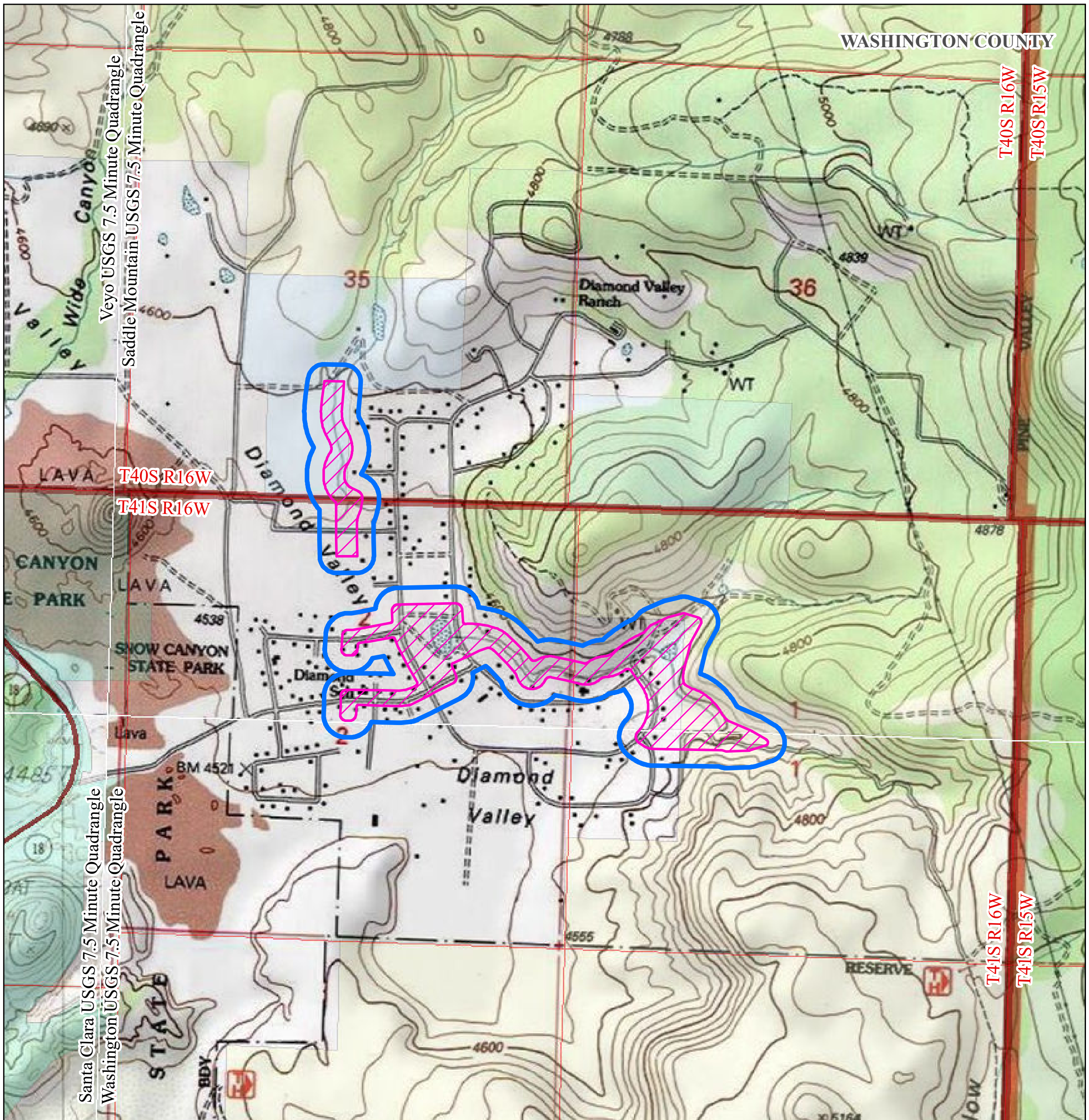
Project Overview Benefited Area

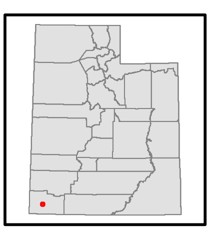
Alpha Engineering
Santa Clara Watershed EA

Date: 9/18/2024
Projection: NAD_1983_UTM_Zone_12N

Eocene Environmental Group

4/23/2024 Document Path: G:\Projects\AlphaD38_05_Santa_Clara_Watershed_EA\Map_Files\MXD\Cultural_MXD\Santa_Clara_Phase_II_Overview_Diamond.mxd





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Legend

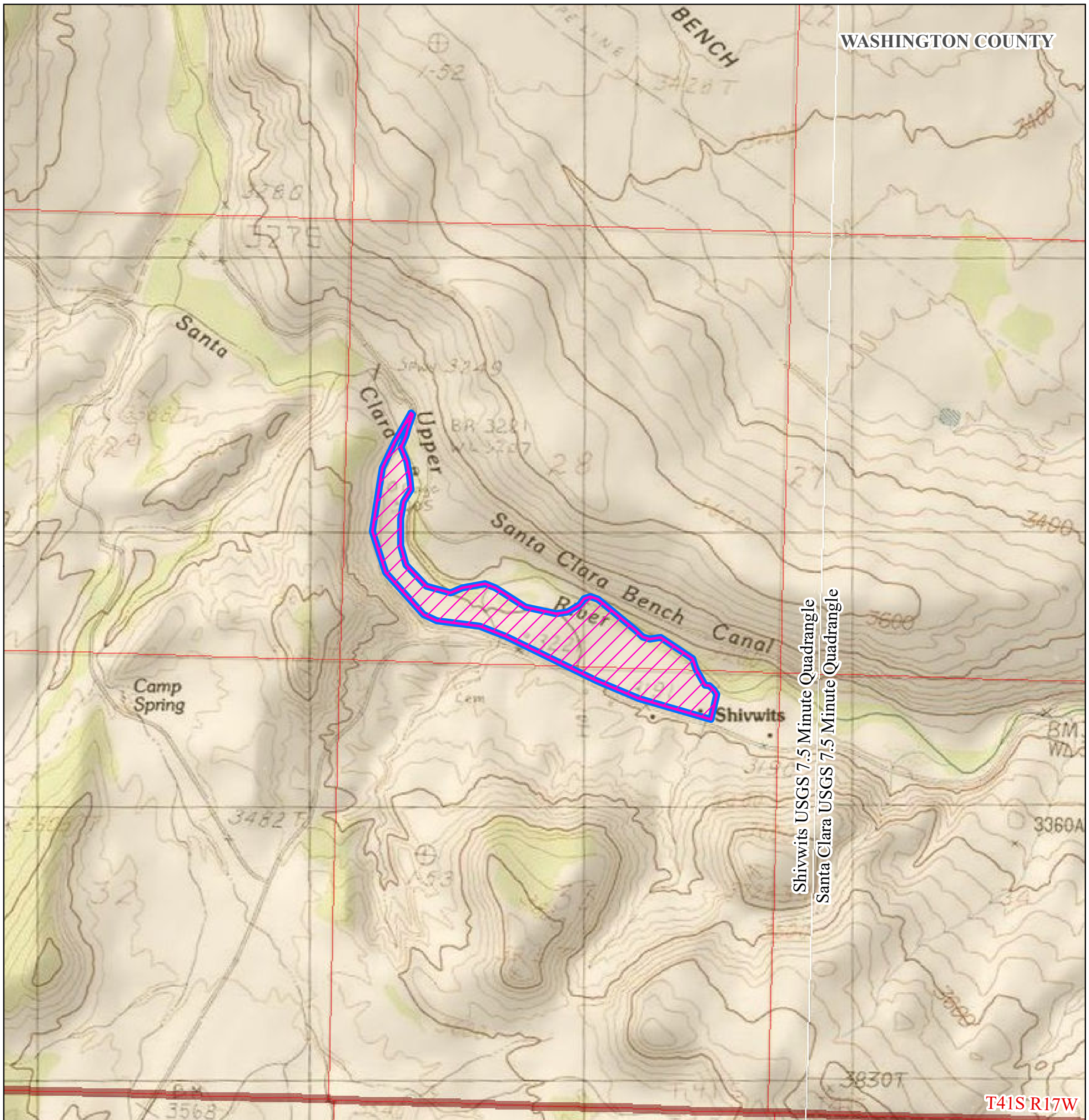
- Diamond Valley Project Area
- Project APE
- Snow Canyon State Park
- BLM
- Private
- SITLA
- USFS

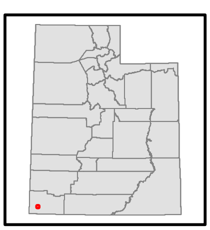
Project Overview
Diamond Valley

USDA NRCS
Santa Clara Watershed
Plan - EA Project
Phase II: Entire Project
U21TN0317

Date: 4/23/2024
Projection: NAD_1983_UTM_Zone_12N

Eocene Environmental Group





Legend

- Shivwits Project Area
- Project APE
- Tribal

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Project Overview
Shivwits

USDA NRCS
Santa Clara Watershed
Plan - EA Project
Phase II: Entire Project
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Date: 4/23/2024
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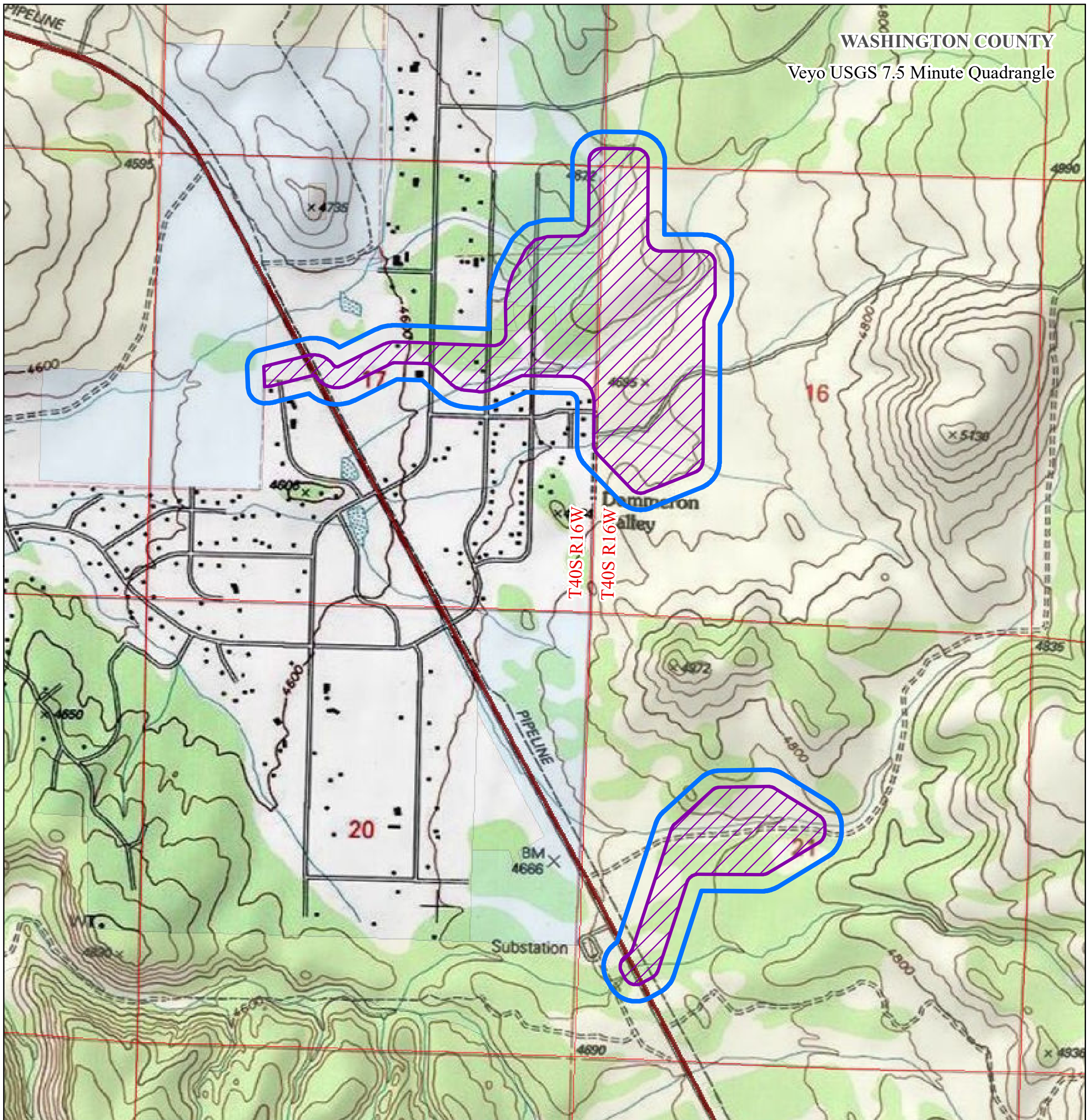
4/23/2024 Document Path: G:\Projects\AlphaD38_05_Santa_Clara_Watershed_EA\Map_Files\MXD\Cultural_MXD\Santa_Clara_Phase_II_Overview_Dammeron.mxd



Legend

- Dammeron Valley Project Area
- Project APE
- BLM
- Private
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Project Overview Dammeron Valley

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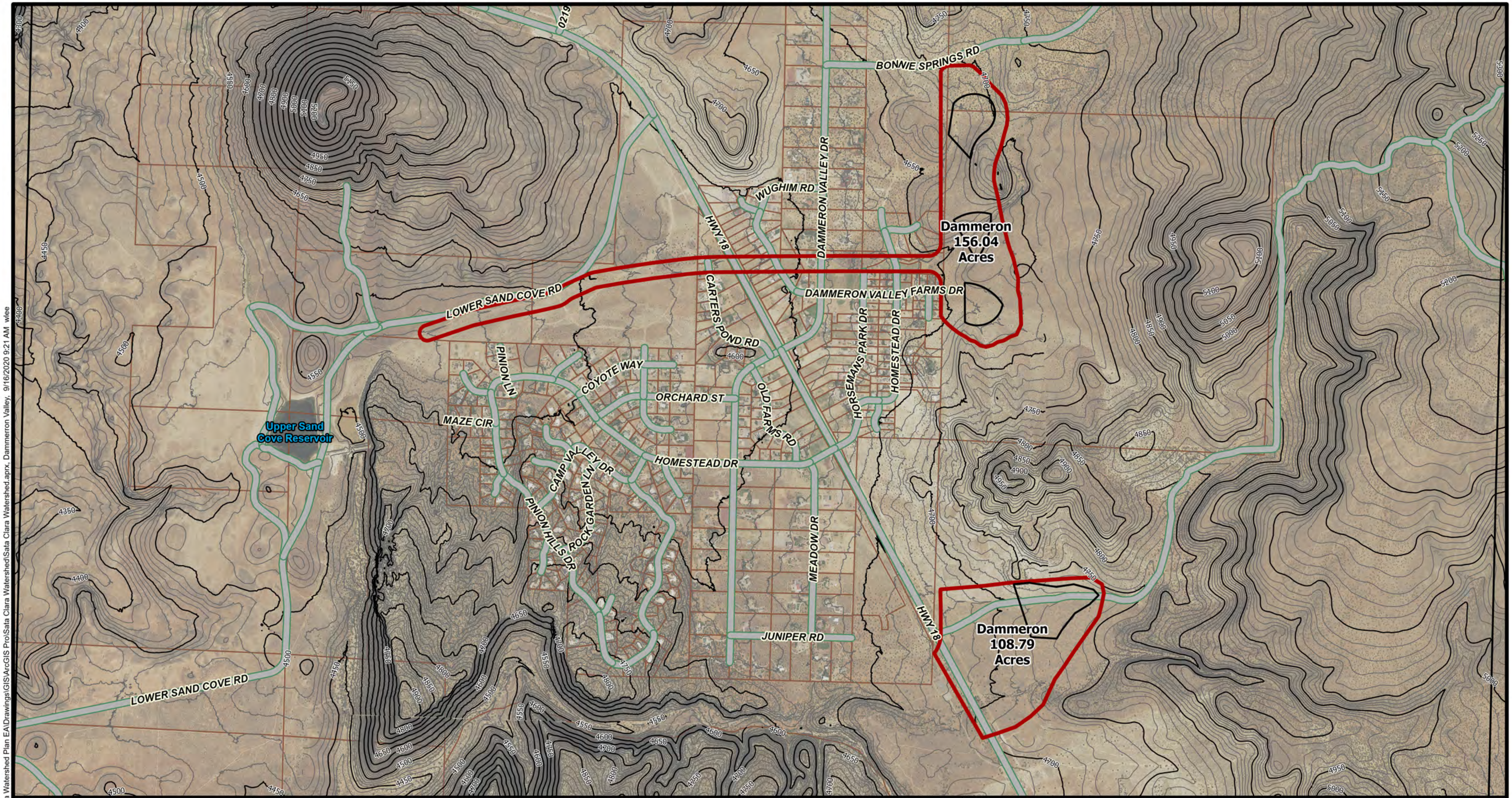
Projection: NAD_1983_UTM_Zone_12N

Eocene Environmental Group



0 500 1,000 2,000
Feet

Legend

- Major Contour (50' Interval)
- Minor Contour (10' Interval)
- Roads

ALPHA ENGINEERING
43 South 100 East, Suite 100 • St George, Utah 84770
T: 435.628.6500 • F: 435.628.6553 • alphaengineering.com

N

1 of 1

Dammeron Valley

Santa Clara Watershed Plan

Spatial Reference:	Utah State Plane NAD 83, feet
Drawn By:	CWL
Scale:	1" = 1,500 feet
Date:	September 16, 2020

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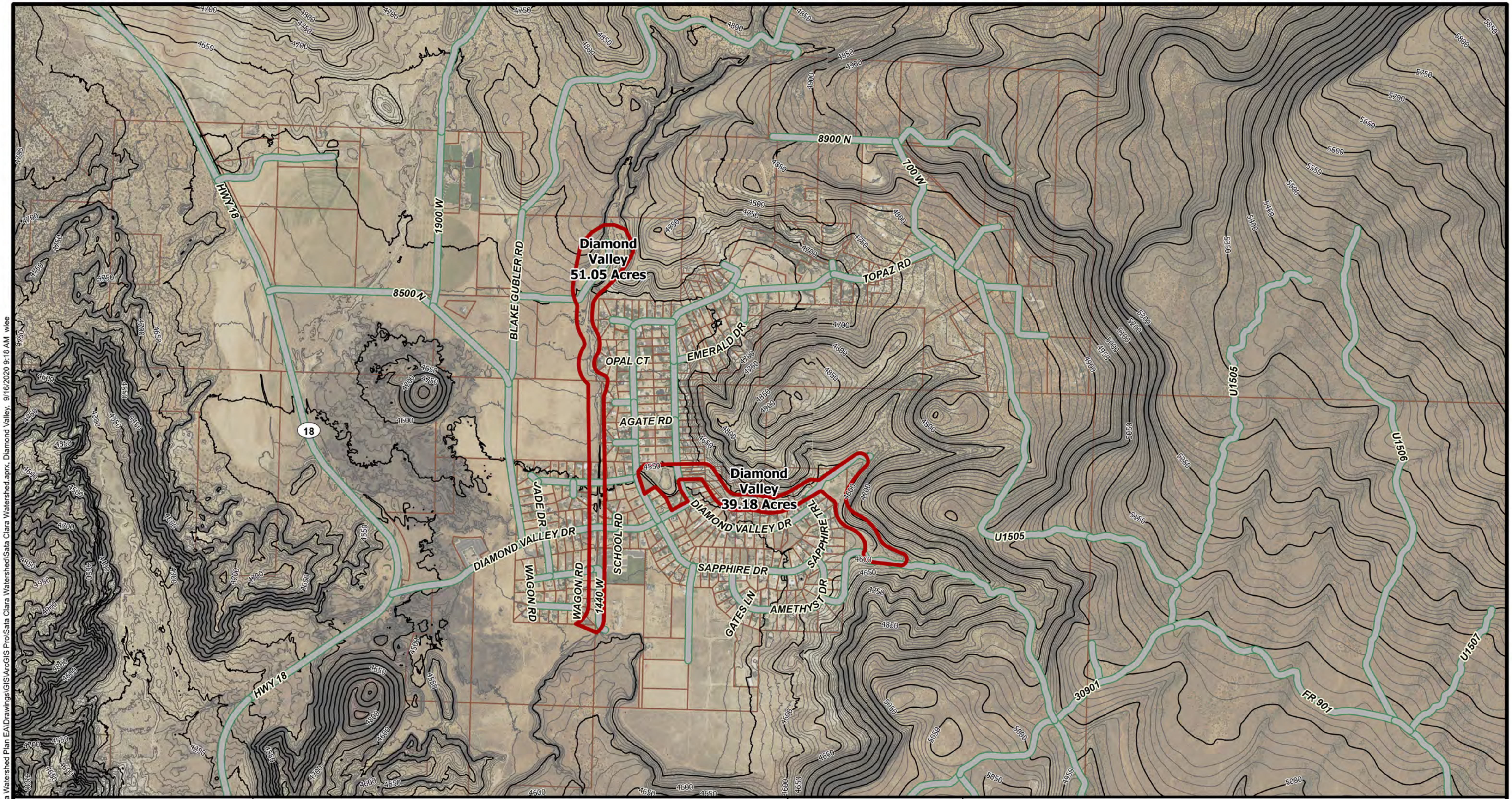

0 500 1,000 2,000 Feet	**Legend**
	Major Contour (50' Interval)
	Minor Contour (10' Interval)
	Roads

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1 of 1

DIAMOND VALLEY
Santa Clara Watershed Plan

Spatial Reference:	Utah State Plane NAD 83, feet
Drawn By:	CWL
Scale:	1" = 1,500 feet
Date:	September 16, 2020

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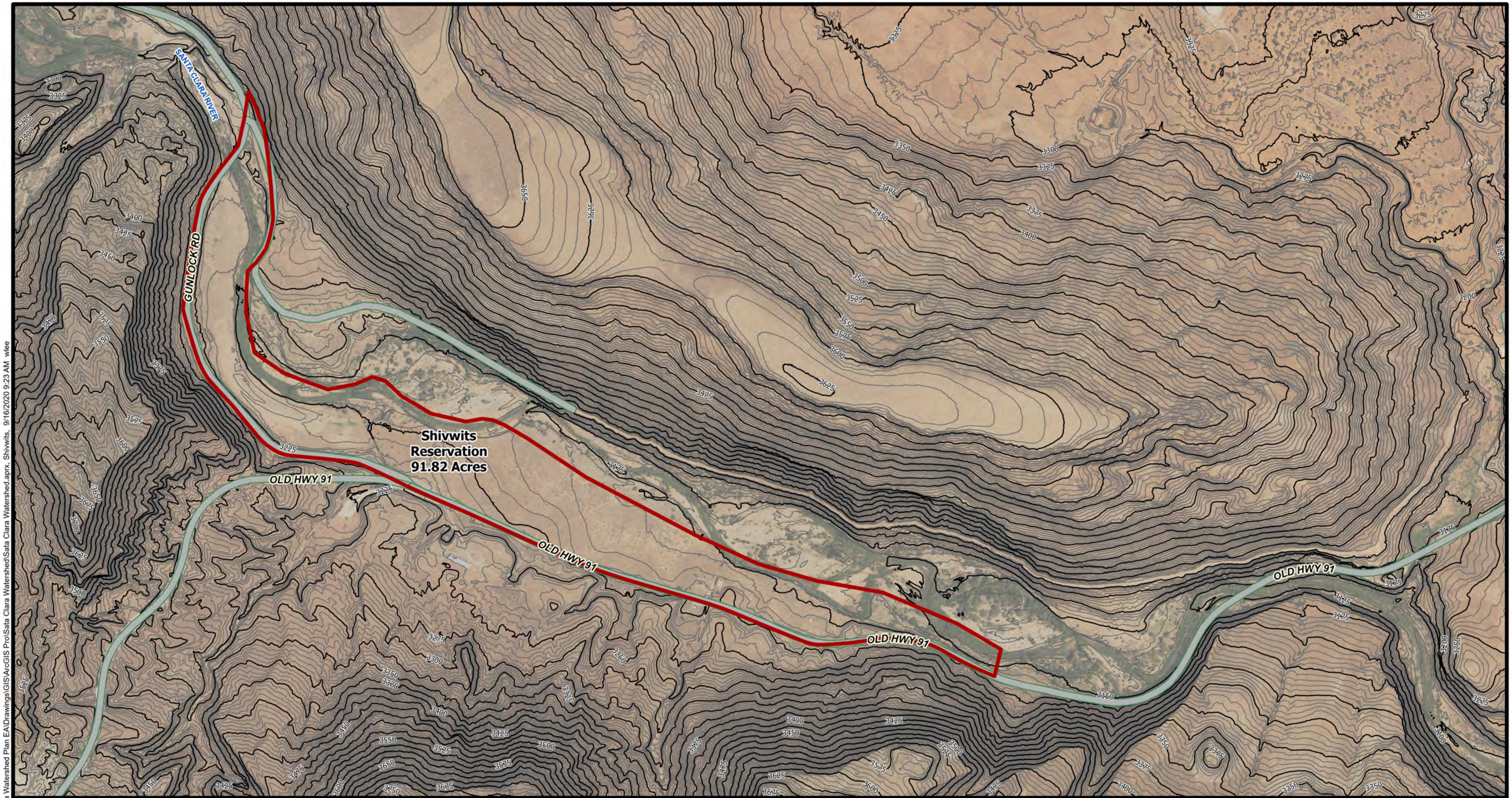

0 360 710 1,400
Feet

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Legend

- Shivwits Boundary
- Roads
- Major Contour (25' interval)
- Minor Contour (5' Interval)

N

1 of 1

Shivwits Reservation

Santa Clara Watershed Plan

Spatial Reference:	Utah State Plane NAD 83, feet
Drawn By:	CWL
Scale:	1" = 700 feet
Date:	September 16, 2020

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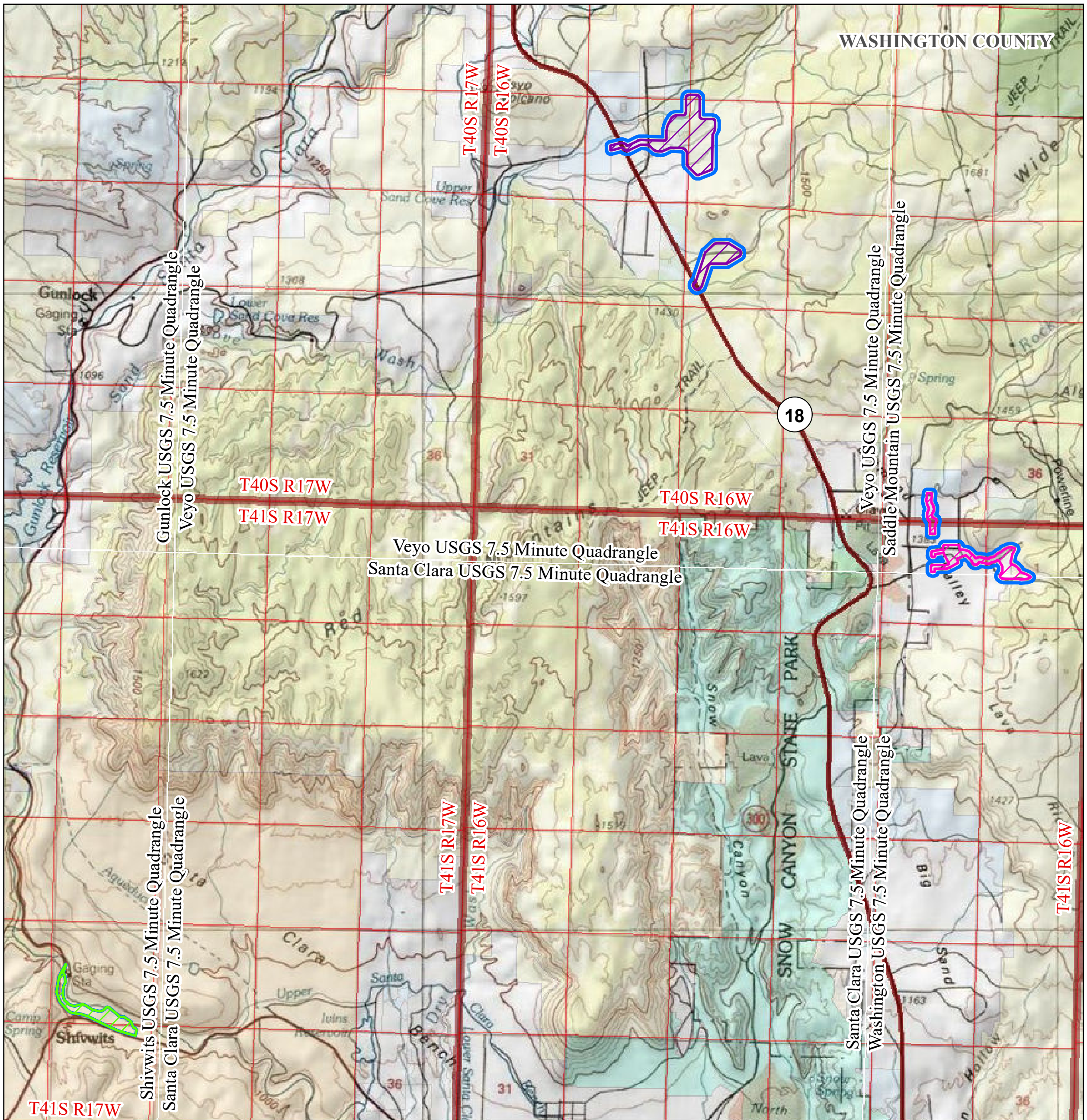
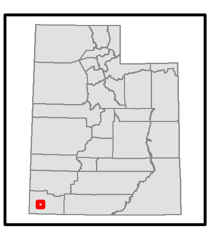




Legend

- Dammeron Valley Project Area
- Diamond Valley Project Area
- Shivwits Project Area
- Project APE
- Snow Canyon State Park
- BLM
- Private
- SITLA
- Tribal
- USFS

0 8,800

Feet

1:103,133

Project Overview

USDA NRCS
Santa Clara Watershed
Plan - EA Project
Phase II: Entire Project
U21TN0317

Date: 4/23/2024
Projection: NAD_1983_UTM_Zone_12N

Eocene Environmental Group

WASHINGTON COUNTY UTAH

Title

Legend

10 ft. Contours
- 10 ft.
- 50 ft.

Parcels

Ownership
- U.S. Forest Service
- U.S. Forest Service Wilderness
- Bureau of Land Management
- Bureau of Land Management Wilde
- National Park Service
- Shivwits Reservation
- Utah Division of Wildlife Resources
- Utah Division of Transportation
- State Park
- State of Utah
- Washington County
- Municipally Owned
- School District
- Privately Owned
- Water
- Water Conservancy District
- State Assessed Oil and Gas
- Mining Claim

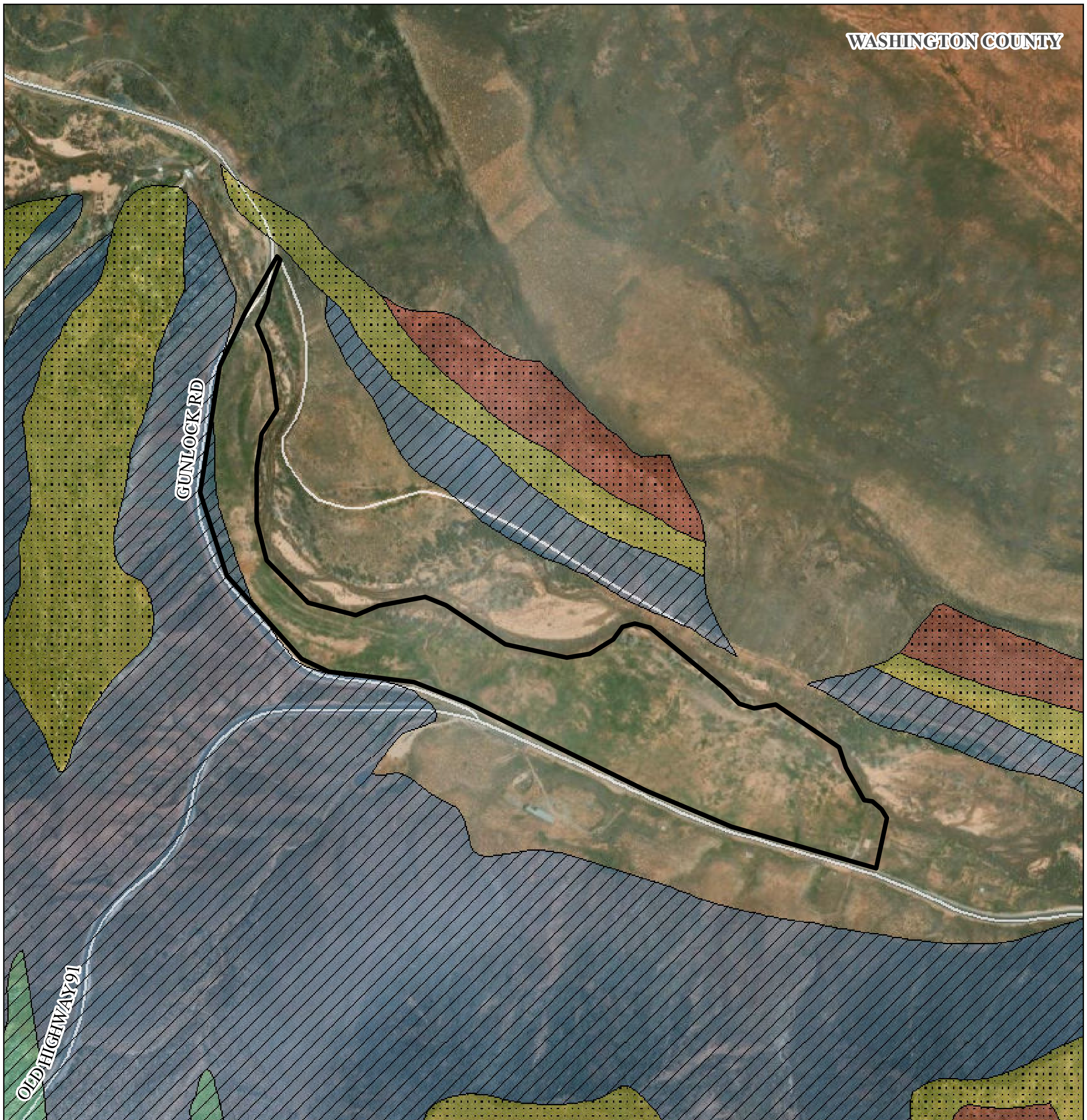
Notes

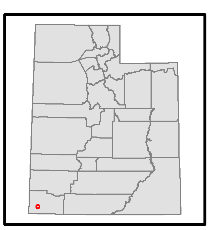
752.3 0 376.17 752.3 Feet

WGS_1984_Web_Mercator_Auxiliary_Sphere

DISCLAIMER: The information shown on this map was compiled from different GIS sources. The land base and facility information on this map is for display purposes only and should not be relied upon without independent verification as to its accuracy. Washington County, Utah will not be held responsible for any claims, losses or damages resulting from the use of this map.

4/23/2024 Document Path: G:\Projects\AlphaD38_05_Santa_Clara_Watershed_EA\Map_Files\MXD\Vegetation_MXD\Santa_Clara_EA_Sensitive_Plants_Shivwits.mxd





Sensitive Plants
Shivwits

Alpha Engineering
Santa Clara Watershed EA

Legend

- Shivwits Project Area
- Chinle Formation
- Moenkopi Formation
- Petrified Forest Member of Chinle Formation
- Shinarump Conglomerate Member of Chinle Formation
- Shnabkaib Member of Moenkopi Formation
- Upper red member of Moenkopi Formation

N S W E

0 1,000
Feet
1:12,000

Date: 4/23/2024
Projection: NAD_1983_UTM_Zone_12N

Eocene Environmental Group

Appendix C

Supporting Figures and Photographs

Photograph C-1. Flooding in Dammeron Valley, Utah.

Photograph C-2. Flooding in Dammeron Valley, Utah.

Photograph C-3. Flooding in Dammeron Valley, Utah.

Photograph C-4. Flooding in Dammeron Valley, Utah.

Photograph C-5. Flooding in Dammeron Valley, Utah.

Photograph C-6. Damaged historic irrigation ditch near Santa Clara River.

Photograph C-7. Second damaged historic irrigation ditch near Santa Clara River.

Photograph C-8. Erosion along the Santa Clara River at the Shivwits site.

Photograph C-9. Gully erosion at the Shivwits site.

Photograph C-10. Santa Clara River flooding near the Shivwits portion of the project area.

Photograph C-11. Santa Clara River flooding north of the Shivwits portion of the project area.

Photograph C-12. Site of proposed new basin site in Dammeron Valley.

Photograph C-13. Site of proposed new basin in Dammeron Valley.

Photograph C-14. Existing Basin in Diamond Valley that would be repaired.

Photograph C-15. Existing Basin in Diamond Valley that would be repaired.

Photograph C-16. Existing Basin in Diamond Valley that would be repaired.

Photograph C-17. Damaged drainage channel in Diamond Valley.

Photograph C-18. Floodplain/historic agriculture site near Santa Clara River.

Photograph C-19. Proposed pipeline would be attached to this bridge over Santa Clara River.

Photograph C-20. Shivwits area floodplain/historic agriculture field. Photograph taken from west side buffer area. Santa Clara River riparian area is to the east.

Photograph C-21. Buffer area on west side of Shivwits site. Santa Clara River riparian area is to the east.

Appendix D

Investigation and Analysis Report

LIST OF TABLES

D.1 Introduction

The planning studies presented in this Investigation and Analysis Report (I&A Report) are based on standard methods, procedures, and computer programs used and approved for use by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). The following information provides a summary of the investigation and analysis for the key planning studies in the preparation of the Plan-EA for the proposed Santa Clara Watershed Project. Additional information relevant to each of the sections provided in this report is available upon request as part of the Administrative Record for the project. Requests for additional information can be submitted to the following address:

USDA-NRCS

Wallace F. Bennett Federal Building

125 South State Street, Room 4010

Salt Lake City, Utah 84138-1100

Washington County is proposing to repair or install a series of new detention basins in Dammeron Valley and Diamond Valley in Washington County, Utah and to provide armoring along the Santa Clara River on Shivwits land near Ivins, Utah. The basins and armoring will provide flood protection to the local communities and Shivwits Tribe farming area.

The project includes the construction of three detention basins on dry washes to the east of Dammeron Valley; the rerouting of existing flows to an adjacent-routed channel on the south end of Dammeron Valley; the re-establishment of three existing detention basins in Diamond Valley; the armoring and protection along an existing channel in Diamond Valley; armoring portions of the south bank of the Santa Clara River just west of the Shivwits tribal community near the Shem dam; repair of two stormwater drainage ditches; and the installation of an irrigation pipeline. The detention basins will include uncontrolled low-level outlets, and the dams will be earthen structures with principal spillways. The purpose of the basins is to detain peak flows during large storm events protecting downstream infrastructure. Due to homes located immediately downstream, these dams are classified as High Hazard.

Note on Vertical Datum: All elevations provided in this I&A Report for current conditions are in the Utah Coordinate System of 1983, South Zone.

D.2 Sedimentation

The proposed locations of the sediment basins are subject to flash floods and debris flows. Initial estimates of sediment accumulation have been developed for preliminary design of the project. Sedimentation was estimated using historical data conveyed by the Diamond Valley Water Manager and the following three methods:

- 1968 Pacific Southwest Inter-Agency Committee Sediment Yield Classification Procedure

- 1973 USDA Soil Conservation Service Sediment Yield Rate Map
- 1982 Strand and Pemberton method developed for the semiarid climate of the southwestern United States

To our knowledge, written records providing indication for sediment accumulation at the existing Diamond Valley sites are not available. Based on verbal reports from Mr. John Crazier (personal communication, 2022), who has lived in Diamond Valley for about 30 years and is the current Water Manager for the Diamond Valley Acres Water Company, we understand that sediment accumulation in the existing detention basins has not significantly reduced the basin capacities. We understand that soil materials have been borrowed from the Diamond Valley 1 and 2 sites periodically, but the primary purpose of the borrow work was to obtain materials for use at other sites. The borrow has not been considered necessary to remove accumulated sediments.

D.2.1 Sediment Yield Classification Procedure

The Pacific Southwest Inter-Agency Committee developed a sediment yield classification procedure that estimates sediment yield as a function of nine individual drainage basin characteristics. Each characteristic is given a subjective numerical rating based on observation and experience. Sediment yield per unit area of the drainage basin is estimated based on the category determined by the sum of the classification ratings.

Based on the analyses performed, the estimated average annual sediment yields within the project area will be 0.2–0.5 acre-feet/mile^2.

D.2.3 Estimated Sediment Yield Rate Map

An estimated sediment yield rate map for the State of Utah was prepared by the USDA Soil Conservation Service in 1973. This map is a general area map with cautions that it is not to be used for specific sites since large variations may occur in the delineated areas. The Dammeron Valley sites are in an area mapped as Yield Class 3 (0.5–1.0 acre-feet/mile^2 per year) and Yield Class 5 (0.1–0.2 acre-feet/mile^2 per year). The Diamond Valley sites are in an area mapped as Yield Class 3 (0.5–1.0 acre-feet/mile^2 per year) and Yield Class 4 (0.2–0.5 acre-feet/mile^2 per year).

D.2.4 Strand and Pemberton Method

An empirical method to estimate sediment yield within the semiarid western United States was developed by Stand and Pemberton in 1982. The estimated sediment yield is calculated using the following equation:

$$Q = 1.84A_d^{-0.24}$$

Where Q = annual sediment yield, acre-feet/mi^2

A_d = drainage area, square miles

This method results in estimated annual average sediment yield rates between 1.4 and 2.5 acre-feet/mile^2. The sediment yield rates calculated using this method are significantly higher than the rates estimated by the methods described above.

D.2.5 Recommended Sediment Yield

Based upon the analyses performed, we recommend that the design of the Dammeron Valley detention basins assumes the average annual sediment yield will be 0.5 acre-feet/mile^2. This value is the upper value estimated using the Sediment Yield Classification Procedure, which considered site-specific characteristics of the Dammeron Valley project drainage basins. The sediment yield rates calculated using the Strand and Pemberton method are significantly higher than the rates estimated by the other two methods described above and, in our opinion, are less credible than those estimated using site-specific data.

Actual sediment accumulation within detention basins is dependent upon the volume of sediment transported (sediment yield), the characteristics of the sediment load, the flow velocity through the detention basin, and other factors. The detention basins planned for this project will have low-level un-gated principal spillways. Gravel and sand particles will likely be retained within the basins; however, fine clay particles will likely remain in suspension and be transported through the basin spillways.

The existing alluvial materials within the proposed basin footprints are likely representative of the sediment materials which will accumulate within the basins during the life of the facilities. As described in Section 4 of this report, the existing overburden soils at the Dammeron Valley sites were predominantly granular soils. Laboratory testing performed on samples obtained from the Dammeron Valley sites had an average of 32 percent fines passing a No. 200 sieve. Since it is likely that the majority of the fines will not be deposited within the detention basins, a trap efficiency of 70 percent is recommended for the Dammeron Valley detention basins.

Based on our analyses and reported historical sediment accumulation, we recommend that an annual sediment yield of 0.25 acre-feet/mile^2 be assumed for the Diamond Valley 1 and 2 detention basins.

The Diamond Valley 3 basin has been in place for at least 30 years. From aerial photos, it appears that the area at the Diamond Valley 3 basin where sediments have accumulated is about 0.35 acre. Assuming an average sediment depth of 5 feet results in a total estimated sediment accumulation of 1.8 acre-feet.

The materials at the Diamond Valley sites had more fine-grained soils compared to the Dammeron Valley sites. Laboratory testing performed on samples obtained from the Diamond Valley sites, neglecting the existing embankment soils, had an average of 54 percent fines passing a No. 200 sieve. A trap efficiency of 50 percent is recommended for the Diamond 1 and 2 Detention Basins.

The Diamond 3 Detention Basin will function as a diversion structure, and outflows from the basin will be approximately equal to inflows during design storm events. The Diamond 3 Detention Basin will be designed assuming that 25 percent of the sediment load will be trapped in the basin, 25 percent will be trapped in the Diamond 2 Detention Basin, and 50 percent will be transported through the basins without being trapped.

Based on the analyses described above, design of the detention basins assumes the following sediment accumulation rates.

Table D-1. Design Sediment Accumulation

Site	Approx. Drainage Basin Area ($mile^2$)	Estimated Average Annual Sediment Accumulation (acre-feet)	Estimated 50-year Sediment Accumulation (acre-feet)
Dammeron 1	0.28	0.11	5.5
Dammeron 2	3.6	1.4	70
Dammeron 3	0.73	0.27	14
Diamond 1	0.90	0.11	5.5
Diamond 2	0.93	0.15	7.5*
Diamond 3	0.60	0.04	2.0

*Includes 2 acre-feet from the Diamond 3 drainage area.

D.3 Flooding and Risk Analysis

Hydrologic and hydraulic analyses have been performed for the Dammeron Valley and Diamond Valley detention basins (**Attachments 7** and **8**). While the following summarizes the inundation due to breaching of each dam, the overall benefit of constructing each of the structures is summarized in Tables D-9 through D-13. Where in existing conditions the residents within the project are currently experiencing occasional, sometimes severe flooding and the existing irrigation system is not meeting user needs, these tables show the reduction in flows from the peak inflow to the peak outflow that residents would previously have been concerned about are now being contained within the reservoirs and routed through and around their homes.

Inundation maps have been prepared based on these analyses (**Attachment 9**). For Dammeron Valley, the inundation areas during a breach of each dam are summarized below, extending down through the community, agricultural land, and a state highway before ultimately draining through natural and improved drainage corridors into the Santa Clara River approximately 11 miles downstream. The areas shown below are the inundation boundaries upstream of the state highway, which are the areas with any form of development or improvements.

- Dammeron 1: 154 ac
- Dammeron 2: 156 ac
- Dammeron 3: 157 ac

For Diamond Valley, the inundation areas during a breach of each dam are summarized below, extending through the community and into a primary drainage corridor through the community before ultimately draining through natural and improved drainage corridors into the Santa Clara River approximately 4 miles downstream. The areas shown below are the inundation boundaries upstream of the state highway and down approximately 1,000 feet from what is currently the furthest south development.

- Diamond 1: 203 ac
- Diamond 2: 247 ac
- Diamond 3: 214 ac

The hazard classification of all the detention basin dams is “high.” The total population at risk is estimated to be 260 for Dammeron Valley and 488 for Diamond Valley, which is the maximum loss of life in the event of a dam failure.

D.4 Geology

D.4.1 Regional Geology

The project area is located near the southwestern corner of Utah and is within the transition zone between the Basin and Range Physiographic Province to the west and the Colorado Plateau Province to the east. The Basin and Range province is typified by a series of northerly trending uplifted mountain ranges and down dropped valleys (horsts and grabens) created by normal faulting resulting from extensional forces. The Colorado Plateau to the east is an area of much greater stability with significantly less seismic activity.

The transitional zone is an area of relatively complex geology with bedrock varying in age from the Proterozoic (greater than 542 million years ago [mya]), as seen in the Beaver Dam Mountains to the west, to younger Quaternary age (less than 0.5 mya) basalt flows. Most of the colorful red-rock scenery is found in the Triassic and Jurassic age sedimentary deposits. The region owes the majority of its present-day structure to geological events younger than ~100 mya (later Cretaceous).

The region went through a period of compressional activity that pushed and compressed western Utah toward eastern Utah, generating folds and overthrust faulting. Periods of compressional activity occurred during the Sevier Orogeny (~100 mya) and Laramide Orogeny (70 mya). During the Tertiary period (Oligocene–early Miocene), a large igneous intrusion pushed up into the southwestern Utah overlying bedrock as a large, shallow, mushroom-shaped intrusion (20.5 mya). This created an uplifted dome where the overlying fractured rock more readily eroded away, leaving behind the Pine Valley Mountains. The Pine Valley laccolith is the largest laccolith in America (Cook 1957, 1960b; Biek et al., 2007). During this time, compressional forces began to be replaced by extensional forces resulting in volcanism and Basin and Range faulting.

The transition zone is broken up by numerous northerly trending faults. This zone of faults makes up the southern end of the Intermountain Seismic Belt (ISB), which trends from western Montana into northern Arizona (Smith and Arabasz 1991). This relatively narrow belt generates a significant amount of seismic activity with numerous active and potentially active faults. The ISB within southwestern Utah is generally considered to be constrained on the east side by the Hurricane fault zone and on the west side by the Gunlock and Grand Wash fault zone. The Gunlock Fault, Washington Fault, and Hurricane Fault are located about 5.5 miles west, 14 miles southeast, and 20 miles east of the project area, respectively.

Dammeron and Diamond Valleys are located southwest of the Pine Valley mountains and east of the Gunlock Fault. Several basalt flows and cinder cones are present within the vicinity of the project area. Volcanism in the region is inactive; however, seismic activity continues. Since 1962, Basin and Range extensional faulting has generated 5 earthquakes with magnitudes of at least 5 within 50 miles of the project area.[1] The second largest earthquake recorded in Utah since 1850, which occurred in Pine Valley in November 1902, had an estimated magnitude of 6.3. The Pine Valley earthquake epicenter was about 8.5 miles northeast of Dammeron Valley.

D.4.2 Dammeron Valley

The topography in the Dammeron Valley area generally slopes towards the southwest. The topography at the proposed dam alignments slopes down towards the drainage channels at a rate of between about 5 and 20 percent. The drainage channel grades within the proposed detention basis are generally less than about 5 percent.

The surficial geology for the proposed Dammeron Valley detention basins, as mapped by R. F. Biek et. Al.,[2] is shown on the geologic maps included in **Attachment 1**. The western portion of the Dammeron 1 detention basin and dam is located in an area mapped as Quaternary alluvial and eolian deposits (Qae), consisting of gravel, sand, and silt deposited in small channels and alluvial flats, with some windblown deposits. The Cretaceous age Cedar Mountain Formation (Kcm) is

[1] *Utah Earthquakes (1850–2016) and Quaternary Faults*; Bowman, S.D. and Arabasz, W.J.; Utah Geological Survey Map 277, 2017.

[2] *Geologic Map of the St. George and East Part of the Clover Mountains 30'x60' Quadrangles, Washington and Iron Counties, Utah*; Biek, R. F. et al.; 2009.

mapped near the right abutment of the dam alignment. Cedar Mountain Formation bedrock may underlie the alluvium on the western side of the planned detention basin.

The southeastern portion of the Dammeron 1 detention basin and the majority of the dam is within an area mapped as Quaternary age Dammeron[3] Valley East lava flow and cinder cone (Qbde). The thickness of the lava flow is generally 10 to 20 feet thick. The lava flow deposits were encountered in test holes performed for the detention basin and are shown on the logs as basalt deposits.

As shown in **Attachment 1**, Dammeron 2 Detention Basin is in an area mapped as Quaternary age Dammeron Valley and Saddle Mountain lava flows and cinder cones (Qbde and Qbsm). As stated above, the Dammeron Valley lava flow deposit is typically 10 to 20 feet thick. The Saddle Mountain deposit is typically 20 to 40 feet thick.

The northern end of the proposed Dammeron 3 detention basin and dam is in an area mapped as Dammeron Valley lava flow and cinder cone deposits. The central portion of the dam and basin is in an area mapped as Quaternary alluvium and colluvium (Qac). Fingers of the Jurassic Age Co-op Creek Limestone Member of the Carmel Formation (Jcc) are mapped near the south end of the proposed alignment. The Jcc formation consists of limestone and may also contain calcareous shale, platy limestone, fine-grained sandstone, and some gypsiferous mudstone and siltstone.

D.4.3 Diamond Valley

The existing Diamond 1 and 2 detention basins are retained by dams with maximum heights of about 10 and 15 feet, respectively. It appears that about 10 feet of native soil materials have been excavated from within the Diamond 1 basin to increase the storage capacity. It is our understanding that the existing Diamond 3 site also functions as a small detention basin. It appears that the Diamond 3 basin was constructed by creating a small berm using materials excavated from within the basin.

The planned Diamond 3 dam will direct flows towards the Diamond 2 detention basin. Outflows from the Diamond 2 detention basin currently flow within a man-made channel in a westerly direction to the Diamond 1 detention basin. It is our understanding that the existing Diamond 1 basin does not currently have an outflow channel.

The Diamond Valley community is built predominately on alluvial valley fill deposits. Along the north and east sides of the study area are hills of Jurassic to Cretaceous age bedrock which appears to dip down gently toward the northeast at about 3 degrees.

As shown in **Attachment 1**, the existing Diamond 1 Detention Basin is in an area mapped as Quaternary alluvial and eolian deposits (Qae), consisting of gravel, sand, and silt deposited in small channels and alluvial flats. The east side of the basin is near the mapped boundary of the

[3] Spelling of the lava flow as shown on the geologic map.

Jurassic age Sinawava Member of the Temple Cap Sandstone (Jts) formation, which contains mudstone, siltstone, and silty sandstone materials.

Diamond 2 Detention Basin is within an old faulted wash. The majority of the existing dam footprint and basin are in an area mapped as Holocene to upper Pleistocene age alluvial and colluvial deposits (Qac), described as clay to boulder-sized sediment. The material underlying the upper portion of the existing dam abutments and upper portion of the basin is mapped as Co-op Creek Limestone (Jcc). The fault line which trends northeast/southwest through the center of the dam and basin is the Wide Canyon Fault. This fault is listed on the Utah Quaternary Fault and Fold Database, but it is not listed on the U.S. Geological Survey (USGS) Quaternary Fault and Fold Database. The fault is believed to be more than 750,000 years old and is not considered to be active.

The proposed Diamond 3 Detention Basin is in an area mapped similarly to the Diamond 2 site, with Co-op Creek Limestone mapped near both abutments and alluvial and colluvial deposits mapped in the center of the dam and basin.

The Utah Geologic Survey published a series of Geologic Hazard maps for the St. George–Hurricane Metropolitan Area in 2008. Most of the project area is beyond the northern limit of the 2008 study area; however, Diamond 3 Detention Basin is within the study area. The hazard map shows the area as having a high risk for flooding associated with flash floods and debris flows, and reducing this risk is the primary purpose of the proposed project. Rockfall hazard, with rock debris usually less than 1.5 feet in size, is shown as moderate due to the existing relatively steep slopes in the Diamond 3 basin area. Soils in this area are classified by the NRCS as having a low susceptibility for expansive volumetric changes. The bedrock units are classified as having a moderate shrink/swell susceptibility, with collapse potential which can be greater than 3 percent. While the soils in this area are not mapped as having a significant amount of gypsum, the bedrock unit surrounding the area does contain some medium-thin beds and veins of gypsum which could also be found in the alluvial material.

The area is mapped as being surrounded by hard bedrock on the geologic hazard maps, while the bottom of the basin is mapped as having buried bedrock likely more than 10 feet deep. The map identifies the alluvial deposits (Qac) as being susceptible to hazards associated with piping and erosion of the soil.

D.4.4 Geologic Hazards

The Dammeron Valley and Diamond Valley areas are subject to flash flooding and debris flows, and reducing the risk of these hazards is the primary purpose of the Santa Clara Watershed project. In addition to flooding and debris flow, the potential geologic hazards which appear to pose the greatest risk to the proposed detention basins are surface and internal erosion. Based on the results of geotechnical investigations performed during this study, the risk of inadequate debris basin performance due to soil or rock volumetric changes (shrinkage, collapse, or swell) and dissolution of soluble minerals (gypsum) appears to be low.

A probabilistic seismic hazard analysis was performed using the USGS Dynamic: Conterminous U.S. Unified Hazard Tool. The Peak Ground Acceleration in the project area for Site Class B/C boundary conditions is 0.30 gram for an earthquake event having a return period of 5,000 years.

The potential for liquefaction to result in significant strength loss beneath the detention basin dams is low since 1) it is unlikely that the foundation soils will be saturated during an earthquake event and 2) Standard Penetration Test (SPT) testing indicated that native soil deposits are generally in a state dense enough to prevent strength loss by liquefaction.

D.5 Subsurface Soil and Water

D.5.1 Field and Laboratory Testing Procedures

Subsurface investigations for the project were performed at the locations shown in **Attachment 2**. Test hole logs and sample photos are included in **Attachment 3**. The test hole numbers shown on the site plan and logs have the prefixes DA1, DA2, and DA3 (Dammeron Valley 1, 2, and 3) and DI1, DI2, and DI3 (Diamond Valley 1, 2, and 3) to indicate the basin where the hole was performed. The test holes were numbered in accordance with NRCS standards, with test holes XXX-1 through 99 performed along the proposed dam alignment and test holes XXX-101 through 199 performed within the proposed detention basins to investigate potential borrow areas.

Investigations performed for this study assumed that earth fill materials would be obtained from within the proposed detention basins or from previously developed commercial sources. We envision that the majority of the materials to be used for construction of detention dams will be obtained from within the basins, and processed filter and drain materials will be obtained from commercial sources. Riprap may be obtained from a combination of available materials within the basins or commercial sources.

The borings were drilled using a CME 55 rotary drill rig. A tri-cone rock bit, and HW or NW casing, with water as the drilling fluid, were used to advance the borings through overburden materials. Drilling and sampling were performed using NWJ drilling rods.

Disturbed samples were obtained within overburden materials by driving a 2- or 2.5-inch outside diameter split spoon sampling tube through a distance of 18 inches using a 140-pound weight dropped from a distance of 30 inches. The sampler size is indicated on the boring logs. Based on energy evaluations conducted approximately annually in general accordance with ASTM D4633, the automatic trip hammer used for sampling with the CME-55 drill rig delivers an average energy greater than 80 percent of the theoretical maximum energy.

The number of hammer blows required to drive the sampling spoon through each 6 inches of penetration is shown on the boring logs. The sum of the last two blow counts, which represents the number of blows recorded while driving the sampling spoon through 12 inches, is defined as the penetration value, *N*.

Penetration values corrected for sampler size, overburden, and hammer energy provide a good indication of the in-place density of sandy soils; however, they only provide an indication of the relative stiffness of cohesive material, since the penetration resistance of materials of this type is a function of moisture content. Considerable care must be exercised when interpreting the penetration value in gravelly type soils, particularly where the size of the granular particles exceeds the inside diameter of the sampling spoon. The penetration value generally provides a good indication of the in-place density of gravelly-type material if the spoon can be driven through the full 18 inches with reasonable sample recovery.

Corrections applied to the blow counts to determine the corrected standard penetration, $(N_1)_{60}$ values, shown on the boring logs were as follows:

- Sampler size correction for 2.5-inch OD sampler (where applicable): multiply by 0.938
- Hammer energy correction from 80 percent hammer energy ratio to 60 percent standard energy ratio: multiply by 1.33
- Overburden correction: multiply by $C_N = (P_a / \sigma'_v)^{0.5} \leq 1.7$

  where: P_a = atmospheric pressure, approximated as 2000 per square foot (psf),

  σ'_v = effective vertical stress, calculated using assumed average total soil unit weights of 120 pcf, and hydrostatic pore pressure calculated from the measured or estimated groundwater level.

The SPT corrections listed above are basic corrections based on generalized interpretations and assumptions. Different and/or additional corrections may be appropriate for specific design applications.

Relatively undisturbed samples were obtained at select locations by pushing a thin-walled sampling tube into the subsurface material using the hydraulic pressure on the drill rig. The locations at which the undisturbed samples were obtained are shown on the boring logs.

Miniature vane shear and pocket penetrometer tests were performed on some of the cohesive samples retrieved from the borings. Miniature vane shear tests, which provide an indication of undrained shear strength, were generally performed on samples with strengths less than about 1,000 psf. Pocket penetrometer tests, which provide an indication of the unconfined compressive strength, were performed on some of the stiffer samples obtained.

Each sample obtained in the field was classified according to the Unified Soil Classification System. The symbol designating soil type according to this system is presented on the boring logs. A description of the Unified Soil Classification System is included in **Attachment 4**, and the meanings of the various symbols shown on the logs can be obtained from this figure.

Bedrock materials encountered within the borings were continuously cored using an NQ wireline system. The percentage of the core run recovered and the Rock Quality Designation (RQD) values measured during the subsurface investigations are shown on the boring logs. The RQD is the percentage of intact core pieces at least 4 inches in length recovered from a single core run. A correlation of rock quality with RQD values is provided in Attachment 3.

Constant head open-hole permeability testing was performed within subsurface materials during the investigations. The tests were performed by drilling ahead of the casing, filling the casing with water, and recording the rate at which water was added to maintain the water level at the top of the casing. Permeability values were calculated using the methods described in *Design of Small Dams* (USBR 1987).

Test pits were excavated using a John Deere 160 excavator operated by Probitas Inc. The test pits were excavated to depths between 10 and 15 feet below the existing ground surface except where excavation was impractical due to the presence of bedrock or dense gravelly materials.

Laboratory testing was performed in accordance with ASTM International standards, except that tests to determine water soluble solids were performed in accordance with a Bureau of Reclamation standard since ASTM does not have a comparable test method. Tests performed during the investigations include:

- Moisture Content (ASTM D2216)
- Sieve Analysis (ASTM C117, C136)
- Atterberg Limits (ASTM D4318)
- Unconfined Compression (ASTM D7012)
- Dispersive Clay (Pinhole, ASTM D4647)
- Consolidation (ASTM D2435)
- Direct Shear (ASTM D3080)
- Moisture Density Relationship (Proctor, ASTM D698)
- Permeability (ASTM D5084)
- Water Soluble Solids (USBR 5450)

The results of the laboratory testing are included in **Attachment 4**.

D.5.2 Subsurface Conditions

As shown on the test hole logs, cobbles and boulders were encountered in many of the test holes. The test results discussed below do not generally include the cobble and boulder size fractions of the materials. Estimates of the sizes and fractions of the cobbles and boulders are shown on test pit logs.

D.5.2.1 Dammeron 1 Detention Basin

The Dammeron 1 Detention Basin dam alignment was investigated by drilling Boring DA1-1 near the bottom of the drainage channel to a depth of 30 feet below the existing ground surface, excavating Test Pit DA1-2 within the left abutment area, and excavating Test Pit DA1-3 within the right abutment area. Test Pits DA1-101 through -103 were excavated within the proposed basin to investigate potential borrow materials.

Basalt rock was encountered about 6 and 3 feet below the ground surface in DA1-1 and DA1-2, respectfully. Bedrock was not encountered within the other test holes performed at this site.

Recovery, which was between 19 and 100 percent, and RQD values, which were between 0 and 57 percent, measured from the basalt core obtained from Boring DA1-1 indicate the rock quality is very poor to fair and is highly fractured and/or fissured. The hydraulic conductivity values calculated from the permeability tests were between 210 and 3,300 feet/year. Basalt deposits are generally highly fractured and fissured due to the volcanic deposition and cooling process. In our experience, the hydraulic conductivity values are relatively low to moderate compared to other basalt deposits. It appears likely that many of the fractures/fissures at this site are infilled with soil or other mineral deposits. Laboratory testing performed on samples of the basalt are summarized below.

Table D-2. DA1 Site Basalt Rock Properties

Soil Property	No. of Tests	Range	Average
Dry Unit Weight (pcf)	2	136.3–139.1	137.7
Moisture Content (%)	2	0.4–0.5	0.5
Unconfined Compressive Strength (psi)	2	4,840–8.730	6,785
In-Situ Hydraulic Conductivity (feet/year)	5	210–3,300	1,400

The overburden soils encountered in the test holes at this site were predominantly mixtures of sands and gravels with low to medium plastic fines; however, deposits of fat clay (CH) several feet thick were encountered in Test Pits DA1-101 and 102. Laboratory testing performed on samples of overburden are summarized below.

Table D-3. DA1 Site Overburden Material Properties

Soil Property	No. of Tests	Range	Average
Fat Clay Samples			
Moisture Content (%)	2	15.0–19.5	17.3
Liquid Limit (%)	2	53–55	54
Plasticity Index (%)	2	27–34	31
Gravel Content (%)	2	1–2	2
Sand Content (%)	2	7–22	15
Silt/Clay Content (%)	2	77–91	84
Dispersive Clay	2	Non-Dispersive (ND-1 & ND-2)	N/A
Sand and Gravel Samples			
Moisture Content (%)	5	2.6–14.4	8.2
Liquid Limit (%)	4 1	24–62 Non-plastic	38 N/A
Plasticity Index (%)	4	4–37	15
Gravel Content (%)	5	6–41	23
Sand Content (%)	5	37–60	52

Soil Property	No. of Tests	Range	Average
Silt/Clay Content (%)	5	16–40	25
Water Soluble Solids (%)	3	0.27–1.15	0.57
Dispersive Clay	2	Non-Dispersive (ND-1)	N/A
In-Situ Hydraulic Conductivity (feet/year)	2	32–650	340
Laboratory Hydraulic Conductivity—Remolded and Compacted Sample (cm/sec)	2	2.62×10^{-8} – 1.09×10^{-5}	5.5×10^{-6}
Moisture Density Relationship—Standard Maximum Laboratory Density (pcf)	2	102.3–106.6	104.5
Optimum Moisture Content		16.3–20.8	18.6
Direct Shear Friction Angle—Remolded and Compacted Sample Cohesion	2	24.5–28.0 4.5–7.2	26.3 5.9

D.5.2.2 Dammeron 2 Detention Basin

The Dammeron 2 Detention Basin dam alignment was investigated by drilling Boring DA2-1 near the bottom of the drainage channel to a depth of 30 feet below the existing ground surface, excavating Test Pit DA2-2 within the left abutment area, and excavating Test Pit DA2-3 within the right abutment area. Test Pits DA2-101 through -106 were excavated within the proposed basin to investigate potential borrow materials.

The overburden soils encountered in the test holes along the dam alignment were predominantly mixtures of sands and gravels with non-plastic fines. Laboratory testing performed on samples of overburden are summarized below.

Table D-4. DA2 Site Material Properties

Soil Property	No. of Tests	Range	Average
Moisture Content (%)	3	6.1–14.4	10.0
Liquid Limit (%)	1 4	33 Non-plastic	33 N/A
Plasticity Index (%)	1	13	13
Gravel Content (%)	5	17–46	37
Sand Content (%)	5	31–53	45
Silt/Clay Content (%)	5	4–39	18
Water Soluble Solids (%)	1	0.1	0.1
Dispersive Clay	1	Non-Dispersive (ND-1)	N/A
In-Situ Hydraulic Conductivity (feet/year)	5	52–520	270
Maximum Laboratory Density (pcf)	2	84.3–100.2	92.3
Optimum Moisture Content	2	20.2–32.5	26.4
Moisture Density Relationship—Standard **Maximum Laboratory Density (pcf)**	2	81.1–100.2	90.7

Soil Property	No. of Tests	Range	Average
Optimum Moisture Content		20.2–35.1	27.7

Basalt rock was encountered 22 feet below the ground surface in DA2-1. Bedrock was not encountered within the other test holes performed along the dam alignment; however, basalt rock was encountered within 2 feet of the ground surface within all six test pits excavated within the proposed basin.

Recovery, which was between 28 and 100 percent, and RQD values, which were between 0 and 92 percent, measured from the basalt core obtained from Boring DA2-1 indicate the rock is relatively intact to highly fractured and/or fissured. A hydraulic conductivity test was performed within the zone between 20 and 27 feet below the ground surface. The hydraulic conductivity of the zone could not be determined because the flow into the formation exceeded the capacity of the pumping equipment being used (17.7 gallon/minute).

The basalt core obtained from a depth of 25 feet in Boring DA2-1 had a moisture content of 0.7 percent, dry unit weight of 170.2 pcf, and unconfined compressive strength of 14,630 psi.

D.5.2.3 Dammeron 3 Detention Basin

The Dammeron 3 Detention Basin dam alignment was investigated by drilling Boring DA3-1 near the bottom of the drainage channel to a depth of 32.5 feet below the existing ground surface and excavating Test Pits DA3-2 through -5 along the proposed detention basin dam alignment. Test Pits DA3-101 through -107 were excavated within the proposed basin to investigate potential borrow materials.

The overburden soils encountered in the test holes were predominantly mixtures of sands and gravels with low to medium plastic fines. Clay layers up to about 4 feet thick were encountered at the ground surface in several of the test pits. Laboratory testing performed on samples of overburden are summarized below.

Table D-5. DA3 Site Material Properties

Soil Property	No. of Tests	Range	Average
Moisture Content (%)	14	2.6–10.1	6.4
Liquid Limit (%)	10	20–57	33

Soil Property	No. of Tests	Range	Average
	8	Non-plastic	N/A
Plasticity Index (%)	10	4–34	15
Gravel Content (%)	18	1–60	25
Sand Content (%)	18	2–71	43
Silt/Clay Content (%)	18	5–97	32
Water Soluble Solids (%)	8	0.1–2.96	0.66
Dispersive Clay	5	Non-Dispersive (ND-1)	N/A
	1	Dispersive (D-1)	N/A
In-Situ Hydraulic Conductivity (feet/year)	6	0–850	110
Laboratory Hydraulic Conductivity—Remolded and Compacted Sample (cm/sec)	2	6.91×10^{-7} – 5.23×10^{-5}	2.65×10^{-5}
Maximum Laboratory Density (pcf)	8	96.8–128.7	110.5
Optimum Moisture Content	8	8.7–20.6	14.7
Direct Shear Friction Angle—Remolded and Compacted Sample Cohesion	2	28.0–29.7	28.9

Soil Property	No. of Tests	Range	Average
		0–1.9	1.0
Swell Potential from Consolidation Test	1	0.1%	0.1%

D.5.2.4 Diamond 1 Detention Basin

The Diamond 1 Detention Basin dam alignment was investigated by drilling Borings DI1-1 and -2 through the existing embankment. There are no known drawings from construction of the existing detention basin, and the project conceptual design includes removing and reconstructing the existing embankment. It is likely that the reconstructed embankment will be slightly upstream of the existing embankment due to property constraints.

The soil materials encountered at the site predominantly consisted of sandy and clayey soils. Laboratory testing performed on samples from this site are summarized below.

Table D-6. DI1 Site Material Properties

Soil Property	No. of Tests	Range	Average
Moisture Content (%)	7	8.4–13.8	11.2
In-Situ Dry Unit Weight (pcf)	4	101.7–124.3	111.8
Liquid Limit (%)	6 1	17–28 Non-plastic	24 N/A
Plasticity Index (%)	6	3–12	8
Gravel Content (%)	7	0–1	0
Sand Content (%)	7	17–64	42
Silt/Clay Content (%)	7	35–83	58

Soil Property	No. of Tests	Range	Average
Water Soluble Solids (%)	2	0.36–0.39	0.38
Dispersive Clay	2	Non-Dispersive (ND-2)	N/A
In-Situ Hydraulic Conductivity (feet/year)	10	5–780	230
Swell/Collapse Potential from Consolidation Test	2	<0.1%	<0.1%

D.5.2.5 Diamond 2 Detention Basin

There are no known drawings from construction of the existing Diamond 2 Detention Basin, and the project conceptual design includes removing the existing embankment and constructing a new embankment upstream of the existing. Moving the embankment is envisioned due to property constraints. The Diamond 2 Detention Basin dam alignment was investigated by drilling Boring DI2-1 through the existing embankment, drilling DI2-2 at the assumed alignment of the new embankment, and drilling DI2-101 within the detention basin.

The soil materials encountered at the site predominantly consisted of clayey materials; however, gravelly materials were encountered within Boring DI2-101. Laboratory testing performed on samples from this site are summarized below.

Table D-7. DI2 Site Material Properties

Soil Property	No. of Tests	Range	Average
Clayey Samples			
Moisture Content (%)	7	8.0–26.6	14.8
In-Situ Dry Unit Weight (pcf)	1	100.7	100.7

Soil Property	No. of Tests	Range	Average
Liquid Limit (%)	7	24–30	26
Plasticity Index (%)	7	9–15	11
Gravel Content (%)	7	0–10	5
Sand Content (%)	7	42–51	45
Silt/Clay Content (%)	7	46–56	50
Water Soluble Solids (%)	1	0.35	0.35
Dispersive Clay	2	Non-Dispersive (ND-1)	N/A
In-Situ Hydraulic Conductivity (feet/year)	6	42–6,400	1,400
Gravel Sample			
Moisture Content (%)	1	8.7	8.7
Liquid Limit (%)	1	Non-plastic	N/A
Gravel Content (%)	1	65	65
Sand Content (%)	1	25	25
Silt/Clay Content (%)	1	10	10

Soil Property	No. of Tests	Range	Average
Water Soluble Solids (%)	1	0.09	0.09

D.5.2.6 Diamond 3 Detention Basin

The proposed Diamond 3 Detention Basin dam alignment was investigated by drilling Boring DI3-1. The soil materials encountered at the site consisted predominantly of clayey materials. Laboratory testing performed on samples from this site are summarized below.

Table D-8. DI3 Site Material Properties

Soil Property	No. of Tests	Range	Average
Moisture Content (%)	2	15.1–24.0	19.6
In-Situ Dry Unit Weight (pcf)	1	98.8	98.8
Liquid Limit (%)	2	32–34	33
Plasticity Index (%)	2	18	18
Gravel Content (%)	2	0–35	18
Sand Content (%)	2	29–35	32
Silt/Clay Content (%)	2	36–65	51
Swell/Collapse Potential from Consolidation Test	1	<0.1%	<0.1%
In-Situ Hydraulic Conductivity (feet/year)	6	5–4,800	2,300

Mr. John Cazier reported that a detention basin was constructed at this site by the Bureau of Land Management (BLM) at least 30 years ago. From site observations, it appears that the detention basin was created by constructing a berm a few feet high using soils excavated from within the basin. The relatively high hydraulic conductivity values within the upper 15 feet of Boring DI3-1 may, in part, be due to the presence of recently (less than 100 years) deposited sediments. However, from site topography and observations, it is unlikely that the recent sediments are 15 feet deep.

D.5.3 Groundwater

Groundwater was not encountered within any of the test holes performed for this study, except that water was measured 28 feet below the ground surface in Boring DA1-1. The water measured in Boring DA1-1 may have been influenced by drill water used during the drilling work.

D.6 Geotechnical Analysis

D.6.1 Available Borrow Materials

Earthfill materials generally having 20 to 80 percent plastic fines are available for use as borrow from the Dammeron 1 Detention Basin site. Fat clay was encountered in the lower portion of Test Pits DA1-101 and -102. Use of the fat clay for construction of dam embankments is not recommended. About 20,000 yd^3 of earthfill generally having 20 to 80 percent passing a No. 200 sieve is available for use from the DA1 site. Processing the earthfill materials to remove cobbles and boulders will be required during construction of embankments.

Basalt rock, which was not practicable to excavate, was encountered within the test pits performed within the Dammeron 2 Detention Basin site. Assuming the basalt is at least 10 feet thick, we estimate that 85,000 yd^3 of basalt is available to borrow for use as riprap or rockfill within the DA2 detention basin site. Assuming that blasting will be required to efficiently borrow the basalt materials, we recommend that all rock needed for construction of the project be borrowed and stockpiled prior to DA2 Detention Basin foundation treatment or embankment construction. We recommend that the limits of the basalt borrow area be at least 100 feet from the planned footprint of the dam embankment. Investigations to evaluate the quantity and quality of the basalt should be performed during final design. Basalt deposits in southwestern Utah are generally suitable for use as riprap.

Earthfill materials, which are predominantly gravelly soils, are available for use as borrow from the Dammeron 3 Detention Basin site. About 200,000 yd^3 of gravelly soil is available to be borrowed from within the DA3 site. Processing the materials to remove cobbles and boulders will be required during embankment construction.

The existing embankment fill at the Diamond 1 and 2 Detention Basin sites, which is predominantly clayey and sandy soil, is suitable for re-use during construction of the embankments. Native deposits encountered within the existing foundations was also predominantly clayey and sandy, and it is likely that additional earthfill materials can be borrowed from within the basins for use as embankment fill. The results of the investigations indicate that less processing to remove oversize rocks will be required at the Diamond Valley sites compared to the Dammeron Valley sites.

D.6.2 Foundation Treatment

D.6.2.1 Dammeron Valley Sites

Basalt and other fractured rock within the dam embankment footprints should be treated to prevent internal erosion caused by soil particles migrating into open bedrock features under hydraulic gradients. The risk of internal erosion is reduced where gravelly soils are present on top of the rock materials since investigations at the Dammeron Valley sites indicate few, if any, open bedrock features are large enough to allow movement of gravel size particles. If particle movement begins to occur in areas where gravelly soils are present, the gravel will likely collect near the top of the openings. Sand will nest on the gravelly matrix, then finer particles will nest on the sand.

Conceptual design cross sections for the Dammeron Valley Detention Basins are included in **Attachment 5**. A conceptual cross section for areas where the bedrock is more than 10 feet below the existing ground surface, less than 10 feet below the existing ground surface, and an alternative section are included in the attachment.

In areas where the bedrock is at least 10 feet below the native ground surface, a keyway trench beneath the dam centerline is recommended. The keyway trench depth should be equal to the maximum height of the dam divided by 5, i.e., the trench depth is 6 feet for a dam with a maximum height of 30 feet. The keyway trench should have side slopes no steeper than 1H:1V with a base width of at least 15 feet.

In areas where the bedrock is within 10 feet of the existing ground surface, the conceptual design assumes that overburden soils will be removed beneath the center and upstream portions of the dam. For conceptual design, we have assumed that a 4-inch-thick layer of unreinforced concrete will be constructed on top of the bedrock to mitigate the potential for internal erosion into open rock features. This cross section has been assumed for the western two-thirds of the DA1 dam and southern one-half of the DA3 dam.

D.6.2.2 Diamond Valley Sites

The alternative cross section shown in **Attachment 6** has been used for conceptual design of the Diamond Valley Detention Basin dams. Hydraulic conductivity test results indicate that the native soils at the DI1 and DI2 sites are relatively impervious. A 3-foot-deep keyway has been included in the conceptual designs for these detention basin dams.

Soils classified as lean clay were encountered within the upper 14 feet at the Diamond 3 Detention Basin site. The hydraulic conductivities within the upper 15 feet were between 2,500 and 4,800 feet/year, which are significantly higher than values typically calculated for lean clay soils. The hydraulic conductivities may be an indication of recently deposited soil and/or fissures within the clay deposits. Additional foundation investigations at this site should be performed during final design. Assuming the detention basin dam will be about 15 feet high at this site, an 8-foot-deep keyway has been assumed beneath the DI3 detention basin dam for preliminary design. This recommended conceptual design keyway depth is about 50 percent of the planned dam height.

D.6.3 Embankment Design

Considering the foundation conditions and available borrow materials at these sites, earth-fill-type embankments are planned at the Dammeron and Diamond Valley sites. The conceptual design embankment cross sections have low-permeable soil cores and granular shells. The low-permeable core will likely be constructed using clayey materials having 20 to 80 percent passing a No. 200 sieve and a dry unit weight of at least 90 pcf. Shell materials will likely be granular soils having 5 to 50 percent passing a No. 200 sieve with a dry unit weight of at least 90 pcf. Many of the samples tested from the Dammeron Valley sites had 20 to 50 percent plastic fines passing a No. 200 sieve and can likely be used for either embankment zone.

Materials sampled from Test Pit DA2-2, located on the southeast side of the proposed Dammeron 2 Detention Basin dam, appeared to be of volcanic origin. The moisture-density relationship test (Proctor) performed in the laboratory on a sample obtained from a depth of 6 feet resulted in a maximum dry density of 84.3 pcf and optimum moisture of 32.5 percent. The material was classified as sand with gravel (SP). The test results indicate high water absorption potential. The embankment design will likely require use of the higher quality materials available from the project area, which will have better strength characteristics compared to lighter materials.

The conceptual design of the Dammeron Valley embankments has 3H:1V (Horizontal:Vertical) upstream and downstream slopes with a toe drain beneath the downstream embankment toe. This cross section is expected to perform satisfactorily for the proposed detention basins. For these detention basins, which will not have a normal storage, it is very unlikely that steady-state reservoir full seepage conditions will ever develop during the life of the facility.

The Diamond Valley detention embankments have been conceptually designed with 2H:1V downstream slopes and internal chimneys (**Attachment 5**, Alternative Cross Section). The steeper downstream slopes are necessary due to property boundaries at the Diamond Valley sites.

Toe drains, as shown in **Attachment 5**, have been included in the conceptual dam designs. The toe drain will improve the safety of the dams by reducing the risk of saturation within embankment and near-surface foundation materials. The toe drain installed beneath the downstream toe will connect to an outfall which daylights downstream of the dams.

Embankments have been designed with crest widths that meet NRCS and State of Utah requirements.

D.7 Water Quality

There is no permanent pool or perennial stream associated with the detention basins being installed with this project. The lower elevations of the drainage course appear to be intermittent while the higher reaches appear ephemeral. There are no potable uses or habitat uses to be associated with the water discharged through the dams. The detention basins will serve as temporary storage facilities during large storm events that will release the flows at a controlled rate to protect downstream communities. As discussed in **Section D.2**, the detention basins are situated in areas that will likely produce large sediment volumes during intense rainfalls. Water storage within the detention basins will allow sediment to settle out of the water before leaving continuing downstream, thus improving downstream water quality conditions.

For the Shivwits community, the project will include the armoring of channels that will prevent further erosion. The channel armoring will include armoring the Santa Clara Riverbank and the discharge points from two diversion channels into the river. The armoring will inhibit erosion, thus improving downstream water quality conditions.

D.8 Hydrologic Analysis

Washington County is proposing to install a series of new detention basins in Dammeron Valley and Diamond Valley in Washington County, Utah, and to provide armoring along the Santa Clara River on Shivwits land near Ivins, Utah. The basins and armoring will provide flood protection to the local communities and Shivwits Tribe farming area.

The project includes the construction of three detention basins on dry washes to the east of Dammeron Valley; the rerouting of existing flows to an adjacent routed channel on the south end of Dammeron Valley; the reestablishment of three existing detention basins in Diamond Valley; the armoring and protection along an existing channel in Diamond Valley; and armoring portions of the south bank of the Santa Clara River just west of the Shivwits Tribal community near the Shem dam. The dams will be earthen structures with principal spillways. The purpose of the basins is to detain peak flows during large storm events, protecting downstream infrastructure. Due to homes located immediately downstream, these dams are classified as High Hazard.

The capacities of the detention basins and channels are based on the 100-year storm event. The detention basins will incorporate a low-level outlet at the base elevation of the respective dams. The low-level outlet peak flows will be designed based on downstream capacities of existing drainage infrastructure and coordination with Washington County. The dam structures will further be analyzed as high-hazard dams due to their classification.

The hydrographs analyzed in the Hydrology are those required by Utah Dam Safety and NRCS and are shown in Table 3 of the *Hydrology Report Santa Clara Watershed, Washington County, May 2022, by Alpha Engineering*. These hydrographs also include project-specific hydrographs. The Utah State Engineers Office requires hydrograph analysis for probable maximum flood events and for 100-year events with saturated soil conditions. The NRCS requires hydrograph analysis for the Principal Spillway, Auxiliary Spillway, and Freeboard, which incorporate probable maximum flood precipitation values. Because the capacity of the detention basins and channels will be based on the 100-year storm event with normal soil saturation conditions, a corresponding project-specific hydrograph was also analyzed.

The tributary drainage basins for the project range in size from 0.3 square mile to 11.4 square miles. The basin characteristics for the watershed that are used in the hydrology analysis define the basin. The land use and soil data were obtained from NLCD and WSS. The basins include larger portions of Evergreen Forest, Shrub/Scrub, Grasslands/Herbaceous, and smaller portions of Developed Open Space/Low Intensity. The soil data for the site mainly classifies the basins to be Hydrologic Soil Group D with small portions of Hydrology soil Group C.

In summary, the hydrologic and hydraulic analyses performed for the project (**Attachments 7** and **8**) includes the identification of general and local design floods per State of Utah and NRCS requirements in development of the low-level outlet and primary spillway. The design floods include the 100-year storm, Spillway Evaluation Hydrographs, the Principal Spillway Hydrograph (PSH), the Auxiliary Spillway Hydrograph (ASH), and the Freeboard Hydrograph (FBH). The results are included in **Tables D-9** through **D-5** and include results for the flows attenuated through the detention basins.

Table D-9. Design Flood Information, Dammeron 1 Detention Basin

Design Flood	Peak Inflow (cfs)	Peak Storage (cfs)	Peak Water Elev. (ft)	Peak Outflow (cfs)
100-Year Storm	252	26	4691.5	5
PSH	298	33	4692.4	223
ASH-Local	475	31	4692.2	152
ASH-General	149	30	4692.0	100
FBH-Local	1,312	46	4694.4	1,199
FBH-General	406	36	4692.9	404

Table D-10. Design Flood Information, Dammeron 2/3 Detention Basin

Design Flood	Peak Inflow (cfs)	Peak Storage (cfs)	Peak Water Elev. (ft)	Peak Outflow (cfs)
100-Year Storm	1,155	390	4697.0	25
PSH	2,832	445	4698.4	2,103
ASH-Local	2,733	429	4698.0	1,263

Design Flood	Peak Inflow (cfs)	Peak Storage (cfs)	Peak Water Elev. (ft)	Peak Outflow (cfs)
ASH-General	1,815	426	4697.9	1,127
FBH-Local	7,766	525	4700.2	6,986
FBH-General	5,274	491	4699.6	5,229

Table D-11. Design Flood Information, Diamond 1 Detention Basin

Design Flood	Peak Inflow (cfs)	Peak Storage (cfs)	Peak Water Elev. (ft)	Peak Outflow (cfs)
100-Year Storm	677	61	4556.0	130
PSH	847	73	4557.9	1,224
ASH-Local	1,183	74	4558.0	1,341
ASH-General	440	72	4557.4	820
FBH-Local	3,344	86	4560.0	3,461
FBH-General	1,214	75	4558.3	1,593

Table D-12. Design Flood Information, Diamond 2 Detention Basin

Design Flood	Peak Inflow (cfs)	Peak Storage (cfs)	Peak Water Elev. (ft)	Peak Outflow (cfs)
100-Year Storm	670	27	4600.0	5

Design Flood	Peak Inflow (cfs)	Peak Storage (cfs)	Peak Water Elev. (ft)	Peak Outflow (cfs)
PSH	860	39	4601.4	614
ASH-Local	1,120	40	4601.8	859
ASH-General	434	37	4600.7	191
FBH-Local	3,275	47	4604.0	2,931
FBH-General	1,201	40	4601.9	958

Table D-13. Design Flood Information, Diamond 3 Detention Basin

Design Flood	Peak Inflow (cfs)	Peak Storage (cfs)	Peak Water Elev. (ft)	Peak Outflow (cfs)
100-Year Storm	500	14	4607.0	5
PSH	608	24	4608.4	467
ASH-Local	893	25	4608.9	741
ASH-General	306	23	4607.7	167
FBH-Local	2,446	31	4611.0	2,228
FBH-General	816	25	4608.8	678

The spillway and top-of-dam parameters were sized and selected to route the flows most efficiently through the detention basins based on these hydrologic criteria. The total required freeboard was calculated and included the determination of the maximum wave runup during different scenarios combining 50-mile-per-hour (mph) and 100-mph winds with storm events. Based on Dam Safety and TR-60 requirements, the spillway and top-of-dam parameters for each detention basin are shown **in Table D-14.**

Table D-14. Detention Basin Freeboard and Top of Dam Summary

Detention Basin	Spillway Crest Elevation (ft)	Spillway Width (ft)	Freeboard Requirement (ft)	Top-of-Dam Elevation (ft)
Dammeron 1	4691.5	90	3.0	4694.5
Dammeron 2/3	4697.0	450	3.2	4700.2
Diamond 1	4556.0	150	4.0	4560.0
Diamond 2	4600.0	130	4.0	4604.0
Diamond 3	4607.0	100	4.0	4611.0

D.9 Auxiliary Spillway Suitability and Integrity Analysis

Integrity design erosion analyses for the auxiliary spillways while passing the freeboard design hydrograph storm events were performed using the NRCS SITES computer program (version 2015.1.8). NRCS requires that the spillway be designed to not breach during passage of the freeboard storm.

Investigations performed as part of the study indicated that silty sands and clays were most prominent at the proposed detention basin locations. Based upon a review of erosion parameters for silty sands and clays included in the SITES program Help menu, a head cut index ranging between 0.05 and 0.2 with diameters ranging between 0.003 and 0.19 inch was used. The results of the SITES analyses are illustrated in **Attachment 6**, and it will be noted that the estimated erosion as a result of the freeboard storms does not result in a spillway breach. The results of the analysis indicate that NRCS auxiliary spillway integrity requirements are satisfied.

D.10 Design Criteria

NRCS TR-60, Earth Dams and Reservoirs, and Utah State Rule R655-11, Requirements for the Design, Construction, and Abandonment of Dams, will be the governing design criteria for the proposed detention basins. In cases where the requirements of the two design criteria are different, the more conservative will be used for design.

D.11 Economic Evaluation

D.11.1 Summary of Requirements and Guidelines

The NRCS National Watershed Program Manual (NWPM) was used as a reference for the economic analysis along with three other documents: the National Resource Economics Handbook, Part 611 Water Resources Handbook for Economics, USDA/NRCS, July 1998; Principles and Guidelines for Water- and Land-Related Resources Implementation Studies (P&G), December 1983; and Guidance for Conducting Analyses under the Principles, Requirements, and Guidelines for Water- and Land-Related Resources Implementation Studies and Federal Water Resource Investments (PR&G), DM 9500-013. The latter includes requirements set forth in the Council on Environmental Quality Principles and Requirements for Federal Investments in Water Resources (P&R) and Interagency Guidelines. DM 9500-013 provides guidance on completing a PR&G analysis, including steps in the planning and evaluation process, differences between project- and programmatic-level evaluations, direction on incorporating an ecosystem services framework, and techniques for economic analysis.

According to the P&G, the alternative that maximizes net economic benefits is referred to as the National Efficiency Evaluation (NEE) alternative and will be the preferred alternative. In addition to P&G requirements, PR&G requires that public benefits (monetary and non-monetary) be maximized relative to cost. Furthermore, there is not a hierarchal relationship among the economic, social, or environmental goals, regardless of whether they can be monetized. Agency policy allows for the use of social effect goals to make the case for flood control activities, even if the associated benefit-cost (B/C) ratio is less than 1:1. This is due to the difficulty in monetizing the value of life and quality of life, which is laden with subjective value judgments. Threat to human life and quality factors can therefore be used to outweigh purely economic considerations when appropriate. PR&G allows a wide range of alternatives to illustrate the range of potential tradeoffs among environmental, economic, and social goals.

The Federal Objective, as set forth in the Water Resources Development Act of 2007, specifies that Federal water resources investments shall reflect national priorities, encourage economic development, and protect the environment by (1) seeking to maximize sustainable economic development; (2) seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used; and (3) protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems.

The guiding principles in P&G and PR&G constitute the concepts that should consider when analyzing Federal investments in water resources and the P&G and PR&G General Requirements are topics that agencies must consider when analyzing Federal investments in water resources. The following Principles constitute the overarching concepts the Federal government seeks to promote through Federal investments in water resources now and into the foreseeable future.

D.11.1.1 Healthy and Resilient Ecosystems.

Federal investments in water resources should protect and restore the functions of ecosystems and mitigate any unavoidable damage to these natural systems.

D.11.1.1 Sustainable Economic Development.

Federal investments in water resources should encourage sustainable economic development.

D.11.1.1 Floodplains.

Federal investments in water resources should avoid the unwise use of floodplains and flood-prone areas and minimize adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used.

D.11.1.1 Public Safety.

Threats to people, including both loss of life and injury from natural events, should be assessed in the determination of existing and future conditions and, ultimately, in the decision-making process.

D.11.1.1 Watershed Approach.

A watershed approach to analysis and decision-making facilitates evaluation of a more complete range of potential solutions and is more likely to identify the best means to achieve multiple goals over the entire watershed.

D.11.2 Alternatives Evaluated

According to the P&G and the NWPM, "Flood Prevention" was the purpose analyzed for the Santa Clara Watershed Plan-EA. **Table D-15**, Comparison of NEE Benefits and Costs Santa Clara Watershed Project, contains a summary of the average annual project costs and benefits. The Workbook "SantaClaraFloodDamagesBenefitsData.xml," with associated sheets within the workbook, provides the detail for the complete economic analysis. The project area contained two sub-basins: Dammeron Valley and Diamond Valley. Incremental analysis was conducted considering each sub-basin and flood control structures.

Table D-15. Comparison of Annual NEE Benefits and Costs Santa Clara Watershed Project (Dollars)[1, 4]

–	Average Annual Costs[3]	Average Annual Benefits[2]	Benefit Cost Ratio	Net Benefits
Dammeron Alt 1	$358,669	$1,074,410	3.00	$715,741
Diamond Alt 1	$307,083	$1,917,963	6.25	$1,610,880
Shivwits Alt 1	$37,090	$160	0.0043	-$36,930

–	Average Annual Costs[3]	Average Annual Benefits[2]	Benefit Cost Ratio	Net Benefits
Grand Total	**$702,842**	**$2,992,533**	**4.26**	**$2,289,691**

[1]Discount rate 2.5 percent with a 51-year period of analysis. Price base 2022.

[2]Taken from **Table 8-4**.

[3]Taken from **Tables 8–5** and **8-6**.

[4]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

As described in the General Plan-EA, the main purpose of the watershed plan is to reduce the average annual flood damages within the watershed. Additional purposes considered include reducing erosion and sediment damages and protecting recreation opportunities and wildlife. While only flood damage-related benefits were quantified, other types of benefits serving the project purposes were still considered qualitatively when evaluating the costs and benefits of project alternatives.

According to PR&G, after preliminary consideration, agencies may remove from detailed study those alternatives that do not achieve the Federal Objective and Guiding Principles. In addition, alternatives that may at first appear reasonable but clearly become unreasonable because of cost, logistics, existing technology, social, or environmental reasons may also be eliminated from further analysis. These alternatives should be briefly discussed to indicate that they were considered, and the analysis should document the reason(s) why they were eliminated (e.g., they do not achieve the Federal Objective and Guiding Principles).

In general, the NEE alternative was developed in accordance with PR&G by evaluating economic, social, and environmental impacts from flood damage reduction in the rural community. Given the emphasis placed on the construction of flood control structures by the local steering committee to provide flood mitigation, the geographic extents of evaluated alternatives are limited to the area in which one or more of the proposed structural alternatives would have an estimated impact to the 500-year flood depth. The annual benefits of the project alternatives are based on the estimated reduction in average annual floodwater damages with proposed flood control measures in place compared to future conditions without mitigative action (No Action Alternative).

Alternatives considered included the No Action Alternative, nonstructural alternatives, the locally preferred alternative, and the NEE Alternative. Alternatives were compared against the No Action Alternative, which involved projecting existing resources and conditions into the future to establish a benchmark against which alternatives were evaluated. Tradeoffs between alternatives with respect to environmental, economic, and social goals were identified.

Both structural and nonstructural alternatives were evaluated for this planning study. However, nonstructural alternatives were eliminated from detailed study by the planning team due to exorbitant cost compared to the potential benefits. One structural alternative was eliminated because the monetary benefits were well below the costs. Following are summaries of eliminated alternatives, which propose to mitigate damages from the 100-year flood.

- **Alternative 2.** Relocation—The alternative to relocate the residences, improvements, structures, and other land value uses to a location outside of the floodplain has been analyzed. There are 69 residences and 0 commercial businesses in the 100-year floodplain. Costs for such relocation include the purchase of new property for the relocated items; the logistical, labor, and material costs associated with relocating and constructing new facilities; and the demolition and cleanup of the existing improvements and structures. Costs to complete this have been estimated at two times the current assessed value of the properties. Relocating the affected properties in Dammeron Valley and Diamond Valley would require costs about $145 million. Further, the demolition and cleanup of the existing properties and the development of properties elsewhere create a larger impact on the environment and communities. This alternative is economically and culturally unreasonable and does not provide any additional flood protection benefit.

- **Alternative 3.** Floodproofing—To protect areas that would be affected by flooding, individual properties could be floodproofed or floodwalls could be constructed within the floodplain boundary. The area protected by the dam includes portions of the communities of Dammeron Valley and Diamond Valley. Floodproofed structures would include 69 residences and 0 commercial businesses. Floodwalls would be required along roadways as well as developed areas throughout the floodplain. Floodproofing structures and several miles of floodwalls with dozens of penetrations would be required at a cost of over $15 million. This alternative is unreasonable because the cost is higher than the cost of the structural alternative considered for final analysis, there are no additional flood protection benefits, and the community and environmental impacts are significantly greater.

Along with the No Action Alternative, one alternative proposing construction of several flood control structures for three project areas, Dammeron Valley, Diamond Valley, and Shivwits Area, was identified and evaluated in detail. The project consists of eight separate dam structures across six debris basins and tributaries. The debris basins have individual uncontrolled low-level outlets that are designed to convey low flows that can be adequately conveyed in downstream drainage facilities. Principal spillways for each detention basin will be used to safely convey large storm events without causing damage to the dam structures. Shivwits Area includes the repair and flood proofing an irrigation canal and delivery system.

In both Dammeron and Diamond Valley, each of the flood control structures works in conjunction with each other, and the omission of any item within the alternative (i.e., omitting any one of the three detention basins in each area) would render the remaining options ineffective. As such, the alternatives for Dammeron Valley and Diamond Valley are inclusive of all items as a single alternative for each area.

- Alternative 1. Dammeron—Dammeron Valley alternative includes three new detention basins and one channel intended to route a fourth drainage area. Dam structure 1 (max dam height: 33.5 feet) for one detention basin (26 acre-feet capacity). Two detention basins, dam structures 2 and 3, each have individual dam structures (max dam height: 38 feet), but as water levels rise, the two basins combine into a single body of water with one spillway (390 acre-feet capacity). Storm events will be attenuated through the three detention basins collected upstream of the community. The limited and attenuated flows will be safely routed through the community, across the downstream highway, and into existing drainage corridors. The property where the dam would be located is privately owned and includes some BLM land.

- Alternative 1. Diamond—Diamond Valley involves four dam structures and three detention basins and the armoring of an existing channel. The detention basins exist but need dredging and rehabilitation. The spillway for Diamond 3 includes an existing bypass channel that conveys flows to Diamond 2, and the spillway for Diamond 2 includes an existing bypass channel that conveys flows to Diamond 1. Diamond 1 is currently a sump basin with no outlet. Each of the detention basins will be dredged and the existing dam structures will be rehabilitated. Due to site constraints, Diamond 1 will require two separate dam structures (max dam height: 12 feet) to reach the required capacity (61 acre-feet capacity). The low-level outlet being proposed on Diamond 1 with this project will drain a portion of the sump basin, but the lower elevations of the detention basin will continue as a sump. Flows leaving Diamond 1 will be conveyed through new pipe to a nearby existing drainage corridor that has capacity to safely receive the flows. Diamond 2 will require a single dam structure (max dam height: 19 feet) to reach the required capacity (27 acre-feet capacity). Diamond 3 will require a single dam structure (max dam height: 15 feet) to reach the required capacity (14 acre-feet capacity). The property where the dam would be located is privately owned and includes some BLM land.

- Alternative 1. Shivwits—Shivwits site includes construction of approximately 2,225 linear feet of rock rip-rap bank protection along the Santa Clara River. The armoring is to prevent stream erosion threatening the historic Shivwits school/meeting house and two Civil Conservation Corps rock-lined ditches. The armoring will also protect approximately 30 acres of cultivated fields. The plan also includes the installation of approximately 5,800 linear feet of 8-inch pipe to provide irrigation to the cultivated acres.

The preferred alternative will allow the sponsors to protect property and infrastructure while maximizing public benefits. Average annual monetary benefits of this alternative are estimated to be $3,747,048. The estimated average annual cost is $703,742, resulting in an annual net benefit of $3,043,306.

D.11.3 Environmental and Social Benefits

Environmental and social benefits were not monetized but are further explained for each alternative studied in detail in the Environmental Consequences Section of the Plan-EA.

Environmentally adverse impacts will be minimized during construction. Long-term, there would only be negligible adverse impacts anticipated from any of the evaluated alternatives. The region is arid with sparse trees along the banks of intermittently dry streams.

Socially, the threat of loss of life or property may be minimized with reduced flood depths at buildings and roads. The annual average daily traffic on county major collector and rural roads near the project area was about 900 vehicles to almost 12,000 vehicles per day (Utah Department of Transportation 2020).

Incidental recreation after construction will continue and is expected to have minimal benefits from the structural alternatives through enhancement of wildlife and scenic improvement. Waterbodies developed from the impoundments would likely attract wildlife for short periods of time, but not significantly increase hunting, fishing, and general outdoor activity in the vicinity of the dams.

The Shiviwits portion of the project is located on the Shivwits Band of Paiutes Tribal land. There are cultural, social, environmental, and economic benefits by bringing irrigation water back to the project area (personnel communication, Karma Grayman, Shivwits Band, 2023). The tribe could use the area for irrigated pasture, alfalfa hay, or native corn species and melons. Based on the lack of data for non-market crops and the high likelihood of growing alfalfa the first few years after flood control, the income from growing alfalfa was used in the economic analysis.

- **Cultural:** The Shivwits Band will be able to revive traditional agricultural practices and grow native corn species, along with melons, which they have not done for decades (Travis Duran, personal communication, 2023). This will help to restore some of their traditional ecological knowledge and they will be able to pass it down to younger generations. Without the pipeline, the fields remain dry and will not support these traditional crops. In addition, by installing rip rap at the end of the historic rock lined ditch, we will be preserving components of the historic Shivwits Indian School (42WS5621), which is eligible for the National Register of Historic Places, and it has also served as a gathering place for Shivwits Band meetings, was home to many Shivwits Band members from the 1900s to 1950s, and was the location of Funeral Cry Ceremonies for the people. The area will also be used to educate tribal school youth about traditional agriculture and the cultural importance of the school.

- **Social:** By being able to grow traditional native plants and restore the field to agricultural practices, the Shivwits Band will also restore traditional gatherings to this area such as the Bear Dance, which was practiced once a year in this area of land (Travis Duran, personal communication, 2023). In addition, with these traditional gatherings, younger generations will be able to learn about the significant historic of the Shivwits Indian School and the experiences of their ancestors. The school served as a day school for Shivwits Paiute Indians from the late 19th century to early 20th century during extremely dire times, and later served as a meetinghouse. By bringing agriculture back to the area and revitalizing it as a traditional gathering area, new traditions will be built and strengthen the Shivwits community and bring younger generations to this area.

- **<u>Environmental</u>:** Converting it to a piped irrigation system will increase irrigation efficiency (Travis Duran, personal communication, 2023).

- **<u>Economics</u>:** The Shivwits Band will be able to employ Band members on this plot of land during planting and harvesting seasons and teach them about the gathering of native corn and melons and traditions associated with them (Travis Duran, personal communication, 2023).

D.11.4 Period of Analysis

The Period of Analysis used was 51 years (including 1 year for design and construction). Floods from the 2, 5, 10, 25, 50, 100, 200, and 500-year storm events were analyzed to estimate average annual flood-related damages.

A net present value analysis was conducted to compare the costs of project alternatives. Average annual values were also estimated. All costs of installation, operation, and maintenance were based on 2022 prices. The costs associated with designing and implementing all structural measures were assumed to be implemented over a 1-year period immediately preceding operation. The alternative with a 51-year period of analysis yielded the highest net benefits using the mandated 2.5 percent discount rate for all federal water resource projects for fiscal year 23 to discount and amortize the anticipated streams of costs and benefits.

D.11.5 Economic Analysis and Documentation

A customized Excel worksheet using Federal Emergency Management Agency (FEMA) depth-damage curves and locally obtained data was used to evaluate benefits and costs of alternatives. Each project alternative, storm event, and flood damage category were included in the worksheet to estimate average annual damages. Alternative cost estimates provided by the project engineers were also included in the worksheet. Economic data and results were linked in the worksheet to create the required P&G tables for the final project report.

D.11.6 Rural Community and Agricultural Damages

The stream of monetary benefits was described in average annual equivalent terms. The average annual expected benefits were the difference between the No Action Alternative and each project Alternative. The expected average annual damages for each alternative, storm event (eight events), and damage category below were estimated with the following equation:

$$\sum_{i=1}^{8} \underline{(PFED_{i-1} + FED_i)/2} * (PPFE_{i-1} - PFE_i)$$

$PFED_{i-1}$ - *Previous Flood Event Damages*
FED_i - *Flood Event Damages*
$PPFE_{i-1}$ - *Probability of Previous Flood Event*
PFE_i - *Probability of Flood Event*

D.11.6.1 Structure, Content, and Vehicle Damages

Structure, building content, and vehicle damages for each storm event and project alternative were estimated based on structures identified from aerial imagery, property data provided by the Washington County, Utah tax assessor, and water depths obtained from hydraulic simulation of the evaluated storm events. Areas flooded and flood depths with and without project were estimated by Alpha Engineering, St. George, Utah. Building types, contents, and the typical number of vehicles and vehicle values associated with impacted buildings were estimated using interpolation of flood depth-damage curves developed by FEMA. The percent damage factor was multiplied by each building structure and vehicle dollar value to estimate flood damages. Total value of structures on impacted properties is shown below. This value does not include land values, only structure values.

Watershed Project Number and Value of Structures Summary[1]

Dammeron	Number	Value
Total Structures:	27	$18,434,275
Residences and Apts:	27	$18,434,275

Diamond	Number	Value
Total Structures:	42	$26,045,250
Residences and Apts:	42	$26,045,250

[1]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

There are no commercial businesses, public properties, or critical facilities in the impacted project area. Structure and content values were estimated as a percentage (about 75 percent structure and 60 percent content damages at 10-feet flood depth in a 1-story, no basement home) of assessed property values. Estimated floodwater depths (where damage occurs) for various storms (including the 500-year storm) for each structure were based on the results of the hydrology and hydraulics simulation modeling. Floodwater data was then used with water depth to damage functions to estimate structural and content damages based on the ground elevation of each structure. A similar analysis was conducted for vehicles located at the property within the floodplain area. Damage to vehicles was estimated to begin at 0.5 foot of flood depth. Each affected property was estimated to have a minimum of two vehicles. The vehicle value was estimated to be $7,500/vehicle.

D.11.6.2 Road Damages

Road damages for each storm event and project alternative were estimated. Road location, flood depth, and road surface area impacted by floodwater were identified. Areas flooded, flood depths, and monetary damages with and without project were estimated by Alpha Engineering, St. George, Utah. The cost of road repair or replacement was estimated. There were no road damages estimated if the flood depth was less than 0.1 foot. If flood depth was between 0.1 and 0.5 foot, flood damages were estimated to be half the road repair or replacement cost. If flood depth was greater than 0.5 foot, flood damages were estimated to be the total road repair replacement cost.

For the economic analysis, there are approximately 12 associated roadways within Dammeron Valley and 6 roadways in Diamond Valley project areas affected by storms up to and including the 500-year storm event.

D.11.6.3 Bridge & Culvert Damages

For the economic analysis, there were no identified culverts and bridges (stream crossings) affected by storms up to and including the 500-year event.

D.11.6.4 Other Damages

No additional “Other Damages” (emergency aid, clean-up, sewer, debris removal, etc.) were provided or estimated by local county officials.

D.11.6.5 Crop Damages

Crop damages from each storm event and project alternative were estimated. About 4 acres of vineyard were flooded in the Dammeron sub-basin. Areas flooded and flood depths with and without project were estimated by Alpha Engineering, St. George, Utah, and the local NRCS Field Agronomist provided crop production data. Five-year average crop yields and prices were estimated using crop budget data published by University of California-Davis and National Agricultural Statistics Service information. Acreage of damages associated with each crop type was estimated by the project GIS specialist. Crop Percent damage factors for flood inundation were obtained from NRCS, and estimated for depths of less than 1 foot, 1 to 3 feet, and greater than 3 feet.

The “Seasonal Damage Factor” represents the probability that the flood event occurs during the crop growing/harvest season, and then is multiplied by the crop damage factor. The Seasonal (crop) Damage Factor was estimated as: [0.5 times (Harvest Starts minus Plant Starts), plus 0.5 times (Harvest Ends minus Harvesting Starts)], divided by 365 Days. The Average Crop Value per acre was estimated as The Average Unit Price times Average Yield.

Damageable Value per Acre (per Flood Depth). The dollar crop damages per flood event were estimated by the sum of the Seasonal Damage Factor, the Inundation Factor, and the Average Crop Value per Acre. The flood event losses were estimated as the sum of Damage Value per Acre times Acres Flooded for each flood event.

The Shivwits Band of Paiutes tribal land could be flooded, and about 30 acres are no longer farmed because of flood damage to ditches, pipeline and sprinklers, and continued flooding, that made farming unfeasible. With flood control measures, the Shivwits Band will be able to farm the field again and employ Band members in crop production and teach tribal members about growing native corn and melons and traditions associated with them (Travis Duran, personal communication, 2023). For the economic analysis, we assumed the Shivwits field would be in alfalfa hay production. The Without Project flood damages are the complete loss of income from the hay land and were estimated as Net Income from Extension Service Crop Budgets (Utah State University). Net Returns was defined as “price” times “yield’ minus annual “crop production costs” (excluding owner unpaid labor, management, equity, and risk). Crop costs were updated to the current year using the Producer Prices Received Index. Crop prices and yields were the previous ten-year averages. The Net Returns per acre were weighted to account for a 10-year Alfalfa-Oat crop rotation. The benefit is the Net Income from hayland that is restored to crop production.

D.11.6.6 Other Agricultural Damages

There were no other pasture, range, livestock, or confined animal feeding operation damages identified within the project area affected by storms up to and including the 500-year event.

D.11.6.7 Recreation

Based on evidence found at the site and information from local residences, the dam sites and upstream and downstream waterways (on private property and BLM land) are used by some people for recreational purposes. The flood control structures are not intended to store water for recreation. Incidental recreational activities, such as hunting and hiking/walking, are expected to be minimal. Since there is no official or unofficial count of usage, estimated annual visitor-days is not available. Therefore, incidental recreation impacts were not evaluated.

D.11.6.8 Scour and Sediment Damages

Flood erosion scour and sediment deposition damages from each storm event and project alternative were estimated. Areas and quantity of scour and sediment with and without project were estimated by Alpha Engineering, St. George, Utah. Erosion-scour was defined as soil loss greater than 6 inches. Up to about 90 acres of rural and residential land were identified with significant erosion-scour in the flooded area. Damages were estimated as the cost per acre to replace lost soil on eroded areas. Sediment deposition damages were estimated to be up to about 1,000 cubic yards in the flooded area. Damages were estimated as the cost to remove sediment from deposition areas.

As reflected in the table below, current average annual floodwater damages without the project (present condition) are $3,848,341. Floodwater damages with the project (Alternative 1) dams were estimated to be $101,293.

Table D-15. Summary of Annual Expected Damages (Dollars)[1, 2]

Category	Present Condition	Alternative[1]
Structure, Contents, & Vehicles	–	–
Dammeron	$1,098,396	$32,073
Diamond	$1,963,451	$48,836
Shivwits	$0	$0
Roads & Culverts	–	–
Dammeron	$1,583	$0
Diamond	$599	$0
Shivwits	$0	$0
Other Damages	–	–
Crop-Flood	–	–
Dammeron	$359	$3

Category	Present Condition	Alternative[1]
Diamond	$0	$0
Shivwits	$4	$0
Scour	–	–
Dammeron	$5,859	$99
Diamond	$2,372	$39
Shivwits	$147	$11
Sediment	–	–
Dammeron	$422	$34
Diamond	$422	$6
Shivwits	$25	$5
Total	**$3,073,640**	**$81,107**

[1]Price base: 2022. Calculated using FY 2022 Water Resources Discount Rate (2.50 percent), annualized over 50 years, and 51-year period of analysis. Prepared March 2023.

[2]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

D.11.7 Watershed Project Costs

Project costs for flood control dams and channel work were estimated by Alpha Engineering, St. George, Utah in September 2022. Installation and operation and maintenance costs for each activity are described in detail in the cost tabs in the economic analysis Excel worksheet.

All costs were allocated to the flood prevention purpose according to the procedure in the National Resource Economics Handbook, Part 611 Water Resources Handbook for Economics, Chapter 6 Costs and Cost Allocation (NRCS 2014b). Work Plan-EA tables were constructed based on the calculated cost allocated to flood prevention. Within this purpose, the costs were shared between NRCS and the local and state entities as specified in the NWPM. In this case, cost share for flood prevention is 100 percent federal and 0 percent local. Within these guidelines, engineering is 100 percent federal and operation, maintenance, and replacement is 100 percent local. See Work Plan Table 2 in the Plan-EA for the results of the cost allocation/cost-sharing process.

All costs were amortized at the fiscal year 2023 Federal Water Resource Discount of 2.50 percent for 51 years. Average Annual Costs are computed as the sum of the amortized construction cost and the annual operation and maintenance cost. Engineers estimate that each of the structures would last 50 years, the life of the project.

All project costs were estimated by project engineers and converted to Present Values by discounting each cost to the beginning of the period of analysis using the applicable project discount rate. Installation expenditures before the project is installed were brought forward to the end of the period of installation by charging compound interest at the project discount rate from the date the costs are incurred. Finally, the project discount rate was used to convert the present values to average annual equivalent terms. All estimated values and damages were assessed within a customized template.

Table D-16. Watershed Project Annual Cost Summary (Dollars)[1, 2]

Evaluation Unit	Project Outlays		Total
	Amortization of Installation Cost	Operation, Maintenance, & Replacement	
Dammeron Valley[1]	$281,800	$76,869	$358,669
Diamond Valley[1]	$222,300	$84,783	$307,083
Shivwits Site[1]	$37,500	$490	$37,990

Grand Total	**$541,600**	**$162,142**	**$703,742**

[1]Discount rate 2.50 percent with a 51-year period of analysis. Price base 2022.

[2]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

D.11.8 Watershed Project Benefits and Costs

As reflected in the table below, current average annual benefits are $3,747,048 and the average annual costs are $703,742. The net annual benefits with and without benefits that the project would provide to downstream properties is $3,043,306.

As reflected below, both Dammeron Valley and Diamond Valley had a B/C ratio greater than 1.0. The Shivwits area had a B/C ratio of less than 1.0 at .27. All three geographic areas, under Alternative 1, produce a B/C ratio of 5.32.

Table D-17. Watershed Project Benefit-Cost Summary (Dollars)[1, 4]

Evaluation Unit	Average Annual Costs[3]	Average Annual Benefits[2]	Benefit Cost Ratio	Net Benefits
Dammeron Valley[1]	$358,669	$1,074,410	3.00	$715,741
Diamond Valley[1]	$307,083	$1,917,963	6.25	$1,610,880
Shivwits Site[1]	$37,090	$160	0.0043	-$36,930
Grand Total	**$702,842**	**$2,992,533**	**4.26**	**$2,289,691**

[1]Discount rate 2.50 percent with a 51-year period of analysis. Price base 2022.

[2]From **Tables D-24** through **D-28**.

[3]From **Table D-23**.

[4]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

D.11.9 Final Tables

All tables, for all alternatives, are displayed below. The following tables show cost-share percentages and amounts for watershed project plan implementation.

Table D-18. Alternative 1 Cost-Share Summary—Dammeron[6]

Works of Improvement	%[3]	NRCS	%[3]	Sponsors	Total
Cost-Sharable Items	–	–	–	–	–
Construction Costs	100%	$6,896,688	0%	$0	$6,896,688
Engineering Technical Assistance Costs[4]	100%	$551,735	0%	$0	$551,735
Project Admin. Costs[1]	100%	$275,868	0%	$0	$275,868
Subtotal: Cost-Share Costs	–	**$7,724,290**	–	**$0**	**$7,724,290**
Non-Cost-Sharable Items[2]	–	–	–	–	–
Construction Costs	0%	$0	100%	$6,00	$6,000
Engineering Costs	0%	$0	100%	$600	$600
Real Property Landrights[5]	0%	$0	100%	$65,000	$65,000
Mitigation	0%	$0	100%	$0	$0

Works of Improvement	%[3]	NRCS	%[3]	Sponsors	Total
Permits	0%	$0	100%	$800	$800
Project Admin. Costs[1]	0%	$0	100%	$0	$0
Subtotal: Non-Cost-Share Costs	–	**$0**	–	**$72,400**	**$72,400**
TOTAL	99%	**$7,724,290**	1%	**$72,400**	**$7,796,690**

[1]The sponsors and NRCS will each bear the costs of project administration that each incurs.

[2]If actual non-cost-sharable item expenditures vary from these figures, the responsible party will bear the change.

[3]As per NWPM Section 500.42 and Figure 500-E2, PL-566 cost share rates depend on the authorized purposes of the particular watershed plan. For flood prevention measures, PL-566 pays 100 percent of construction and engineering. Installation of compensatory mitigation is considered part of the construction of the flood control measure (per text between Figures 500-E1 and 500-E2). Real property rights acquisition is 100 percent sponsor cost for most PL-566 activities. However, acquisition of property rights for mitigation and recreation may be cost-shared (see referenced sections).

[4]Cost-sharable at 100 percent NRCS if Sponsor hires engineering for structure design. Not cost-shareable if sponsor's engineering is for elements required for real property rights (road improvements, power line modification, livestock water supply line, etc.).

[5]Construction elements required to satisfy real property rights are also 100 percent Sponsor cost.

[6]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

Table D-19. Alternative 1 Cost-Share Summary—Diamond[6]

Works of Improvement	%[3]	NRCS	%[3]	Sponsors	Total
Cost-Sharable Items	–	–	–	–	–
Construction Costs	100%	$5,473,508	0%	$0	$5,473,508
Engineering Technical Assistance Costs[4]	100%	$437,881	0%	$0	$437,881
Project Admin. Costs[1]	100%	$218,940	0%	$0	$218,940
Subtotal: Cost-Share Costs	–	**$6,130,328**	–	**$0**	**$6,130,328**
Non-Cost-Sharable Items[2]	–	–	–	–	–
Construction Costs	0%	$0	100%	$20,000	$20,000
Engineering Costs	0%	$0	100%	$2,000	$2,000
Real Property Landrights[5]	0%	$0	100%	$0	$0
Mitigation	0%	$0	100%	$0	$0
Permits	0%	$0	100%	$500	$500
Project Admin. Costs[1]	0%	$0	100%	$0	$0
Subtotal: Non-Cost-Share Costs	–	**$0**	–	**$22,500**	**$22,500**

Works of Improvement	%[3]	NRCS	%[3]	Sponsors	Total
TOTAL	100%	**$6,130,328**	1%	**$22,500**	**$6,152,828**

[1]The sponsors and NRCS will each bear the costs of project administration that each incurs.

[2]If actual non-cost-sharable item expenditures vary from these figures, the responsible party will bear the change.

[3]As per NWPM Section 500.42 and Figure 500-E2, PL-566 cost-share rates depend on the authorized purposes of the particular watershed plan. For flood prevention measures, PL-566 pays 100 percent of construction and engineering. Installation of compensatory mitigation is considered part of the construction of the flood control measure (per text between Figures 500-E1 and 500-E2). Real property rights acquisition is 100 percent sponsor cost for most PL-566 activities. However, acquisition of property rights for mitigation and recreation may be cost-shared (see referenced sections).

[4]Cost-sharable at 100 percent NRCS if Sponsor hires engineering for structure design. Not cost-shareable if sponsor's engineering is for elements required for real property rights (road improvements, power line modification, livestock water supply line, etc.).

[5]Construction elements required to satisfy real property rights are also 100 percent Sponsor cost.

[6]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

Table D-20. Alternative 1 Cost-Share Summary—Shivwits[6]

Works of Improvement	%[3]	NRCS	%[3]	Sponsors	Total
Cost-Sharable Items	–	–	–	–	–
Construction Costs	100%	$709,800	0%	$0	$709,800
Engineering Technical Assistance Costs[4]	100%	$30,000	0%	$0	$30,000

Works of Improvement	%[3]	NRCS	%[3]	Sponsors	Total
Project Admin. Costs[1]	100%	$10,000	0%	$0	$10,000
Subtotal: Cost-Share Costs	–	**$749,800**	–	**$0**	**$749,800**
Non-Cost-Sharable Items[2]	–	–	–	–	–
Construction Costs	0%	$0	100%	$262,100	$262,100
Engineering Costs	0%	$0	100%	$0	$0
Real Property Landrights[5]	0%	$0	100%	$0	$0
Mitigation	0%	$0	100%	$0	$0
Permits	0%	$0	100%	$500	$500
Project Admin. Costs[1]	0%	$0	100%	$0	$0
Subtotal: Non-Cost-Share Costs	–	**$0**	–	**$262,600**	**$262,600**
TOTAL	74%	**$749,800**	26%	**$262,600**	**$1,012,400**

[1]The sponsors and NRCS will each bear the costs of project administration that each incurs.

[2]If actual non-cost-sharable item expenditures vary from these figures, the responsible party will bear the change.

[3]As per NWPM Section 500.42 and Figure 500-E2, PL-566 cost-share rates depend on the authorized purposes of the particular watershed plan. For flood prevention measures, PL-566 pays 100 percent of construction and engineering. Installation of compensatory mitigation is

considered part of the construction of the flood control measure (per text between Figures 500-E1 and 500-E2). Real property rights acquisition is 100 percent sponsor cost for most PL-566 activities. However, acquisition of property rights for mitigation and recreation may be cost-shared (see referenced sections).

[4]Cost-sharable at 100 percent NRCS if Sponsor hires engineering for structure design. Not cost-shareable if sponsor's engineering is for elements required for real property rights (road improvements, power line modification, livestock water supply line, etc.).

[5]Construction elements required to satisfy real property rights are also 100 percent Sponsor cost.

[6]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

Table D-21. Estimated Installation Cost for Alternatives[1, 2]

Installation Cost Items	Estimated Costs		
–	PL-83-566 Funds	Other Funds	Total
Dammeron Alt 1	$7,724,290	$72,400	$7,796,690
Diamond Alt 1	$6,130,328	$22,500	$6,152,828
Shivwits Alt 1	$749,800	$262,600	$1,012,400
Total Project	$14,604,418	$357,500	$14,961,918

[1]Price base 2022.

[2]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

Table D-22. Estimated Cost Distribution for Alternatives[1, 3]

Installation Cost Items[2]	Installation Costs: PL-83-566 Funds				Installation Costs: Other Funds								Amortized Costs, FY2022 Rate	Annual OM&R	Total Annual Costs
	Construction Costs	Engineering Technical Assistance Costs	Project Admin. Costs	Total PL-83-566 Costs	Construction Costs	Engineering Costs	Real Property Land Rights	Permits	Mitigation	Project Admin. Costs	Total Other Funds	Total Project Cost			
Dammeron Alt 1	$6,896,688	$551,735	$275,868	$7,724,290	$6,000	$600	$65,000	$800	$0	$0	$72,400	$7,796,690	$281,800	$76,869	$358,669
Diamond Alt 1	$5,473,508	$437,881	$218,940	$6,130,328	$20,000	$2,000	$0	$500	$0	$0	$22,500	$6,152,828	$222,300	$84,783	$307,083
Shivwits Alt 1	$709,800	$30,000	$10,000	$749,800	$262,100	$0	$0	$500	$0	$0	$262,600	$1,012,400	$36,600	$490	$37,090
Total Project	$13,079,995	$1,019,616	$504,808	$14,604,418	$288,100	$2,600	$65,000	$1,800	$0	$0	$357,500	$14,961,918	$540,700	$162,142	**$702,842**

[1]Discount rate 2.50 percent with a 51-year period of analysis. Price base 2022.

[2]All costs towards the Project Purpose of Flood Prevention.

[3]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

Table D-23. Estimated Average Annual Costs for Alternatives[1, 2, 3]

Evaluation Unit	Project Outlays		Total
	Amortization of Installation Cost	Operation, Maintenance, & Replacement	
Dammeron Alt 1	$281,800	$76,869	$358,669
Diamond Alt 1	$222,300	$84,783	$307,083
Shiviwits Alt 1	$36,600	$490	$37,090
Grand Total	**$540,700**	**$162,142**	**$702,842**

[1]Discount rate 2.50 percent with a 51-year period of analysis. Price base 2022.

[2]From **Table D-22**.

[3]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

Table D-24. Estimated Average Annual Flood Damage Reduction Benefits Alternative 1—Dammeron[1, 2]

Dammeron Alt 1	Average Annual Damages without Project		Average Annual Damages with Project		Average Annual Benefits	
Item	Ag Related	Non-Ag Related	Ag Related	Non-Ag Related	Ag Related	Non-Ag Related
Floodwater Damage	–	–	–	–	–	–

Dammeron Alt 1	Average Annual Damages without Project		Average Annual Damages with Project		Average Annual Benefits	
Item	**Ag Related**	**Non-Ag Related**	**Ag Related**	**Non-Ag Related**	**Ag Related**	**Non-Ag Related**
Structures, Contents, Vehicles	–	$1,098,396	–	$32,073	$0	$1,066,323
Roads	–	$1,583	–	–	$0	$1,583
Crop and Pasture	$359	–	$3	–	$356	$0
Subtotal	$359	$1,099,979	$3	$32,073	$356	$1,067,906
Sediment/ Erosion Damage	–	–	–	–	–	–
Sediment Deposition	–	$422	–	$34	$0	$388
Flood Plain Scour	–	$5,859	–	$99	$0	$5,760
Road and Bridge	–	$0	–	$0	$0	$0
Urban	–	$0	–	$0	$0	$0
Subtotal	–	$6,281	–	$133	$0	$6,148

Dammeron Alt 1	Average Annual Damages without Project		Average Annual Damages with Project		Average Annual Benefits	
Item	Ag Related	Non-Ag Related	Ag Related	Non-Ag Related	Ag Related	Non-Ag Related
Indirect Damage	$0	$0	$0	$0	$0	$0
Grand Total	$359	$1,106,260	$3	$32,206	$356	$1,074,054

[1]Discount rate 2.50 percent with a 51-year period of analysis. Price base 2022.

[2]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

Table D-25. Estimated Average Annual Flood Damage Reduction Benefits Alternative 1—Diamond[1, 2]

Diamond Alt 1	Average Annual Damages without Project		Average Annual Damages with Project		Average Annual Benefits	
Item	Ag Related	Non-Ag Related	Ag Related	Non-Ag Related	Ag Related	Non-Ag Related
Floodwater Damage	–	–	–	–	–	–
Structures, Contents, Vehicles	–	$1,963,451	–	$48,836	$0	$1,914,615
Roads	–	$599	–	–	$0	$599

Diamond Alt 1	Average Annual Damages without Project		Average Annual Damages with Project		Average Annual Benefits	
Item	**Ag Related**	**Non-Ag Related**	**Ag Related**	**Non-Ag Related**	**Ag Related**	**Non-Ag Related**
Crop and Pasture	–	–	–	–	$0	$0
Subtotal	–	$1,964,050	–	$48,836	$0	$1,915,214
Sediment/ Erosion Damage	–	–	–	–	–	–
Sediment Deposition	–	$422	–	$6	$0	$416
Flood Plain Scour	–	$2,372	–	$39	$0	$2,333
Road and Bridge	–	$0	–	$0	$0	$0
Urban	–	$0	–	$0	$0	$0
Subtotal	–	$2,794	–	$45	$0	$2,750
Indirect Damage	$0	$0	$0	$0	$0	$0
Grand Total	$0	$1,966,845	$0	$48,881	$0	$1,917,963

[1]Discount rate 2.50 percent with a 51-year period of analysis. Price base 2022.

[2]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

Table D-26. Estimated Average Annual Flood Damage Reduction Benefits Alternative 1—Shivwits

Shivwits Alt 1	Average Annual Damages without Project		Average Annual Damages with Project		Average Annual Benefits	
Item	**Ag Related**	**Non-Ag Related**	**Ag Related**	**Non-Ag Related**	**Ag Related**	**Non-Ag Related**
Floodwater Damage	–	–	–	–	–	–
Structures, Contents, Vehicles	–	–	–	–	$0	$0
Roads	–	–	–	–	$0	$0
Crop and Pasture	$4	–	$0	–	$4	$0
Subtotal	$4	–	$0	–	$4	$0
Sediment/Erosion Damage	–	–	–	–	–	–
Sediment Deposition	$25	–	$5	–	$20	$0
Flood Plain Scour	$147	–	$11	–	$136	$0
Road and Bridge	–	–	–	–	$0	$0

Shivwits Alt 1	Average Annual Damages without Project		Average Annual Damages with Project		Average Annual Benefits	
Item	**Ag Related**	**Non-Ag Related**	**Ag Related**	**Non-Ag Related**	**Ag Related**	**Non-Ag Related**
Urban	–	–	–	–	$0	$0
Subtotal	$172	–	$16	–	$156	$0
Indirect Damage	$0	$0	$0	$0	$0	$0
Grand Total	$176	$0	$16	$0	$160	$0

[1]Discount rate 2.50 percent with a 51-year period of analysis. Price base 2022.

[1]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

Table D-27. Estimated Average Annual Flood Damage Reduction Benefits Alternative 1—Dammeron, Diamond and Shivwits[1, 2]

Dammeron, Diamond & Shivwits Alt 1	Average Annual Damages without Project		Average Annual Damages with Project		Average Annual Benefits	
Item	**Ag Related**	**Non-Ag Related**	**Ag Related**	**Non-Ag Related**	**Ag Related**	**Non-Ag Related**
Floodwater Damage	–	–	–	–	–	–

Dammeron, Diamond & Shivwits Alt 1	Average Annual Damages without Project		Average Annual Damages with Project		Average Annual Benefits	
Item	**Ag Related**	**Non-Ag Related**	**Ag Related**	**Non-Ag Related**	**Ag Related**	**Non-Ag Related**
Structures, Contents, Vehicles	$0	$3,061,847	$0	$80,909	$0	$2,980,938
Roads	$0	$2,182	$0	$0	$0	$2,182
Crop and Pasture	$363	$0	$3	$0	$360	$0
Subtotal	$363	$3,064,029	$3	$80,909	$360	$2,983,120
Sediment/ Erosion Damage	–	–	–	–	–	–
Sediment Deposition	$25	$844	$5	$40	$20	$804
Flood Plain Scour	$147	$8,231	$11	$138	$0	$8,093
Road and Bridge	$0	$0	$0	$0	$0	$0
Urban	$0	$0	$0	$0	$0	$0
Subtotal	$172	$9,076	$16	$178	$156	$8,897

Dammeron, Diamond & Shivwits Alt 1	Average Annual Damages without Project		Average Annual Damages with Project		Average Annual Benefits	
Item	**Ag Related**	**Non-Ag Related**	**Ag Related**	**Non-Ag Related**	**Ag Related**	**Non-Ag Related**
Indirect Damage	$0	$0	$0	$0	$0	$0
Grand Total	$535	$3,073,104	$20	$81,087	$516	$2,992,017

[1]Discount rate 2.50 percent with a 51-year period of analysis. Price base 2022.

[2]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

Table D-28. Estimated Average Annual Flood Damage Reduction Benefits Santa Clara Watershed Project[1, 2]

Item	Estimated Average Annual Damage		Damage Reduction Benefit
	Without Project (No Action Alternative)	**With Project (Preferred Alternative)**	
Floodwater Damage	–	–	–
Structures, Contents, Vehicles	$3,061,847	$80,909	$2,980,938
Roads	$2,182	$0	$2,182

Item	Estimated Average Annual Damage		Damage Reduction Benefit
	Without Project (No Action Alternative)	With Project (Preferred Alternative)	
Crop and Pasture	$363	$3	$360
Subtotal	$3,064,392	$80,912	$2,983,480
Sediment/Erosion Damage	–	–	–
Sediment Deposition	$869	$45	$824
Flood Plain Scour	$8,379	$149	$8,230
Road and Bridge	$0	$0	$0
Urban	$0	$0	$0
Subtotal	$9,248	$194	$9,053
Total	$3,073,640	$81,107	$2,992,533

[1] Price base: 2022. Calculated using FY 2022 Water Resources Discount Rate (2.50 percent), annualized over 50 years, and 51-year period of analysis. Prepared March 2023.

[2] Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

Table D-29. Comparison of Benefits and Costs[1, 4]

–	Average Annual Costs[3]	Average Annual Benefits[2]	Benefit Cost Ratio	Net Benefits
Dammeron Alt 1	$358,669	$1,074,410	3.00	$715,741
Diamond Alt 1	$307,083	$1,917,963	6.25	$1,610,880
Shivwits Alt 1	$37,090	$160	0.0043	-$36,930
Grand Total	**$702,842**	**$2,992,533**	**4.26**	**$2,289,691**

[1]Discount rate 2.50 percent with a 51-year period of analysis. Price base 2022.

[2]From **Tables D-24** through **D-28**.

[3]From **Table D-23**.

[4]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Washington County, Utah. Prepared by Hal Gordon, Economist. December 2024.

Appendix E

Supporting Information

APPENDIX E

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- Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project-Phase I: Borehole and Test Pit Locations, Washington County, Utah
- Summary Report of Cultural Resources Inspection
- UDSA NRCS's Santa Clara Watershed Plan-EA Project-Supplemental Cultural Resources Desktop Review Memo
- Agreement letter from Shivwits Band of Paiutes to be a cooperating agency

Appendix E-9a: Aquatic Resources

- Preliminary Aquatic Resource Delineation Report
    - Report
    - Appendix A, Aquatic Resources Maps

Appendix E-9b: Aquatic Resources, continued

- Preliminary Aquatic Resource Delineation Report
    - Appendix B, Field Photographs
    - OHWM and Wetland Delineation Datasheets

Appendix E-9c: Aquatic Resources, continued

- Preliminary Aquatic Resource Delineation Report
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Appendix E-10: Public Involvement

- Scoping Summary Report

Appendix E-11: BLM Environmental Documents

- Categorical Exclusion: Diamond & Dammeron Valley Soil Testing Land Use Permit

APPENDIX E-1

PRINCIPLES, REQUIREMENTS, AND GUIDELINES ANALYSIS TABLE AND REPORT

Santa Clara Watershed Project

PR&G Framework and Trade-Off Analysis Table (Dammeron Valley)

Alternatives Considered[1]			
Future Without Federal Investment (FWOFI): No Action Alternative Implementation of the No Action Alternative would not improve flood management. Losses associated with flooding would continue.			
Future With Federal Investment (FWFI) Alternative 1: Three detention basins would be constructed. Flow in one other drainage would be re-routed to an adjacent channel.			
Summary and Comparison			
Item	FWOFI (No Action Alternative)	FWFI (Action Alternative)	Comments
Locally Preferred		XX	Washington County and local stakeholders support the Action Alternative.
Nonstructural	N/A	N/A	A nonstructural alternative would not meet the purpose and need and is not considered in detail in the Plan-EA.
Environmentally Preferred		XX	The Action Alternative would provide for enhanced flood management.
Socially Preferred		XX	The Action Alternative would reduce the potential for infrastructure damage to approximately 27 residences, 4 acres of agricultural land, and 12 roadways. Scour and sediment deposition would be reduced approximately 90 acres.[2]
National Economic Efficiency		XX	The Action Alternative would minimize environmental impacts and maximize social, environmental, and economic benefits by reducing potential damages from $1,106,619 to $32,209 annually.
Guiding Principles			
Healthy and Resilient Ecosystems		XX	Action Alternative would support a healthy and resilient ecosystem through enhanced flood management measures (construction of three

			detention basins and the reroute of flood water in one drainage). Human safety and infrastructure protection would be enhanced by reducing potential flood related damages as discussed above.
Sustainable Economic Development		XX	The Action Alternative would improve economic well-being by reducing the potential for loss due to flooding by reducing potential damages from $1,106,619 to $32,209 annually.
Floodplains		XX	While not a designated floodplain, the Action Alternative would reduce the potential for damaging flood events on approximately 95 acres of residential and agricultural land.[2]
Public Safety		XX	Action Alternative would enhance public safety in the community of Dammeron Valley by reducing the potential of damaging flooding to 27 residences, 4 acres of agricultural land, and highways and roadways.
Environmental Justice		N/A	There would be no adverse impacts to subject populations.
Watershed Approach		XX	Action Alternative addresses watershed problems resulting from flooding events.

Evaluation Framework and Tradeoffs		
Item	**FWOFI (No Action)**	**FWIFI (Action Alternative)**
Provisioning Services		
Ecosystem Productivity	Ecosystem productivity would not be improved due to continued flooding potential	Detention basin construction would improve ecosystem productivity by reducing flooding potential on 95 acres of residential and agricultural land[2]
Food (agricultural yield)	No change	Improves agricultural production on 4 acres through flood management
Regulating Services		
Climate	No change	No change

Water Regulation (quantity and quality)	No change	The Action Alternative would not alter water quantity and quality.
Biological Regulation (plants and animals)	Flooding would continue to affect local ecosystems	Ecosystems would benefit from reduced flooding potential on approximately 95 acres.[2]
Cultural Services		
Peace and Sustainability (Tribal, agricultural, and rural communities)	Flooding would continue to affect local infrastructure and agriculture and potentially affect long-term sustainability on 95 acres. [2]	Reduction in flooding potential on approximately 95 acres[2] would improve local infrastructure and agriculture and improve long-term sustainability within Dammeron Valley.
Community Well-Being (Tribal, agricultural, and rural communities)	Crop yield and infrastructure would continue to be affected by flooding events.	Dammeron Valley infrastructure would be protected by detention basin development. Potential for damage to 27 residences, 4 acres of agricultural land, and highways and roadways would be reduced. Scour and sediment deposition would be reduced on approximately 95 acres[2].
Cultural/Historical Identity and Heritage	No known cultural/historical values would be affected.	No known cultural/historical values would be affected
Supporting Services		
Water Cycling	No change	Potential for severe flooding events would be reduced on approximately 95 acres[2].
Habitat and Biomass	No change	No change
Nutrient Cycling	No change	No change
Economic Analysis[1]		
Costs		
Installation Federal PL 83-566	N/A	$7,724,290
Installation Sponsor	N/A	$72,400
Annual Installation Costs	N/A	$281,800
Annual O&M Costs	N/A	$76,869
Total Annual Costs	N/A	$358,669
Annual Benefits		
Agriculture	N/A	$356
Non-Agricultural	N/A	$1,074,054
Total Annual Benefits	N/A	$1,074,410
Cost-Benefit Ratio and Net Benefits		
Cost-Benefit Ratio	N/A	3.00

Net Benefit	N/A	$715,740
Decision-Making Conclusion	This Alternative is provided for comparison purposes and is not selected as the National Economic Efficiency (NEE) Alternative. It does not meet the purpose and need of the Project nor result in benefits to ecosystem services.	Selected as the NEE Alternative. The Action Alternative provides the highest benefit to ecosystem services, has the greatest cost-benefit, and is the locally/socially/environmentally preferred alternative that meets the project goals and objectives.

[1]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Prepared by Hal Gordon, Economist. December 2024

[2]Personal communication with Todd Gardner, Alpha Engineering, December 17, 2024

PR&G Framework and Trade-Off Analysis Table (Diamond Valley)[1]

Alternatives Considered			
FWOFI: No Action Alternative Implementation of the No Action Alternative would not improve flood management. Losses associated with flooding would continue.			
FWFI: Alternative 1 Three detention basins would be repaired. Rock Hollow Wash in Diamond Valley would be repaired and armored.			
Summary and Comparison			
Item	FWOFI (No Action Alternative)	FWFI (Action Alternative)	Comments
Locally Preferred		XX	Washington County and local stakeholders support the Action Alternative.
Nonstructural	N/A	N/A	A nonstructural alternative would not meet the purpose and need and is not considered in detail in the Plan-EA.
Environmentally Preferred		XX	The Action Alternative would provide for enhanced flood management.
Socially Preferred		XX	The Action Alternative would reduce the potential for infrastructure damage and provide for additional agricultural land to 42 residences and highways and roadways. Scour and sediment deposition would be reduced on approximately 180 acres[2].

National Economic Efficiency		XX	The Action Alternative would minimize environmental impacts and maximize environmental and economic benefits by reducing potential damages from $1,966,845 to $48,881 annually.
Guiding Principles			
Healthy and Resilient Ecosystems		XX	Action Alternative would support a healthy and resilient ecosystem through enhanced flood management measures (repair of three detention basins and armoring of Rock Hollow Wash). Human safety and infrastructure protection would be enhanced by reducing potential flood related damages as discussed above.
Sustainable Economic Development		XX	The Action Alternative would improve economic well-being by reducing the potential for loss due to flooding by reducing potential damages from $1,966,845 to $48,881 annually.
Floodplains		XX	Action Alternative would reduce the potential for damaging flood events on 180 acres of residential land[2].
Public Safety		XX	Action Alternative would enhance public safety in the community of Dammeron Valley by reducing the potential of damaging flooding as described above.
Environmental Justice		N/A	There would be no adverse impacts to subject populations.
Watershed Approach		XX	Action Alternative addresses watershed problems resulting from flooding events.
Evaluation Framework and Tradeoffs			
Item	**FWOFI (No Action)**		**FWIFI (Action Alternative)**
Provisioning Services			
Ecosystem Productivity	Ecosystem productivity would not be improved due to continued flooding potential.		Detention basin repair and wash armoring would improve ecosystem productivity by reducing flooding potential on 180 acres of residential and agricultural land.[2]
Food (agricultural yield)	No change		There would be no change in agricultural production.
Regulating Services			
Climate	No Change		No change

Water Regulation (quantity and quality)	No change	The Action Alternative would not alter water quantity or quality
Biological Regulation (plants and animals)	Flooding would continue to affect local ecosystems	Ecosystems would benefit from reduced flooding potential on 180 acres.
Cultural Services		
Peace and Sustainability (Tribal, agricultural, and rural communities)	Flooding would continue to affect local infrastructure, potentially affecting long-term sustainability on 180 acres.[2]	Reduction in flooding potential would improve local infrastructure and improve long-term sustainability on 180 acres.[2]
Community Well-Being (Tribal, agricultural, and rural communities)	Infrastructure would continue to be affected by flooding events.	Diamond Valley infrastructure would be protected by detention basin development. Potential for damage to 42 residences and six roadways would be reduced. Scour and sediment deposition would be reduced on approximately 180 acres.[2]
Cultural/Historical Identity and Heritage	No known cultural/historical values would be affected.	No known cultural/historical values would be affected.
Supporting Services		
Water Cycling	No change	Potential for severe flooding events would be reduced on approximately 180 acres.[2]
Habitat and Biomass	No change	No change
Nutrient Cycling	No change	No change
Economic Analysis		
Costs		
Installation Federal PL 83-566	N/A	$6,130,328
Installation Sponsor	N/A	$22,500
Annual Installation Costs	N/A	$222,300
Annual O&M Costs	N/A	$84,783
Total Annual Costs	N/A	$307,083
Annual Benefits		
Agriculture	N/A	$0
Non-Agricultural	N/A	$1,917,963
Total Annual Benefits	N/A	$1,917,963

Cost-Benefit Ratio and Net Benefits		
Cost-Benefit Ratio	N/A	6.25
Net Benefit	N/A	$1,610,880
Decision-Making Conclusion	This Alternative is provided for comparison purposes and is not selected as the NEE Alternative. It does not meet the purpose and need of the project nor result in benefits to ecosystem services.	Selected as the NEE Alternative. The Action Alternative provides the highest benefit to ecosystem services, has the greatest cost-benefit, and is the locally/socially/environmentally preferred alternative that meets the project goals and objectives.

[1]Economic Investigation and Analysis Report, Santa Clara Watershed Plan, Proposed Floodwater Retarding Structures. Prepared by Hal Gordon, Economist. December 2024

[2]Personal communication with Todd Gardner, Alpha Engineering, December 17, 2024

PR&G Framework and Trade-Off Analysis Table (Shivwits Site)[1]

Alternatives Considered
FWOFI: No Action Alternative Implementation of the No Action Alternative would not improve flood management. Losses associated with flooding would continue.
FWFI: Alternative 1 The south bank of the Santa Clara River would be armored, two stormwater ditches would be repaired, and an 8-inch water pipeline would be installed, replacing an existing pipeline.

Summary and Comparison			
Item	FWOFI (No Action Alternative)	FWFI (Action Alternative)	Comments
Locally Preferred		XX	Washington County and local stakeholders including the Shivwits Band of Paiutes support the Action Alternative.
Nonstructural	N/A	N/A	There is not a nonstructural alternative that would meet the purpose and need and is not considered in detail in the Plan-EA.
Environmentally Preferred		XX	The Action Alternative would provide for enhanced flood management, irrigation on 30 acres, drainage system restoration, and stream bank protection on 0.53 acre.

Socially Preferred		XX	The Action Alternative would reduce the potential for infrastructure damage and provide for approximately 30 acres of additional agricultural land.
National Economic Efficiency		XX	The Action Alternative would minimize environmental impacts and maximize social, environmental, economic, and Tribal benefits.
Guiding Principles			
Healthy and Resilient Ecosystems		XX	Action Alternative measures would support a healthy and resilient ecosystem through enhanced flood management measures (repair of two stormwater drainage ditches, installation of an irrigation pipeline, and armoring of the Santa Clara River). Infrastructure protection would be enhanced by reducing potential flood-related damages discussed above.
Sustainable Economic Development		XX	The Action Alternative would improve economic well-being by making approximately 30 acres available for agricultural use.
Floodplains		XX	Action Alternative would reduce the potential for damaging flood on approximately 63 acres adjacent to the Santa Clara River.
Public Safety		XX	Stream erosion would be reduced on 0.53 mile along the Santa Clara River.
Environmental Justice		N/A	Tribal members could face disruptions to cultural practices and land-based activities in the Shivwits portion of the project area during the 7-month construction time. Environmental Justice populations would benefit from traditional agricultural and improved cultural, traditional, and social opportunities.
Watershed Approach		XX	Action Alternative addresses watershed problems resulting from flooding events
Evaluation Framework and Tradeoffs			
Item	**FWOFI (No Action)**		**FWIFI (Action Alternative)**

Provisioning Services		
Ecosystem Productivity	Ecosystem productivity would not be improved due to continued unavailability of 30 acres for traditional agricultural use.	Armoring of the Santa Clara River and irrigation water pipeline installation would improve ecosystem productivity on 30 acres of agricultural land and reduce streambank erosion.
Food (agricultural yield)	No change	Action Alternative would provide agricultural production potential on 30 acres through flood management.
Regulating Services		
Climate	No change	No change
Water Regulation (quantity and quality)	No change	The Action Alternative would not alter water quantity or quality.
Biological Regulation (plants and animals)	Flooding would continue to affect the local ecosystem.	The local ecosystem would benefit from reduced flooding potential.
Cultural Services		
Peace and Sustainability (Tribal, agricultural, and rural communities)	Approximately 30 acres of land would continue to be unavailable for agricultural and other uses.	Reduction in flooding potential and pipeline installation would improve local infrastructure and agriculture on 30 acres and improve long-term sustainability.
Community Well-Being (Tribal, agricultural, and rural communities)	Approximately 30 acres of land would continue to remain unavailable.	Infrastructure would be protected and enhanced by river armoring and pipeline installation. Approximately 30 acres would be made available for agricultural use.
Cultural/Historical Identity and Heritage	Traditional agriculture and improved cultural and traditional social opportunities along the Santa Clara River in the Shivwits area would continue to be foregone.	Floodplain management would provide traditional agriculture, improve cultural and traditional social opportunities along the Santa Clara River within the Shivwits portion of the Project Area.
Supporting Services		
Water Cycling	No change	Potential for flooding would be reduced.
Habitat and Biomass	No change	Agriculture on approximately 30 acres would increase biomass production.
Nutrient Cycling	No change	Agriculture on approximately 30 acres would increase nutrient cycling.
Economic Analysis		

Costs		
Installation Federal PL 83-566	N/A	$749,800
Installation Sponsor	N/A	$262,600
Annual Installation Costs	N/A	$36,600
Annual O&M Costs	N/A	$490
Total Annual Costs	A/A	$37,090
Annual Benefits		
Agriculture	N/A	$160
Non-Agricultural	N/A	$0
Total Annual Benefits	N/A	$160
Cost-Benefit Ratio and Net Benefits		
Cost-Benefit Ratio	N/A	0.0043
Net Benefit	N/A	-$36,930
Decision-Making Conclusion	This Alternative is provided for comparison purposes and is not selected as the NEE Alternative. It does not meet the purpose and need of the Project nor result in benefits to ecosystem services.	Selected as the NEE Alternative. The Action Alternative provides the highest benefit to ecosystem services and is the locally/socially/environmentally preferred alternative that meets the project goals and objectives.

[1]Investigation and Analysis Report, Sanat Clara Watershed Plan, Proposed Floodwater Retarding Structures. Prepared by Hal Gordon, Economist. December 2024

APPENDIX E-2

ECONOMIC ANALYSIS

Economic Investigation and Analysis Report

Santa Clara Watershed Plan

Proposed Floodwater Retarding Structures

Washington County, Utah

Prepared for:

NRCS

June 2025

Prepared by:

Hal Gordon, Economist

Table of Contents

1.0 SUMMARY OF REQUIREMENTS AND GUIDELINES

The NRCS National Watershed Program Manual (NWPM) was used as a reference for the economic analysis along with three other documents: the National Resource Economics Handbook, Part 611 Water Resources Handbook for Economics, USDA/Natural Resources Conservation Service, July 1998; Principles and Guidelines for Water and Land Related Resources Implementation Studies (P&G), December 1983; and Guidance for Conducting Analyses Under the Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies and Federal Water Resource Investments (PR&G), DM 9500-013. The latter includes requirements set forth in the Council on Environmental Quality (CEQ) Principles and Requirements for Federal Investments in Water Resources (P&R) and Interagency Guidelines (IAG). DM 9500-013 provides guidance on completing a PR&G analysis, including steps in the planning and evaluation process, differences between project- and programmatic-level evaluations, direction on incorporating an ecosystem services framework, and techniques for economic analysis. NRCS's Nine Steps of Conservation Planning were broadly followed while developing the watershed plan, as described in the National Planning Procedures Handbook (180-VI-NPPH, Amend. 4, March 2003).

According to the P&G, the alternative that maximizes net economic benefits is referred to as the National Efficiency Evaluation (NEE) alternative and will be the preferred alternative. In addition to P&G requirements, PR&G requires that public benefits (monetary and non-monetary) be maximized relative to cost. Furthermore, there is not a hierarchal relationship among the economic, social, or environmental goals regardless of whether they can be monetized. Agency policy allows for the use of social effect goals to make the case for flood control activities, even if the associated benefit-cost (B/C) ratio is less than 1:1. This is due to the difficulty in monetizing the value of life and quality of life, which is laden with subjective value judgments. Threat to human life and quality factors can therefore be used to outweigh purely economic considerations when appropriate. PR&G allows a wide range of alternatives to illustrate the range of potential tradeoffs among environmental, economic, and social goals.

The Federal Objective, as set forth in the Water Resources Development Act of 2007, specifies that Federal water resources investments shall reflect national priorities, encourage economic development, and protect the environment by: (1) seeking to maximize sustainable economic development; (2) seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used; and (3) protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems.

The guiding principles in P&G and PR&G constitute the concepts that should consider when analyzing Federal investments in water resources and the P&G and PR&G General Requirements are topics that agencies must consider when analyzing Federal investments in water resources. The following Principles constitute the overarching concepts the Federal government seeks to promote through Federal investments in water resources now and into the foreseeable future.

A. Healthy and Resilient Ecosystems. Federal investments in water resources should protect and restore the functions of ecosystems and mitigate any unavoidable damage to these natural systems.

B. Sustainable Economic Development. Federal investments in water resources should encourage sustainable economic development.

C. Floodplains. Federal investments in water resources should avoid the unwise use of floodplains and flood-prone areas and minimize adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used.

D. Public Safety. Threats to people, including both loss of life and injury from natural events, should be assessed in the determination of existing and future conditions and, ultimately, in the decision-making process.

E. Environmental Justice. Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Agencies should ensure that Federal actions identify any disproportionately high and adverse public safety, human health, or environmental burdens of projects on minority, Tribal, and low-income populations.

F. Watershed Approach. A watershed approach to analysis and decision-making facilitates evaluation of a more complete range of potential solutions and is more likely to identify the best means to achieve multiple goals over the entire watershed.

2.0 ALTERNATIVES EVALUATED

According to the P&G and the NWPM, “Flood Prevention” was the purpose analyzed for the Santa Clara Watershed Plan-EA. Table 6, Comparison of NED Benefits and Costs, contains a summary of the average annual project costs and benefits. The Excel Workbook "SantaClaraFloodDamagesBenefitsData.xml", with associated sheets within the workbook, provide the detail for the complete economic analysis. The project area contained two sub-basins: Dammeron Valley and Diamond Valley. Incremental analysis was conducted considering each sub-basin. There were no increments within each sub-basin. The first increment was Dammeron Valley, the second increment was Diamond Vally and the third increment was Shivwits area. The Dammeron Valley Alternative includes three new detention basins and one channel intended to route a fourth drainage area. The Diamond Valley Alternative includes the rehabilitation of three existing detention basins and the armoring of an existing channel. In both Dammeron and Diamond Valley, the alternatives work in conjunction with each other and the omission of any item within the alternative (i.e. omitting any one of the three detention basins in each area) would render the remaining options ineffective. As such, the alternatives for Dammeron Valley and Diamond Valley are inclusive of all items as a single alternative for each area (Jared Madsen, PE, 09/07/2022).

As described in the General Plan EA, the main purpose of the watershed plan is to reduce the average annual flood damages within the watershed. Additional purposes considered include reducing erosion and sediment damages, and protecting recreation opportunities and wildlife. While only flood-damage related benefits were quantified, other types of benefits serving the project purposes were still considered qualitatively when evaluating the costs and benefits of project alternatives.

According to PR&G, after preliminary consideration, agencies may remove from detailed study those alternatives that do not achieve the Federal Objective and Guiding Principles. In addition, alternatives that may at first appear reasonable but clearly become unreasonable because of cost, logistics, existing technology, social, or environmental reasons may also be eliminated from further analysis. These alternatives should be briefly discussed to indicate that they were considered, and the analysis should document the reason(s) why they were eliminated (e.g., they do not achieve the Federal Objective and Guiding Principles).

In general, the NEE alternative was developed in accordance with PR&G by evaluating economic, social, and environmental impacts from flood damage reduction in the rural community. Given the emphasis placed on the construction of flood control structures by the local steering committee to provide flood mitigation, the geographic extents of evaluated alternatives are limited to the area in which one or more of the proposed structural alternatives would have an estimated impact to the 500-year flood depth. The annual benefits of the project alternatives are based on the estimated reduction in average annual floodwater damages with proposed flood control measures in place compared to future conditions without mitigative action (No Action Alternative).

Alternatives considered included the No Action Alternative, nonstructural alternatives, the locally preferred alternative, and the NEE Alternative. Alternatives were compared against the No Action Alternative which involved projecting existing resources and conditions into the future to establish a benchmark against which alternatives were evaluated. Tradeoffs between alternatives with respect to environmental, economic, and social goals were identified.

Both structural and nonstructural alternatives were evaluated for this planning study. However, nonstructural alternatives were eliminated from detailed study by the planning team due to exorbitant cost compared to the potential benefits. One structural alternative was eliminated because the monetary benefits were well below the costs. Following are summaries of eliminated alternatives, which propose to mitigate damages from the 100-year flood.

- **Alternative 2.** Relocation - The alternative to relocate the residences, improvements, structures, and other land value uses to a location outside of the floodplain has been analyzed. There are 69 residences and 0 commercial businesses in the 100-year floodplain. Costs for such relocation include the purchase of new property for the relocated items; the logistical, labor, and material costs associated with relocating and constructing new facilities; and the demolition and cleanup of the existing improvements and structures. Costs to complete this have been estimated at two times the current assessed value of the properties. Relocating the affected properties in Dammeron Valley and Diamond Valley would require costs about $140 million. Further, the demolition and cleanup of the existing properties and the development of properties elsewhere create a larger impact on the environment and communities. This alternative is economically and culturally unreasonable and does not provide any additional flood protection benefit.

- **Alternative 3.** Floodproofing - To protect areas that would be affected by flooding, individual properties could be floodproofed or floodwalls could be constructed within the floodplain boundary. The area protected by the dam includes portions of the communities of Dammeron Valley and Diamond Valley. Floodproofed structures would include 69 residences and 0 commercial businesses. Floodwalls would be required along roadways as well as developed areas throughout the floodplain. Floodproofing structures and several miles of floodwalls with dozens of penetrations would be required at a cost of over $13 million. This alternative is unreasonable because the cost is higher than the cost of the structural alternative considered for final analysis, there are no additional flood protection benefits, and the community and environmental impacts are significantly greater.

Along with the No Action Alternative, one alternative proposing construction of several flood control structures, for three project areas: Dammeron Valley, Diamond Valley and Shivwits Area, were identified and evaluated in detail. The project consists of eight separate dam structures across six debris basins and tributaries. The debris basins have individual uncontrolled low-level outlets that are designed to convey low flows that can be adequately conveyed in downstream drainage facilities. Principal spillways for each detention basin will be used to safely convey large storm events without causing damage to the dam structures. Shivwits Area includes the repair and flood proofing an irrigation canal and delivery system.

In both Dammeron and Diamond Valley, each of the flood control structures work in conjunction with each other, and the omission of any item within the alternative (i.e., omitting any one of the three detention basins in each area) would render the remaining options ineffective. As such, the alternatives for Dammeron Valley and Diamond Valley are inclusive of all items as a single alternative for each area.

- **Alternative 1 - Dammeron.** Dammeron Valley alternative includes three new detention basins and one channel intended to route a fourth drainage area. Dam structure 1 (max dam height: 33.5’) for one detention basin (26 ac-ft capacity). Two detention basins, dam structure 2 and 3, each have individual dam structures (max dam height: 38’), but as water levels rise, the two basins combine into a single body of water with one spillway (390 ac-ft capacity). Storm events will be attenuated through the three detention basins collected upstream of the community. The limited and attenuated flows will be safely routed through the community, across the downstream highway, and into existing drainage corridors. The property where the dam would be located is privately owned and includes some BLM land.

- **Alternative 1 – Diamond.** Diamond Valley involves four dam structures and three detention basins, and the armoring of an existing channel. The detention basins are existing but need dredging and rehabilitation. The spillway for Diamond 3 includes an existing bypass channel that conveys flows to Diamond 2, and the spillway for Diamond 2 includes an existing bypass channel that conveys flows to Diamond 1. Diamond 1 is currently a sump basin with no outlet. Each of the detention basins will be dredged and the existing dam structures will be rehabilitated. Due to site constraints, Diamond 1 will require two separate dam structures (max dam height: 12’) to reach the required capacity (61 ac-ft capacity). The low-level outlet being proposed on Diamond 1 with this project will drain a portion of the sump basin, but the lower elevations of the detention basin will continue as a sump. Flows leaving Diamond 1 will be conveyed through new pipe to a nearby existing drainage corridor that has capacity to safely receive the flows. Diamond 2 will require a single dam structure (max dam height: 19') to reach the required capacity (27 ac-ft capacity). Diamond 3 will require a single dam structure (max dam height: 15') to reach the required capacity (14 ac-ft capacity). The property where the dam would be located is privately owned and includes some BLM land.

- **Alternative 1 - Shivwits.** Shivwits site includes construction of approximately 2,225 linear feet of rock rip-rap bank protection along the Santa Clara River. The armoring is to prevent stream erosion threatening the historic Shivwits school/meeting house and two Civil Conservation Corps rock lined ditches. The armoring will also protect a cultivated field. The plan also includes the installation of approximately 5,800 linear feet of eight-inch pipe to provide irrigation to the cultivated acres.

The preferred alternative will allow the Sponsors to protect property and infrastructure while maximizing public benefits. Average annual monetary benefits of this alternative are estimated to be $2,992,533. The estimated average annual cost is $703,142, resulting in an annual net benefit of $2,289,391.

3.0 ENVIRONMENTAL AND SOCIAL BENEFITS

Environmental and social benefits were not monetized but are further explained for each alternative studied in detail in the Environmental Consequences Section of the Plan/EA.

Environmentally adverse impacts will be minimized during construction. Long-term, there would only be negligible adverse impacts anticipated from any of the evaluated alternatives. The region is arid with sparse trees along the banks of intermittently dry streams.

Socially, the threat of loss of life or property will may be minimized with reduced flood depths at buildings and roads. The annual average daily traffic on county major collector and rural roads near the project area was about 900 vehicles to almost 12,000 vehicles per day (Utah Department of Transportation, 2020). Incidental recreation after construction will continue and is expected to have minimal benefits from the structural alternatives through enhancement of wildlife and scenic improvement. Waterbodies developed from the impoundments would likely attract wildlife for short periods of time, but not significantly increase hunting, fishing, and general outdoor activity in the vicinity of the dams.

The Shivwits portion of the project is located on the Shivwits Band of Paiutes tribal land. There are cultural, social, environmental, and economic benefits by bringing irrigation water back to the project area (personnel communication, Karma Grayman, Shivwits Band, 2023). The tribe could use the area for irrigated pasture, alfalfa hay or native corn species and melons. Based on the lack of data for non-market crops and the high likelihood of growing alfalfa the first few years after flood control, the income from growing alfalfa was used in the economic analysis.

- Cultural: the Shivwits Band will be able to revive traditional agricultural practices and grow native corn species, along with melons, which they have not done for decades (Travis Duran, personal communication, 2023). This will help to restore some of their traditional ecological knowledge and pass it down to younger generations. Without the pipeline, the fields remain dry and will not support these traditional crops. In addition, by installing rip rap at the end of the historic rock lined ditch, we will be preserving components of the historic Shivwits Indian School (42WS5621), which is eligible for the National Register of Historic Places, and it has also served as a gathering place for Shivwits Band meetings, was home to many Shivwits Band members from the 1900-1950s, and was the location of Funeral Cry Ceremonies for the people. The area will also be used to educate tribal school youth about traditional agriculture and the cultural importance of the school.

- Social: by being able to grown traditional native plants and restore the field to agricultural practices, the Shivwits Band will also restore traditional gatherings to this area such as the Bear Dance, which was practiced once a year in this area of land (Travis Duran, personal communication, 2023). In addition, with these traditional gatherings, younger generations will be able to learn about the significant historic of the Shivwits Indian School and the experiences of their ancestors. The school served as a day school for Shivwits Paiute Indians from the late 19th century to early 20th century during extremely dire times, and later served as a meetinghouse. By bringing agriculture back to the area and revitalizing it as a traditional gathering area, new traditions will be built and strengthen the Shivwits community and bring younger generations to this area.

- Environmental: this area used to be flood irrigated from the rock lined irrigation ditches, and by converting it to a piped irrigation system, this will increase irrigation efficiency (Travis Duran, personal communication, 2023).

- Economics: the Shivwits Band will be able to employ Band members on this plot of land during planting and harvesting seasons, and teach them about the gathering of native corn and melons and traditions associated with them (Travis Duran, personal communication, 2023).

4.0 PERIOD OF ANALYSIS

The Period of Analysis used was 51-years (including 1 year for design and construction). Floods from the 2, 5, 10, 25, 50, 100, 200 and 500-year storm events were analyzed to estimate average annual flood-related damages.

A net present value analysis was conducted to compare the costs of project alternatives. Average annual values were also estimated. All costs of installation, operation and maintenance were based on 2022 prices. The costs associated with designing and implementing all structural measures were assumed to be implemented over a one-year period immediately preceding operation. The alternative with a 51-year period of analysis yielded the highest net benefits using the mandated 2.50% discount rate for all federal water resource projects for FY23 to discount and amortize the anticipated streams of costs and benefits.

5.0 ECONOMIC ANALYSIS AND DOCUMENTATION

A customized Excel worksheet using Federal Emergency Management Agency (FEMA) depth-damage curves and locally-obtained data was used to evaluate benefits and costs of alternatives. Each project alternative, storm event and flood damage category were included in the worksheet to estimate average annual damages. Alternative cost estimates provided by the project engineers were also included in the worksheet. Economic data and results were linked in the worksheet to create the required P&G tables for the final project report.

6.0 RURAL COMMUNITY AND AGRICULTURAL DAMAGES

The stream of monetary benefits was described in average annual equivalent terms. The average annual expected benefits were the difference between the No Action Alternative and each project Alternative. The expected average annual damages for each alternative, storm event (8-events), and damage category below were estimated with the following equation:

$$\sum_{i=1}^{8} \underline{(PFED_{i-1} + FED_i)/2} * (PPFE_{i-1} - PFE_i)$$

$PFED_{i-1}$ - Previous Flood Event Damages
FED_i - Flood Event Damages
$PPFE_{i-1}$ - Probability of Previous Flood Event
PFE_i - Probability of Flood Event

6.1 STRUCTURE, CONTENT & VEHICLE DAMAGES

Structure, building content and vehicle damages for each storm event and project alternative were estimated based on structures identified from aerial imagery, property data provided by the Washington County, Utah tax assessor. The structure damages were estimated using methodology described in the Structural Damages Calculations Template (Tim Goody, NWMC). The value of the structures was estimated by subtracting the depreciated replacement value from the Washinton County Tax Accessor's structure value. The structures in the project area that are affected by flooding are located in a small rural town. Most if not all the structures are 40-60 years old, most typical about 45-years old. Based on the Life Cycle Chart (Swiftestimator.com, building cost reports online 2/2007) the Depreciated Multiplier ranges from 17% to 36% (20-30 years effective age). A Depreciated Multiplier of .20 was selected because most homes and businesses are well kept and necessary repairs and maintenance have been made. The structure value used in the flood damage analysis was estimated as: The County Tax Accessed Value * (1-Depreciated Replacement Value Factor) (see: SantaClaraFloodDamagesBenefitsData.xls for calculations). For vehicles, local project managers estimated the typical vehicle replacement dollar value.

This estimated Depreciated Replacement Values is also consistent with the USACE National Structure Inventory documentation: "Structure Valuation - These replacement values for structures are then depreciated in order to obtain depreciated replacement value; each structure is depreciated by 1% per year for the first 20 years, after which it is assumed that routine maintenance would keep structure values at 80% of their replacement values".

(https://www.hec.usace.army.mil/confluence/nsi/technicalreferences/latest/technical-documentation).

The water depths were obtained from hydraulic simulation of the evaluated storm events. Areas flooded and flood depths with and without project were estimated by Alpha Engineering, St. George, Utah. Building types, contents, and the typical number of vehicles and vehicle values associated with impacted buildings were estimated using interpolation of flood depth-damage curves developed by FEMA. The percent damage factor was multiplied by each building structure and vehicle dollar value to estimate flood damages. Total value of structures on impacted properties is shown below. This value does not include land values, only structure values.

Watershed Project Number and Value of Structures Summary

Dammeron	Number	Value
Total Structures:	27	$14,747,420
Residences:	27	$14,747,420
Commercial Properties:	0	$0
Public Properties:	0	$0
Critical Facilities:	0	$0

Diamond	Number	Value
Total Structures:	42	$20,836,200
Residences:	42	$20,836,200
Commercial Properties:	0	$0
Public Properties:	0	$0
Critical Facilities:	0	$0

There are no commercial businesses, public properties or critical facilities in the impacted project area. Structure and content values were estimated as a percentage (about 75% structure and 60% content damages at 10-feet flood depth in a 1-story, no basement home) of assessed property values. Estimated floodwater depths (where damage occurs) for various storms (including the 500-year storm) for each structure were based on the results of the hydrology and hydraulics (H&H) simulation modeling. Floodwater data was then used with water depth to damage functions to estimate structural and content damages based on the ground elevation of each structure. A similar analysis was conducted for vehicles located at the property within the floodplain area. Damages to vehicles was estimated to begin at 0.5 foot of flood depth. Each affected property was estimated to have a minimum of two vehicles. The vehicle value was estimated to be $7,500/vehicle.

6.2 ROAD DAMAGES

Road damages for each storm event and project alternative were estimated. Road location, flood depth and road surface area impacted by floodwater were identified. Areas flooded, flood depths and monetary damages with and without project were estimated by Alpha Engineering, St. George, Utah. The cost of road repair or replacement was estimated. There were no road damages estimated if the flood depth was less than 0.1 foot. If flood depth was between 0.1- and 0.5-foot, flood damages were estimated to be half the road repair or replacement cost. If flood depth was greater than .5-foot, flood damages were estimated to be the total road repair replacement cost.

For the economic analysis, there are approximately 12 associated roadways within Dammeron Valley and 6 roadways in Diamond Valley project areas affected by storms up to and including the 500-year storm event.

6.3 BRIDGE & CULVERT DAMAGES

For the economic analysis, there were no identified culverts and bridges (stream crossings) affected by storms up to and including the 500-year event.

6.4 OTHER DAMAGES

No additional "Other Damages" (emergency aid, clean-up, sewer, debris removal, etc.) were provided or estimated by local county officials.

6.5 CROP DAMAGES

Crops damages from each storm event and project alternative were estimated. About 4 acres of vineyard was flooded area in the Dammeron sub-basin. Areas flooded and flood depths with and without project were estimated by Alpha Engineering, St. George, Utah; and the local NRCS Field Agronomist provided crop production data. Five-year average crop yields and prices were estimated using crop budget data published by University of California-Davis and National Agricultural Statistics Service (NASS) information. Acreage of damages associated with each crop type were estimated by the project GIS specialist. Crop Percent damage factors for flood inundation were obtained from NRCS, and estimated for depths of less than 1 foot, 1 to 3 feet, and greater than 3 feet.

The "Seasonal Damage Factor" represents the probability that the flood event occurs during the crop growing/harvest season, and then is multiplied by the crop damage factor. The Seasonal (crop) Damage Factor was estimated as: [0.5 times (Harvest Starts minus Plant Starts), plus 0.5 times (Harvest Ends minus Harvesting Starts)], divided by 365 Days. The Average Crop Value per acre was estimated as: The Average Unit Price times Average Yield

Damageable Value per Acre (per Flood Depth). The dollar crop damages per flood event were estimated by the sum of the Seasonal Damage Factor, the Inundation Factor, and the Average Crop Value per Acre. The flood event losses were estimated as the sum of Damage Value per Acre times Acres Flooded, for each flood event.

The Shivwits Band of Paiutes tribal land could be flooded, and about 30 acres are no longer farmed because of flood damages to ditches, pipeline and sprinklers, and continued streambank flooding, that made farming unfeasible. With flood control measures the Shivwits Band will be able to farm the field again and employ Band members in crop production, and teach tribal members about growing native corn and melons and traditions associated with them (Travis Duran, personal communication, 2023). For the economic analysis, we assumed the Shivwits field would be in alfalfa hay production. The Without Project flood damages are the complete loss of income from the hay land, are were estimated as Net Income from Extension Service Crop Budgets (Utah State University). Net Returns was defined as “price” times “yield minus annual “crop production costs” (excluding owner unpaid labor, management, equity and risk). Crop costs were updated to the current year using the Producer Prices Received Index. Crop prices and yields were the previous ten-year averages. The Net Returns per acre were weighted to account for a 10-year Alfalfa-Oat crop rotation. The benefit is the Net Income from hay land that is restored to crop production

6.6 OTHER AGRICULTURAL DAMAGES

There were no other pasture, range, livestock or confined animal feeding operation damages identified within the project area affected by storms up to and including the 500-year event.

6.7 RECREATION

Based on evidence found at the site and information from local residences, the dam sites and upstream and downstream waterways (on private property and BLM land) are used by some people for recreational purposes. The flood control structures are not intended to store water for recreation. Incidental recreational activities such as hunting and hiking/walking are expected to be minimal. Since there is no official or unofficial count of usage, estimated annual visitor-days is not available. Therefore, incidental recreation impacts were not evaluated.

6.8 SCOUR & SEDIMENT DAMAGES

Flood erosion scour and sediment deposition damages from each storm event and project alternative were estimated. Areas and quantity of scour and sediment with and without project were estimated by Alpha Engineering, St. George, Utah. Erosion-scour was defined as soil loss greater than 6-inches. Up to about 90 acres of rural and residential land was identified with significant erosion-scour in the flooded area. Damages were estimated as the cost per acre to replace lost soil on eroded areas. Sediment deposition damages were estimated to be up to about 1,000 Cubic Yards in the flooded area. Damages were estimated as the cost to remove sediment from deposition areas.

As reflected in the table below, current average annual floodwater damages without project (present condition) are $3,073,615. Floodwater damages with project (Alternative 1) dams were estimated to be $81,102.

Table 6-1: Summary of Annual Expected Damages

Plan Annual Expected Damages		
Category	Present Condition	Alternative 1
Structure, Contents & Vehicles		
Dammeron	$1,098,396	$32,073
Diamond	$1,963,451	$48,836
Shiviwits	$0	$0
Roads & Culverts		
Dammeron	$1,583	$0
Diamond	$599	$0
Shiviwits	$0	$0
Other Damages		
Crop-Flood		
Dammeron	$359	$3
Diamond	$0	$0
Shiviwits	$4	$0
Scour		
Dammeron	$5,859	$99
Diamond	$2,372	$39
Shiviwits	$147	$11
Sediment		
Dammeron	$422	$34
Diamond	$422	$6
Shiviwits	$25	$5
Total:	$3,073,640	$81,107

1 Price base: 2022. Calculated using FY 2022 Water Resources Discount Rate (2.50%), annualized over 50 years, and 51-year period of analysis. Prepared March 2023

The number of structures that could be flooded and their total structural value are displayed below. Also displayed are the present value and average annual damages to the structures, contents and associated vehicles for each flood event, for each of the two sub-basins:

Dammeron Valley	Number	Structure Value
Total Structures:	27	$18,434,275
Residences and Apts:	27	$18,434,275
Commercial Properties:	0	$0
Public Properties:	0	$0
Critical Facilities:	0	$0

Dammeron Valley

Event	< 1 ft Home	1 to 3 ft Home	> 3 ft Home	< 1 ft Shed	1 to 3 ft Shed	> 3 ft Shed	Present Value Damage	Average Annual Damage
2-yr	5	0	0	0	0	0	$1,890,853	-
5-yr	9	0	0	0	0	0	$2,544,431	$665,293
10-yr	10	0	0	0	0	0	$3,243,018	$289,372
25-yr	12	0	0	0	0	0	$3,771,027	$210,421
50-yr	16	0	0	0	0	0	$5,259,013	$90,300
100-yr	21	0	0	0	0	0	$6,772,790	$60,159
200-yr	22	0	0	0	0	0	$6,979,522	$34,381
500-yr	26	0	0	0	0	0	$8,201,237	$22,771
Total:								$1,372,698

Diamond	Number	Value
Total Structures:	42	$26,045,250
Residences:	42	$26,045,250
Commercial Properties:	0	$0
Public Properties:	0	$0
Critical Facilities:	0	$0

Diamond Valley

Event	< 1 ft Home	1 to 3 ft Home	> 3 ft Home	< 1 ft Shed	1 to 3 ft Shed	> 3 ft Shed	Present Value Damage	Average Annual Damage
2-yr	14	0	0	4	0	0	$4,238,220	-
5-yr	14	0	0	4	0	0	$4,297,314	$1,280,330
10-yr	17	0	0	4	0	0	$5,416,714	$485,701
25-yr	22	1	0	5	0	0	$7,051,101	$374,034
50-yr	24	1	0	5	0	0	$7,806,045	$148,571
100-yr	27	1	0	5	0	0	$8,408,586	$81,073
200-yr	37	2	0	6	0	0	$11,047,121	$48,639
500-yr	43	1	1	6	0	0	$12,623,521	$35,506
Total:								$2,453,856

7.0 WATERSHED PROJECT COSTS

Project costs for flood control dams and channel work were estimated by Alpha Engineering, St. George, Utah in September, 2022. Installation and operation & maintenance costs for each activity are described in detail in the cost tabs in the economic analysis Excel worksheet.

All costs were allocated to the flood prevention purpose according to the procedure in the National Resource Economics Handbook, Part 611 Water Resources Handbook for Economics, Chapter 6 Costs and Cost Allocation (NRCS 2014b). Work Plan-EA tables were constructed based on the calculated cost allocated to flood prevention. Within this purpose the costs were shared between NRCS and the local and state entities as specified in the NWPM, in this case cost share for flood prevention is 100 percent federal and 0 percent local. Within these guidelines, engineering is 100 percent federal; and operation, maintenance, and replacement is 100 percent local. See Work Plan Table 2 in the Plan-EA for the results of the cost allocation/cost sharing process.

All costs were amortized at the Fiscal Year 2023 Federal Water Resource Discount of 2.50 percent for 51 years. Average Annual Costs are computed as the sum of the amortized construction cost and the annual operation and maintenance cost. Engineers estimate that each of the structures would last 50 years, the life of the project.

All project costs were estimated by project engineers and converted to Present Values by discounting each cost to the beginning of the period of analysis using the applicable project discount rate. Installation expenditures before the project is installed were brought forward to the end of the period of installation by charging compound interest at the project discount rate from the date the costs are incurred. Finally, the project discount rate was used to convert the present values to average annual equivalent terms. All estimated values and damages were assessed within a customized Excel template.

Watershed Project Annual Cost Summary

Evaluation Unit	Project Outlays: Amortization of Installation Cost	Project Outlays: Operation, Maintenance & Replacement	Total
Dammeron Alt 1	$281,800	$76,869	$358,669
Diamond Alt 1	$222,300	$84,783	$307,083
Shivwits Alt 1	$36,900	$490	$37,390
Grand Total	**$541,000**	**$162,142**	**$703,142**

1/ Discount rate 2.50% with a 51 year period of analysis. Price base 2022

2/ From Table 2

8.0 WATERSHED PROJECT BENEFITS AND COSTS

As reflected in the table below, current average annual benefits are $2,992,533 and the average annual costs are $703,142. The net annual benefits between with and without project that the project would provide to downstream properties is $2,289,391.

As reflected below, both Dammeron Valley and Diamond Valley had a B/C ratio greater than 1.0. The Shivwits area had a B/C ratio less than 1.0 at .0043. All three geographic areas, under Alternative 1, produces a B/C ratio of 4.26.

Watershed Project Benefit-Cost Summary

	Average Annual Costs [3/]	Average Annual Benefits [2/]	Benefit Cost Ratio	Net Benefits
Dammeron Alt 1	$358,669	$1,074,410	3.00	$715,741
Diamond Alt 1	$307,083	$1,917,963	6.25	$1,610,880

Shivwits Alt 1	$37,390	$160	0.0043	-$37,230
Grand Total	**$703,142**	**$2,992,533**	**4.26**	**$2,289,391**

1/ Discount rate 2.50% with a 51 year period of analysis. Price base 2022

2/ From Table 5.

3/ From Table 4.

Funding Schedule*				
Fiscal Year		**PL-83-566**	**Other Funds**	**Total**
2025	Dammeron Alt 1	$7,724,290	$72,400	$7,796,690
2025	Diamond Alt 1	$6,130,328	$22,500	$6,152,828
2025	Shivwits Alt 1	$758,300	$262,600	$1,020,900

9.0 FINAL TABLES

All tables, for all alternatives, are displayed below. The following tables show cost-share percentages and amounts for watershed project plan implementation.

Table 9-1: Alternative 1 Cost-Share Summary – Dammeron

Works of Improvement	**%[3]**	**NRCS**	**%[3]**	**Sponsors**	**Total**
Cost-Sharable Items					
Construction Costs	100%	$6,896,688	0%	$0	$6,896,688
Engineering Technical Assistance Costs[4]	100%	$551,735	0%	$0	$551,735
Project Admin. Costs [1]	100%	$275,868	0%	$0	$275,868
Subtotal: Cost-Share Costs		**$7,724,290**		**$0**	**$7,724,290**
Non Cost-Sharable Items [2]					
Construction Costs	0%	$0	100%	$6,000	$6,000
Engineering Costs	0%	$0	100%	$600	$600
Real Property Landrights[5]	0%	$0	100%	$65,000	$65,000
Mitigation	0%	$0	100%	$0	$0
Permits	0%	$0	100%	$800	$800
Project Admin. Costs [1]	0%	$0	100%	$0	$0
Subtotal: Non Cost-Share Costs		**$0**	-	**$72,400**	**$72,400**
TOTAL:	99%	**$7,724,290**	1%	**$72,400**	**$7,796,690**

1/ The sponsors and NRCS will each bear the costs of project administration that each incurs.

2/ If actual non-cost-sharable item expenditures vary from these figures, the responsible party will bear the change.

3/ As per NWPM Section 500.42 and Figure 500-E2. PL-566 cost share rates depend on the authorized purposes of the particular watershed plan. For flood prevention measures, PL-566 pays 100% of construction and engineering. Installation of compensatory mitigation is considered part of the construction of the flood control measure (per text between Figures 500-E1 and 500-E2). Real property rights acquisition is 100% sponsor cost for most PL-566 activities. However, acquisition of property rights for mitigation and recreation may be cost-shared (see referenced sections).

4/ Cost-sharable at 100% NRCS if Sponsor hires engineering for structure design. Not cost-shareable if sponsor's engineering is for elements required for real property rights (road improvements, power line modification, livestock water supply line, etc.).

5/ Construction elements required to satisfy real property rights are also 100% Sponsor cost.

Table 9-2: Alternative 1 Cost-Share Summary – Diamond

Works of Improvement	%[3]	NRCS	%[3]	Sponsors	Total
Cost-Sharable Items					
Construction Costs	100%	$5,473,508	0%	$0	$5,473,508
Engineering Technical Assistance Costs[4]	100%	$437,881	0%	$0	$437,881
Project Admin. Costs [1]	100%	$218,940	0%	$0	$218,940
Subtotal: Cost-Share Costs		**$6,130,328**		**$0**	**$6,130,328**
Non Cost-Sharable Items [2]					
Construction Costs	0%	$0	100%	$20,000	$20,000
Engineering Costs	0%	$0	100%	$2,000	$2,000
Real Property Landrights[5]	0%	$0	100%	$0	$0
Mitigation	0%	$0	100%	$0	$0
Permits	0%	$0	100%	$500	$500
Project Admin. Costs [1]	0%	$0	100%	$0	$0
Subtotal: Non Cost-Share Costs		**$0**	**-**	**$22,500**	**$22,500**
TOTAL:	100%	**$6,130,328**	0%	**$22,500**	**$6,152,828**

1/ The sponsors and NRCS will each bear the costs of project administration that each incurs.

2/ If actual non-cost-sharable item expenditures vary from these figures, the responsible party will bear the change.

3/ As per NWPM Section 500.42 and Figure 500-E2. PL-566 cost share rates depend on the authorized purposes of the particular watershed plan. For flood prevention measures, PL-566 pays 100% of construction and engineering. Installation of compensatory mitigation is considered part of the construction of the flood control measure (per text between Figures 500-E1 and 500-E2). Real property rights acquisition is 100% sponsor cost for most PL-566 activities. However, acquisition of property rights for mitigation and recreation may be cost-shared (see referenced sections).

4/ Cost-sharable at 100% NRCS if Sponsor hires engineering for structure design. Not cost-shareable if sponsor's engineering is for elements required for real property rights (road improvements, power line modification, livestock water supply line, etc.).

5/ Construction elements required to satisfy real property rights are also 100% Sponsor cost.

Table 9-3: Alternative 1 Cost-Share Summary – Shivwits

Works of Improvement	% WS Protect[3]	% AG Water[3]	NRCS	% WS Protect[3]	% AG Water[3]	Sponsors	Total
Cost-Sharable Items							
Construction Costs	38%	38%	$728,925	0%	0%	$0	$728,925
Engineering Technical Assistance Costs[4]	38%	38%	$22,500	0%	0%	$0	$22,500
Project Admin. Costs [1]	38%	38%	$7,500	0%	0%	$0	$7,500
Subtotal: Cost-Share Costs			$758,925			$0	$758,925
Sponsor Other Funds[2]							
Construction Costs	0%	0%	$0	13%	13%	$242,975	$242,975
Engineering Costs	0%	0%	$0	13%	13%	$7,500	$7,500
Real Property Landrights[5]	0%	0%	$0	50%	50%	$0	$0
Mitigation	0%	0%	$0	50%	50%	$8,500	$8,500
Permits	0%	0%	$0	50%	50%	$500	$500
Project Admin. Costs [1]	0%	0%	$0	13%	13%	$2,500	$2,500
Subtotal: Non Cost-Share Costs			**$0**			**$261,975**	$261,975
TOTAL:							**$1,020,900**

1/ The sponsors and NRCS will each bear the costs of project administration that each incurs.
2/ If actual non-cost-sharable item expenditures vary from these figures, the responsible party will bear the change.
3/ As per NWPM Section 500.42 and Figure 500-E2. PL-566 cost share rates depend on the authorized purposes of the particular watershed plan. For flood prevention measures, PL-566 pays 100% of construction and engineering. Installation of compensatory mitigation is considered part of the construction of the flood control measure (per text between Figures 500-E1 and 500-E2). Real property rights acquisition is 100% sponsor cost for most PL-566 activities. However, acquisition of property rights for mitigation and recreation may be cost-shared (see referenced sections).
4/ Cost-sharable at 100% NRCS if Sponsor hires engineering for structure design. Not cost-shareable if sponsor's engineering is for elements required for real property rights (road improvements, power line modification, livestock water supply line, etc.).
5/ Construction elements required to satisfy real property rights are also 100% Sponsor cost.
6/ NRCS Construction Cost includes Tribal Mitigation Cost.

Table 1: Estimated Installation Cost for Alternatives 1

Installation Cost Items	Estimated Costs		
	PL-83-566 Funds[2]	Other Funds	
Dammeron Alt 1	$7,724,290	$72,400	$7,796,690
Diamond Alt 1	$6,130,328	$22,500	$6,152,828
Shivwits Alt 1	$758,925	$261,975	$1,020,900
Total Project	$14,613,543	$356,875	$14,970,418

1/ Price base 2022

Table 2: Estimated Cost Distribution for Alternatives 1

Installation Cost Items[2]	Installation Costs: PL-83-566 Funds				Installation Costs: Other Funds								**Amortized Costs, FY2022**	Annual OM&R	Total Annual Costs
	Construction Costs[3]	Engineering Technical Assistance Costs	Project Admin. Costs	Total PL-83-566 Costs	Construction Costs	Engineering Costs	Real Property Landrights	Mitigation	Permits	Project Admin. Costs	Total Other Funds	Total Project Cost			
Dammeron Alt 1	$6,896,688	$551,735	$275,868	$7,724,290	$6,000	$600	$65,000	$0	$800	$0	$72,400	$7,796,690	$281,800	$76,869	$358,669
Diamond Alt 1	$5,473,508	$437,881	$218,940	$6,130,328	$20,000	$2,000	$0	$0	$500	$0	$22,500	$6,152,828	$222,300	$84,783	$307,083
Shivwits Alt 1	$728,925	$22,500	$7,500	$758,925	$242,975	$7,500	$0	$8,500	$500	$2,500	$261,975	$1,020,900	$36,900	$490	$37,390
Total Project	$13,099,120	$1,012,116	$502,308	$14,613,543	$268,975	$10,100	$65,000	$8,500	$1,800	$2,500	$356,875	$14,970,418	$541,000	$162,142	**$703,142**

1/ Discount rate 2.50% with a 51 year period of analysis. Price base 2022

2/ All costs towards the Project Purpose of Flood Prevention.

Table 4: Estimated Average Annual Costs for Alternatives 1

Evaluation Unit	Project Outlays		Total
	Amortization of Installation Cost	Operation, Maintenance & Replacement	
Dammeron Alt 1	$281,800	$76,869	$358,669
Diamond Alt 1	$222,300	$84,783	$307,083
Shivwits Alt 1	$36,900	$490	$37,390
Grand Total	**$541,000**	**$162,142**	**$703,142**

1/ Discount rate 2.50% with a 51 year period of analysis. Price base 2022

2/ From Table 2

Table 5a: Estimated Average Annual Flood Damage Reduction Benefits
Alternative 1 – Dammeron

Dammeron Alt 1	Average Annual Damages Without Project		Average Annual Damages With Project		Average Annual Benefits	
Item	Ag Related	Non-Ag Related	Ag Related	Non-Ag Related	Ag Related	Non-Ag Related
Floodwater Damage						
Structures, Contents, Vehicles		$1,098,396		$32,073	$0	$1,066,323
Roads		$1,583			$0	$1,583
Crop and Pasture	$359		$3		$356	$0
Subtotal	$359	$1,099,979	$3	$32,073	$356	$1,067,906
Sediment/Erosion Damage						
Sediment Deposition		$422		$34	$0	$388
Flood Plain Scour		$5,859		$99	$0	$5,760
Road and Bridge		0.00%		$0	$0	$0
Urban		$0		$0	$0	$0
Subtotal		$6,281		$133	$0	$6,148
Indirect Damage	$0	$0	$0	$0	$0	$0
Grand Total	$359	$1,106,260	$3	$32,206	$356	$1,074,054

1/ Discount rate 2.50% with a 51 year period of analysis. Price base 2022

Table 5b: Estimated Average Annual Flood Damage Reduction Benefits
Alternative 1 – Diamond

Diamond Alt 1	Average Annual Damages Without Project		Average Annual Damages With Project		Average Annual Benefits	
Item	Ag Related	Non-Ag Related	Ag Related	Non-Ag Related	Ag Related	Non-Ag Related
Floodwater Damage						
Structures, Contents, Vehicles		$1,963,451		$48,836	$0	$1,914,615
Roads		$599			$0	$599
Crop and Pasture					$0	$0
Subtotal		$1,964,050		$48,836	$0	$1,915,214
Sediment/Erosion Damage						
Sediment Deposition		$422		$6	$0	$416
Flood Plain Scour		$2,372		$39	$0	$2,333
Road and Bridge		$0		$0	$0	$0
Urban		$0		$0	$0	$0
Subtotal		$2,794		$45	$0	$2,750
Indirect Damage	$0	$0	$0	$0	$0	$0
Grand Total	$0	$1,966,845	$0	$48,881	$0	$1,917,963

1/ Discount rate 2.50% with a 51 year period of analysis. Price base 2022

Table 5c: Estimated Average Annual Flood Damage Reduction Benefits, Alternative 1 – Shivwits

Shivwits Alt 1	Average Annual Damages Without Project		Average Annual Damages With Project		Average Annual Benefits	
Item	Ag Related	Non-Ag Related	Ag Related	Non-Ag Related	Ag Related	Non-Ag Related
Floodwater Damage						
Structures, Contents, Vehicles					$0	$0
Roads					$0	$0
Crop and Pasture	$4		$0		$4	$0
Subtotal	$4		$0		$4	$0
Sediment/Erosion Damage						
Sediment Deposition	$25		$5		$20	$0
Flood Plain Scour	$147		$11		$136	$0
Road and Bridge					$0	$0
Urban					$0	$0
Subtotal	$172		$16		$156	$0
Indirect Damage	$0	$0	$0	$0	$0	$0
Grand Total	$176	$0	$16	$0	$160	$0

1/ Discount rate 2.50% with a 51 year period of analysis. Price base 2022

Table 5c: Estimated Average Annual Flood Damage Reduction Benefits
Alternative 1 – Dammeron, Diamond and Shivwits

Dammeron, Diamond & Shivwits Alt 1	Average Annual Damages Without Project		Average Annual Damages With Project		Average Annual Benefits	
Item	Ag Related	Non-Ag Related	Ag Related	Non-Ag Related	Ag Related	Non-Ag Related
Floodwater Damage						
Structures, Contents, Vehicles	$0	$3,061,847	$0	$80,909	$0	$2,980,938
Roads	$0	$2,182	$0	$0	$0	$2,182
Crop and Pasture	$363	$0	$3	$0	$360	$0
Subtotal	$363	$3,064,029	$3	$80,909	$360	$2,983,120
Sediment/Erosion Damage						
Sediment Deposition	$25	$844	$5	$40	$20	$804
Flood Plain Scour	$147	$8,231	$11	$138	$136	$8,093
Road and Bridge	$0	$0	$0	$0	$0	$0
Urban	$0	$0	$0	$0	$0	$0
Subtotal	$172	$9,076	$16	$178	$156	$8,897
Indirect Damage	$0	$0	$0	$0	$0	$0
Grand Total	$535	$3,073,104	$20	$81,087	$516	$2,992,017

1/ Discount rate 2.50% with a 51 year period of analysis. Price base 2022

Economic Table 5d - Estimated Average Annual Flood Damage Reduction Benefits
Santa Clara Watershed Project

Item	Estimated Average Annual Damage: Without Project (No Action Alternative)	Estimated Average Annual Damage: With Project (Preferred Alternative)	Damage Reduction Benefit
Floodwater Damage			
Structures, Contents, Vehicles	$3,061,847	$80,909	$2,980,938
Roads	$2,182	$0	$2,182
Crop and Pasture	$363	$3	$360
Subtotal	$3,064,392	$80,912	$2,983,480
Sediment/Erosion Damage			
Sediment Deposition	$869	$45	$824
Flood Plain Scour	$8,379	$149	$8,230
Road and Bridge	$0	$0	$0
Urban	$0	$0	$0
Subtotal	$9,248	$194	$9,053
Indirect Damage	$0	$0	$0
Total	$3,073,640	$81,107	$2,992,533

1 Price base: 2022. Calculated using FY 2022 Water Resources Discount Rate (2.50%), annualized over 50 years, and 51-year period of analysis.

Table 9: Comparison of Benefits and Costs

	Average Annual Costs 3/	Average Annual Benefits 2/	Benefit Cost Ratio	Net Benefits
Dammeron Alt 1	$358,669	$1,074,410	3.00	$715,741
Diamond Alt 1	$307,083	$1,917,963	6.25	$1,610,880
Shivwits Alt 1	$37,390	$160	0.0043	-$37,230
Grand Total	**$703,142**	**$2,992,533**	**4.26**	**$2,289,391**

1/ Discount rate 2.50% with a 51 year period of analysis. Price base 2022

2/ From Table 5.

3/ From Table 4.

APPENDIX E-3

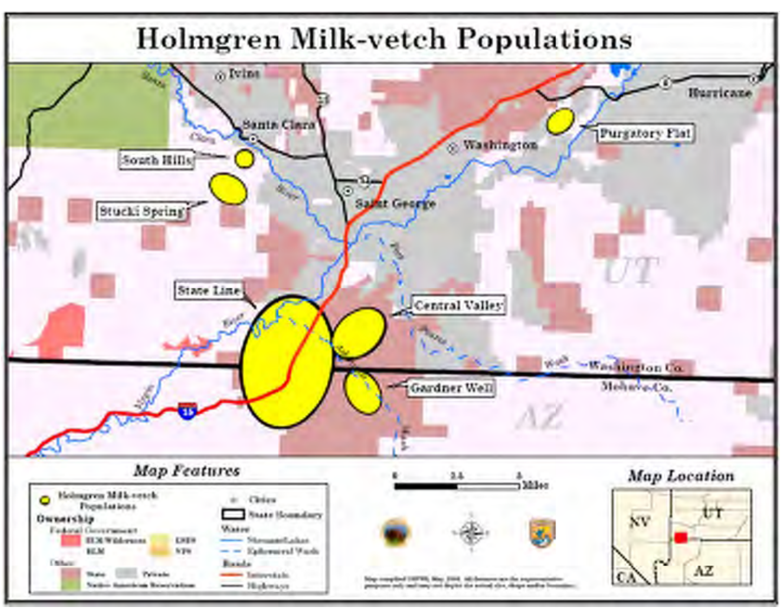
BIOLOGICAL DOCUMENTS

Santa Clara Project Rare Species Evaluation

Holmgren milk-vetch (*Astragalus holmgreniorum*)

Habitat Requirements and Limiting Factors: Holmgren milk-vetch occurs at elevations between 2,480-2,999 feet in areas that drain to the Santa Clara and Virgin Rivers. It is typically found on the skirt edges of hill and plateau formations slightly above or at the edge of drainage areas; it occurs on soils characterized by small stone and gravel deposits and where vegetation cover averages less than 15 percent of the landscape. Holmgren milk-vetch is associated with geological layers or parent materials found within the Moenkopi formation. The species is thinly and discontinuously distributed within its habitat. The figure below depicts the known populations sites. These sites are also included in designated critical habitat is located within each of the six sites.

Findings: The closest known population (South Hills population) is located approximately 6.8 miles to the southeast from the Shivwits Project Area. The site is located south of the community of Santa Clara and south of the Santa Clara River. At 3200 feet, the Shivwits Project Area is located just above upper most elevation level of recognized Holmgren milk-vetch habitat (2,999 feet). Additionally, while the Moenkopi Formation is present near the project area, it does not appear that milk-vetch habitat is present due to the lack of skirt edges of hills; therefore, stone and gravel deposits from these hills are not present. Much of the project area has been disturbed due to farming activities. This is only a desk top analysis so a survey of the project area may be advisable. The Dammeron Valley and Diamond Valley Project Areas are not located within Holmgren milk-vetch habitat. The Moenkopi Formation (including skirt hills and stone and gravel deposits) is not present. At 4600 feet elevation, the two project sites are much higher than is currently recognized for Holmgren milk-vetch habitat (2900 feet).

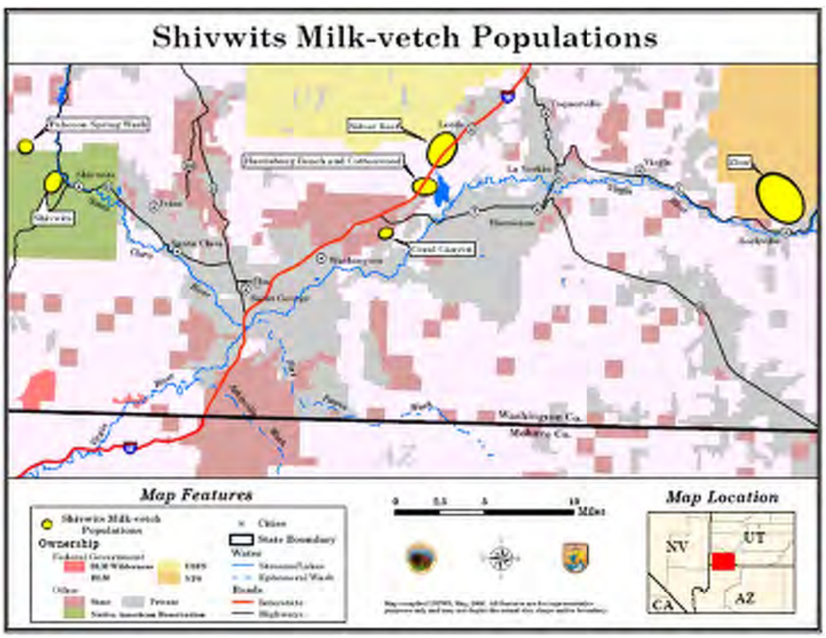


Taken from *Astragalus holmgreniorum* (Holmgren Milk-Vetch) and *Astragalus ampullarioides* (Shivwits Milk-Vetch) Recovery Plan

Shivwits milk-vetch (*Astragalus ampullarioides*)

Habitat Requirements and Limiting Factors: Shivwits: milk-vetch is predominately found in isolated pockets of purple-hued, soft clay soil outcrops found on the Chinle formation near St. George, Utah. Occupied sites are small, and populations are found between 3,018 and 4,363 feet in elevation in sparsely vegetated habitat with an average of 12 percent cover. It is found in dense patches. The milk-vetch is constrained by the isolation of appropriate soil substrate. The figure below depicts the known populations sites. Designated critical habitat is located within each of these sites. The Shivwits milk-vetch site is located almost adjacent to the Shivwits project area.

Findings: The Chinle formation is found adjacent to the Shivwits project area but apparently does not extend into the actual site itself (per David Sims maps). A desk top review did not reveal the presence of any of the purple-hued, soft clay soil outcrops required by the Shivwits milk-vetch. Much of the project area has been disturbed as the result of farming activities. It is unlikely that the milk-vetch is present within the project area. However, because designated habitat is located almost adjacent to the project area, the site should probably be surveyed.



Taken from *Astragalus holmgreniorum* (Holmgren Milk-Vetch) and *Astragalus ampullarioides* (Shivwits Milk-Vetch) Recovery Plan

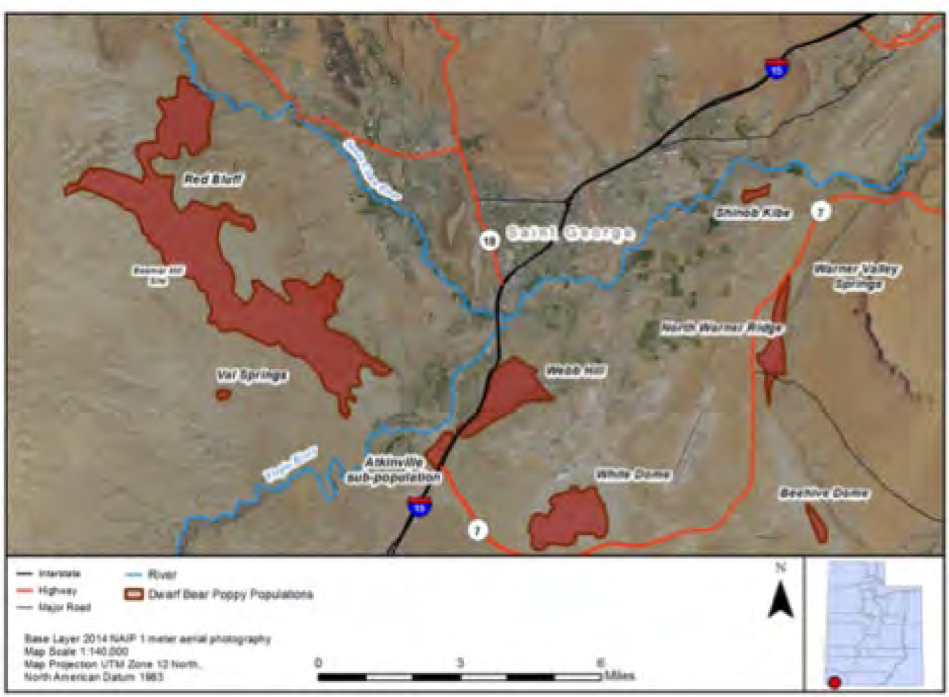
The following Google Earth photograph shows a typical purple-hued, soft clay soil outcrop required by the Shivwits milk-vetch. This site is located between the north and south bound lanes of Interstate 15 near Harrisburg Junction.

Dwarf bear-claw poppy (Arctomecon humilis)

Habitat Requirements and Limiting Factors: Dwarf bear claw-poppy is restricted to approximately 9,000 acres of habitat in the vicinity of St. George in Washington County, Utah. The elevation range the species is between 2,700 to 3,300 feet. Approximately 30 percent of the habitat is located on state, private or municipally administered lands; the remaining 70 percent occurs on public lands managed by the Bureau of Land Management (BLM). The poppy most commonly occurs on soils of the Shnabkaib Member of the Moenkopi Formation, but sometimes is found on the Middle Red Member or Upper Red Member. These soils are slightly basic, high in both gypsum and calcium carbonate, and in comparison with desert shrub soils have lower concentrations of magnesium, potassium and iron and higher levels of calcium and copper. A recent habitat model indicates annual precipitation is the strongest predictor of suitable habitat followed by geology, soil gypsum content, and summer maximum temperatures.

Dwarf bear-claw poppy habitat is sparsely vegetated, and consists of highly weathered rounded hill and dome formations. Roughly half of the soil surface is bare of vegetation, and the majority of the living cover in the habitat is biological soil crust (see photograph below). Associated native plants include shadscale (*Atriplex confertifolia*), Torrey's ephedera (*Ephedra torreyana*), nodding buckwheat (*Eriogonum cernum*), desert trumpet (*E. inflatum*), desert pepperweed (*Lepidium fremontii*) and burrobush (*Ambrosia salsola*). Invasive species include red brome (*Bromus rubens*), cheatgrass (*Bromus tectorum*), barb-wire Russian thistle (*Salsola paulsenii*), and African mustard (*Malcomia africana*). The presence of these invasive species make the habitat unsuitable for the poppy and it soon disappears once these species become established.

Findings: The extreme northeast portion of the Red Bluff poppy population is located adjacent to the southwest boundary of the Shivwits project area (See attached figure). However, the soils and habitat conditions within the project area are not conducive to the poppy. The poppy is not usually found on the Chinle Formation that overlies the project area. Additionally, no gypsum soils or rounded hill or dome formations preferred by the poppy are present. The surface of the project area is highly disturbed and has a substantial vegetation cover of invasive weeds or domestic plants. All of these conditions would retard the establishment of the poppy in the area. However, because the Shivwits project area is located adjacent to the Red Bluff poppy population area, it would be advisable to conduct a survey of the area to ensure that the poppy is not present.
The Dammeron Valley and Diamond Valley Project Areas are not located within or near any dwarf bear-claw poppy habitat due to elevation and lack of Moenkopi Formation related soils. These two project areas do not need to be surveyed for the poppy.



USFWS. 5-Year Review Summary and Evaluation

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Siler Pincushion Cactus (Pediocactus sileri)
Habitat Requirements and Limiting Factors: Siler pincushion cactus grows on gypsiferous clay and sandy soils derived from the Moenkopi Formation. The majority of the plants are associated with the Shnabkaib Member of this particular formation. The Shnabkaib Member is composed of 65 percent siltstone, 25 percent gypsum, and 10 percent limestone and dolomite. Siler pincushion cacti are also found scattered on the Middle Red Member of the formation, which is a reddish siltstone with thin to thick layers of gypsum. The cacti are found growing on elevations between 2,800 and 5,400 feet, in the Great Basin Desert Shrub vegetation community. The geographic range of Siler pincushion cactus extends from southeast of Fredonia, extreme northwestern Coconino County, Arizona, and west for about 70 air miles in north-central Mohave County, Arizona. It also includes about 3 miles of southern Utah in Washington and Kane Counties. The majority of the habitat occurs on lands managed by the BLM (Arizona Strip and Cedar City Districts), with smaller amounts of land managed by the Kaibab-Paiute Indian Tribe, Arizona and Utah State trust lands, and lands in private ownership.

The BLM has been monitoring populations of Siler pincushion cactus since 1985 on five plots located on public lands in Arizona and Utah. Four plots are located in Arizona. The Warner Ridge plot in Utah is located generally east of the new St. George Airport. The cactus is also found in the White Dome Nature Preserve located immediately west of the airport. The Muggins Flat area located east of Kanab, Utah, has also been monitored for the species.

Findings: The Siler pincushion cactus Warner Ridge study plot is located over 20 miles south and east of the Shivwits project area. The White Dome Nature Preserve is located approximately 16.5 miles from the project area. The Moenkopi formation surrounds but is not found within the project area, which is entirely composed of the Chinle formation. Soils within the project area are highly disturbed and the gypsum element preferred by the cactus appears to be absent. No known populations are known within or near the project area. It is highly unlikely that the Siler pincushion cactus or its habitat is found within the Shivwits project area.

The Dammeron Valley and Diamond Valley Project Areas are not located within or near any Siler pincushion cactus habitat due to elevation and lack of Moenkopi Formation related soils. These two project areas do not need to be surveyed for the cactus.

stgeorgeutah.com

dwrcdc.utah.gov

Southwestern Willow Flycatcher (*Empidonax traillii extimus*)
Habitat Requirements and Limiting Factors: The flycatcher breeds in relatively dense riparian tree and shrub communities associated with rivers, swamps, wetlands, and lakes. Most of these habitats are classified as forested wetlands or scrub-shrub wetlands. Its breeding range includes far western Texas, New Mexico, Arizona, southern California, southern portions of Nevada and Utah, and southwestern Colorado. Breeding habitat includes vegetation alongside rivers, streams, or other wetlands (i.e., riparian habitat). Flycatchers establish breeding and nesting territories, build nests, and forage where mosaics of relatively dense and expansive growths of trees and shrubs are established near or adjacent to surface water or are underlain by saturated soil. While riparian habitat vegetation composition, structure, height, and density vary, flycatcher habitat usually includes patches of dense vegetation, most often within the first 3– 4 meters aboveground. Flycatchers have only been documented nesting in stands with a width of 10 meters or more, although they will use narrower, linear habitats during migration. Hydrological conditions play an important role in where flycatchers choose to nest; they will nest along lentic water such as slow moving stream reaches, at river backwaters, in swampy abandoned channels, and in oxbows and margins of impounded water. Washington County is located within the Virgin River Management Unit within the Lower Colorado River Recovery Unit. Between 2008 and 2013, the number of breeding pairs in Washington County fluctuated between seven and ten. In 2014, 13 successful nest sites were documented.

In Washington County, Utah, designated critical habitat occurs along the banks of the Virgin River from the Utah/Arizona state line to Highway 9 near Hurricane, Utah. There is no designated critical habitat on any of the streams or drainages tributary to the Virgin River. This includes the Santa Clara River within the Shivwits project area.

Findings: Based on a desktop review, flycatcher habitat requirements described above within the Shivwits project area are minimal at best. Mosaics of established, relatively dense and expansive growths of trees and shrubs are limited or absent. While flycatchers have only been documented nesting in stands with a width of 10 meters or more, they will use narrower, linear habitats during migration. Therefore, an on-the-ground survey of the project area would be beneficial to determine habitat quality and potential, particularly for migration. The survey should be limited to habitat suitability and not presence/absence. The presence/absence survey is a detailed and time consuming effort that should only be undertaken if suitable habitat is located or birds observed incidentally.

The Dammeron Valley and Diamond Valley project areas are not located within or near any southwestern willow flycatcher habitat due to a lack of riparian vegetation present. These two project areas do not need to be surveyed for the flycatcher.

Southwestern willow flycatcher nps.gov

Western Yellow-Billed Cuckoo (*Coccyzus americanus*)

Habitat Requirements and Limiting Factors: Cuckoo habitat is largely associated with perennial rivers and streams that support the expanse of vegetation characteristics needed by breeding cuckoos. Cuckoos require large tracts of willow-cottonwood or mesquite forest or woodland for their breeding and nesting season habitat, with canopy heights of 16–98 feet and understory heights of 3–19 feet. Sites with strips of habitat less than 325 feet wide are rarely occupied, indicating that edge affects, in addition to overall patch size, influence habitat selection for nesting. In Utah, cuckoos breed and nest in patches that are 12 acres or greater in extent; vegetation within these patches is predominantly multi-layered, with riparian canopy trees and at least one layer of shrubby understory vegetation. The multi-layered vegetation should contain an area at least 100 meters wide by 100 meters long. Patches that are narrower than 100 meters wide are considered unsuitable for breeding and nesting. Open areas or gaps of multi-layered vegetation within a patch should be less than 300 meters in length. Breeding and nesting cuckoos will forage in riparian patches that have only an overstory canopy and are within 300 meters of the edge of suitable breeding and nesting habitat.

Migration and wintering habitat needs are not well known, although they appear to include a relatively wide variety of conditions. Migrating cuckoos have been found in coastal scrub, second growth forests, hedgerows, forest hedges, and in riparian patches. When dispersing between nest sites, cuckoos can be found at riparian sites with small groves or strips of trees, sometimes less than 10 acres in size. These stopover sites can be similar to breeding sites but are smaller in size, narrower in width, and lack understory vegetation when compared to nesting sites.

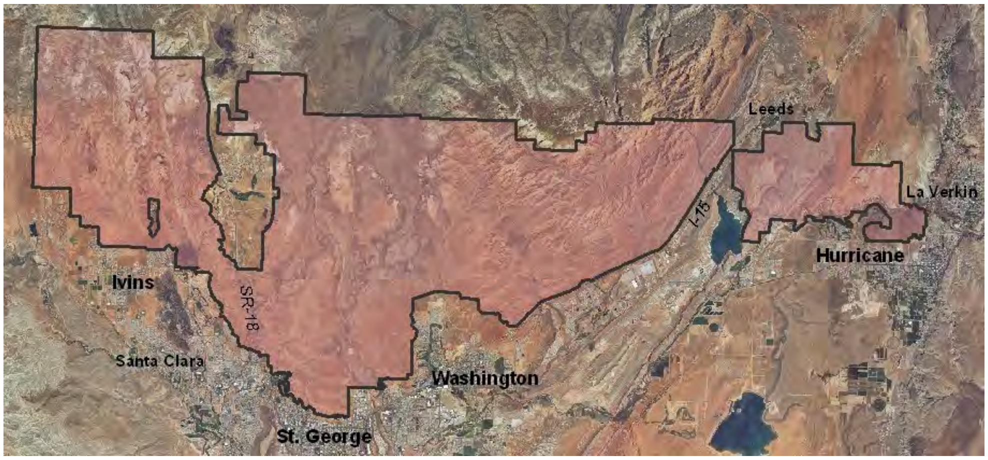
Revised critical habitat for the cuckoo was designated on April 20, 2021. No critical habitat was designated in Washington County.

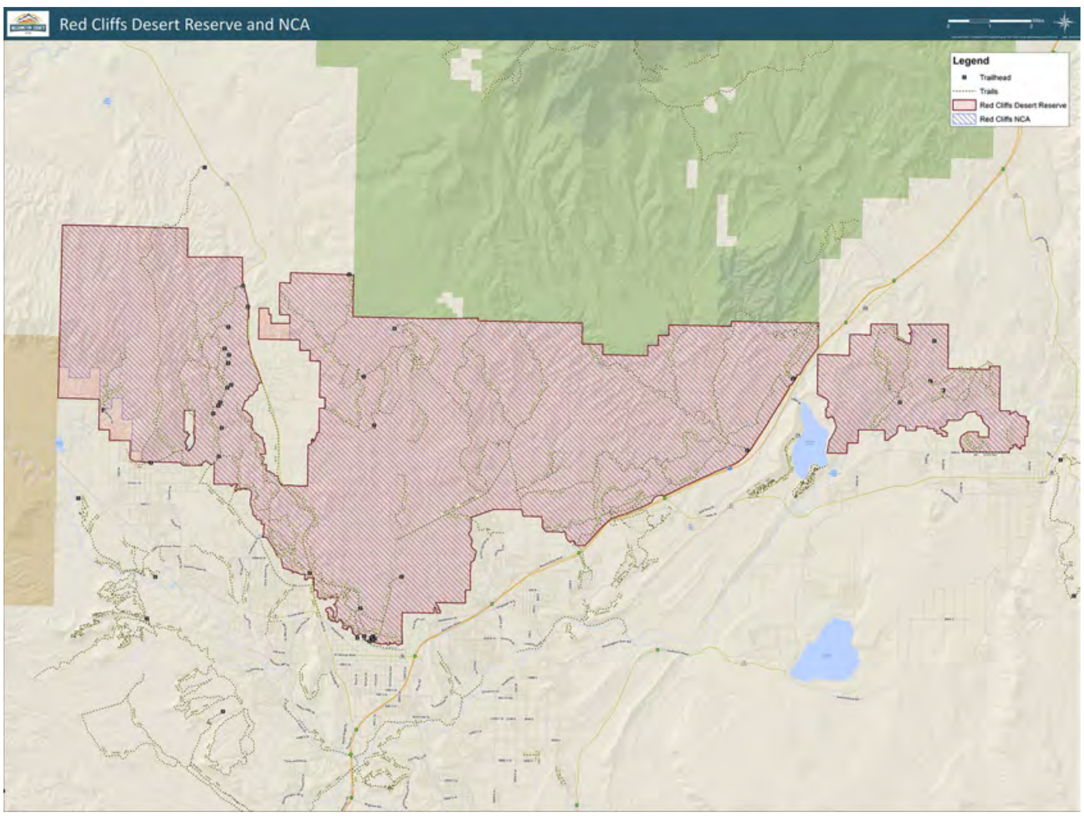
Findings: Based on a desktop review, cuckoo habitat requirements described above within the Shivwits project area are extremely limited if present at all. The cuckoo demands a more robust riparian habitat than is present in the project area. Large tracts of willow-cottonwood breeding and nesting season habitat are lacking. Sites with strips of habitat less than 325 feet wide are rarely occupied. In Utah, cuckoos breed and nest in patches that are 12 acres or greater and are multi-layered with riparian canopy trees and at least one layer of shrubby understory vegetation. Patches that are narrower than 100 meters wide are considered unsuitable for breeding and nesting. An on-the-ground survey of the project area would be beneficial to clearly determine habitat quality and potential, particularly for migration. The survey should be limited to habitat suitability and not presence/absence. The presence/absence survey is a detailed and time consuming effort that should only be undertaken if suitable habitat is located or birds observed incidentally.

The Dammeron Valley and Diamond Valley project areas are not located within or near any southwestern willow flycatcher habitat due to a lack of riparian vegetation present. These two project areas do not need to be surveyed for the flycatcher.

Desert Tortoise (Gopherus agassizii)

An analysis of desert tortoise habitat was not undertaken as it is recognized that the three project areas are located within tortoise habitat. Attached below are two maps showing the Red Cliffs Desert Tortoise Reserve. The Dammeron Valley and Diamond Valley project areas are located just north of the Reserve. The Shivwits project area is located approximately 2.6 miles to the southwest of the Reserve. All three sites should be surveyed for the tortoise.





Other Listed Species and Migratory Birds

A review of the US Fish and Wildlife Service Information for Planning and Consultation (IPaC) site was undertaken. The review showed that in addition to the species discussed above, USFWS also identified Mexican spotted owl (*Strix occidentalis lucida*) and Jones Cycladenia (*Cycladenia humilis* var. *jonesii*) as potentially present. However, it is clear that no habitat for either of these species is located near the three project areas. Therefore, no survey for these two species is necessary.

Eight migratory birds were identified as potentially occurring within the project areas. These are black-chinned sparrow (*Spizella atrogularis*), Brewer's sparrow (*Spizella breweri*), golden eagle (*Aquila chrysaetos*), Clark's grebe (*Aechmophorus clarkii*), olive-sided flycatcher (*Contopus cooperi*), pinyon jay (*Gymnorhinus cyanocephalus*), Rufous hummingbird (*Selasphorus rufus*), Virginia's warbler (*Vermivora virginiae*), and willow flycatcher (*Empidonax trailii*).

APPENDIX E-4A

TECHNICAL DOCUMENTS

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TECHNICAL MEMO

DRAFT

Date: March 3, 2021

To: NRCS, Lance Smith, P.E.
Washington County, Todd Edwards, P.E.

From: Alpha Engineering, Jared Madsen, P.E.

Re: Santa Clara Watershed EA Dammeron Valley and Diamond Valley Alternatives

Items:

1. **Dammeron Valley**

The Dammeron Valley area includes four principal drainage areas. See attached Exhibit 1 for an overall exhibit of Dammeron Valley and Exhibits 2 through 5 for exhibits specific to the proposed alternative for each drainage area. It is proposed to route three drainage areas through three separate detention basins (Dammeron 1, 2 and 3 Detention Basins), and the fourth drainage area will be diverted (Dammeron 4 Diversion Channel) to an adjacent existing drainage channel.

Information for each of the three detention basins is shown in the table below. The 100-year peak flow and volume numbers are based off a preliminary analysis and will be updated per NRCS requirements. Earthwork quantities are estimated based on the existing grade surface without grubbing or keyways and will be updated in the detailed design stages of the project.

Alternative	Tributary Area	100-year Peak Flow	100-year Volume	Est. Earthwork Quantity
Dammeron 1 Detention Basin	182 ac	75 cfs	5 ac-ft	2,620 cu-yd
Dammeron 2 Detention Basin	2,286 ac	559 cfs	63 ac-ft	31,835 cu-yd
Dammeron 3 Detention Basin	470 ac	209 cfs	15 ac-ft	31,840 cu-yd

Each of the three outlet pipes will convey flows from its corresponding detention basin with a reduced inlet that will limit flows leaving each detention basins. The outlet pipe for Dammeron 1 Detention Basin is proposed to limit flows to 5 cfs, which will then discharge into an open channel that will convey the flows downstream. The outlet pipes for Dammeron 2 and 3 Detention Basins will connect downstream into a single discharge point that will limit the overall flow to 25 cfs. This flow will be conveyed downstream south of the Dammeron Valley community via an open channel. The required conveyance geometries are shown in the table below.

Alternative	Limited Flow	Open Channel	Culvert
Dammeron 1 Detention Basin	5 cfs	2' depth, 1' base width, 2:1 banks	18"
Dammeron 2 & 3 Detention Basin	25 cfs	3' depth, 2' base width, 2:1 banks	30"

Information for the drainage area that will be diverted to an adjacent existing drainage channel is shown in the table below. Once the drainage area is routed to the adjacent existing drainage channel, it is combined with the flows from a fifth drainage area that corresponds to it. The table below includes the required geometry to convey the flows, including flows once it is combined with the existing drainage corridor.

Alternative	Tributary Area	100-year Peak Flow	Open Channel	Culvert
Dammeron 4 Diversion Channel	1,104 ac	333 cfs	5' depth, 10' base width, 2:1 bank	N/A
Dammeron 4 Diversion Channel, including Existing Drainage Channel	2,404 ac	708 cfs	7' depth, 12' base width, 2:1 bank	(2) 72"

2. Diamond Valley

The Diamond Valley area includes four drainage areas. See attached Exhibit 6 for an overall exhibit of Diamond Valley and Exhibits 7 through 9 for exhibits specific to the proposed alternative for each drainage area. It is proposed to rehabilitate an existing detention basin (Diamond 1 Existing Detention Basin), which collects flows from three of the four drainage areas. Upstream of this detention basin, it is proposed rehabilitate another existing detention basin (Diamond 2 Existing Detention Basin), which collects flows from two drainage areas. The fourth and largest tributary drainage area is conveyed through the Diamond Valley community via an existing drainage channel. It is proposed to armor this channel (Diamond 4 Existing Channel) to protect adjacent infrastructure.

Information for both rehabilitated existing detention basins in shown in the table below. The 100-year peak flow and volume numbers are based off a preliminary analysis and will be updated per NRCS requirements. Earthwork quantities are estimated based on an estimated surface that removes the existing dams but does not include keyways and will be updated in the detailed design stages of the project.

Alternative	Tributary Area	100-year Peak Flow	100-year Volume	Est. Earthwork Quantity
Diamond 1 Existing Detention Basin	575 ac	505 cfs	37 ac-ft	12,390 cu-yd (cut) 11,370 cu-yd (fill)
Diamond 2 Existing Detention Basin	597 ac	536 cfs	38 ac-ft	10,900 cu-yd (cut) 10,200 cu-yd (fill)

An existing drainage channel conveys flows from Diamond 2 Existing Detention Basin to Diamond 1 Existing Detention Basin and another existing drainage channel conveys flows from the upstream drainage area into Diamond 2 Existing Detention Basin. Information for these channels is shown in the table below.

Downstream Channel Outlet	Channel Existing Capacity	Channel Existing Geometry
Diamond 1 Existing Detention Basin	380 cfs	3’ depth, 10’ base width, 3:1 banks
Diamond 2 Existing Detention Basin	138 cfs	2’ depth, 6’ base width, 4:1 banks

Finally, information for the Diamond 4 Existing Channel is shown in the table below. Note the geometry shown is intended to represent a general section of the channel since the geometry varies along the length of the channel. Riprap and other armoring methods will be analyzed in the detailed design stages of the project.

Alternative	100-year Peak Flow	Channel Existing Capacity	Channel Existing Geometry
Diamond 4 Existing Channel	2,214 cfs	3,704 cfs	12’ depth, 10’ base width, 1:1 banks

Hydraulic and Freeboard Report

Santa Clara Watershed

Washington County

PRELIMINARY

May 2022

ALPHA ENGINEERING

Table of Contents

Part I. Introduction

Washington County is proposing to install a series of new detention basins in Dammeron Valley and Diamond Valley in Washington County, Utah and to provide armoring along the Santa Clara River on Shivwits land near Ivins, Utah. The basins and armoring will provide flood protection to the local communities and Shivwits tribe farming area. The engineering design is being performed by Alpha Engineering Company out of its office in St. George, Utah.

The project includes the construction of three detention basins on dry washes to the east of Dammeron Valley; the rerouting of existing flows to an adjacent routed channel on the south end of Dammeron Valley; the reestablishment of three existing detention basins in Diamond Valley; the armoring and protection along an existing channel in Diamond Valley; and armoring portions of the south bank of the Santa Clara River just west of the Shivwits tribal community near the Shem dam. The dams will be earthen structures with principal spillways. The purpose of the basins is to detain peak flows during large storm events protecting downstream infrastructure. Due to homes located immediately downstream, these dams are classified as High Hazard.

This hydraulic analysis is being prepared to design elements associated with the construction and operation of the proposed detention basins and channels. The hydrologic analysis has been prepared under a separate report (Alpha Hydrology). The project locations are shown in **Figure 1**.

This report references the following sources in the hydraulic analysis of the Diamond and Dammeron Valley Detention Basins:

- Technical Release 210-60 (TR-210-60), USDA 2019
- Technical Release 210-56 (TR-210-56), USDA 2014
- National Engineering Handbook Part 630 (NEH), USDA 2019
- Preliminary Hydrology Report Santa Clara Watershed (Alpha Hydrology), Alpha Engineering 2021
- Design of Small Dams (USBR DAMS), USBR 1987

The following software programs were used in modeling the hydraulic conditions:

- HEC-HMS version 4.7.1, USACE 2021
- HEC-RAS version 5.0.7, USACE 2022

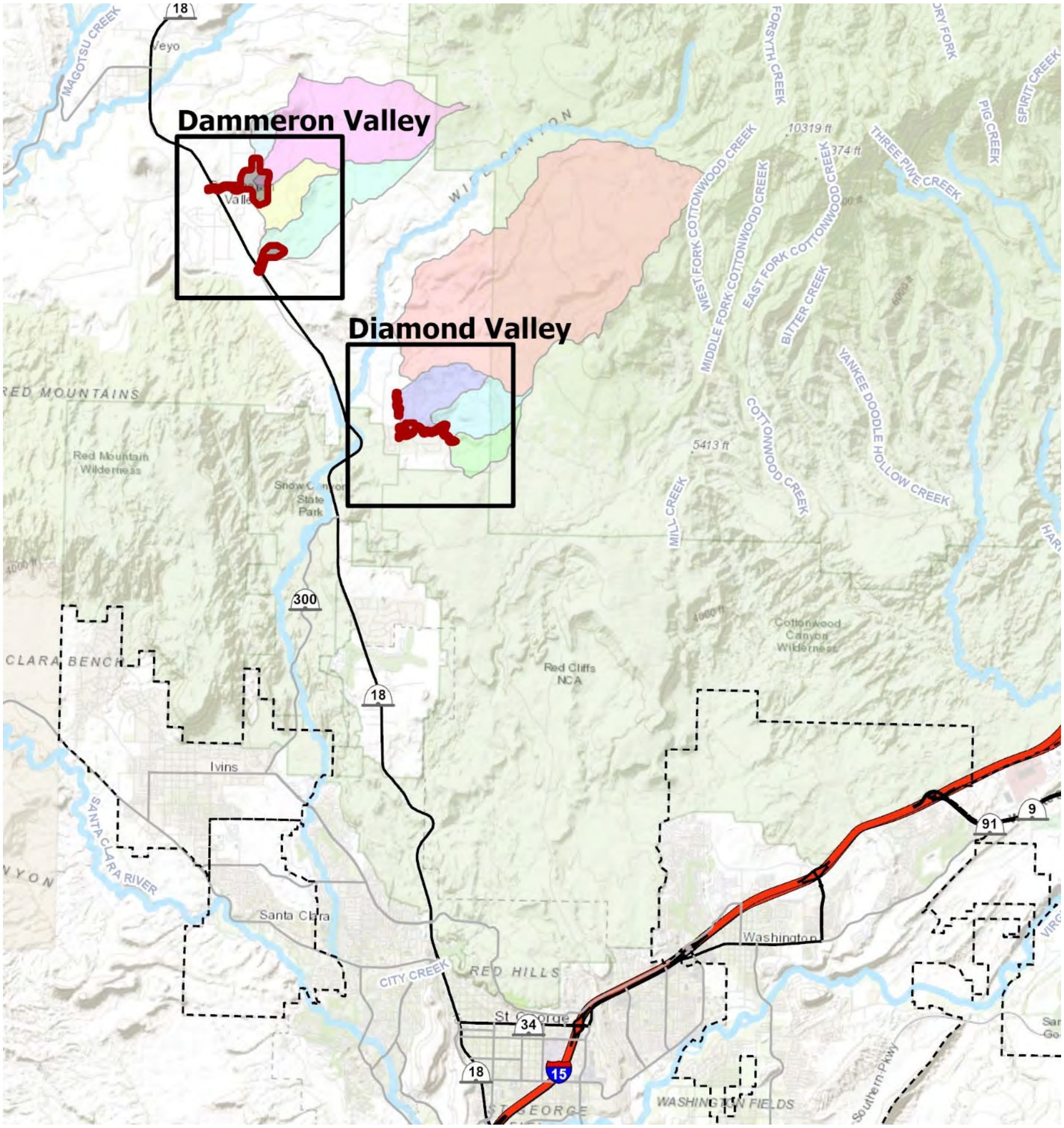


Figure 1 Dammeron Valley and Diamond Valley Location

Part II. Hydraulic Analysis

A. Detention Basin Operation

The project consists of eight separate dam structures across six debris basins and tributaries. The debris basins have individual uncontrolled low-level outlets that are designed to convey low flows that can be adequately conveyed in downstream drainage facilities (Alpha Hydrology), which are:

- Dammeron 1, 2 and 3: 30 cfs
- Diamond 1: 130 cfs
- Diamond 2: 5 cfs
- Diamond 3: 5 cfs

Principal spillways for each detention basin will be used to safely convey large storm events without causing damage to the dam structures.

Dammeron Valley involves four of the dam structures and three detention basins. Dammeron 1 includes two dam structures for one detention basin. Two detention basins, Dammeron 2 and 3, each have individual dam structures, but as water levels rise, the two basins combine into a single body of water with one spillway. Storm events will be attenuated through the three detention basins collected upstream of the community. The limited and attenuated flows will be safely routed through the community, across the downstream highway, and into existing drainage corridors. The hydraulic components of Dammeron Valley are shown in **Exhibit 1, Appendix A**.

Diamond Valley involves four more dam structures and three detention basins. The detention basins are existing but need dredging and rehabilitation. The spillway for Diamond 3 includes an existing bypass channel that conveys flows to Diamond 2, and the spillway for Diamond 2 includes an existing bypass channel that conveys flows to Diamond 1. Diamond 1 is currently a sump basin with no outlet. Each of the detention basins will be dredged and the existing dam structures will be rehabilitated. Due to site constraints, Diamond 1 will require two separate dam structures to reach the required capacity. The low-level outlet being proposed on Diamond 1 with this project will drain a portion of the sump basin, but the lower elevations of the detention basin will continue as a sump. Flows leaving Diamond 1 will be conveyed through new pipe to a nearby existing drainage corridor that has capacity to safely receive the flows. The hydraulic components of Diamond Valley are shown in **Exhibit 2, Appendix A**.

B. Spillway Analysis

The detention basins will consist of an uncontrolled outlet at the low point within each reservoir and a principal spillway at the 100-year volume storage elevation (Storm Event 01). The principal spillway, which includes a broad-crested weir discharging into a trapezoidal open channel, will be engaged for storm events larger than the 100-year storm event. Based on TR-60, Section 2-2 and Part 7, the hydrographs analyzed in designing the spillway configuration are the Principal Spillway Hydrograph (PSH), Auxiliary Spillway Hydrographs (ASH) and the Freeboard Hydrographs (FBH) (Storm Events 06-10). Additional storm events are being analyzed for comparison purposes and to ensure they are routed adequately through the uncontrolled outlet and spillway configuration (Storm Events 02-06 and 11-18). A summary of the storms is shown in **Table 1**.

	Storm Event	Duration	Frequency	AMC
01	100-year 24-hour	24-hour	100-year	II
02	100-year 6-hour AMC III	6-hour	100-year	III
03	100-year 24-hour AMC III	24-hour	100-year	III
04	Local SEP Hydrograph (SEP-L)	6-hour	Maximum	II
05	General SEP Hydrograph (SEP-G)	72-hour	Maximum	II
06	Principal Spillway Hydrograph (PSH)	10-day	100-year	-[1]
07	Local Auxiliary Spillway Hydrograph (ASH-L)	6-hour	Maximum	II
08	General Auxiliary Spillway Hydrograph (ASH-G)	24-hour	Maximum	II
09	Local Freeboard Hydrograph (FBH-L)	6-hour	Maximum	II
10	General Freeboard Hydrograph (FBH-G)	24-hour	Maximum	II
11	2-year 6-hour	6-hour	2-year	II
12	5-year 6-hour	6-hour	5-year	II
13	10-year 6-hour	6-hour	10-year	II
14	25-year 6-hour	6-hour	25-year	II
15	50-year 6-hour	6-hour	50-year	II
16	100-year 6-hour	6-hour	100-year	II
17	200-year 6-hour	6-hour	200-year	II
18	500-year 6-hour	6-hour	500-year	II

Table 1 Summary of Storm Events

HEC-HMS and SITES was used to model the storm events. The spillway was iteratively designed in the model to accurately reflect conditions. A principal spillway crest elevation adequate to hold the 100-year storm event (Storm Event 01) was used and each of the storm events were attenuated accordingly.

C. Spillway Parameters

Models were setup in HEC-HMS and calibrated with the uncontrolled outlets and spillways based on the corresponding storm events. The inflow hydrographs for each storm event produced in the Alpha Hydrology report were input into the model. Output for the model is included in **Appendix C**. A summary of parameters derived from the Alpha Hydrology report in conjunction with the calibrated uncontrolled outlets and spillways for each detention basin are shown in **Table 2**. Sediment volumes have been incorporated to each detention basin based on preliminary

[1] Curve Numbers reflected in NEH 630.2102, Table 21-2, are used for the PSH where precipitation value exceeds 6”.

calculations. These sediment volumes will be refined with more detailed analysis of the upstream tributary basins. This table also includes the results from these parameters within the HEC-HMS model.

	Damm 1	Damm 2	Damm 3	Diam 1	Diam 2	Diam 3
Tributary Area	0.3 sq mi 182 ac	3.6 sq mi 2,286 ac	0.7 sq mi 470 ac	0.9 sq mi 575 ac	0.9 sq mi 597 ac	0.6 sq mi 386 ac
Curve Number	86.8	83.9	87.9	87.8	85.8	88.9
10-day, 100-yr (PSH) Flow	298 cfs	2,518 cfs	655 cfs	847 cfs	860 cfs	608 cfs
10-day, 100-yr (PSH) Volume	80 ac ft	1,013 ac ft	188 ac ft	246 ac ft	246 ac ft	171 ac ft
Low Level Outlet Flow	5 cfs	25 cfs[2]		130 cfs	5 cfs	5 cfs
ASH Flow (L/G), cfs	475/149	2,325/1,520	941/348	1,183/440	1,120/434	893/306
ASH Runoff Volume (L/G), in	4.91/5.73	4.37/5.84	4.90/5.71	4.91/6.25	4.94/6.31	4.91/6.27
FBH Flow (L/G), cfs	1,312/406	6,533/4,406	2,658/946	3,344/1,214	3,275/1,201	2,446/816
FBH Runoff Volume (L/G), in	11.73/14.10	9.30/14.05	11.73/14.10	11.73/14.10	11.73/14.10	11.73/14.10
Storm Detention Volume	21 ac ft	312 ac ft[2]		51 ac ft	13 ac ft	8 ac ft
Sediment Detention Volume	5 ac ft	65 ac ft	15 ac ft	10 ac ft	11 ac ft	4 ac ft
Total Detention Volume	26 ac ft	392 ac ft[2]		61 ac ft	24 ac ft	12 ac ft
Maximum Water Elevation	4694.4’	4700.2’[2]		4560.0’	4604.0’	4611.0’
Spillway Peak Flow	1,199 cfs	7,124 cfs[2]		3,296 cfs	2,538 cfs	2,078 cfs

Table 2 Summary of Results

The worst-case scenario storm event for each detention basin is the Local Freeboard Hydrograph (FBH-L, Storm Event 09). This storm event is also referred to as the Inflow Design Flood (IDF) and was used in determining the maximum water elevation.

Additional constraints are considered in the design of the uncontrolled outlets and principal spillways. A riser is proposed to be installed at the inlet to the uncontrolled outlet. The riser shall have a larger cross-sectional area to reduce excessive surging, noise, vibration and vortex action. Per TR-60, Section 6-2, this cross-sectional area shall be a minimum of 2.5’ x 7.5’ (L x W). A trash rack shall be incorporated into the riser structure to avoid clogging, and an anti-vortex device (i.e. anti-vortex baffle plate) shall also be incorporated to prevent a vortex condition as water spills into the riser. An air vent is also added to the inlet to remove air and improve hydraulic performance.

Based on the HEC-HMS model results and the site and code constraints, spillway parameters were selected and are shown in **Table 3**.

[2] Dammeron 2 and 3 collect flows from separate tributary basins. However, their low-level outlets combine just downstream of the dam; and during large storm events, they combine and discharge through a single spillway.

	Damm 1	Damm 2	Damm 3	Diam 1	Diam 2	Diam 3
Uncontrolled Outlet Diameter[3]	30 in	30 in	30 in	30 in	30 in	30 in
Spillway Crest Elevation	4691.5’	4697.0’[3]		4556.0’	4600.0’	4607.0’
Spillway Base Width	90’	450’[3]		150’	130’	100’
Top of Dam Elev	4694.5’	4700.2’[3]		4560.0’	4604.0’	4611.0’
Height of Dam	33.5’	38.0’[3]		12’	19’	15’

Table 3 Spillway Design Parameters

D. Emergency Drain and Outlet Works

The emergency drain pipeline is required to drain the water supply storage in case of emergency. According to Utah State Code R655-11-7A, the pipeline is required to drain 90% of the storage volume within 30 days neglecting reservoir inflows.

As discussed, the detention basins have uncontrolled low-level outlets that are sized based on allowable downstream flows. These allowable flows and the amount of time required to drain the detention basins is summarized in **Table 4**.

	Damm 1	Damm 2	Damm 3	Diam 1	Diam 2	Diam 3
Detention Basin Storage	26 ac ft	390 ac ft[4]		61 ac ft	27 ac ft	14 ac ft
Low Level Outlet Flow	5 cfs	25 cfs[5]		120 cfs	10 cfs	10 cfs
Time to Drain	2.6 days	7.9 days[5]		0.3 days	1.4 days	0.71 days

Table 4 Emergency Drain Calculations

[3] An orifice plate or similar structure will be required to limit flows to less than the capacity of the indicated diameter such that flows do not exceed the Low-Level Outlet Flow shown in Table 2.

[4] Dammeron 2 and 3 collect flows from separate tributary basins. However, their low-level outlets combine just downstream of the dam; and during large storm events, they combine and discharge through a single spillway.

Part III. Freeboard Analysis

A. Storm and Wind Events

The Administrative Rules for Dam Safety and TR-60, Part 5, state that the freeboard above the spillway crest elevation must exceed the values produced by the scenarios given below. In analyzing a permeable and an impermeable dam, a range of freeboard is given for the first and second condition. The dam is considered to be semi-permeable, and therefore, the actual freeboard requirement is adjusted within this range.

1. 100-year, 24-hour storm (AMC III) in conjunction with a 50-mph wind.
2. 100-mph wind without any significant rainstorm.
3. IDF (or FBH-G) without any significant windstorm.
4. ASH with Wave Action (TR-60)

Where these detention basins will be empty under non-storm event conditions, Scenario 2 will not produce any wave runup and is not further analyzed.

B. Design Waves

Historic data for the design wind for these detention basins is not available. The fetch length was determined for each of the detention basins. The fetch lengths are illustrated in **Exhibits 3 and 4, Appendix A**. Calculations are included in **Appendix B**. The fetch lengths are less than one mile and a minimum freeboard of three feet is assumed for each detention basin for Scenario 1 (USBR DAMS).

Wave Action was further calculated using procedures outlined in TR-210-56. The maximum overwater wind velocity calculated to 81 mph and produced wave heights for each detention basin less than one foot. A minimum freeboard of one foot is assumed for each detention basin in Scenario 4. Calculations are included in **Appendix B**.

C. Results

The total required freeboard for each storm and wind event is summarized in **Table 5**. The Storm Freeboard is taken from the difference between the principal spillway crest elevation and the maximum water surface elevation produced by the respective storm events. The Total Freeboard is the sum of the Storm Freeboard plus the Wave Freeboard.

	Damm 1	Damm 2	Damm 3	Diam 1	Diam 2	Diam 3
100-yr, 24-hr Water Rise	0.0 ft	0.0 ft[5]		0.0 ft	0.0 ft	0.0 ft
50-mph Wind Wave	3.0 ft	3.0 ft[6]		3.0 ft	3.0 ft	3.0 ft
Scenario 1 Freeboard	3.0 ft	3.0 ft[6]		3.0 ft	3.0 ft	3.0 ft
IDF Water Rise	3.0 ft	3.2 ft[6]		4.0 ft	4.0 ft	4.0 ft
Scenario 3 Freeboard	3.0 ft	3.2 ft[6]		4.0 ft	4.0 ft	4.0 ft
ASH Water Rise	0.7 ft	1.4 ft[6]		2.7 ft	2.1 ft	1.9 ft
Wave Action	1.0 ft	1.0 ft[6]		1.0 ft	1.0 ft	1.0 ft
Scenario 4 Freeboard	1.7 ft	2.4 ft[6]		3.7 ft	3.1 ft	2.9 ft

Table 5 Total Freeboard Requirements

The governing total freeboard requirement is Scenario 3 for each of the detention basins. The top of dam outlined in Table 3 therefore considers freeboard requirements and is the proposed top of dam for each of the detention basins.

[5] Dammeron 2 and 3 collect flows from separate tributary basins. However, their low-level outlets combine just downstream of the dam; and during large storm events, they combine and discharge through a single spillway.

Part IV. Inundation Maps

A. Inundation Events

A breach analysis and each of the frequency storm events (Storm Events 11 through 18) before and after the project was modeled using HEC-RAS to determine the inundation boundaries. Constraints were input based on the hydraulic analysis discussed in this report. The terrain downstream of the dam structure was imported into the HEC-RAS geometry editor using USGS 2017 1M Bare Earth LiDAR DEM files.

The inundation boundaries were mapped and are shown on Exhibits 5 through 26. The following inundation boundaries are included for both Dammeron Valley and Diamond Valley:

- IDF (or FBH-G), Breach Analysis
- 2-year, 6-hour
- 5-year, 6-hour
- 10-year, 6-hour
- 25-year, 6-hour
- 50-year, 6-hour
- 100-year, 6-hour
- 200-year, 6-hour
- 500-year, 6-hour

B. Breach Analysis

A breach simulation was completed at each detention basin during a "Rainy Day" scenario. Where these detention basins are not designed to hold water, the "Sunny Day" scenario was not included. It is assumed that the water level is at the auxiliary spillway crest elevation at the start of each model. Per TR-60, the minimum peak discharge of the breach hydrograph is:

$$Q_{max} = 1{,}100\left(\frac{V_s H_w}{A}\right)^{1.35}$$

But not less than,

$$Q_{max} = 3.2H_w^{2.5}$$

Nor more than,

$$Q_{max} = 65H_w^{1.85}$$

Where,

V_s = Reservoir Storage at Breach
H_w = Depth of Water at Breach
A = Cross-sectional Area of Dam Embankment at Breach Location

A summary of the breach parameters for each detention basin, including the peak flow during the breach, is summarized in **Table 6**.

	Damm 1	Damm 2	Damm 3	Diam 1	Diam 2	Diam 3
Reservoir Storage at Breach	26 ac ft	266 ac ft	126 ac ft	61 ac ft	24 ac ft	12 ac ft
Depth of Water at Breach	30.5 ft	35 ft	25 ft	8 ft	15 ft	11 ft
Cross-Sectional Area of Dam	3,770 sf	4,790 sf	2,690 sf	580 sf	1,310 sf	860 sf
Peak Flow during Breach	16,440 cfs	23,191 cfs	10,000 cfs	879 cfs	2,789 cfs	1,284 cfs

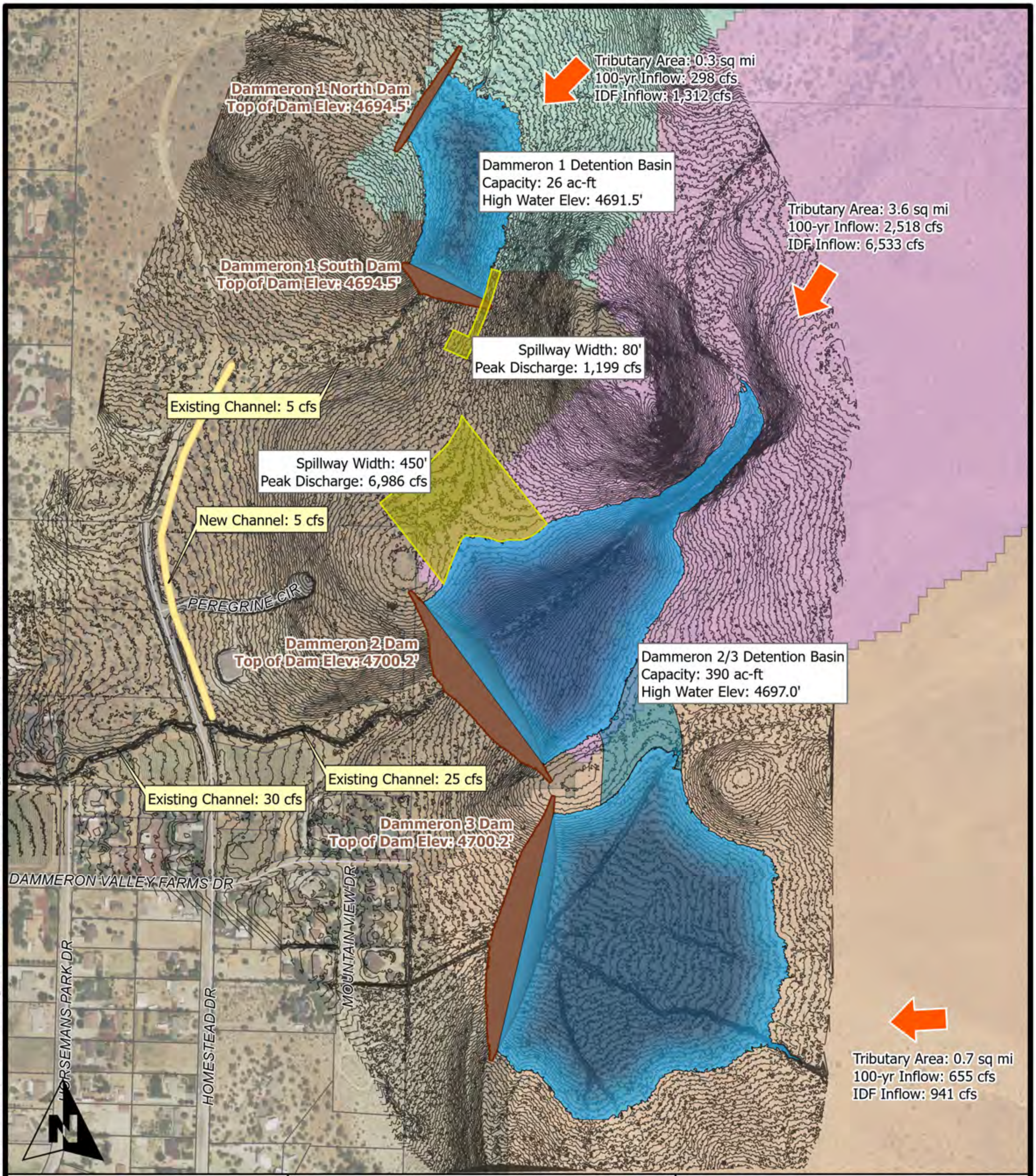
Table 6 Breach Parameters

APPENDIX E-4B

TECHNICAL DOCUMENTS, CONTINUED

Appendix A. Exhibits

Exhibits 1-2	***Hydraulic Overview Exhibits***
Exhibits 3-4	***Fetch Length Exhibits***
Exhibits 5-10	***Breach Inundation Maps***
Exhibits 11-26	***Frequency Storms Inundation Maps***



0 130 260 520 780

Feet

- Dam
- Detention Basin High Water
- Excavated Channel
- Spillway
- New Channel
- DiamDamBndry
- Spillway

DRAFT

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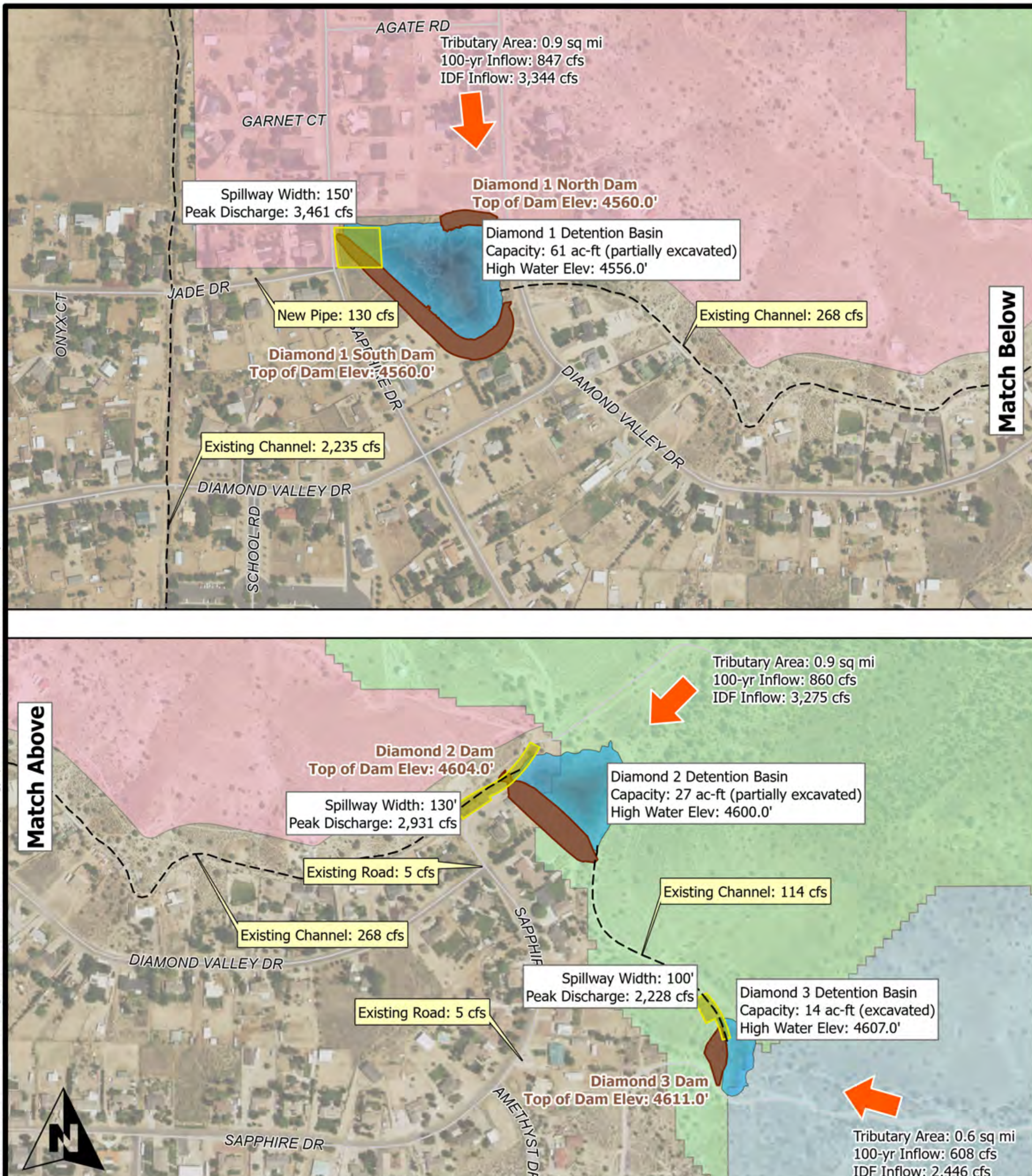
Exhibit 1. Dammeron Valley

Santa Clara Watershed Hydraulics

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 500 feet
Date:	January 4, 2022



0 130 260 520 780
Feet

Dam
Detention Basin High Water
Spillway

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Exhibit 2. Diamond Valley
Santa Clara Watershed Hydraulics

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 500 feet
Date:	February 28, 2022

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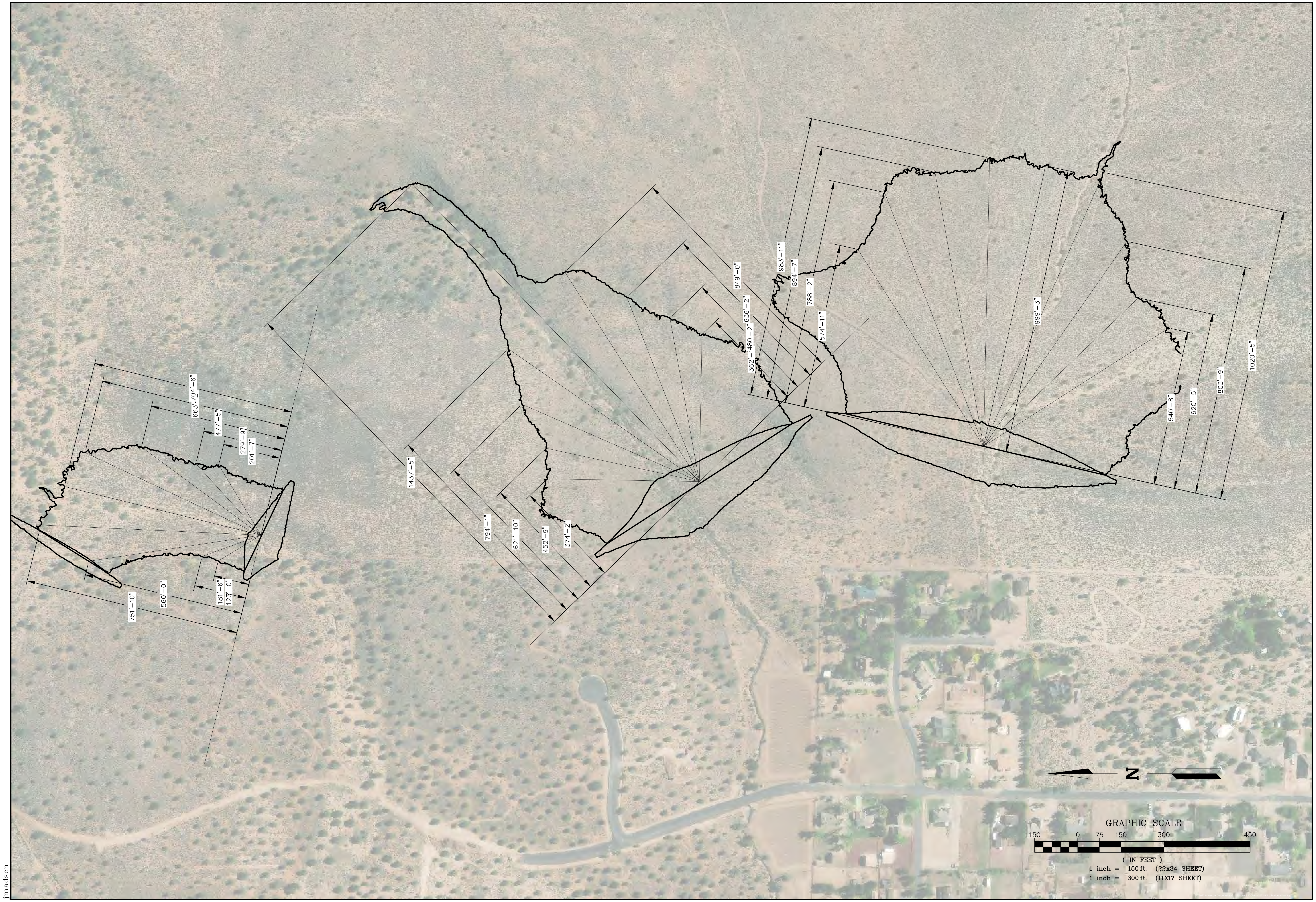

NO.	DATE	BY	DESCRIPTION

REVISIONS

PRELIMINARY
NOT FOR CONSTRUCTION

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TITLE
DAMMERON VALLEY FETCH LENGTH EXHIBIT

PROJECT
SANTA CLARA EA
WASHINGTON COUNTY, UTAH

PROJECT #	308-10
NAME	JTM
DATE	FEBRUARY 1, 2022
SCALE	AS NOTED
SHEET	Exhibit 3
FILE	308-10 EXH.dwg

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NO.	DATE	BY	DESCRIPTION

REVISIONS

PRELIMINARY
NOT FOR CONSTRUCTION

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TITLE: DIAMOND VALLEY FETCH LENGTH EXHIBIT

PROJECT: SANTA CLARA EA
WASHINGTON COUNTY, UTAH

PROJECT # 308-10
NAME JTM
DATE FEBRUARY 1, 2022
SCALE AS NOTED

SHEET Exhibit 4

FILE 308-10 EXH.dwg

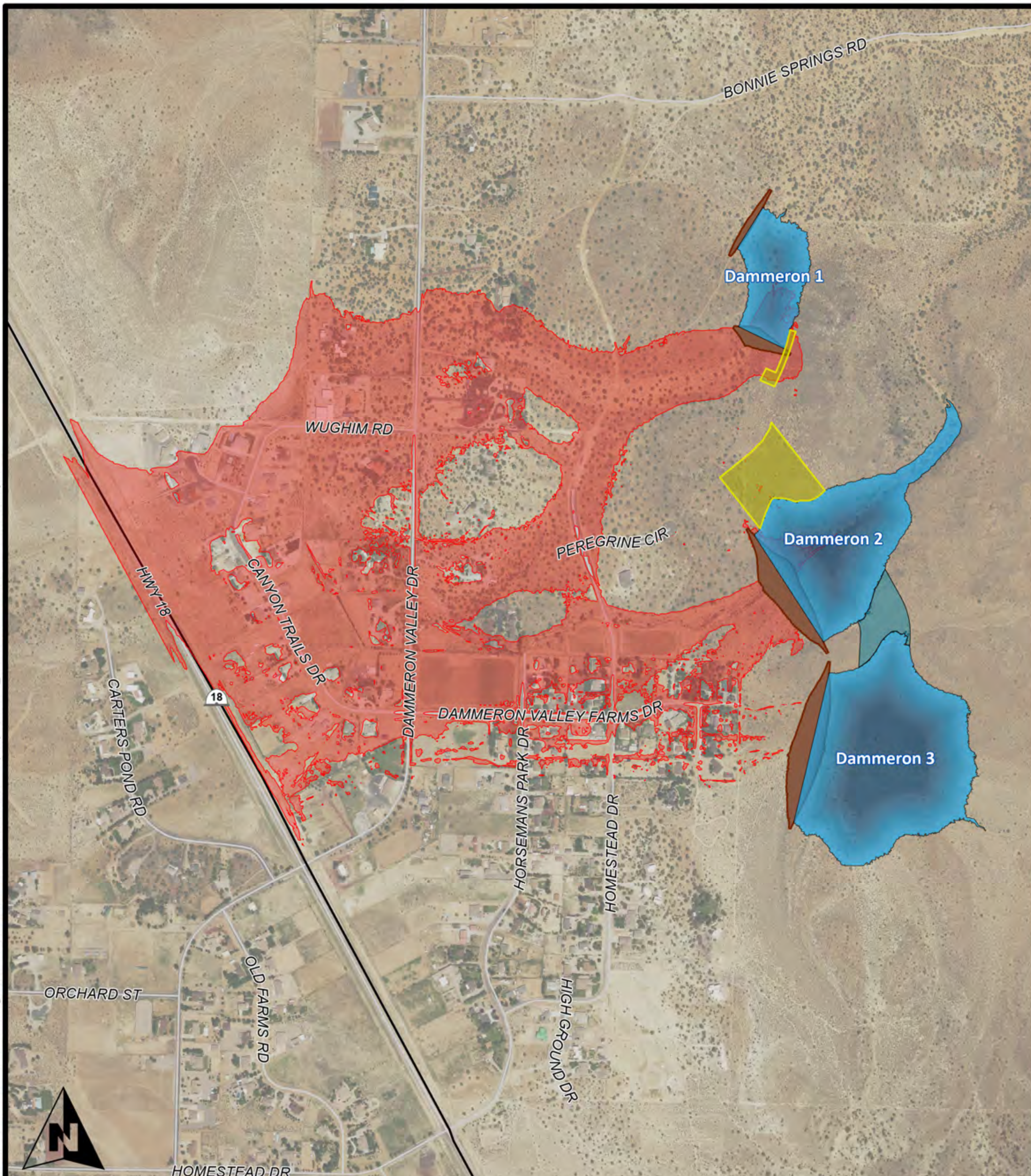

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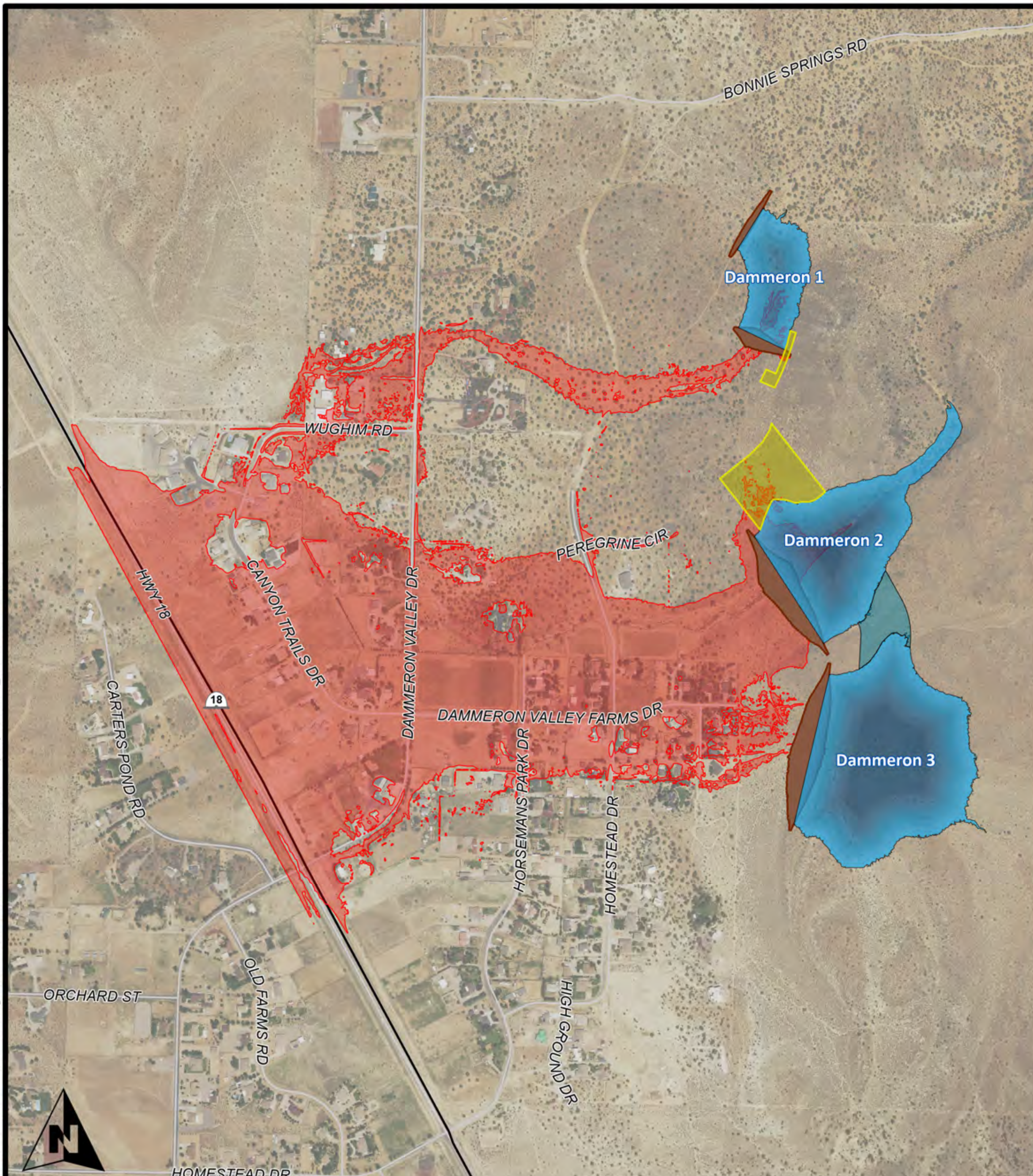
Fig 5. Damm1 Breach Map
Santa Clara EA, Dammeron Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 800 feet
Date:	May 11, 2022



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Feet

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- Dam
- Detention Basin High Water
- Excavated Channel
- Spillway
- Dammeron 2 Breach Inundation Boundary
- Diamond 2 Breach Inundation Boundary

Fig 6. Damm2 Breach Map
Santa Clara EA, Dammeron Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 800 feet
Date:	May 11, 2022

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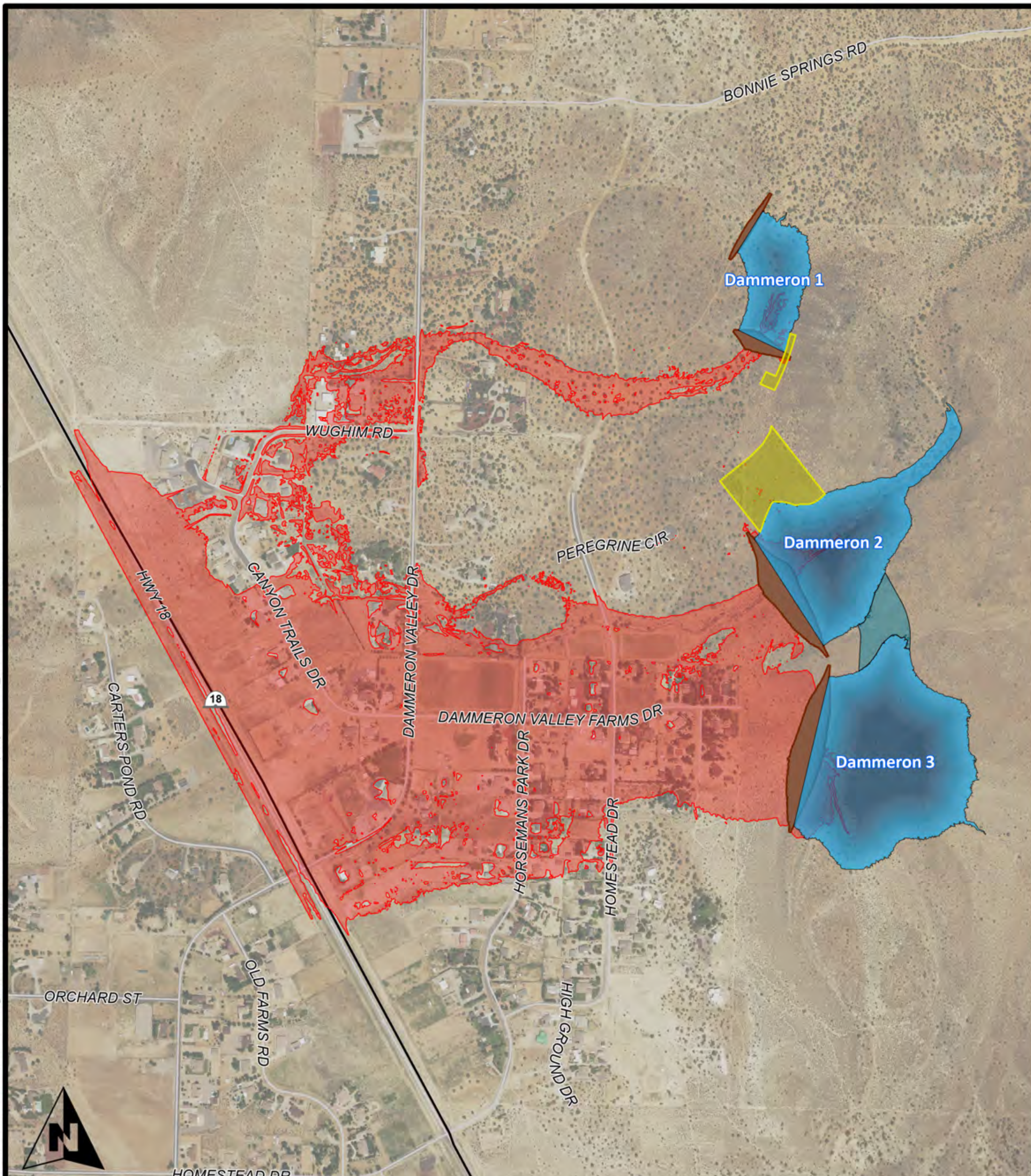

0 200 400 800 1,200
Feet

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- Dam
- Detention Basin High Water
- Excavated Channel
- Spillway
- Dammeron 3 Breach Inundation Boundary
- Diamond 3 Breach Inundation Boundary

Fig 7. Damm3 Breach Map
Santa Clara EA, Dammeron Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 800 feet
Date:	May 11, 2022

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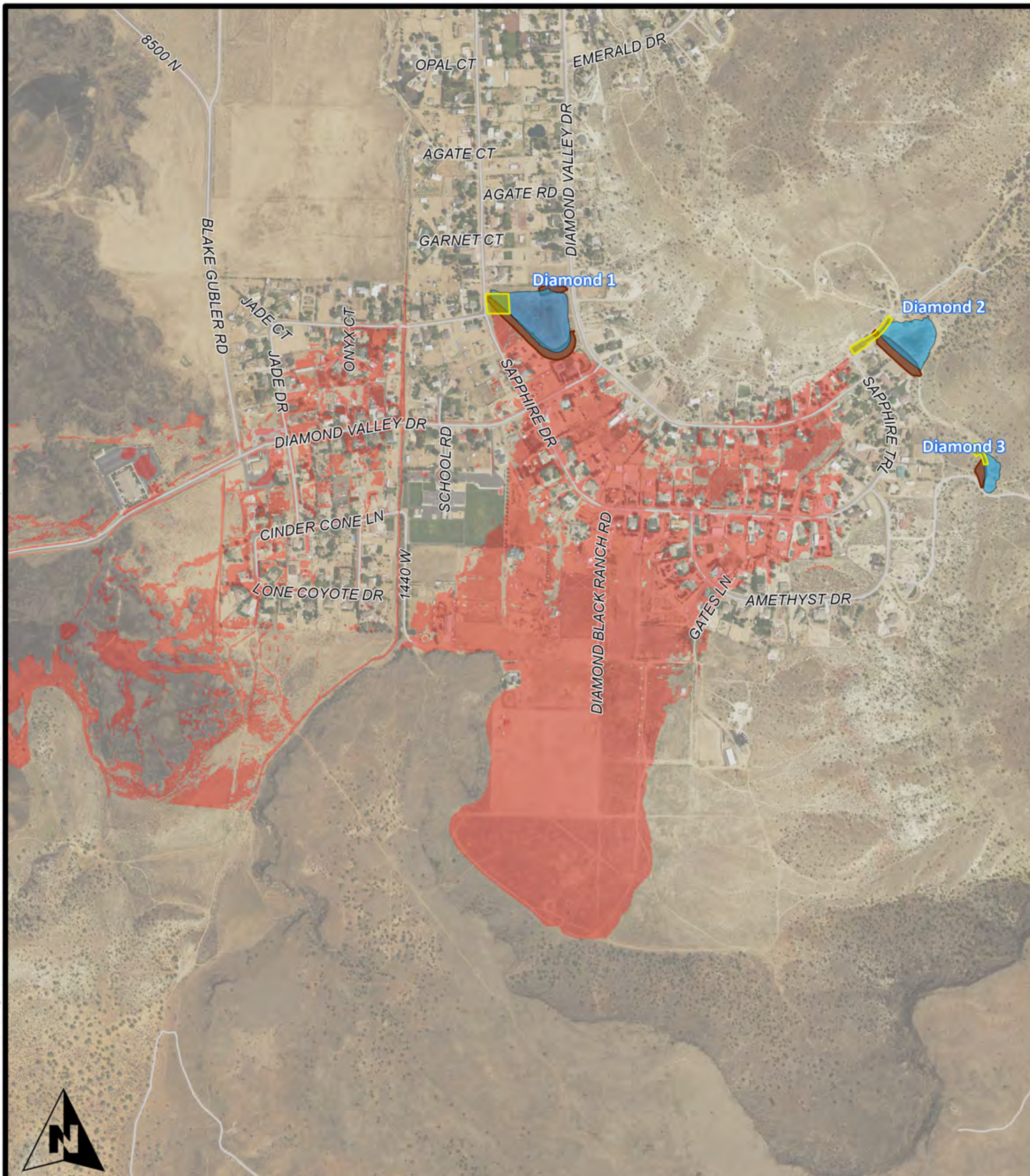

Dam
Detention Basin High Water
Excavated Channel
Spillway
Diamond 1 Breach Inundation Boundary

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Fig 8. Diam1 Breach Map
Santa Clara EA, Diamond Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 1,000 feet
Date:	May 11, 2022

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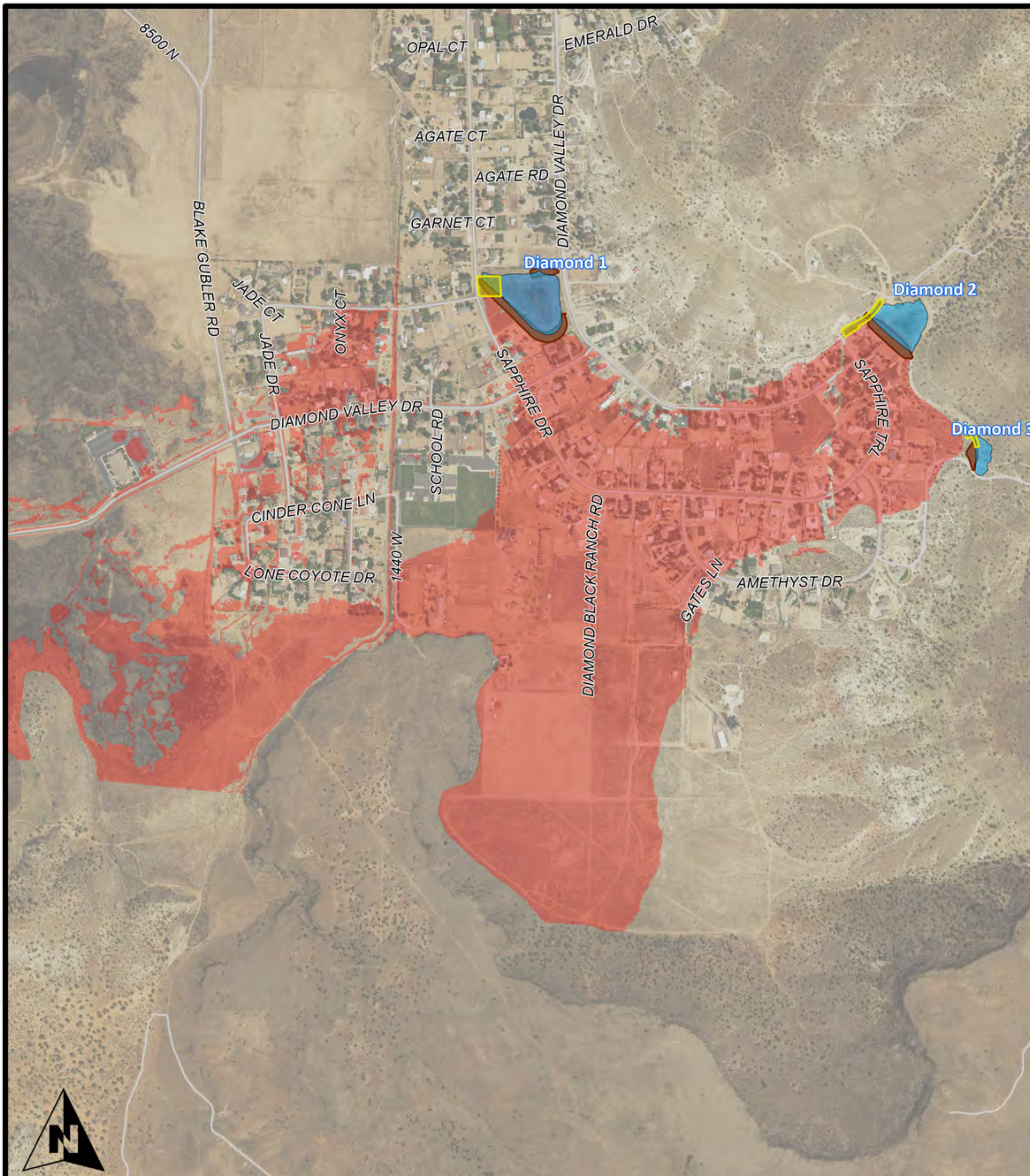

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Feet

Dam
Detention Basin High Water
Excavated Channel
Spillway
Diamond 2 Breach Inundation Boundary

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Fig 9. Diam2 Breach Map
Santa Clara EA, Diamond Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 1,000 feet
Date:	May 11, 2022

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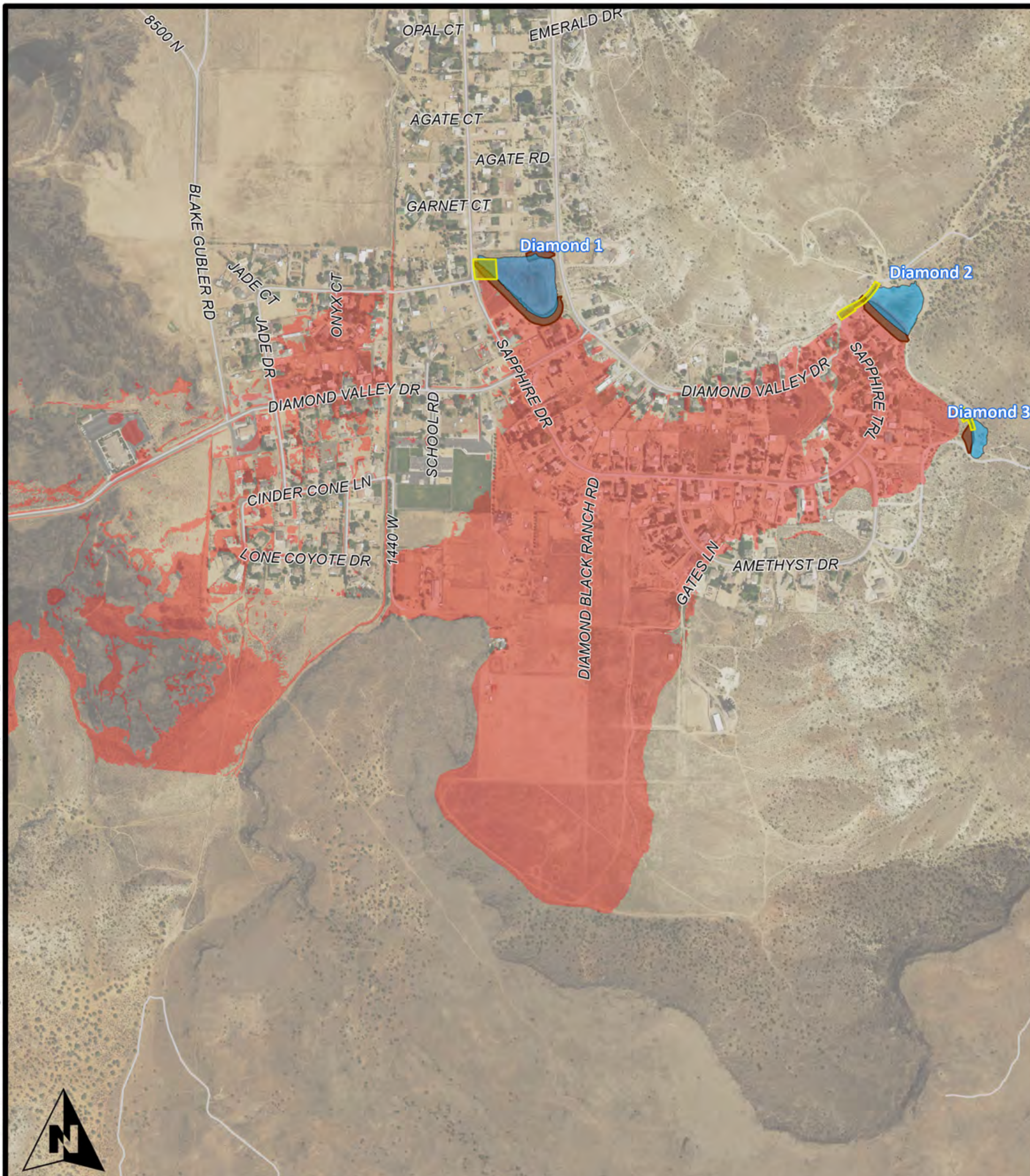

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Dam
Detention Basin High Water
Excavated Channel
Spillway
Diamond 3 Breach Inundation Boundary

Fig 10. Diam3 Breach Map
Santa Clara EA, Diamond Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 1,000 feet
Date:	May 11, 2022

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APPENDIX E-4C

TECHNICAL DOCUMENTS, CONTINUED

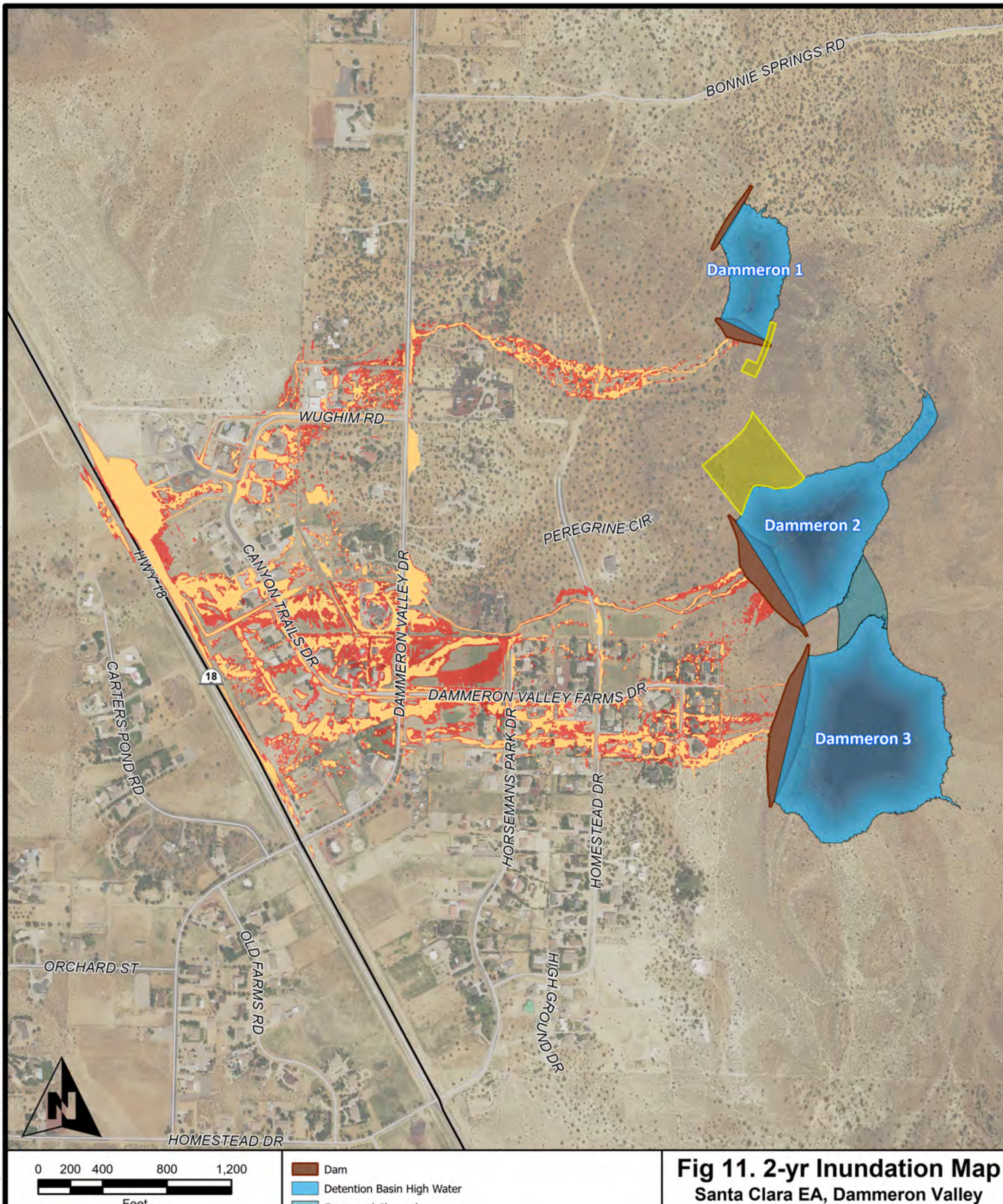

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Fig 11. 2-yr Inundation Map

Santa Clara EA, Dammeron Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 800 feet
Date:	May 11, 2022

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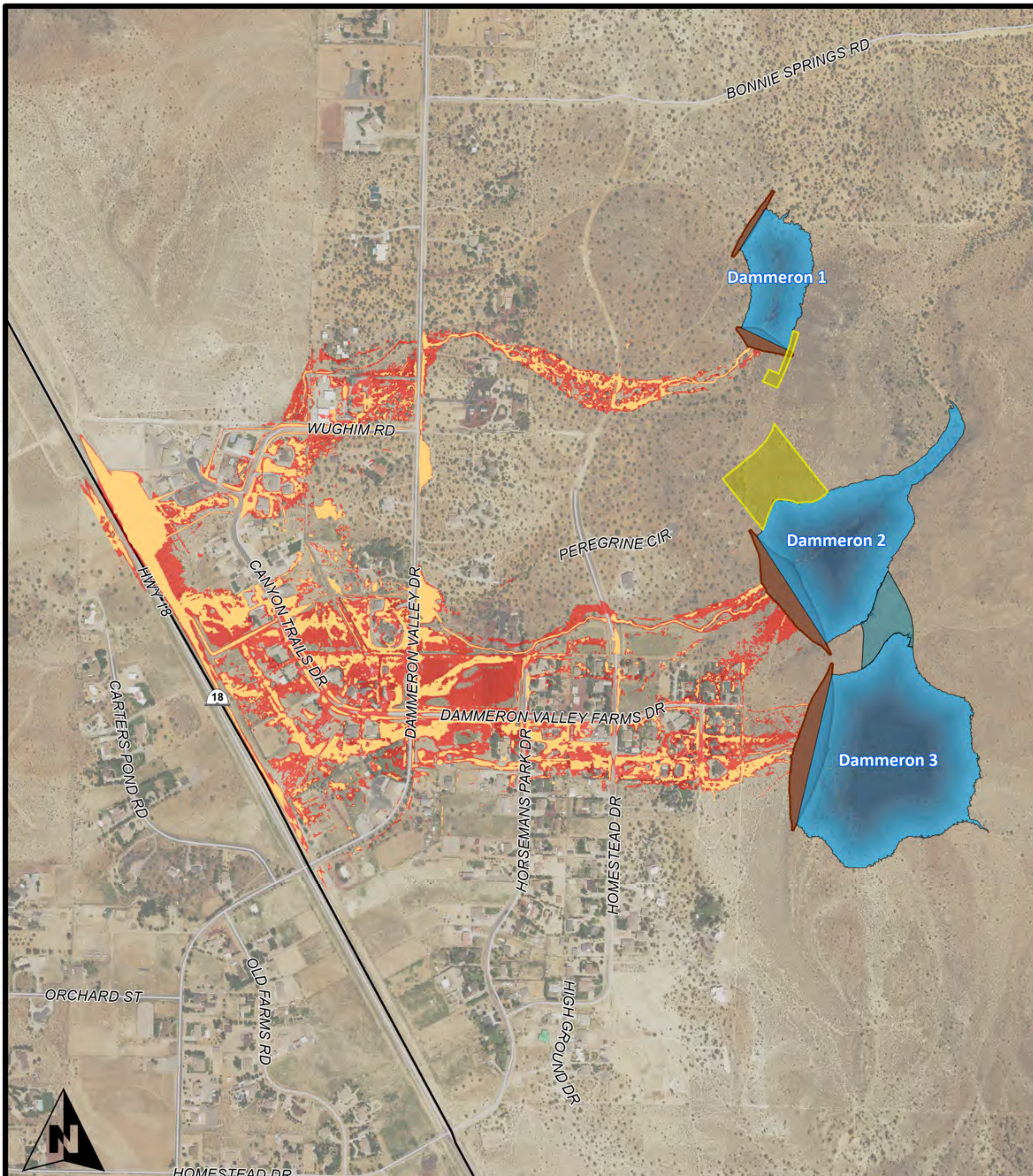

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Feet

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- Dam
- Detention Basin High Water
- Excavated Channel
- Spillway
- 5-year Inundation Boundary without Dams
- 5-year Inundation Boundary with Dams
- 5-year Inundation Boundary without Dams
- 5-year Inundation Boundary with Dams

Fig 12. 5-yr Inundation Map

Santa Clara EA, Dammeron Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 800 feet
Date:	May 11, 2022

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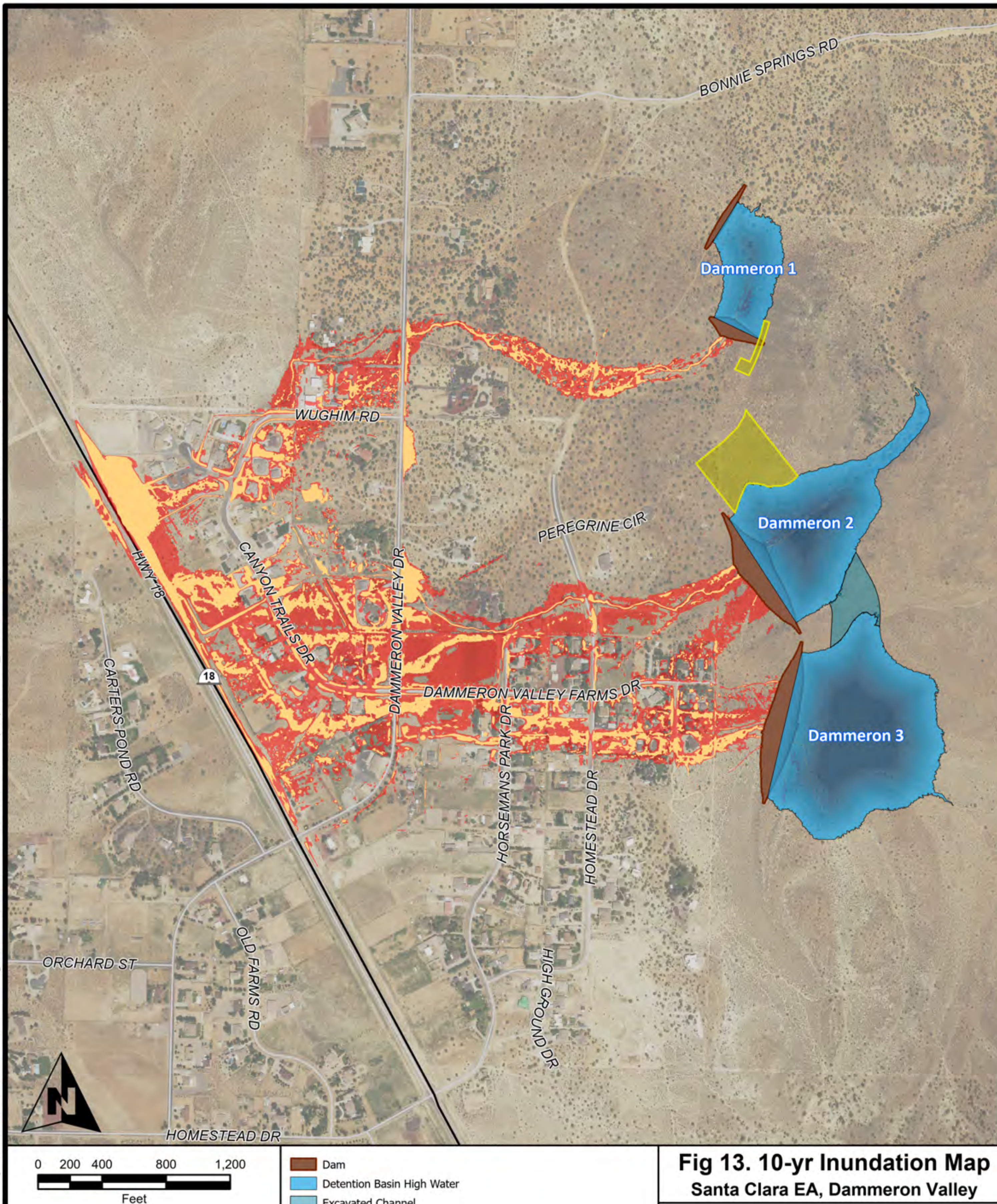

Dam
Detention Basin High Water
Excavated Channel
Spillway
10-year Inundation Boundary without Dams
10-year Inundation Boundary with Dams
10-year Inundation Boundary without Dams
10-year Inundation Boundary with Dams

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Fig 13. 10-yr Inundation Map
Santa Clara EA, Dammeron Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 800 feet
Date:	May 11, 2022

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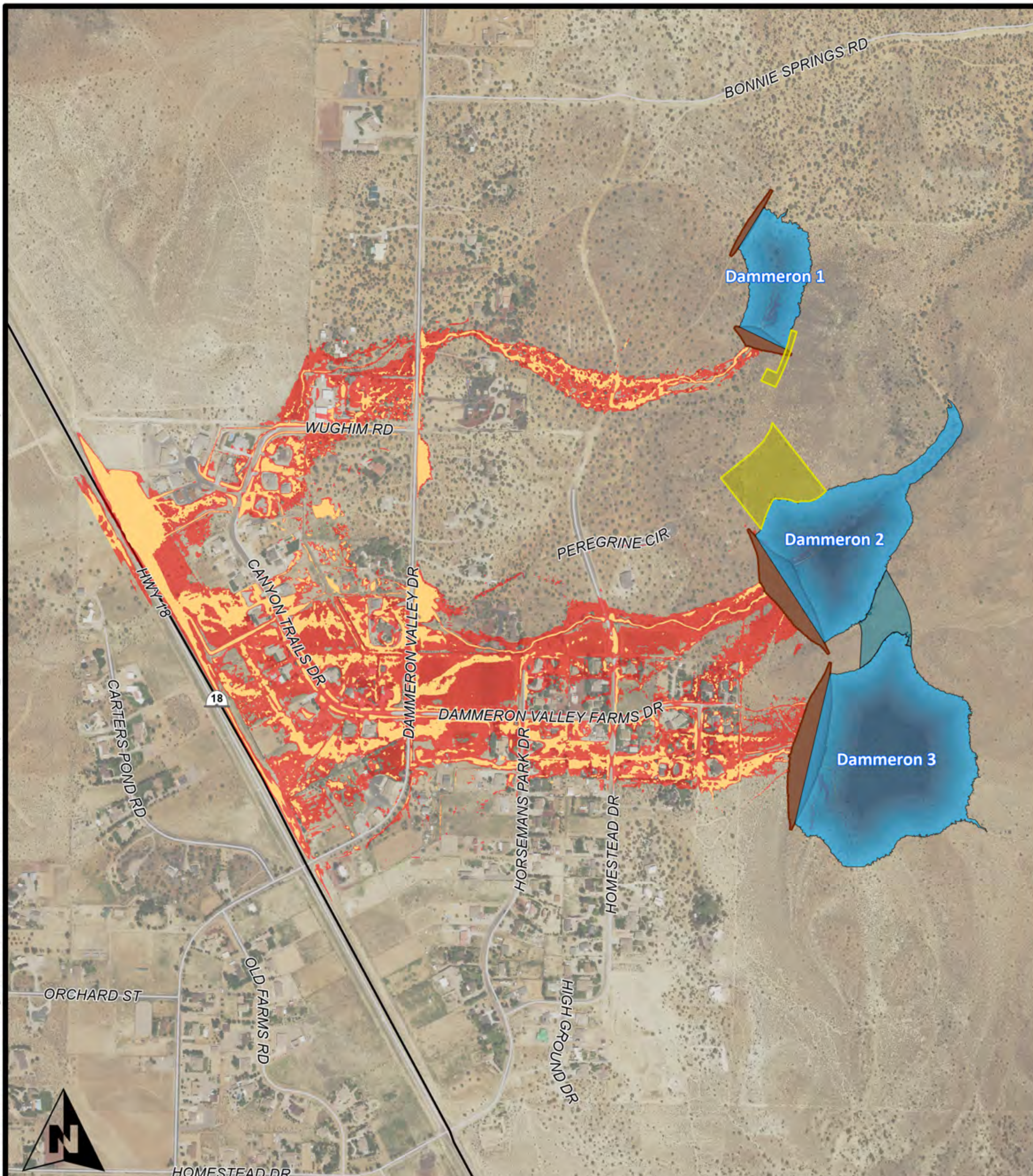

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Feet

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- Dam
- Detention Basin High Water
- Excavated Channel
- Spillway
- 25-year Inundation Boundary without Dams
- 25-year Inundation Boundary with Dams
- 25-year Inundation Boundary without Dams
- 25-year Inundation Boundary with Dams

Fig 14. 25-yr Inundation Map

Santa Clara EA, Dammeron Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 800 feet
Date:	May 11, 2022

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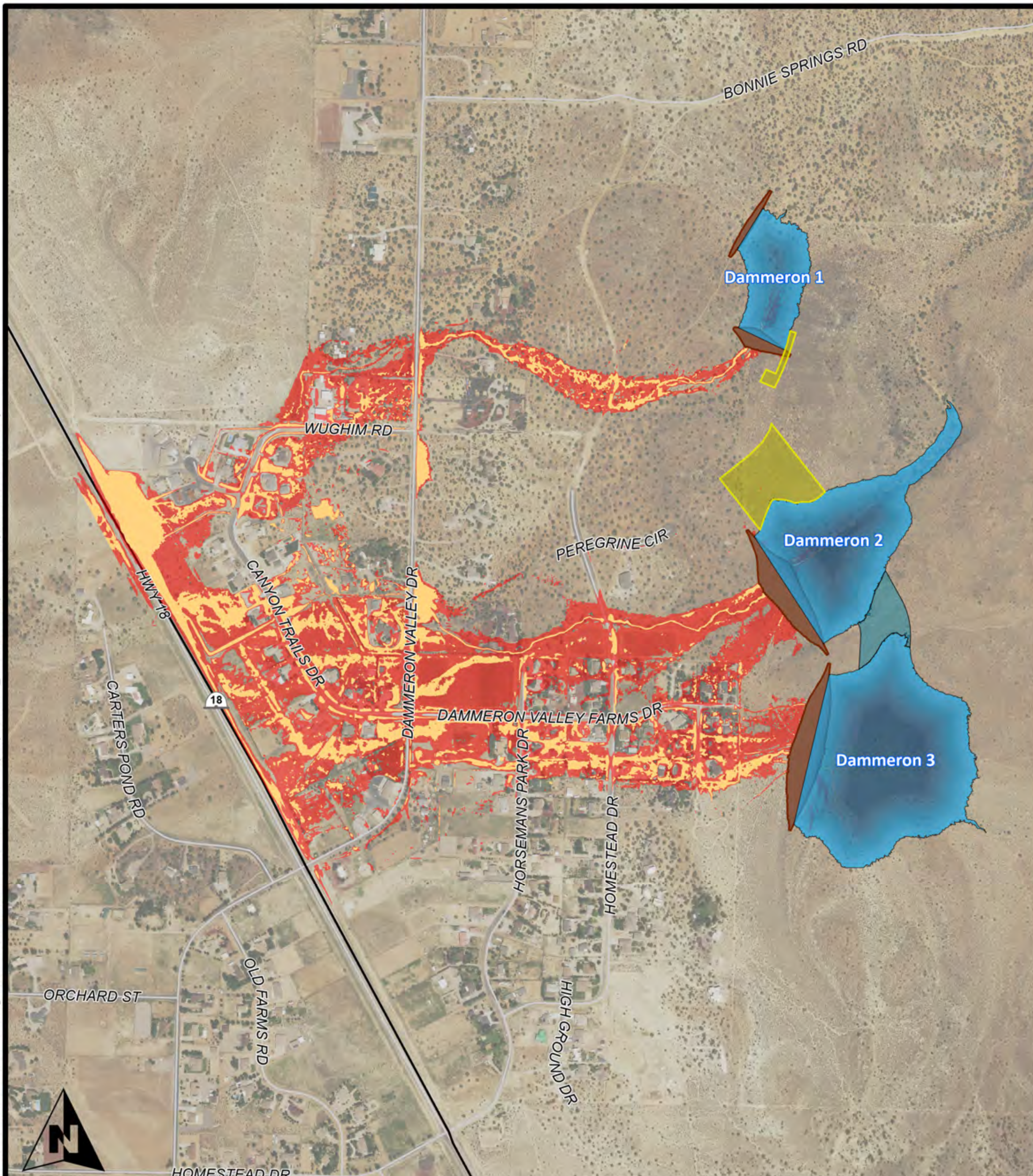

0 200 400 800 1,200

Feet

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- Dam
- Detention Basin High Water
- Excavated Channel
- Spillway
- 50-year Inundation Boundary without Dams
- 50-year Inundation Boundary with Dams
- 50-year Inundation Boundary without Dams
- 50-year Inundation Boundary with Dams

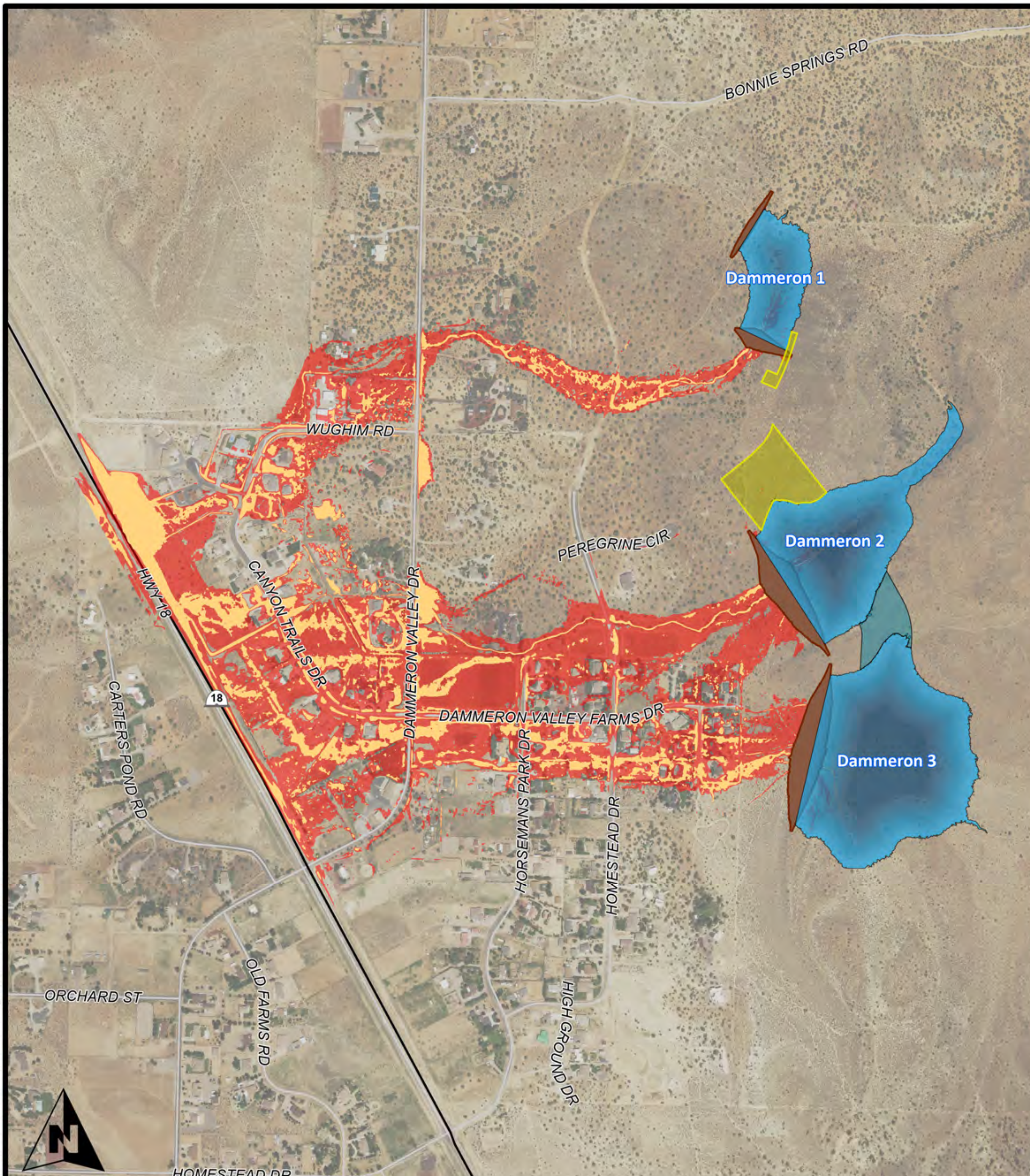
Fig 15. 50-yr Inundation Map

Santa Clara EA, Dammeron Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 800 feet
Date:	May 11, 2022

P:\308-10 Washington County - Santa Clara Watershed Plan EA\Drawings\GIS\ArcGIS Pro\Santa Clara EA Inundation Maps.aprx, DAMM_Inundation Comparison - 50-yr, 5/25/2022 10:42 AM jmadsen

P:\308-10 Washington County - Santa Clara Watershed Plan EA\Drawings\GIS\ArcGIS Pro\Santa Clara EA Inundation Maps.aprx, DAMM_Inundation Comparison - 100-yr, 5/25/2022 10:42 AM jmadsen



0 200 400 800 1,200

Feet

- Dam
- Detention Basin High Water
- Excavated Channel
- Spillway
- 100-year Inundation Boundary without Dams
- 100-year Inundation Boundary with Dams
- 100-year Inundation Boundary without Dams
- 100-year Inundation Boundary with Dams

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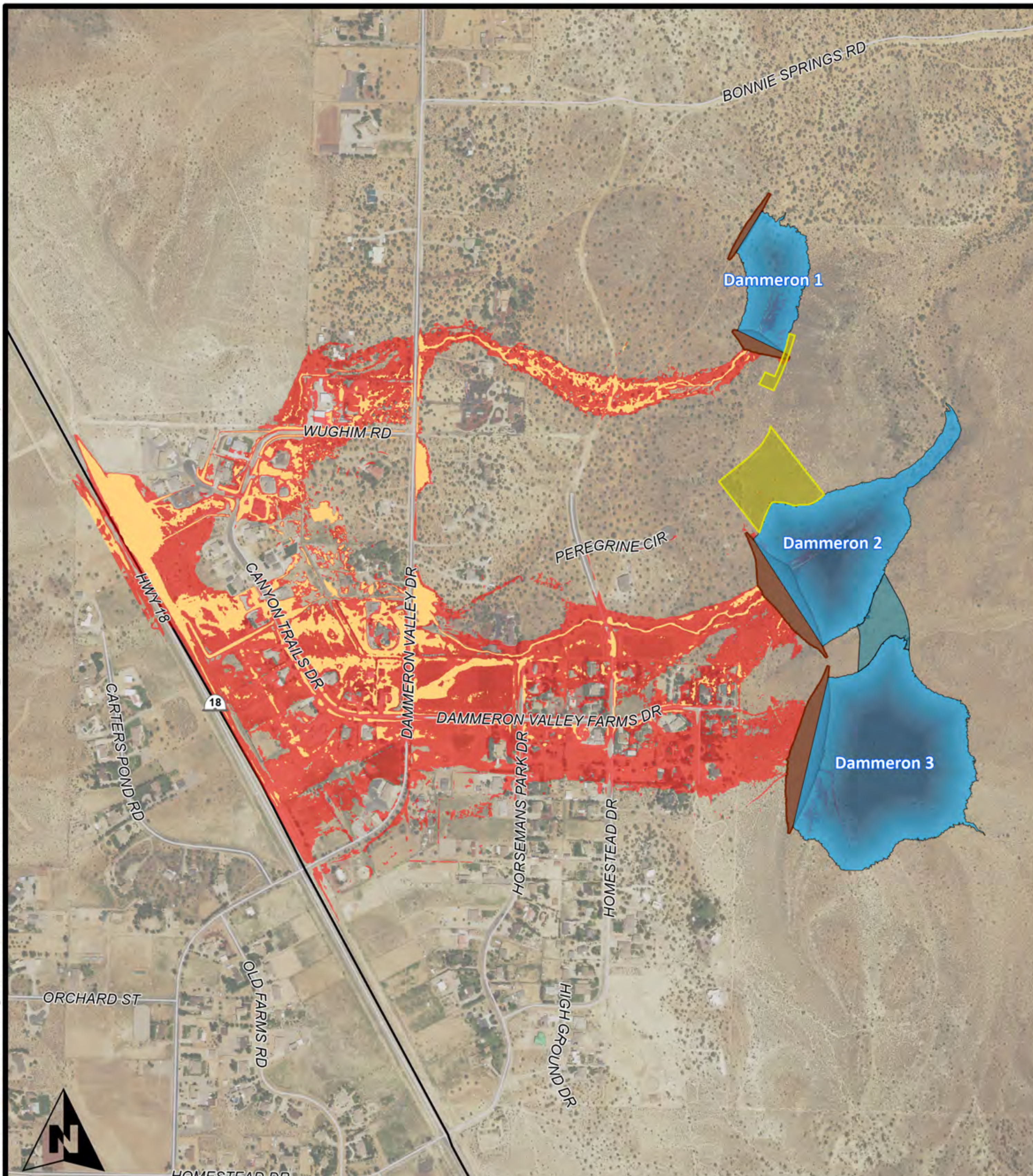
Fig 16. 100-yr Inundation Map

Santa Clara EA, Dammeron Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 800 feet
Date:	May 11, 2022



0 200 400 800 1,200

Feet

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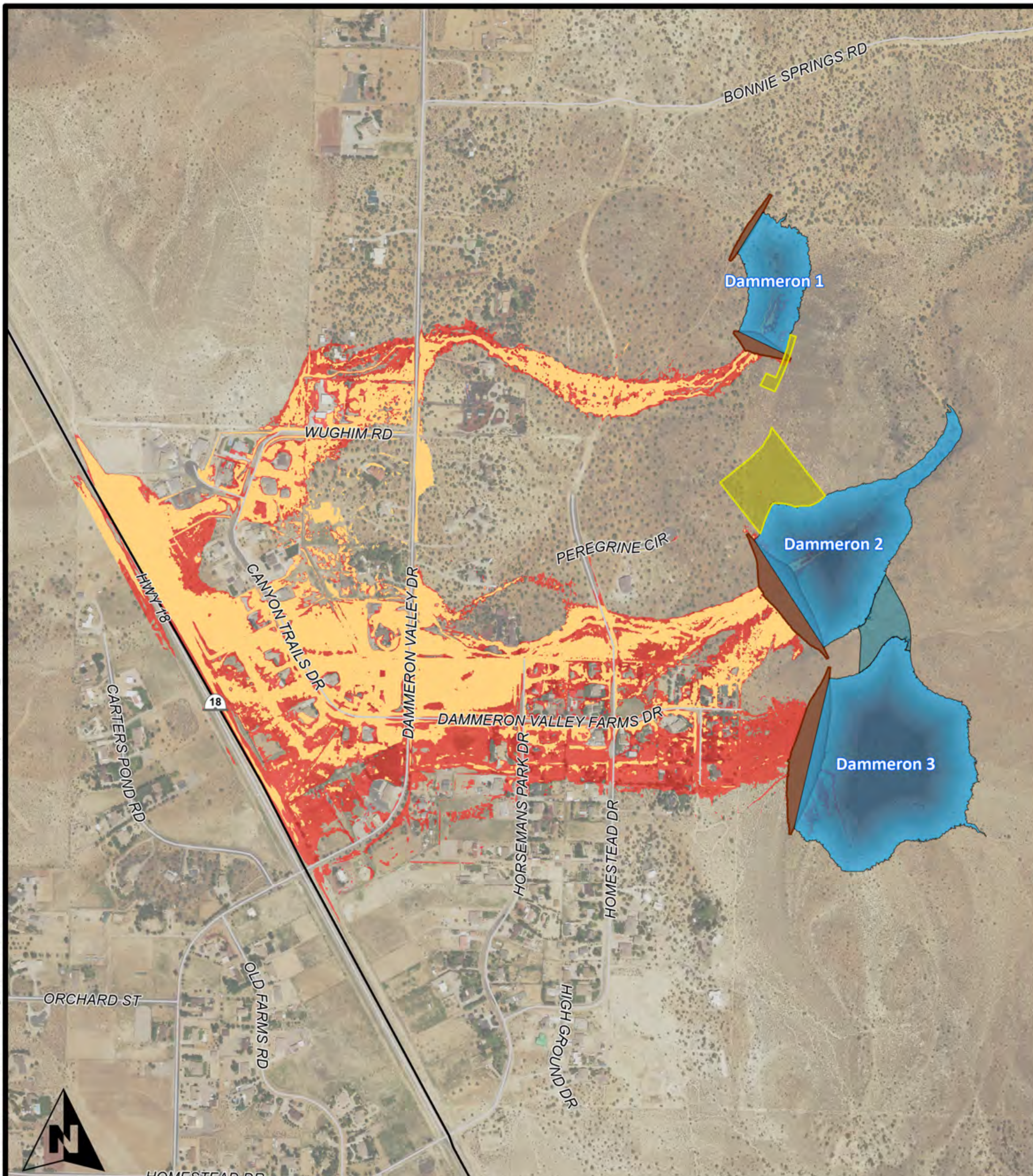
- Dam
- Detention Basin High Water
- Excavated Channel
- Spillway
- 200-year Inundation Boundary without Dams
- 200-year Inundation Boundary with Dams
- 200-year Inundation Boundary without Dams
- 200-year Inundation Boundary with Dams

Fig 17. 200-yr Inundation Map

Santa Clara EA, Dammeron Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 800 feet
Date:	May 11, 2022

P:\308-10 Washington County - Santa Clara Watershed Plan EA\Drawings\GIS\ArcGIS Pro\Santa Clara EA Inundation Maps.aprx, DAMM_Inundation Comparison - 200-yr, 5/25/2022 10:41 AM jmadsen



0 200 400 800 1,200

Feet

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- Dam
- Detention Basin High Water
- Excavated Channel
- Spillway
- 500-year Inundation Boundary without Dams
- 500-year Inundation Boundary with Dams
- 500-year Inundation Boundary without Dams
- 500-year Inundation Boundary with Dams

Fig 18. 500-yr Inundation Map

Santa Clara EA, Dammeron Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 800 feet
Date:	May 11, 2022

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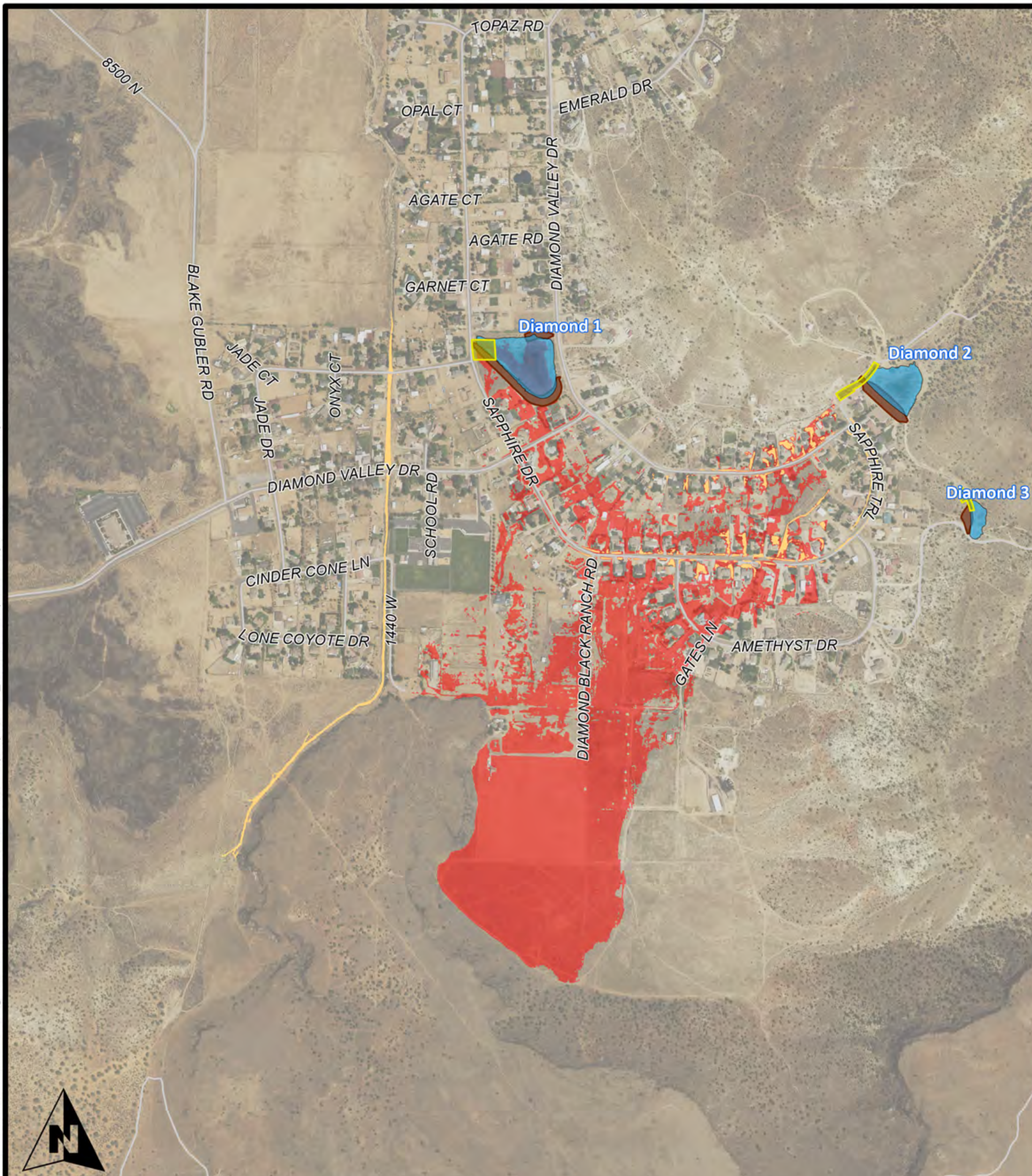

0 250 500 1,000 1,500

Feet

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- Dam
- Detention Basin High Water
- Excavated Channel
- Spillway
- 2-year Inundation Boundary without Dams
- 2-year Inundation Boundary with Dams

Fig 19. 2-yr Inundation Map

Santa Clara EA, Diamond Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 1,000 feet
Date:	May 11, 2022

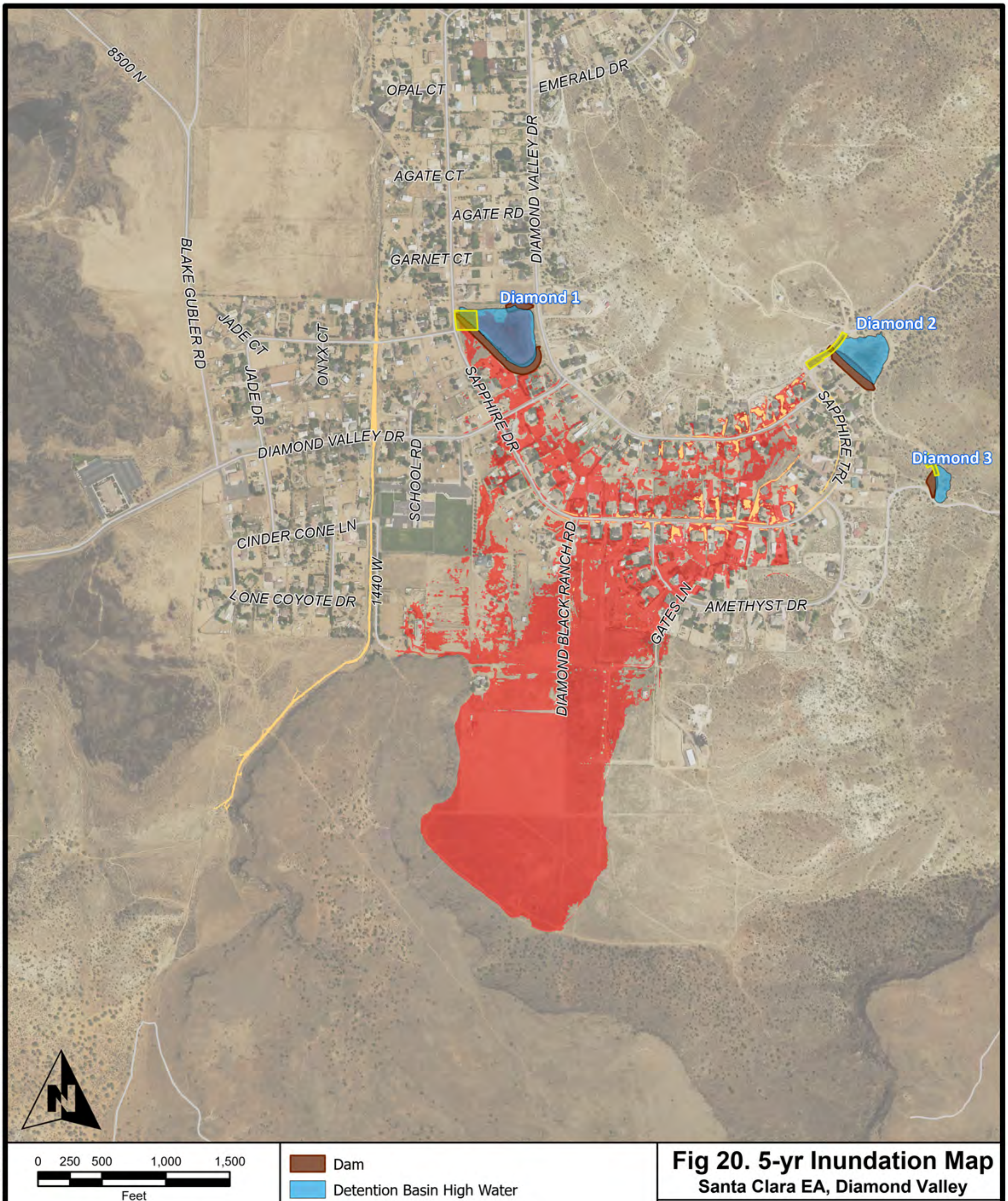

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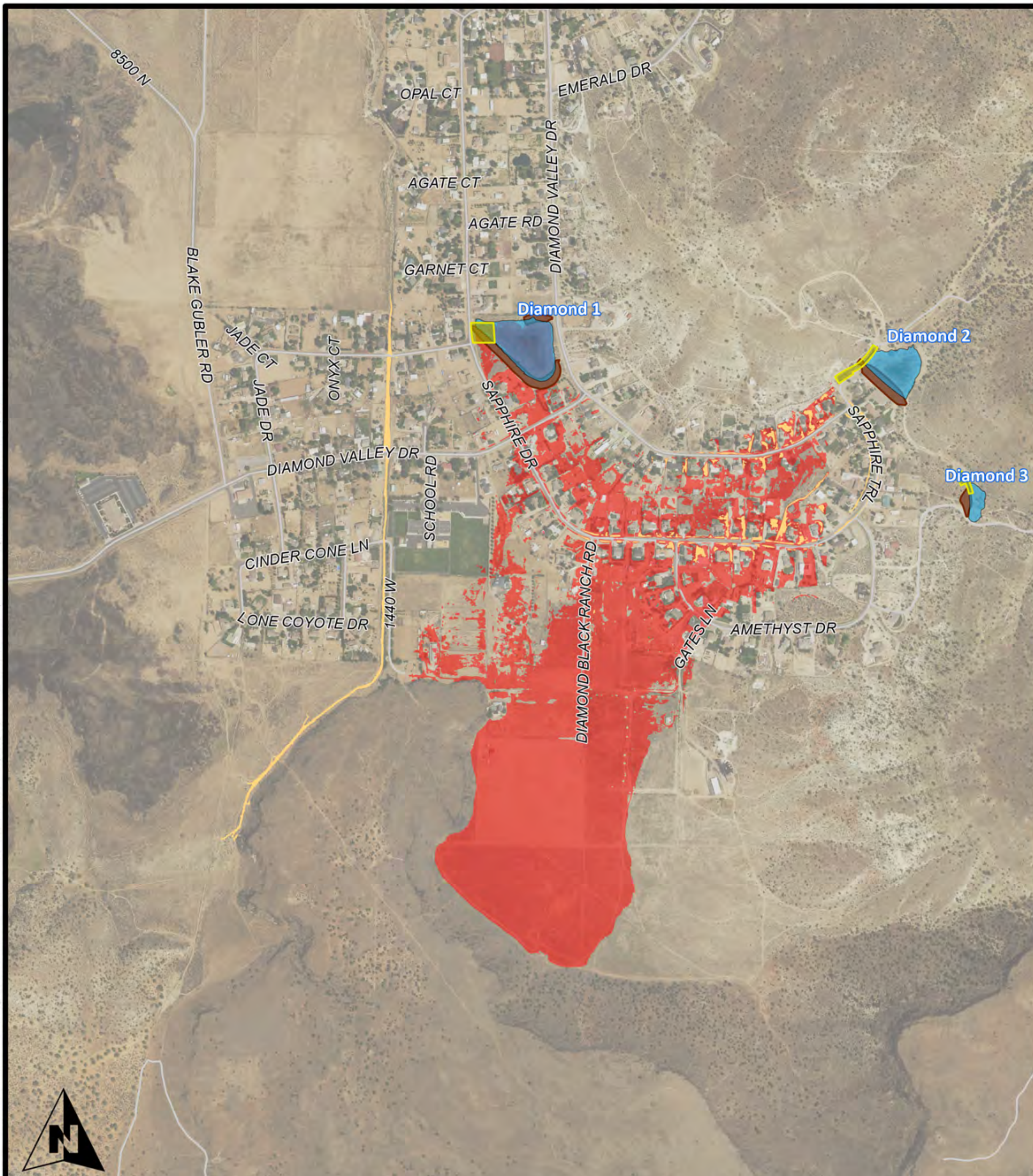
Fig 20. 5-yr Inundation Map
Santa Clara EA, Diamond Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 1,000 feet
Date:	May 11, 2022



0 250 500 1,000 1,500
Feet

Legend
Dam
Detention Basin High Water
Excavated Channel
Spillway
10-year Inundation Boundary without Dams
10-year Inundation Boundary with Dams

Fig 21. 10-yr Inundation Map

Santa Clara EA, Diamond Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 1,000 feet
Date:	May 11, 2022

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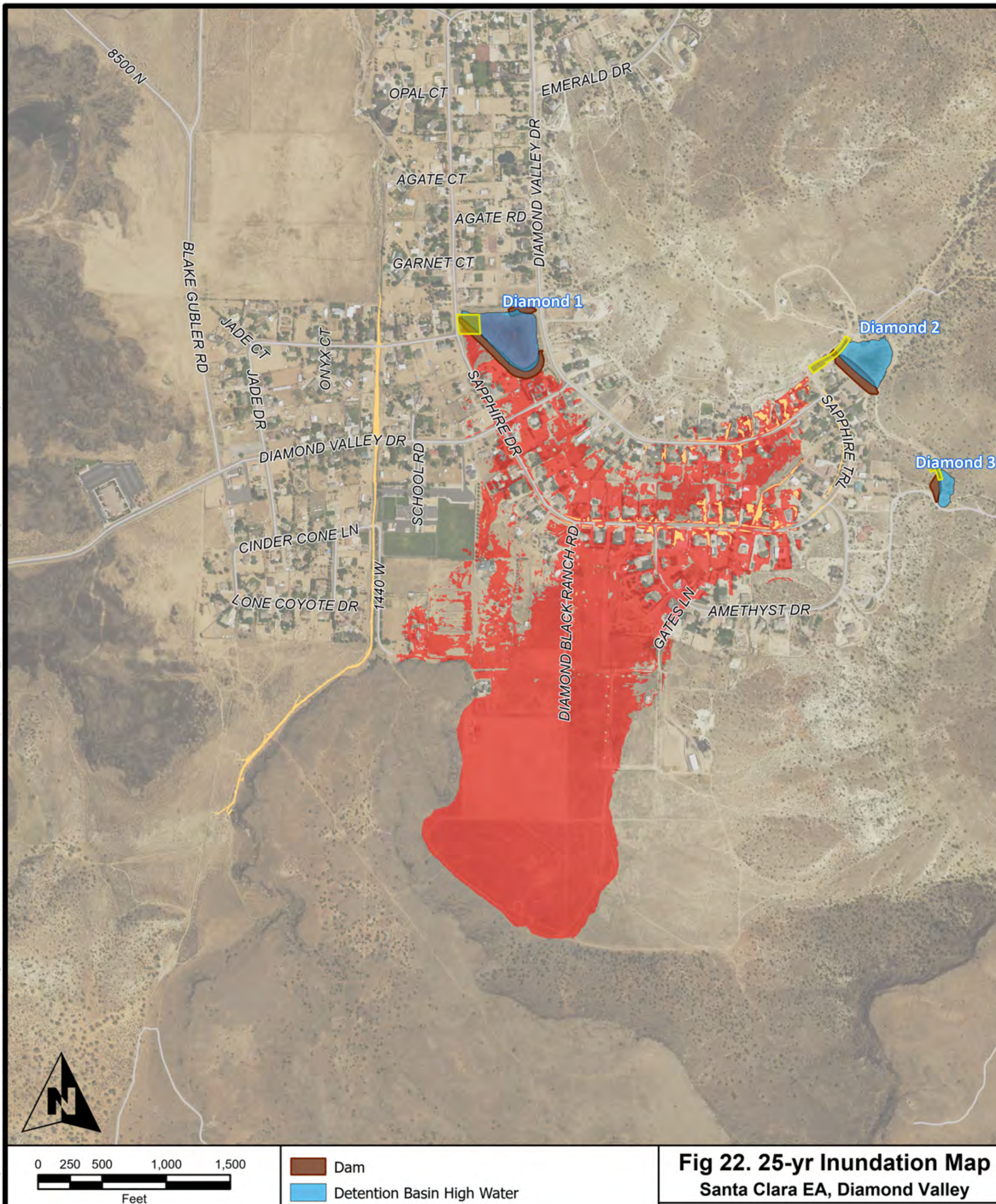

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Fig 22. 25-yr Inundation Map
Santa Clara EA, Diamond Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 1,000 feet
Date:	May 11, 2022

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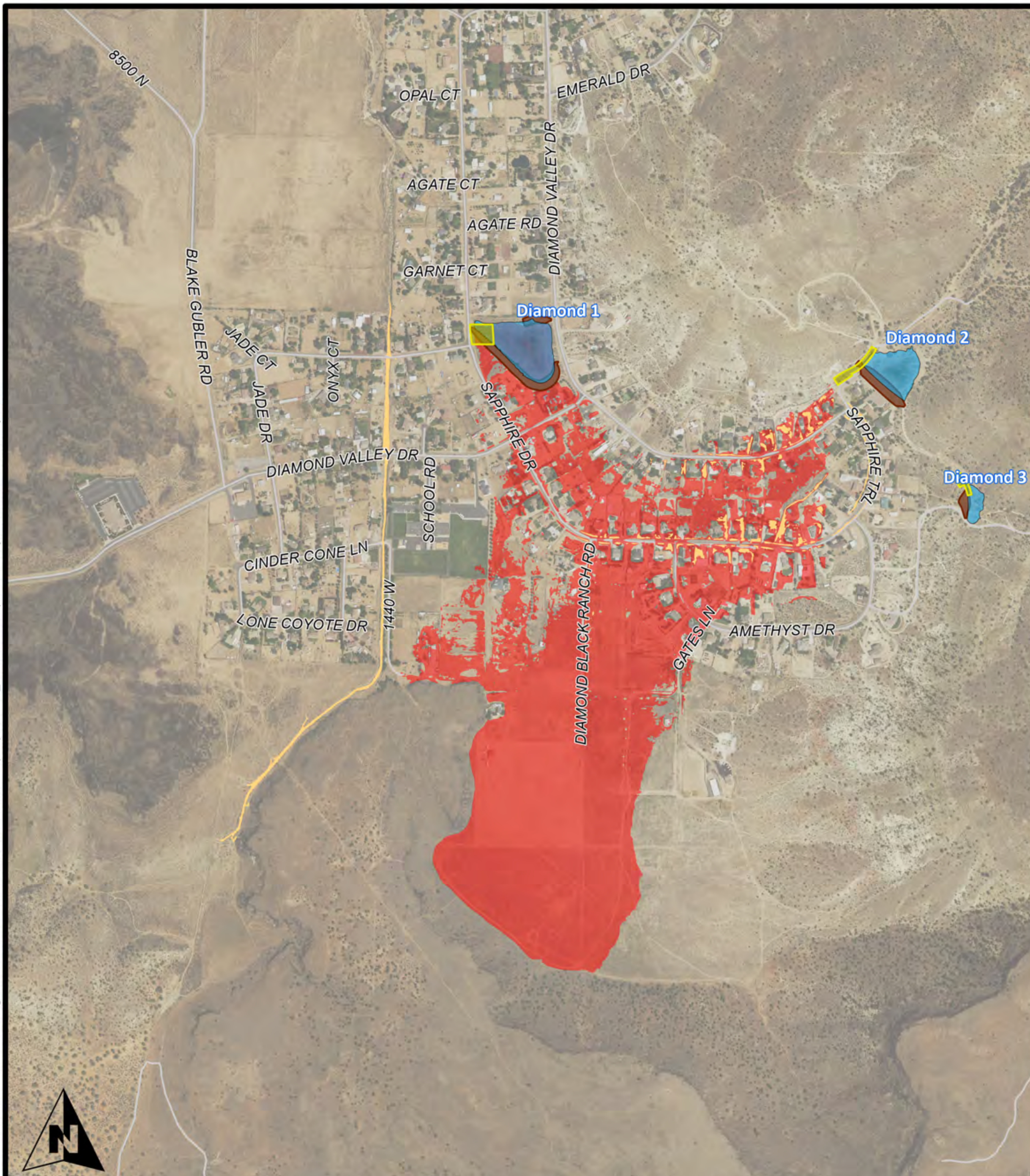

0 250 500 1,000 1,500
Feet

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- Dam
- Detention Basin High Water
- Excavated Channel
- Spillway
- 50-year Inundation Boundary without Dams
- 50-year Inundation Boundary with Dams

Fig 23. 50-yr Inundation Map
Santa Clara EA, Diamond Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 1,000 feet
Date:	May 11, 2022

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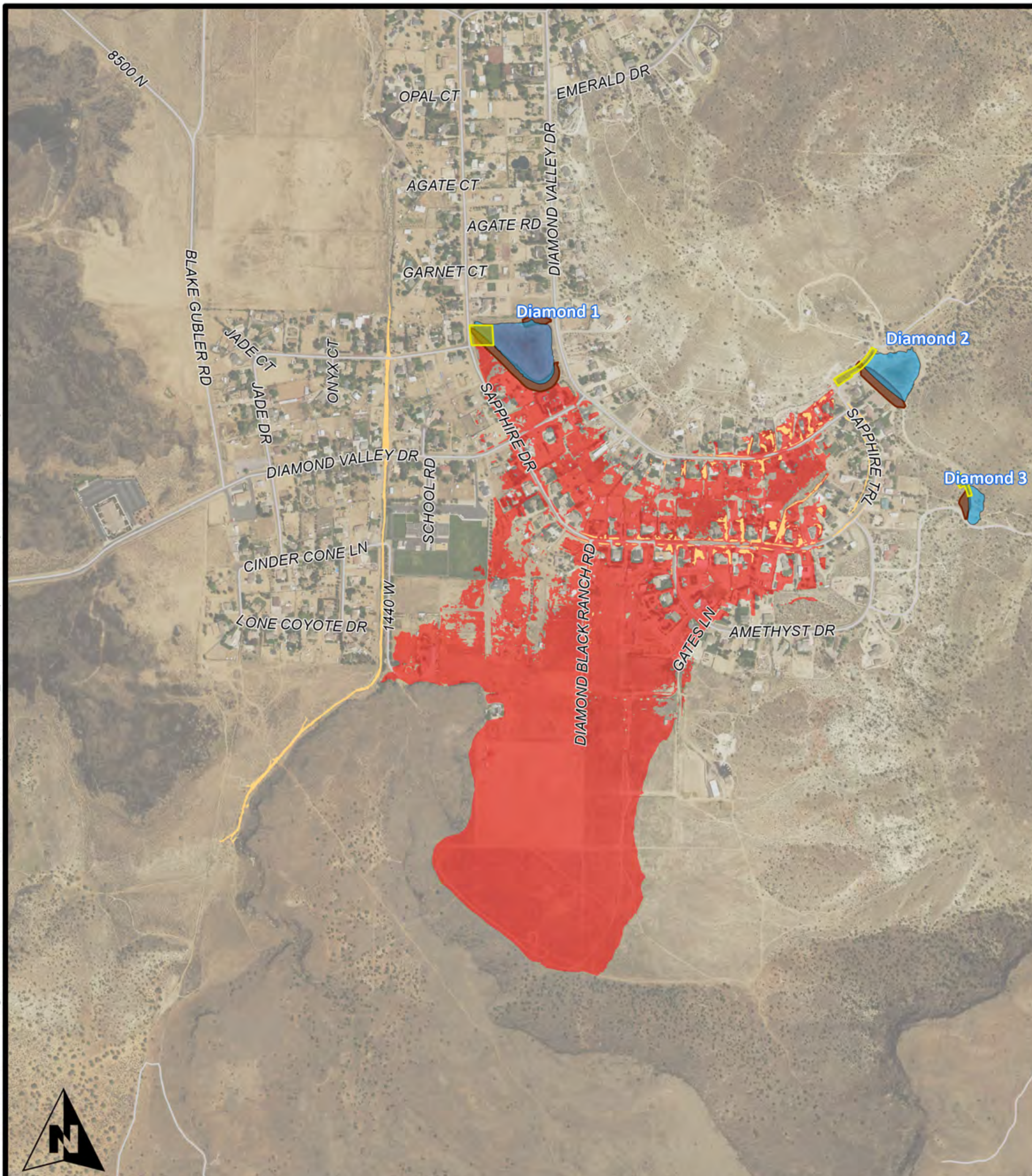

0 250 500 1,000 1,500

Feet

Dam

Detention Basin High Water

Excavated Channel

Spillway

100-year Inundation Boundary without Dams

100-year Inundation Boundary with Dams

Fig 24. 100-yr Inundation Map

Santa Clara Watershed Hydraulics

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 1,000 feet
Date:	May 11, 2022

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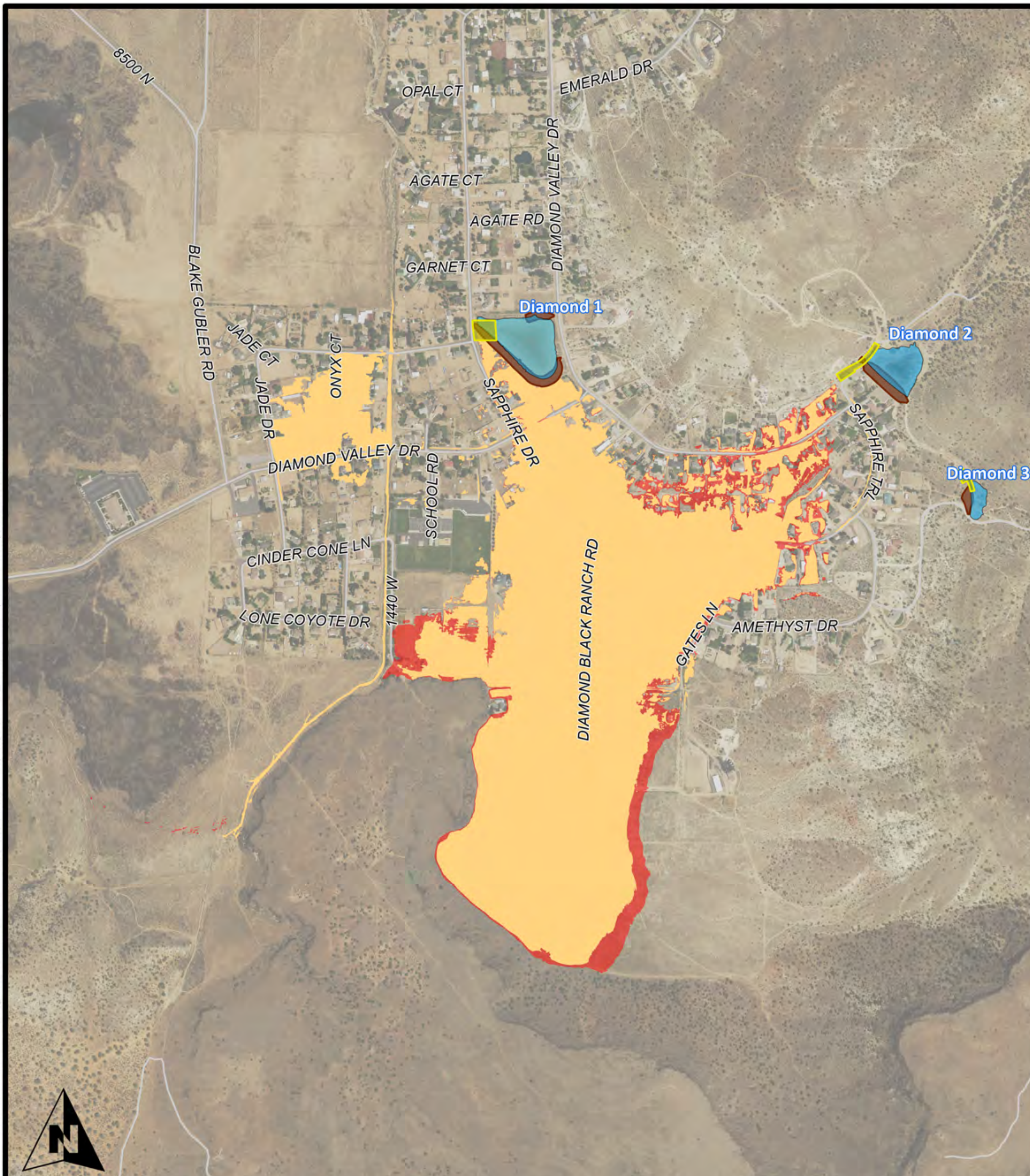

0 250 500 1,000 1,500
Feet

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- Dam
- Detention Basin High Water
- Excavated Channel
- Spillway
- 200-year Inundation Boundary without Dams
- 200-year Inundation Boundary with Dams

Fig 25. 200-yr Inundation Map

Santa Clara EA, Diamond Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 1,000 feet
Date:	May 11, 2022

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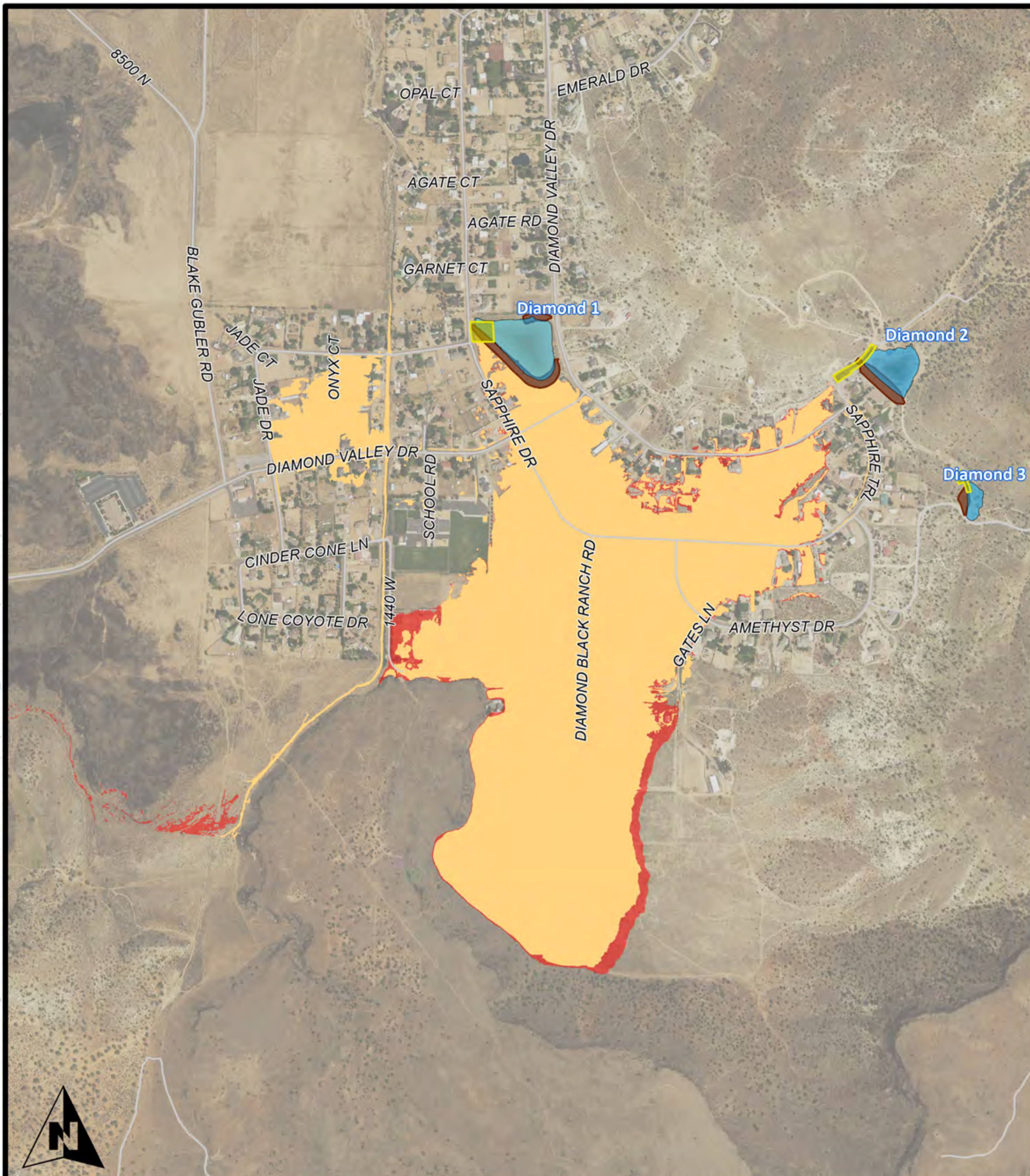

Fig 26. 500-yr Inundation Map

Santa Clara EA, Diamond Valley

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 1,000 feet
Date:	May 11, 2022

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Appendix B. Calculations

Section 1. Freeboard Calculations

Section 1. Freeboard Calculations

Wave Action

Wave Action

Fetch (F) Length:		(see attached *Fetch Length Exhibit*)
Damm1	0.09 miles	
Damm2	0.13 miles	
Damm3	0.16 miles	
Diam1	0.07 miles	
Diam2	0.05 miles	
Diam3	0.02 miles	

Maximum Land Wind Velocity:
81 mph (TR-210-56, Figure 4)

Water-Land Velocity Ratio:
1.02 (TR-210-56, Figure 5)

Overwater Wind Velocity
82 mph (TR-210-56, Equation 2)

Significant Wave Height		(TR-210-56, Equation 3)
Damm1	0.79 ft	
Damm2	0.96 ft	
Damm3	1.04 ft	
Diam1	0.72 ft	
Diam2	0.60 ft	
Diam3	0.39 ft	

Fetch

Fetch Calculations (see Fetch Exhibits)

$$\frac{\Sigma\, x_i (\cos \alpha)}{\Sigma \cos \alpha} = \text{Fetch}$$

α, deg	α, rad	cos α	Damm1 x_i	Damm1 x_i (cos α)	Damm2 x_i	Damm2 x_i (cos α)	Damm3 x_i	Damm3 x_i (cos α)	Diam1 x_i	Diam1 x_i (cos α)	Diam2 x_i	Diam2 x_i (cos α)	Diam3 x_i	Diam3 x_i (cos α)
45	0.785398	0.707107	123	86.97413	374	264.4579	575	406.5864	143	101.1163	187	132.229	96	67.88225
33.75	0.589049	0.83147	181	150.496	453	376.6557	788	655.1981	320	266.0703	211	175.4401	118	98.11341
22.5	0.392699	0.92388	560	517.3725	622	574.6531	895	826.8722	576	532.1546	248	229.1221	120	110.8655
11.25	0.19635	0.980785	752	737.5505	794	778.7435	984	965.0927	528	517.8546	290	284.4277	111	108.8672
0	0	1	705	705	1437	1437	999	999	487	487	339	339	115	115
11.25	0.19635	0.980785	663	650.2606	849	832.6867	1020	1000.401	473	463.9114	332	325.6207	113	110.8287
22.5	0.392699	0.92388	477	440.6905	636	587.5874	803	741.8753	407	376.019	291	268.8489	100	92.38795
33.75	0.589049	0.83147	280	232.8115	480	399.1054	620	515.5112	231	192.0695	225	187.0807	85	70.67492
45	0.785398	0.707107	202	142.8356	362	255.9727	541	382.5448	131	92.63099	153	108.1873	84	59.39697
	Σ	7.886482	Σ	3663.991	Σ	5506.862	Σ	6493.082	Σ	3028.827	Σ	2049.957	Σ	834.017
			Fetch	0.087991	Fetch	0.132247	Fetch	0.155931	Fetch	0.072737	Fetch	0.04923	Fetch	0.020029

Appendix C. Model Output

Project: Rev3

Simulation Run: Storm Event 01 100y24h

Simulation Start: 31 December 1999, 24:00

Simulation End: 2 January 2000, 03:00

HMS Version: 4.9

Executed: 30 March 2022, 12:30

Global Parameter Summary - Subbasin

	Area (MI²)
Element Name	**Area (MI²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard
Di3	16.8	Standard

Di4	64.2 Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	57.25	01Jan2000, 10:00	1.55
Reservoir - Da1	0.3	5	02Jan2000, 00:08	0.43
Da2	3.6	534.86	01Jan2000, 10:40	1.47
Reservoir - Da2/3	4.3	25.02	02Jan2000, 01:36	0.14
Da3	0.7	130.31	01Jan2000, 10:06	1.59
Da4	1.7	287.91	01Jan2000, 10:24	1.57
Di1	0.9	170.81	01Jan2000, 10:06	1.61
Reservoir - Di1	0.9	119.84	01Jan2000, 13:42	2.97
Di2	0.9	162.26	01Jan2000, 10:08	1.55
Reservoir - Di2	0.9	5.22	01Jan2000, 10:28	0.16
Di3	0.6	122.39	01Jan2000, 10:04	1.71
Reservoir - Di3	0.6	5.16	01Jan2000, 10:18	0.24
Di4	11.4	2225.38	01Jan2000, 10:38	1.92
Junction - 1	4.6	29.96	02Jan2000, 01:18	0.16
Junction - 2	1.5	10.38	01Jan2000, 10:24	0.19
Junction - 3	0.9	119.84	01Jan2000, 13:42	2.97
Reach - Di3 to Di2	0	99.93	01Jan2000, 10:20	Not specified
Reach - Di2 to Di1	0	232.29	01Jan2000, 10:34	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	57.25
Time of Peak Discharge	01Jan2000, 10:00
Volume (IN)	1.55
Precipitation Volume (AC - FT)	44.64
Loss Volume (AC - FT)	19.91
Excess Volume (AC - FT)	24.73
Direct Runoff Volume (AC - FT)	24.73
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	5
Time of Peak Discharge	02Jan2000, 00:08
Volume (IN)	0.43
Peak Inflow (CFS)	57.25
Time of Peak Inflow	01Jan2000, 10:00
Inflow Volume (AC - FT)	24.73
Maximum Storage (AC - FT)	20.72
Peak Elevation (FT)	4688.56
Discharge Volume (AC - FT)	6.94

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	534.86
Time of Peak Discharge	01Jan2000, 10:40
Volume (IN)	1.47
Precipitation Volume (AC - FT)	566.4
Loss Volume (AC - FT)	283.9
Excess Volume (AC - FT)	282.5
Direct Runoff Volume (AC - FT)	282.39
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	25.02
Time of Peak Discharge	02Jan2000, 01:36

Volume (IN)	0.14
Peak Inflow (CFS)	636.82
Time of Peak Inflow	01Jan2000, 10:30
Inflow Volume (AC - FT)	341.93
Maximum Storage (AC - FT)	312.09
Peak Elevation (FT)	4691.01
Discharge Volume (AC - FT)	31.6

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs

Lag	22.2
Unitgraph Type	Standard

Results: Da3

Peak Discharge (CFS)	130.31
Time of Peak Discharge	01Jan2000, 10:06
Volume (IN)	1.59
Precipitation Volume (AC - FT)	103.04
Loss Volume (AC - FT)	43.5
Excess Volume (AC - FT)	59.54
Direct Runoff Volume (AC - FT)	59.54
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs

Lag	46.8
Unitgraph Type	Standard

Results: Da4

Peak Discharge (CFS)	287.91
Time of Peak Discharge	01Jan2000, 10:24
Volume (IN)	1.57
Precipitation Volume (AC - FT)	260.21
Loss Volume (AC - FT)	118.18
Excess Volume (AC - FT)	142.03
Direct Runoff Volume (AC - FT)	142.02
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	170.81
Time of Peak Discharge	01Jan2000, 10:06
Volume (IN)	1.61
Precipitation Volume (AC - FT)	133.44
Loss Volume (AC - FT)	56.31
Excess Volume (AC - FT)	77.13
Direct Runoff Volume (AC - FT)	77.13
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	119.84
Time of Peak Discharge	01Jan2000, 13:42
Volume (IN)	2.97
Peak Inflow (CFS)	378.05
Time of Peak Inflow	01Jan2000, 10:22
Inflow Volume (AC - FT)	166.2
Maximum Storage (AC - FT)	60.63
Peak Elevation (FT)	4555.9
Discharge Volume (AC - FT)	142.52

Subbasin: Di2

Area (MI²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	162.26
Time of Peak Discharge	01Jan2000, 10:08
Volume (IN)	1.55
Precipitation Volume (AC - FT)	138.24
Loss Volume (AC - FT)	64.01
Excess Volume (AC - FT)	74.23
Direct Runoff Volume (AC - FT)	74.23
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	5.22
Time of Peak Discharge	01Jan2000, 10:28
Volume (IN)	0.16
Peak Inflow (CFS)	259.41
Time of Peak Inflow	01Jan2000, 10:14
Inflow Volume (AC - FT)	114.98
Maximum Storage (AC - FT)	23.89
Peak Elevation (FT)	4598.83
Discharge Volume (AC - FT)	7.62

Subbasin: Di3

Area (MI²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	122.39
Time of Peak Discharge	01Jan2000, 10:04
Volume (IN)	1.71
Precipitation Volume (AC - FT)	89.6
Loss Volume (AC - FT)	34.82
Excess Volume (AC - FT)	54.78
Direct Runoff Volume (AC - FT)	54.78
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	5.16
Time of Peak Discharge	01Jan2000, 10:18
Volume (IN)	0.24
Peak Inflow (CFS)	122.39
Time of Peak Inflow	01Jan2000, 10:08
Inflow Volume (AC - FT)	54.78
Maximum Storage (AC - FT)	12.07
Peak Elevation (FT)	4606.17
Discharge Volume (AC - FT)	7.7

Subbasin: Di4

Area (MI²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	2225.38
Time of Peak Discharge	01Jan2000, 10:38
Volume (IN)	1.92
Precipitation Volume (AC - FT)	1890.88
Loss Volume (AC - FT)	724.3
Excess Volume (AC - FT)	1166.58
Direct Runoff Volume (AC - FT)	1165.99
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	29.96
Time of Peak Discharge	02Jan2000, 01:18
Volume (IN)	0.16

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	10.38
Time of Peak Discharge	01Jan2000, 10:24
Volume (IN)	0.19

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	119.84
Time of Peak Discharge	01Jan2000, 13:42
Volume (IN)	2.97

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2	
Peak Discharge (CFS)	99.93
Time of Peak Discharge	01Jan2000, 10:20
Peak Inflow (CFS)	99.96
Inflow Volume (AC - FT)	40.75

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1	
Peak Discharge (CFS)	232.29
Time of Peak Discharge	01Jan2000, 10:34
Peak Inflow (CFS)	232.28
Inflow Volume (AC - FT)	89.04

Project: Rev3

Simulation Run: Storm Event 02 100y6h3

Simulation Start: 31 December 1999, 24:00

Simulation End: 1 January 2000, 09:00

HMS Version: 4.9

Executed: 30 March 2022, 12:30

Global Parameter Summary - Subbasin

Area (MI²)

Element Name	Area (MI²)
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

Downstream

Element Name	Downstream
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Da1	0	93.8	0.13
Da2	0	92.3	0.17
Da3	0	94.4	0.12
Da4	0	93.5	0.14
Di1	0	94.3	0.12
Di2	0	93.3	0.14
Di3	0	94.9	0.11
Di4	0	94.4	0.12

Transform: Scs

Element Name	Lag	Unitgraph Type
Da1	5.4	Standard
Da2	43.2	Standard
Da3	16.8	Standard
Da4	34.8	Standard
Di1	18	Standard
Di2	17.4	Standard
Di3	13.2	Standard

Di4	48.6 Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	252.08	01Jan2000, 02:30	1.86
Reservoir - Da1	0.3	34.47	01Jan2000, 05:50	0.36
Da2	3.6	1944.49	01Jan2000, 03:08	1.85
Reservoir - Da2/3	4.3	228.2	01Jan2000, 06:50	0.15
Da3	0.7	537.61	01Jan2000, 02:38	1.91
Da4	1.7	1004.72	01Jan2000, 02:58	1.83
Di1	0.9	678.47	01Jan2000, 02:40	1.91
Reservoir - Di1	0.9	622.24	01Jan2000, 03:26	2.97
Di2	0.9	671.2	01Jan2000, 02:40	1.86
Reservoir - Di2	0.9	287.17	01Jan2000, 02:56	0.3
Di3	0.6	498.5	01Jan2000, 02:36	1.97
Reservoir - Di3	0.6	294.36	01Jan2000, 02:46	0.52
Di4	11.4	6042.93	01Jan2000, 03:12	1.91
Junction - 1	4.6	238.41	01Jan2000, 06:48	0.16
Junction - 2	1.5	542.69	01Jan2000, 02:52	0.39
Junction - 3	0.9	622.24	01Jan2000, 03:26	2.97
Reach - Di3 to Di2	0	138	01Jan2000, 02:52	Not specified
Reach - Di2 to Di1	0	384.38	01Jan2000, 02:46	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	93.8
Initial Abstraction	0.13

Transform: Scs

Lag	5.4
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	252.08
Time of Peak Discharge	01Jan2000, 02:30
Volume (IN)	1.86
Precipitation Volume (AC - FT)	40.16
Loss Volume (AC - FT)	10.36
Excess Volume (AC - FT)	29.8
Direct Runoff Volume (AC - FT)	29.8
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	34.47
Time of Peak Discharge	01Jan2000, 05:50
Volume (IN)	0.36
Peak Inflow (CFS)	252.08
Time of Peak Inflow	01Jan2000, 02:30
Inflow Volume (AC - FT)	29.8
Maximum Storage (AC - FT)	27.75
Peak Elevation (FT)	4691.75
Discharge Volume (AC - FT)	5.83

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	92.3
Initial Abstraction	0.17

Transform: Scs	
Lag	43.2
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	1944.49
Time of Peak Discharge	01Jan2000, 03:08
Volume (IN)	1.85
Precipitation Volume (AC - FT)	506.88
Loss Volume (AC - FT)	152.37
Excess Volume (AC - FT)	354.51
Direct Runoff Volume (AC - FT)	354.48
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	228.2
Time of Peak Discharge	01Jan2000, 06:50

Volume (IN)	0.15
Peak Inflow (CFS)	2249.16
Time of Peak Inflow	01Jan2000, 03:02
Inflow Volume (AC - FT)	425.61
Maximum Storage (AC - FT)	402.22
Peak Elevation (FT)	4697.3
Discharge Volume (AC - FT)	34.38

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	94.4
Initial Abstraction	0.12

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	537.61
Time of Peak Discharge	01Jan2000, 02:38
Volume (IN)	1.91
Precipitation Volume (AC - FT)	93.33
Loss Volume (AC - FT)	22.21
Excess Volume (AC - FT)	71.13
Direct Runoff Volume (AC - FT)	71.13
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	93.5
Initial Abstraction	0.14

Transform: Scs	
Lag	34.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	1004.72
Time of Peak Discharge	01Jan2000, 02:58
Volume (IN)	1.83
Precipitation Volume (AC - FT)	227.57
Loss Volume (AC - FT)	61.43
Excess Volume (AC - FT)	166.15
Direct Runoff Volume (AC - FT)	166.15
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	94.3
Initial Abstraction	0.12

Transform: Scs	
Lag	18
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	678.47
Time of Peak Discharge	01Jan2000, 02:40
Volume (IN)	1.91
Precipitation Volume (AC - FT)	120.48
Loss Volume (AC - FT)	28.92
Excess Volume (AC - FT)	91.56
Direct Runoff Volume (AC - FT)	91.56
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	622.24
Time of Peak Discharge	01Jan2000, 03:26
Volume (IN)	2.97
Peak Inflow (CFS)	1045.98
Time of Peak Inflow	01Jan2000, 02:44
Inflow Volume (AC - FT)	187.41
Maximum Storage (AC - FT)	66.59
Peak Elevation (FT)	4557.12
Discharge Volume (AC - FT)	142.42

Subbasin: Di2

Area (MI²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	93.3
Initial Abstraction	0.14

Transform: Scs	
Lag	17.4
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	671.2
Time of Peak Discharge	01Jan2000, 02:40
Volume (IN)	1.86
Precipitation Volume (AC - FT)	122.4
Loss Volume (AC - FT)	33.28
Excess Volume (AC - FT)	89.12
Direct Runoff Volume (AC - FT)	89.12
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	287.17
Time of Peak Discharge	01Jan2000, 02:56
Volume (IN)	0.3
Peak Inflow (CFS)	809.2
Time of Peak Inflow	01Jan2000, 02:42
Inflow Volume (AC - FT)	129.02
Maximum Storage (AC - FT)	31.53
Peak Elevation (FT)	4600.86
Discharge Volume (AC - FT)	14.63

Subbasin: Di3

Area (MI²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	94.9
Initial Abstraction	0.11

Transform: Scs	
Lag	13.2
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	498.5
Time of Peak Discharge	01Jan2000, 02:36
Volume (IN)	1.97
Precipitation Volume (AC - FT)	80.64
Loss Volume (AC - FT)	17.58
Excess Volume (AC - FT)	63.06
Direct Runoff Volume (AC - FT)	63.06
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	294.36
Time of Peak Discharge	01Jan2000, 02:46
Volume (IN)	0.52
Peak Inflow (CFS)	498.5
Time of Peak Inflow	01Jan2000, 02:40
Inflow Volume (AC - FT)	63.06
Maximum Storage (AC - FT)	17.92
Peak Elevation (FT)	4608.05
Discharge Volume (AC - FT)	16.55

Subbasin: Di4

Area (MI²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	94.4
Initial Abstraction	0.12

Transform: Scs	
Lag	48.6
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	6042.93
Time of Peak Discharge	01Jan2000, 03:12
Volume (IN)	1.91
Precipitation Volume (AC - FT)	1526.08
Loss Volume (AC - FT)	361.92
Excess Volume (AC - FT)	1164.16
Direct Runoff Volume (AC - FT)	1163.89
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	238.41
Time of Peak Discharge	01Jan2000, 06:48
Volume (IN)	0.16

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	542.69
Time of Peak Discharge	01Jan2000, 02:52
Volume (IN)	0.39

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	622.24
Time of Peak Discharge	01Jan2000, 03:26
Volume (IN)	2.97

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2

Peak Discharge (CFS)	138
Time of Peak Discharge	01Jan2000, 02:52
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	39.89

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge

Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	384.38
Time of Peak Discharge	01Jan2000, 02:46
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	95.81

Project: Rev3

Simulation Run: Storm Event 03 100y24h3

Simulation Start: 31 December 1999, 24:00

Simulation End: 2 January 2000, 03:00

HMS Version: 4.9

Executed: 30 March 2022, 12:30

Global Parameter Summary - Subbasin

	Area (MI²)
Element Name	**Area (MI²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

		Loss Rate: Scs	
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	93.8	0.13
Da2	0	92.3	0.17
Da3	0	94.4	0.12
Da4	0	93.5	0.14
Di1	0	94.3	0.12
Di2	0	93.3	0.14
Di3	0	94.9	0.11
Di4	0	94.4	0.12

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	5.4	Standard
Da2	43.2	Standard
Da3	16.8	Standard
Da4	34.8	Standard
Di1	18	Standard
Di2	17.4	Standard
Di3	13.2	Standard

Di4	48.6 Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	74.58	01Jan2000, 10:00	2.13
Reservoir - Da1	0.3	12.38	01Jan2000, 18:04	0.65
Da2	3.6	841.16	01Jan2000, 10:16	2.14
Reservoir - Da2/3	4.3	156.77	01Jan2000, 22:10	0.44
Da3	0.7	170.56	01Jan2000, 10:02	2.16
Da4	1.7	412.36	01Jan2000, 10:10	2.18
Di1	0.9	223.98	01Jan2000, 10:02	2.17
Reservoir - Di1	0.9	528.73	01Jan2000, 10:20	4.18
Di2	0.9	223.58	01Jan2000, 10:02	2.17
Reservoir - Di2	0.9	5.36	01Jan2000, 10:12	0.17
Di3	0.6	152.87	01Jan2000, 10:00	2.24
Reservoir - Di3	0.6	5.33	01Jan2000, 10:10	0.26
Di4	11.4	3012.85	01Jan2000, 10:16	2.49
Junction - 1	4.6	167.79	01Jan2000, 22:06	0.46
Junction - 2	1.5	10.69	01Jan2000, 10:10	0.21
Junction - 3	0.9	528.73	01Jan2000, 10:20	4.18
Reach - Di3 to Di2	0	137.59	01Jan2000, 10:12	Not specified
Reach - Di2 to Di1	0	346.07	01Jan2000, 10:16	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	93.8
Initial Abstraction	0.13

Transform: Scs

Lag	5.4
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	74.58
Time of Peak Discharge	01Jan2000, 10:00
Volume (IN)	2.13
Precipitation Volume (AC - FT)	44.64
Loss Volume (AC - FT)	10.55
Excess Volume (AC - FT)	34.09
Direct Runoff Volume (AC - FT)	34.09
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	12.38
Time of Peak Discharge	01Jan2000, 18:04
Volume (IN)	0.65
Peak Inflow (CFS)	74.58
Time of Peak Inflow	01Jan2000, 10:00
Inflow Volume (AC - FT)	34.09
Maximum Storage (AC - FT)	26.76
Peak Elevation (FT)	4691.61
Discharge Volume (AC - FT)	10.34

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	92.3
Initial Abstraction	0.17

Transform: Scs	
Lag	43.2
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	841.16
Time of Peak Discharge	01Jan2000, 10:16
Volume (IN)	2.14
Precipitation Volume (AC - FT)	566.4
Loss Volume (AC - FT)	155.84
Excess Volume (AC - FT)	410.56
Direct Runoff Volume (AC - FT)	410.55
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	156.77
Time of Peak Discharge	01Jan2000, 22:10

Volume (IN)	0.44
Peak Inflow (CFS)	1002.88
Time of Peak Inflow	01Jan2000, 10:08
Inflow Volume (AC - FT)	491.03
Maximum Storage (AC - FT)	399.11
Peak Elevation (FT)	4697.22
Discharge Volume (AC - FT)	101.5

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	94.4
Initial Abstraction	0.12

Transform: Scs

Lag	16.8
Unitgraph Type	Standard

Results: Da3

Peak Discharge (CFS)	170.56
Time of Peak Discharge	01Jan2000, 10:02
Volume (IN)	2.16
Precipitation Volume (AC - FT)	103.04
Loss Volume (AC - FT)	22.56
Excess Volume (AC - FT)	80.48
Direct Runoff Volume (AC - FT)	80.48
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	93.5
Initial Abstraction	0.14

Transform: Scs

Lag	34.8
Unitgraph Type	Standard

Results: Da4

Peak Discharge (CFS)	412.36
Time of Peak Discharge	01Jan2000, 10:10
Volume (IN)	2.18
Precipitation Volume (AC - FT)	260.21
Loss Volume (AC - FT)	62.93
Excess Volume (AC - FT)	197.28
Direct Runoff Volume (AC - FT)	197.28
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	94.3
Initial Abstraction	0.12

Transform: Scs	
Lag	18
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	223.98
Time of Peak Discharge	01Jan2000, 10:02
Volume (IN)	2.17
Precipitation Volume (AC - FT)	133.44
Loss Volume (AC - FT)	29.4
Excess Volume (AC - FT)	104.04
Direct Runoff Volume (AC - FT)	104.04
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	528.73
Time of Peak Discharge	01Jan2000, 10:20
Volume (IN)	4.18
Peak Inflow (CFS)	563.98
Time of Peak Inflow	01Jan2000, 10:06
Inflow Volume (AC - FT)	238.63
Maximum Storage (AC - FT)	65.85
Peak Elevation (FT)	4556.97
Discharge Volume (AC - FT)	200.51

Subbasin: Di2

Area (MI²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	93.3
Initial Abstraction	0.14

Transform: Scs	
Lag	17.4
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	223.58
Time of Peak Discharge	01Jan2000, 10:02
Volume (IN)	2.17
Precipitation Volume (AC - FT)	138.24
Loss Volume (AC - FT)	34.03
Excess Volume (AC - FT)	104.21
Direct Runoff Volume (AC - FT)	104.21
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	5.36
Time of Peak Discharge	01Jan2000, 10:12
Volume (IN)	0.17
Peak Inflow (CFS)	359.45
Time of Peak Inflow	01Jan2000, 10:06
Inflow Volume (AC - FT)	161.18
Maximum Storage (AC - FT)	26.29
Peak Elevation (FT)	4599.73
Discharge Volume (AC - FT)	8.33

Subbasin: Di3

Area (MI²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	94.9
Initial Abstraction	0.11

Transform: Scs	
Lag	13.2
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	152.87
Time of Peak Discharge	01Jan2000, 10:00
Volume (IN)	2.24
Precipitation Volume (AC - FT)	89.6
Loss Volume (AC - FT)	17.85
Excess Volume (AC - FT)	71.75
Direct Runoff Volume (AC - FT)	71.75
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	5.33
Time of Peak Discharge	01Jan2000, 10:10
Volume (IN)	0.26
Peak Inflow (CFS)	152.87
Time of Peak Inflow	01Jan2000, 10:04
Inflow Volume (AC - FT)	71.75
Maximum Storage (AC - FT)	13.98
Peak Elevation (FT)	4606.99
Discharge Volume (AC - FT)	8.45

Subbasin: Di4

Area (MI²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	94.4
Initial Abstraction	0.12

Transform: Scs	
Lag	48.6
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	3012.85
Time of Peak Discharge	01Jan2000, 10:16
Volume (IN)	2.49
Precipitation Volume (AC - FT)	1890.88
Loss Volume (AC - FT)	373.93
Excess Volume (AC - FT)	1516.95
Direct Runoff Volume (AC - FT)	1516.88
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	167.79
Time of Peak Discharge	01Jan2000, 22:06
Volume (IN)	0.46

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	10.69
Time of Peak Discharge	01Jan2000, 10:10
Volume (IN)	0.21

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	528.73
Time of Peak Discharge	01Jan2000, 10:20
Volume (IN)	4.18

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2

Peak Discharge (CFS)	137.59
Time of Peak Discharge	01Jan2000, 10:12
Peak Inflow (CFS)	137.62
Inflow Volume (AC - FT)	56.97

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge

Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	346.07
Time of Peak Discharge	01Jan2000, 10:16
Peak Inflow (CFS)	346.11
Inflow Volume (AC - FT)	134.57

Project: Rev3

Simulation Run: Storm Event 04 SEPL

Simulation Start: 31 December 1999, 24:00

Simulation End: 1 January 2000, 09:00

HMS Version: 4.9

Executed: 30 March 2022, 12:31

Global Parameter Summary - Subbasin

	Area (MI²)
Element Name	**Area (MI²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard
Di3	16.8	Standard

Di4	64.2	Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	1312.24	01Jan2000, 02:30	10.09
Reservoir - Da1	0.3	1198.11	01Jan2000, 02:36	8.6
Da2	3.6	6533.46	01Jan2000, 03:24	7.33
Reservoir - Da2/3	4.3	7149.67	01Jan2000, 03:38	6.07
Da3	0.7	2657.47	01Jan2000, 02:42	10.22
Da4	1.7	4804.31	01Jan2000, 03:08	10
Di1	0.9	3344.14	01Jan2000, 02:44	10.21
Reservoir - Di1	0.9	3435.53	01Jan2000, 02:56	12.62
Di2	0.9	3275.07	01Jan2000, 02:44	9.95
Reservoir - Di2	0.9	2923.79	01Jan2000, 02:52	7.44
Di3	0.6	2446.04	01Jan2000, 02:38	10.35
Reservoir - Di3	0.6	2221.72	01Jan2000, 02:42	8.13
Di4	11.4	27796.15	01Jan2000, 03:26	10.22
Junction - 1	4.6	7483.79	01Jan2000, 03:36	6.23
Junction - 2	1.5	5103.92	01Jan2000, 02:48	7.71
Junction - 3	0.9	3435.53	01Jan2000, 02:56	12.62
Reach - Di3 to Di2	0	138	01Jan2000, 02:06	Not specified
Reach - Di2 to Di1	0	383.82	01Jan2000, 02:04	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	1312.24
Time of Peak Discharge	01Jan2000, 02:30
Volume (IN)	10.09
Precipitation Volume (AC - FT)	187.68
Loss Volume (AC - FT)	26.27
Excess Volume (AC - FT)	161.41
Direct Runoff Volume (AC - FT)	161.41
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	1198.11
Time of Peak Discharge	01Jan2000, 02:36
Volume (IN)	8.6
Peak Inflow (CFS)	1312.24
Time of Peak Inflow	01Jan2000, 02:30
Inflow Volume (AC - FT)	161.41
Maximum Storage (AC - FT)	46.02
Peak Elevation (FT)	4694.39
Discharge Volume (AC - FT)	137.53

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	6533.46
Time of Peak Discharge	01Jan2000, 03:24
Volume (IN)	7.33
Precipitation Volume (AC - FT)	1785.6
Loss Volume (AC - FT)	376.17
Excess Volume (AC - FT)	1409.43
Direct Runoff Volume (AC - FT)	1407.63
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	7149.67
Time of Peak Discharge	01Jan2000, 03:38

Volume (IN)	6.07
Peak Inflow (CFS)	7765.51
Time of Peak Inflow	01Jan2000, 03:14
Inflow Volume (AC - FT)	1789.22
Maximum Storage (AC - FT)	524.62
Peak Elevation (FT)	4700.25
Discharge Volume (AC - FT)	1391.57

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	2657.47
Time of Peak Discharge	01Jan2000, 02:42
Volume (IN)	10.22
Precipitation Volume (AC - FT)	437.92
Loss Volume (AC - FT)	56.33
Excess Volume (AC - FT)	381.59
Direct Runoff Volume (AC - FT)	381.59
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	4804.31
Time of Peak Discharge	01Jan2000, 03:08
Volume (IN)	10
Precipitation Volume (AC - FT)	1063.52
Loss Volume (AC - FT)	156.3
Excess Volume (AC - FT)	907.22
Direct Runoff Volume (AC - FT)	907.08
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	3344.14
Time of Peak Discharge	01Jan2000, 02:44
Volume (IN)	10.21
Precipitation Volume (AC - FT)	563.04
Loss Volume (AC - FT)	72.92
Excess Volume (AC - FT)	490.12
Direct Runoff Volume (AC - FT)	490.12
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	3435.53
Time of Peak Discharge	01Jan2000, 02:56
Volume (IN)	12.62
Peak Inflow (CFS)	3724.14
Time of Peak Inflow	01Jan2000, 02:44
Inflow Volume (AC - FT)	656.48
Maximum Storage (AC - FT)	87.14
Peak Elevation (FT)	4560.03
Discharge Volume (AC - FT)	605.97

Subbasin: Di2

Area (MI²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	3275.07
Time of Peak Discharge	01Jan2000, 02:44
Volume (IN)	9.95
Precipitation Volume (AC - FT)	563.04
Loss Volume (AC - FT)	85.21
Excess Volume (AC - FT)	477.83
Direct Runoff Volume (AC - FT)	477.83
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	2923.79
Time of Peak Discharge	01Jan2000, 02:52
Volume (IN)	7.44
Peak Inflow (CFS)	3413.07
Time of Peak Inflow	01Jan2000, 02:46
Inflow Volume (AC - FT)	542.17
Maximum Storage (AC - FT)	49.95
Peak Elevation (FT)	4604.08
Discharge Volume (AC - FT)	356.93

Subbasin: Di3

Area (MI²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	2446.04
Time of Peak Discharge	01Jan2000, 02:38
Volume (IN)	10.35
Precipitation Volume (AC - FT)	375.36
Loss Volume (AC - FT)	44.04
Excess Volume (AC - FT)	331.32
Direct Runoff Volume (AC - FT)	331.32
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	2221.72
Time of Peak Discharge	01Jan2000, 02:42
Volume (IN)	8.13
Peak Inflow (CFS)	2446.04
Time of Peak Inflow	01Jan2000, 02:42
Inflow Volume (AC - FT)	331.32
Maximum Storage (AC - FT)	30.12
Peak Elevation (FT)	4611.06
Discharge Volume (AC - FT)	260.03

Subbasin: Di4

Area (MI^2) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	27796.15
Time of Peak Discharge	01Jan2000, 03:26
Volume (IN)	10.22
Precipitation Volume (AC - FT)	7131.84
Loss Volume (AC - FT)	905.09
Excess Volume (AC - FT)	6226.75
Direct Runoff Volume (AC - FT)	6215.3
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	7483.79
Time of Peak Discharge	01Jan2000, 03:36
Volume (IN)	6.23

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	5103.92
Time of Peak Discharge	01Jan2000, 02:48
Volume (IN)	7.71

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	3435.53
Time of Peak Discharge	01Jan2000, 02:56
Volume (IN)	12.62

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2

Peak Discharge (CFS)	138
Time of Peak Discharge	01Jan2000, 02:06
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	64.34

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge

Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	383.82
Time of Peak Discharge	01Jan2000, 02:04
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	166.32

Project: Rev3

Simulation Run: Storm Event 05 SEPG

Simulation Start: 31 December 1999, 24:00

Simulation End: 4 January 2000, 03:00

HMS Version: 4.9

Executed: 30 March 2022, 12:31

Global Parameter Summary - Subbasin

Area (MI²)

Element Name	Area (MI²)
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

Downstream

Element Name	Downstream
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

Transform: Scs

Element Name	Lag	Unitgraph Type
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard
Di3	16.8	Standard

Di4	64.2 Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	135.45	02Jan2000, 06:00	12.43
Reservoir - Da1	0.3	135.26	02Jan2000, 06:00	10.97
Da2	3.6	1579.63	02Jan2000, 06:06	11.99
Reservoir - Da2/3	4.3	1893.12	02Jan2000, 06:08	10.37
Da3	0.7	317.07	02Jan2000, 06:00	12.57
Da4	1.7	761.62	02Jan2000, 06:02	12.35
Di1	0.9	407.43	02Jan2000, 06:00	12.56
Reservoir - Di1	0.9	787.3	02Jan2000, 06:02	27.98
Di2	0.9	403.66	02Jan2000, 06:00	12.29
Reservoir - Di2	0.9	161.33	02Jan2000, 06:02	2.03
Di3	0.6	273	02Jan2000, 06:00	12.7
Reservoir - Di3	0.6	134.86	02Jan2000, 06:00	2.94
Di4	11.4	5139.33	02Jan2000, 06:04	12.59
Junction - 1	4.6	2027.51	02Jan2000, 06:04	10.41
Junction - 2	1.5	296.2	02Jan2000, 06:02	2.39
Junction - 3	0.9	787.3	02Jan2000, 06:02	27.98
Reach - Di3 to Di2	0	138	01Jan2000, 23:50	Not specified
Reach - Di2 to Di1	0	380.43	02Jan2000, 00:36	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	135.45
Time of Peak Discharge	02Jan2000, 06:00
Volume (IN)	12.43
Precipitation Volume (AC - FT)	225.6
Loss Volume (AC - FT)	26.72
Excess Volume (AC - FT)	198.88
Direct Runoff Volume (AC - FT)	198.88
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	135.26
Time of Peak Discharge	02Jan2000, 06:00
Volume (IN)	10.97
Peak Inflow (CFS)	135.45
Time of Peak Inflow	02Jan2000, 06:00
Inflow Volume (AC - FT)	198.88
Maximum Storage (AC - FT)	30.56
Peak Elevation (FT)	4692.16
Discharge Volume (AC - FT)	175.48

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	1579.63
Time of Peak Discharge	02Jan2000, 06:06
Volume (IN)	11.99
Precipitation Volume (AC - FT)	2697.6
Loss Volume (AC - FT)	396.04
Excess Volume (AC - FT)	2301.55
Direct Runoff Volume (AC - FT)	2301.36
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	1893.12
Time of Peak Discharge	02Jan2000, 06:08

Volume (IN)	10.37
Peak Inflow (CFS)	1896.21
Time of Peak Inflow	02Jan2000, 06:02
Inflow Volume (AC - FT)	2770.57
Maximum Storage (AC - FT)	444.05
Peak Elevation (FT)	4698.33
Discharge Volume (AC - FT)	2379.25

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs

Lag	22.2
Unitgraph Type	Standard

Results: Da3

Peak Discharge (CFS)	317.07
Time of Peak Discharge	02Jan2000, 06:00
Volume (IN)	12.57
Precipitation Volume (AC - FT)	526.4
Loss Volume (AC - FT)	57.19
Excess Volume (AC - FT)	469.21
Direct Runoff Volume (AC - FT)	469.21
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs

Lag	46.8
Unitgraph Type	Standard

Results: Da4

Peak Discharge (CFS)	761.62
Time of Peak Discharge	02Jan2000, 06:02
Volume (IN)	12.35
Precipitation Volume (AC - FT)	1278.4
Loss Volume (AC - FT)	159.06
Excess Volume (AC - FT)	1119.34
Direct Runoff Volume (AC - FT)	1119.33
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	407.43
Time of Peak Discharge	02Jan2000, 06:00
Volume (IN)	12.56
Precipitation Volume (AC - FT)	676.8
Loss Volume (AC - FT)	74.04
Excess Volume (AC - FT)	602.76
Direct Runoff Volume (AC - FT)	602.76
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	787.3
Time of Peak Discharge	02Jan2000, 06:02
Volume (IN)	27.98
Peak Inflow (CFS)	787.43
Time of Peak Inflow	02Jan2000, 06:00
Inflow Volume (AC - FT)	1383.01
Maximum Storage (AC - FT)	67.93
Peak Elevation (FT)	4557.39
Discharge Volume (AC - FT)	1343.18

Subbasin: Di2

Area (MI²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	403.66
Time of Peak Discharge	02Jan2000, 06:00
Volume (IN)	12.29
Precipitation Volume (AC - FT)	676.8
Loss Volume (AC - FT)	86.76
Excess Volume (AC - FT)	590.04
Direct Runoff Volume (AC - FT)	590.04
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	161.33
Time of Peak Discharge	02Jan2000, 06:02
Volume (IN)	2.03
Peak Inflow (CFS)	541.66
Time of Peak Inflow	02Jan2000, 06:02
Inflow Volume (AC - FT)	895.93
Maximum Storage (AC - FT)	30.05
Peak Elevation (FT)	4600.58
Discharge Volume (AC - FT)	97.26

Subbasin: Di3

Area (MI²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	273
Time of Peak Discharge	02Jan2000, 06:00
Volume (IN)	12.7
Precipitation Volume (AC - FT)	451.2
Loss Volume (AC - FT)	44.65
Excess Volume (AC - FT)	406.55
Direct Runoff Volume (AC - FT)	406.55
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	134.86
Time of Peak Discharge	02Jan2000, 06:00
Volume (IN)	2.94
Peak Inflow (CFS)	273
Time of Peak Inflow	02Jan2000, 06:04
Inflow Volume (AC - FT)	406.55
Maximum Storage (AC - FT)	16.3
Peak Elevation (FT)	4607.61
Discharge Volume (AC - FT)	94.22

Subbasin: Di4

Area (MI²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	5139.33
Time of Peak Discharge	02Jan2000, 06:04
Volume (IN)	12.59
Precipitation Volume (AC - FT)	8572.8
Loss Volume (AC - FT)	918.84
Excess Volume (AC - FT)	7653.96
Direct Runoff Volume (AC - FT)	7652.99
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	2027.51
Time of Peak Discharge	02Jan2000, 06:04
Volume (IN)	10.41

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	296.2
Time of Peak Discharge	02Jan2000, 06:02
Volume (IN)	2.39

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	787.3
Time of Peak Discharge	02Jan2000, 06:02
Volume (IN)	27.98

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2

Peak Discharge (CFS)	138
Time of Peak Discharge	01Jan2000, 23:50
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	305.88

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge

Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	380.43
Time of Peak Discharge	02Jan2000, 00:36
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	780.24

Project: Rev3

Simulation Run: Storm Event 06 PSH

Simulation Start: 31 December 1999, 24:00

Simulation End: 11 January 2000, 03:00

HMS Version: 4.9

Executed: 30 March 2022, 14:39

Global Parameter Summary - Subbasin

Area (MI²)

Element Name	Area (MI²)
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

Downstream

Element Name	Downstream
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

Transform: Scs

Element Name	Lag	Unitgraph Type
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard
Di3	16.8	Standard

Di4	64.2	Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	298.2	05Jan2000, 24:00	5.01
Reservoir - Da1	0.3	200.21	06Jan2000, 00:08	4.68
Da2	3.6	2518.19	06Jan2000, 00:36	5.27
Reservoir - Da2/3	4.3	2066.78	06Jan2000, 01:08	3.64
Da3	0.7	654.86	06Jan2000, 00:04	5.03
Da4	1.7	1259.56	06Jan2000, 00:24	4.94
Di1	0.9	847.03	06Jan2000, 00:06	5.12
Reservoir - Di1	0.9	1218.43	06Jan2000, 00:10	9.04
Di2	0.9	859.93	06Jan2000, 00:06	5.13
Reservoir - Di2	0.9	601.6	06Jan2000, 00:10	2.19
Di3	0.6	607.65	06Jan2000, 00:02	5.35
Reservoir - Di3	0.6	462.45	06Jan2000, 00:06	2.86
Di4	11.4	7391.81	06Jan2000, 00:40	5.15
Junction - 1	4.6	2129.34	06Jan2000, 01:08	3.71
Junction - 2	1.5	1057.01	06Jan2000, 00:08	2.46
Junction - 3	0.9	1218.43	06Jan2000, 00:10	9.04
Reach - Di3 to Di2	0	138	05Jan2000, 23:50	Not specified
Reach - Di2 to Di1	0	381.98	05Jan2000, 23:38	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	298.2
Time of Peak Discharge	05Jan2000, 24:00
Volume (IN)	5.01
Precipitation Volume (AC - FT)	104.48
Loss Volume (AC - FT)	24.36
Excess Volume (AC - FT)	80.12
Direct Runoff Volume (AC - FT)	80.12
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	200.21
Time of Peak Discharge	06Jan2000, 00:08
Volume (IN)	4.68
Peak Inflow (CFS)	298.2
Time of Peak Inflow	05Jan2000, 24:00
Inflow Volume (AC - FT)	80.12
Maximum Storage (AC - FT)	31.97
Peak Elevation (FT)	4692.36
Discharge Volume (AC - FT)	74.85

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	2518.19
Time of Peak Discharge	06Jan2000, 00:36
Volume (IN)	5.27
Precipitation Volume (AC - FT)	1372.8
Loss Volume (AC - FT)	360.03
Excess Volume (AC - FT)	1012.77
Direct Runoff Volume (AC - FT)	1012.75
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	2066.78
Time of Peak Discharge	06Jan2000, 01:08

Volume (IN)	3.64
Peak Inflow (CFS)	2831.84
Time of Peak Inflow	06Jan2000, 00:28
Inflow Volume (AC - FT)	1200.35
Maximum Storage (AC - FT)	447.35
Peak Elevation (FT)	4698.41
Discharge Volume (AC - FT)	834.15

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs

Lag	22.2
Unitgraph Type	Standard

Results: Da3

Peak Discharge (CFS)	654.86
Time of Peak Discharge	06Jan2000, 00:04
Volume (IN)	5.03
Precipitation Volume (AC - FT)	240.05
Loss Volume (AC - FT)	52.45
Excess Volume (AC - FT)	187.61
Direct Runoff Volume (AC - FT)	187.61
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs

Lag	46.8
Unitgraph Type	Standard

Results: Da4

Peak Discharge (CFS)	1259.56
Time of Peak Discharge	06Jan2000, 00:24
Volume (IN)	4.94
Precipitation Volume (AC - FT)	592.05
Loss Volume (AC - FT)	144.41
Excess Volume (AC - FT)	447.64
Direct Runoff Volume (AC - FT)	447.64
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	847.03
Time of Peak Discharge	06Jan2000, 00:06
Volume (IN)	5.12
Precipitation Volume (AC - FT)	313.92
Loss Volume (AC - FT)	68.02
Excess Volume (AC - FT)	245.9
Direct Runoff Volume (AC - FT)	245.9
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	1218.43
Time of Peak Discharge	06Jan2000, 00:10
Volume (IN)	9.04
Peak Inflow (CFS)	1227.03
Time of Peak Inflow	06Jan2000, 00:06
Inflow Volume (AC - FT)	447.47
Maximum Storage (AC - FT)	70.67
Peak Elevation (FT)	4557.93
Discharge Volume (AC - FT)	434.13

Subbasin: Di2

Area (MI^2) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	859.93
Time of Peak Discharge	06Jan2000, 00:06
Volume (IN)	5.13
Precipitation Volume (AC - FT)	325.44
Loss Volume (AC - FT)	79.06
Excess Volume (AC - FT)	246.38
Direct Runoff Volume (AC - FT)	246.38
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	601.6
Time of Peak Discharge	06Jan2000, 00:10
Volume (IN)	2.19
Peak Inflow (CFS)	997.93
Time of Peak Inflow	06Jan2000, 00:08
Inflow Volume (AC - FT)	323.23
Maximum Storage (AC - FT)	34.47
Peak Elevation (FT)	4601.42
Discharge Volume (AC - FT)	105.03

Subbasin: Di3

Area (MI²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	607.65
Time of Peak Discharge	06Jan2000, 00:02
Volume (IN)	5.35
Precipitation Volume (AC - FT)	212.48
Loss Volume (AC - FT)	41.42
Excess Volume (AC - FT)	171.06
Direct Runoff Volume (AC - FT)	171.06
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	462.45
Time of Peak Discharge	06Jan2000, 00:06
Volume (IN)	2.86
Peak Inflow (CFS)	607.65
Time of Peak Inflow	06Jan2000, 00:06
Inflow Volume (AC - FT)	171.06
Maximum Storage (AC - FT)	19.32
Peak Elevation (FT)	4608.42
Discharge Volume (AC - FT)	91.54

Subbasin: Di4

Area (MI²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	7391.81
Time of Peak Discharge	06Jan2000, 00:40
Volume (IN)	5.15
Precipitation Volume (AC - FT)	3976.32
Loss Volume (AC - FT)	845.15
Excess Volume (AC - FT)	3131.17
Direct Runoff Volume (AC - FT)	3131.07
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	2129.34
Time of Peak Discharge	06Jan2000, 01:08
Volume (IN)	3.71

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	1057.01
Time of Peak Discharge	06Jan2000, 00:08
Volume (IN)	2.46

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	1218.43
Time of Peak Discharge	06Jan2000, 00:10
Volume (IN)	9.04

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2	
Peak Discharge (CFS)	138
Time of Peak Discharge	05Jan2000, 23:50
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	76.85

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1	
Peak Discharge (CFS)	381.98
Time of Peak Discharge	05Jan2000, 23:38
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	201.56

Project: Rev3

Simulation Run: Storm Event 07 ASHL

Simulation Start: 31 December 1999, 24:00

Simulation End: 1 January 2000, 09:00

HMS Version: 4.9

Executed: 30 March 2022, 12:33

Global Parameter Summary - Subbasin

	Area (MI²)
Element Name	**Area (MI²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard
Di3	16.8	Standard

Di4	64.2 Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	474.65	01Jan2000, 02:32	3.47
Reservoir - Da1	0.3	150.98	01Jan2000, 03:04	1.98
Da2	3.6	2324.75	01Jan2000, 03:28	2.69
Reservoir - Da2/3	4.3	1247.65	01Jan2000, 05:12	1.11
Da3	0.7	940.91	01Jan2000, 02:44	3.56
Da4	1.7	1619.14	01Jan2000, 03:12	3.4
Di1	0.9	1183.36	01Jan2000, 02:46	3.56
Reservoir - Di1	0.9	1331.1	01Jan2000, 03:04	5.37
Di2	0.9	1120	01Jan2000, 02:48	3.39
Reservoir - Di2	0.9	823.35	01Jan2000, 02:56	1.3
Di3	0.6	892.46	01Jan2000, 02:38	3.68
Reservoir - Di3	0.6	724.01	01Jan2000, 02:44	1.8
Di4	11.4	9656.43	01Jan2000, 03:30	3.58
Junction - 1	4.6	1326.27	01Jan2000, 05:12	1.17
Junction - 2	1.5	1481.59	01Jan2000, 02:52	1.5
Junction - 3	0.9	1331.1	01Jan2000, 03:04	5.37
Reach - Di3 to Di2	0	138	01Jan2000, 02:44	Not specified
Reach - Di2 to Di1	0	385.84	01Jan2000, 02:40	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	474.65
Time of Peak Discharge	01Jan2000, 02:32
Volume (IN)	3.47
Precipitation Volume (AC - FT)	78.56
Loss Volume (AC - FT)	23.1
Excess Volume (AC - FT)	55.46
Direct Runoff Volume (AC - FT)	55.46
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	150.98
Time of Peak Discharge	01Jan2000, 03:04
Volume (IN)	1.98
Peak Inflow (CFS)	474.65
Time of Peak Inflow	01Jan2000, 02:32
Inflow Volume (AC - FT)	55.46
Maximum Storage (AC - FT)	30.92
Peak Elevation (FT)	4692.21
Discharge Volume (AC - FT)	31.72

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	2324.75
Time of Peak Discharge	01Jan2000, 03:28
Volume (IN)	2.69
Precipitation Volume (AC - FT)	839.04
Loss Volume (AC - FT)	321.75
Excess Volume (AC - FT)	517.29
Direct Runoff Volume (AC - FT)	516.52
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	1247.65
Time of Peak Discharge	01Jan2000, 05:12

Volume (IN)	1.11
Peak Inflow (CFS)	2732.99
Time of Peak Inflow	01Jan2000, 03:22
Inflow Volume (AC - FT)	649.4
Maximum Storage (AC - FT)	430.72
Peak Elevation (FT)	4698
Discharge Volume (AC - FT)	254.76

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs

Lag	22.2
Unitgraph Type	Standard

Results: Da3

Peak Discharge (CFS)	940.91
Time of Peak Discharge	01Jan2000, 02:44
Volume (IN)	3.56
Precipitation Volume (AC - FT)	182.93
Loss Volume (AC - FT)	50.05
Excess Volume (AC - FT)	132.89
Direct Runoff Volume (AC - FT)	132.89
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs

Lag	46.8
Unitgraph Type	Standard

Results: Da4

Peak Discharge (CFS)	1619.14
Time of Peak Discharge	01Jan2000, 03:12
Volume (IN)	3.4
Precipitation Volume (AC - FT)	445.17
Loss Volume (AC - FT)	136.63
Excess Volume (AC - FT)	308.54
Direct Runoff Volume (AC - FT)	308.49
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	1183.36
Time of Peak Discharge	01Jan2000, 02:46
Volume (IN)	3.56
Precipitation Volume (AC - FT)	235.68
Loss Volume (AC - FT)	64.74
Excess Volume (AC - FT)	170.94
Direct Runoff Volume (AC - FT)	170.94
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	1331.1
Time of Peak Discharge	01Jan2000, 03:04
Volume (IN)	5.37
Peak Inflow (CFS)	1563.09
Time of Peak Inflow	01Jan2000, 02:46
Inflow Volume (AC - FT)	306.06
Maximum Storage (AC - FT)	71.32
Peak Elevation (FT)	4558.06
Discharge Volume (AC - FT)	257.88

Subbasin: Di2

Area (MI²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	1120
Time of Peak Discharge	01Jan2000, 02:48
Volume (IN)	3.39
Precipitation Volume (AC - FT)	237.12
Loss Volume (AC - FT)	74.29
Excess Volume (AC - FT)	162.83
Direct Runoff Volume (AC - FT)	162.83
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	823.35
Time of Peak Discharge	01Jan2000, 02:56
Volume (IN)	1.3
Peak Inflow (CFS)	1258
Time of Peak Inflow	01Jan2000, 02:50
Inflow Volume (AC - FT)	216.14
Maximum Storage (AC - FT)	36.23
Peak Elevation (FT)	4601.76
Discharge Volume (AC - FT)	62.28

Subbasin: Di3

Area (MI²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	892.46
Time of Peak Discharge	01Jan2000, 02:38
Volume (IN)	3.68
Precipitation Volume (AC - FT)	157.12
Loss Volume (AC - FT)	39.51
Excess Volume (AC - FT)	117.61
Direct Runoff Volume (AC - FT)	117.61
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	724.01
Time of Peak Discharge	01Jan2000, 02:44
Volume (IN)	1.8
Peak Inflow (CFS)	892.46
Time of Peak Inflow	01Jan2000, 02:42
Inflow Volume (AC - FT)	117.61
Maximum Storage (AC - FT)	21.2
Peak Elevation (FT)	4608.92
Discharge Volume (AC - FT)	57.49

Subbasin: Di4

Area (MI²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	9656.43
Time of Peak Discharge	01Jan2000, 03:30
Volume (IN)	3.58
Precipitation Volume (AC - FT)	2985.28
Loss Volume (AC - FT)	804.94
Excess Volume (AC - FT)	2180.34
Direct Runoff Volume (AC - FT)	2175.79
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	1326.27
Time of Peak Discharge	01Jan2000, 05:12
Volume (IN)	1.17

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	1481.59
Time of Peak Discharge	01Jan2000, 02:52
Volume (IN)	1.5

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	1331.1
Time of Peak Discharge	01Jan2000, 03:04
Volume (IN)	5.37

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2

Peak Discharge (CFS)	138
Time of Peak Discharge	01Jan2000, 02:44
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	53.31

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge

Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	385.84
Time of Peak Discharge	01Jan2000, 02:40
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	135.08

Project: Rev3

Simulation Run: Storm Event 08 ASHG

Simulation Start: 31 December 1999, 24:00

Simulation End: 2 January 2000, 03:00

HMS Version: 4.9

Executed: 30 March 2022, 12:33

Global Parameter Summary - Subbasin

Area (MI²)

Element Name	Area (MI²)
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

Downstream

Element Name	Downstream
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

Transform: Scs

Element Name	Lag	Unitgraph Type
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard
Di3	16.8	Standard

Di4	64.2 Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	149.14	01Jan2000, 10:00	4.24
Reservoir - Da1	0.3	96.6	01Jan2000, 10:18	2.77
Da2	3.6	1520.45	01Jan2000, 10:32	4.04
Reservoir - Da2/3	4.3	1110.31	01Jan2000, 11:54	2.38
Da3	0.7	347.57	01Jan2000, 10:04	4.33
Da4	1.7	771.85	01Jan2000, 10:18	4.17
Di1	0.9	440.33	01Jan2000, 10:04	4.33
Reservoir - Di1	0.9	819.09	01Jan2000, 10:08	8.71
Di2	0.9	434	01Jan2000, 10:04	4.2
Reservoir - Di2	0.9	188.37	01Jan2000, 10:10	0.69
Di3	0.6	305.8	01Jan2000, 10:02	4.47
Reservoir - Di3	0.6	166.11	01Jan2000, 10:06	1.07
Di4	11.4	5086.32	01Jan2000, 10:32	4.36
Junction - 1	4.6	1160.02	01Jan2000, 11:54	2.4
Junction - 2	1.5	353.6	01Jan2000, 10:08	0.84
Junction - 3	0.9	819.09	01Jan2000, 10:08	8.71
Reach - Di3 to Di2	0	138	01Jan2000, 08:52	Not specified
Reach - Di2 to Di1	0	380.7	01Jan2000, 08:50	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	149.14
Time of Peak Discharge	01Jan2000, 10:00
Volume (IN)	4.24
Precipitation Volume (AC - FT)	91.68
Loss Volume (AC - FT)	23.81
Excess Volume (AC - FT)	67.87
Direct Runoff Volume (AC - FT)	67.87
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	96.6
Time of Peak Discharge	01Jan2000, 10:18
Volume (IN)	2.77
Peak Inflow (CFS)	149.14
Time of Peak Inflow	01Jan2000, 10:00
Inflow Volume (AC - FT)	67.87
Maximum Storage (AC - FT)	29.6
Peak Elevation (FT)	4692.02
Discharge Volume (AC - FT)	44.4

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	1520.45
Time of Peak Discharge	01Jan2000, 10:32
Volume (IN)	4.04
Precipitation Volume (AC - FT)	1121.28
Loss Volume (AC - FT)	345.58
Excess Volume (AC - FT)	775.7
Direct Runoff Volume (AC - FT)	775.45
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	1110.31
Time of Peak Discharge	01Jan2000, 11:54

Volume (IN)	2.38
Peak Inflow (CFS)	1815.1
Time of Peak Inflow	01Jan2000, 10:18
Inflow Volume (AC - FT)	937.17
Maximum Storage (AC - FT)	427.6
Peak Elevation (FT)	4697.93
Discharge Volume (AC - FT)	545.39

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs

Lag	22.2
Unitgraph Type	Standard

Results: Da3

Peak Discharge (CFS)	347.57
Time of Peak Discharge	01Jan2000, 10:04
Volume (IN)	4.33
Precipitation Volume (AC - FT)	213.17
Loss Volume (AC - FT)	51.45
Excess Volume (AC - FT)	161.72
Direct Runoff Volume (AC - FT)	161.72
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs

Lag	46.8
Unitgraph Type	Standard

Results: Da4

Peak Discharge (CFS)	771.85
Time of Peak Discharge	01Jan2000, 10:18
Volume (IN)	4.17
Precipitation Volume (AC - FT)	519.52
Loss Volume (AC - FT)	141.02
Excess Volume (AC - FT)	378.5
Direct Runoff Volume (AC - FT)	378.49
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	440.33
Time of Peak Discharge	01Jan2000, 10:04
Volume (IN)	4.33
Precipitation Volume (AC - FT)	274.56
Loss Volume (AC - FT)	66.57
Excess Volume (AC - FT)	207.99
Direct Runoff Volume (AC - FT)	207.99
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	819.09
Time of Peak Discharge	01Jan2000, 10:08
Volume (IN)	8.71
Peak Inflow (CFS)	820.33
Time of Peak Inflow	01Jan2000, 10:04
Inflow Volume (AC - FT)	460.37
Maximum Storage (AC - FT)	68.15
Peak Elevation (FT)	4557.43
Discharge Volume (AC - FT)	417.93

Subbasin: Di2

Area (MI²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	434
Time of Peak Discharge	01Jan2000, 10:04
Volume (IN)	4.2
Precipitation Volume (AC - FT)	278.4
Loss Volume (AC - FT)	76.83
Excess Volume (AC - FT)	201.57
Direct Runoff Volume (AC - FT)	201.57
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	188.37
Time of Peak Discharge	01Jan2000, 10:10
Volume (IN)	0.69
Peak Inflow (CFS)	572
Time of Peak Inflow	01Jan2000, 10:06
Inflow Volume (AC - FT)	303.98
Maximum Storage (AC - FT)	30.4
Peak Elevation (FT)	4600.65
Discharge Volume (AC - FT)	33.15

Subbasin: Di3

Area (MI²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	305.8
Time of Peak Discharge	01Jan2000, 10:02
Volume (IN)	4.47
Precipitation Volume (AC - FT)	183.68
Loss Volume (AC - FT)	40.55
Excess Volume (AC - FT)	143.13
Direct Runoff Volume (AC - FT)	143.13
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	166.11
Time of Peak Discharge	01Jan2000, 10:06
Volume (IN)	1.07
Peak Inflow (CFS)	305.8
Time of Peak Inflow	01Jan2000, 10:06
Inflow Volume (AC - FT)	143.13
Maximum Storage (AC - FT)	16.65
Peak Elevation (FT)	4607.71
Discharge Volume (AC - FT)	34.22

Subbasin: Di4

Area (MI²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	5086.32
Time of Peak Discharge	01Jan2000, 10:32
Volume (IN)	4.36
Precipitation Volume (AC - FT)	3477.76
Loss Volume (AC - FT)	827.32
Excess Volume (AC - FT)	2650.44
Direct Runoff Volume (AC - FT)	2649.2
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	1160.02
Time of Peak Discharge	01Jan2000, 11:54
Volume (IN)	2.4

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	353.6
Time of Peak Discharge	01Jan2000, 10:08
Volume (IN)	0.84

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	819.09
Time of Peak Discharge	01Jan2000, 10:08
Volume (IN)	8.71

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2

Peak Discharge (CFS)	138
Time of Peak Discharge	01Jan2000, 08:52
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	102.41

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge

Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	380.7
Time of Peak Discharge	01Jan2000, 08:50
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	252.35

Project: Rev3

Simulation Run: Storm Event 09 FBHL

Simulation Start: 31 December 1999, 24:00

Simulation End: 1 January 2000, 09:00

HMS Version: 4.9

Executed: 30 March 2022, 12:33

Global Parameter Summary - Subbasin

	Area (MI²)
Element Name	**Area (MI²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

		Loss Rate: Scs	
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard
Di3	16.8	Standard

Di4	64.2	Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	1312.24	01Jan2000, 02:30	10.09
Reservoir - Da1	0.3	1198.11	01Jan2000, 02:36	8.6
Da2	3.6	6533.46	01Jan2000, 03:24	7.33
Reservoir - Da2/3	4.3	7149.67	01Jan2000, 03:38	6.07
Da3	0.7	2657.47	01Jan2000, 02:42	10.22
Da4	1.7	4804.31	01Jan2000, 03:08	10
Di1	0.9	3344.14	01Jan2000, 02:44	10.21
Reservoir - Di1	0.9	3435.53	01Jan2000, 02:56	12.62
Di2	0.9	3275.07	01Jan2000, 02:44	9.95
Reservoir - Di2	0.9	2923.79	01Jan2000, 02:52	7.44
Di3	0.6	2446.04	01Jan2000, 02:38	10.35
Reservoir - Di3	0.6	2221.72	01Jan2000, 02:42	8.13
Di4	11.4	27796.15	01Jan2000, 03:26	10.22
Junction - 1	4.6	7483.79	01Jan2000, 03:36	6.23
Junction - 2	1.5	5103.92	01Jan2000, 02:48	7.71
Junction - 3	0.9	3435.53	01Jan2000, 02:56	12.62
Reach - Di3 to Di2	0	138	01Jan2000, 02:06	Not specified
Reach - Di2 to Di1	0	383.82	01Jan2000, 02:04	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	1312.24
Time of Peak Discharge	01Jan2000, 02:30
Volume (IN)	10.09
Precipitation Volume (AC - FT)	187.68
Loss Volume (AC - FT)	26.27
Excess Volume (AC - FT)	161.41
Direct Runoff Volume (AC - FT)	161.41
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	1198.11
Time of Peak Discharge	01Jan2000, 02:36
Volume (IN)	8.6
Peak Inflow (CFS)	1312.24
Time of Peak Inflow	01Jan2000, 02:30
Inflow Volume (AC - FT)	161.41
Maximum Storage (AC - FT)	46.02
Peak Elevation (FT)	4694.39
Discharge Volume (AC - FT)	137.53

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	6533.46
Time of Peak Discharge	01Jan2000, 03:24
Volume (IN)	7.33
Precipitation Volume (AC - FT)	1785.6
Loss Volume (AC - FT)	376.17
Excess Volume (AC - FT)	1409.43
Direct Runoff Volume (AC - FT)	1407.63
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	7149.67
Time of Peak Discharge	01Jan2000, 03:38

Volume (IN)	6.07
Peak Inflow (CFS)	7765.51
Time of Peak Inflow	01Jan2000, 03:14
Inflow Volume (AC - FT)	1789.22
Maximum Storage (AC - FT)	524.62
Peak Elevation (FT)	4700.25
Discharge Volume (AC - FT)	1391.57

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs

Lag	22.2
Unitgraph Type	Standard

Results: Da3

Peak Discharge (CFS)	2657.47
Time of Peak Discharge	01Jan2000, 02:42
Volume (IN)	10.22
Precipitation Volume (AC - FT)	437.92
Loss Volume (AC - FT)	56.33
Excess Volume (AC - FT)	381.59
Direct Runoff Volume (AC - FT)	381.59
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs

Lag	46.8
Unitgraph Type	Standard

Results: Da4

Peak Discharge (CFS)	4804.31
Time of Peak Discharge	01Jan2000, 03:08
Volume (IN)	10
Precipitation Volume (AC - FT)	1063.52
Loss Volume (AC - FT)	156.3
Excess Volume (AC - FT)	907.22
Direct Runoff Volume (AC - FT)	907.08
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	3344.14
Time of Peak Discharge	01Jan2000, 02:44
Volume (IN)	10.21
Precipitation Volume (AC - FT)	563.04
Loss Volume (AC - FT)	72.92
Excess Volume (AC - FT)	490.12
Direct Runoff Volume (AC - FT)	490.12
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	3435.53
Time of Peak Discharge	01Jan2000, 02:56
Volume (IN)	12.62
Peak Inflow (CFS)	3724.14
Time of Peak Inflow	01Jan2000, 02:44
Inflow Volume (AC - FT)	656.48
Maximum Storage (AC - FT)	87.14
Peak Elevation (FT)	4560.03
Discharge Volume (AC - FT)	605.97

Subbasin: Di2

Area (MI²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	3275.07
Time of Peak Discharge	01Jan2000, 02:44
Volume (IN)	9.95
Precipitation Volume (AC - FT)	563.04
Loss Volume (AC - FT)	85.21
Excess Volume (AC - FT)	477.83
Direct Runoff Volume (AC - FT)	477.83
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	2923.79
Time of Peak Discharge	01Jan2000, 02:52
Volume (IN)	7.44
Peak Inflow (CFS)	3413.07
Time of Peak Inflow	01Jan2000, 02:46
Inflow Volume (AC - FT)	542.17
Maximum Storage (AC - FT)	49.95
Peak Elevation (FT)	4604.08
Discharge Volume (AC - FT)	356.93

Subbasin: Di3

Area (MI²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	2446.04
Time of Peak Discharge	01Jan2000, 02:38
Volume (IN)	10.35
Precipitation Volume (AC - FT)	375.36
Loss Volume (AC - FT)	44.04
Excess Volume (AC - FT)	331.32
Direct Runoff Volume (AC - FT)	331.32
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	2221.72
Time of Peak Discharge	01Jan2000, 02:42
Volume (IN)	8.13
Peak Inflow (CFS)	2446.04
Time of Peak Inflow	01Jan2000, 02:42
Inflow Volume (AC - FT)	331.32
Maximum Storage (AC - FT)	30.12
Peak Elevation (FT)	4611.06
Discharge Volume (AC - FT)	260.03

Subbasin: Di4

Area (MI²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	27796.15
Time of Peak Discharge	01Jan2000, 03:26
Volume (IN)	10.22
Precipitation Volume (AC - FT)	7131.84
Loss Volume (AC - FT)	905.09
Excess Volume (AC - FT)	6226.75
Direct Runoff Volume (AC - FT)	6215.3
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	7483.79
Time of Peak Discharge	01Jan2000, 03:36
Volume (IN)	6.23

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	5103.92
Time of Peak Discharge	01Jan2000, 02:48
Volume (IN)	7.71

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	3435.53
Time of Peak Discharge	01Jan2000, 02:56
Volume (IN)	12.62

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2

Peak Discharge (CFS)	138
Time of Peak Discharge	01Jan2000, 02:06
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	64.34

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge

Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	383.82
Time of Peak Discharge	01Jan2000, 02:04
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	166.32

Project: Rev3

Simulation Run: Storm Event 11 2y6h

Simulation Start: 31 December 1999, 24:00

Simulation End: 1 January 2000, 09:00

HMS Version: 4.9

Executed: 30 March 2022, 12:34

Global Parameter Summary - Subbasin

	Area (MI²)
Element Name	**Area (MI²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard
Di3	16.8	Standard

Di4	64.2 Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	29.6	01Jan2000, 02:34	0.26
Reservoir - Da1	0.3	2.18	01Jan2000, 06:12	0.06
Da2	3.6	138.61	01Jan2000, 03:56	0.21
Reservoir - Da2/3	4.3	9.75	01Jan2000, 08:10	0.02
Da3	0.7	62.47	01Jan2000, 02:56	0.29
Da4	1.7	87.52	01Jan2000, 03:30	0.24
Di1	0.9	77.66	01Jan2000, 02:58	0.29
Reservoir - Di1	0.9	6.59	01Jan2000, 06:40	0.01
Di2	0.9	62.16	01Jan2000, 02:58	0.24
Reservoir - Di2	0.9	3.91	01Jan2000, 07:02	0.04
Di3	0.6	70.68	01Jan2000, 02:46	0.33
Reservoir - Di3	0.6	4.71	01Jan2000, 06:06	0.07
Di4	11.4	664.34	01Jan2000, 03:52	0.29
Junction - 1	4.6	11.84	01Jan2000, 07:50	0.02
Junction - 2	1.5	8.56	01Jan2000, 06:46	0.05
Junction - 3	0.9	6.59	01Jan2000, 06:40	0.01
Reach - Di3 to Di2	0	14.22	01Jan2000, 06:08	Not specified
Reach - Di2 to Di1	0	0	31Dec1999, 24:00	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	29.6
Time of Peak Discharge	01Jan2000, 02:34
Volume (IN)	0.26
Precipitation Volume (AC - FT)	17.12
Loss Volume (AC - FT)	12.98
Excess Volume (AC - FT)	4.14
Direct Runoff Volume (AC - FT)	4.14
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	2.18
Time of Peak Discharge	01Jan2000, 06:12
Volume (IN)	0.06
Peak Inflow (CFS)	29.6
Time of Peak Inflow	01Jan2000, 02:34
Inflow Volume (AC - FT)	4.14
Maximum Storage (AC - FT)	5.37
Peak Elevation (FT)	4680
Discharge Volume (AC - FT)	1.03

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	138.61
Time of Peak Discharge	01Jan2000, 03:56
Volume (IN)	0.21
Precipitation Volume (AC - FT)	216.96
Loss Volume (AC - FT)	176.49
Excess Volume (AC - FT)	40.47
Direct Runoff Volume (AC - FT)	40.36
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	9.75
Time of Peak Discharge	01Jan2000, 08:10

Volume (IN)	0.02
Peak Inflow (CFS)	171.12
Time of Peak Inflow	01Jan2000, 03:50
Inflow Volume (AC - FT)	51.11
Maximum Storage (AC - FT)	47.42
Peak Elevation (FT)	4670.65
Discharge Volume (AC - FT)	4.01

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	62.47
Time of Peak Discharge	01Jan2000, 02:56
Volume (IN)	0.29
Precipitation Volume (AC - FT)	39.95
Loss Volume (AC - FT)	29.19
Excess Volume (AC - FT)	10.75
Direct Runoff Volume (AC - FT)	10.75
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	87.52
Time of Peak Discharge	01Jan2000, 03:30
Volume (IN)	0.24
Precipitation Volume (AC - FT)	97.01
Loss Volume (AC - FT)	75.32
Excess Volume (AC - FT)	21.69
Direct Runoff Volume (AC - FT)	21.69
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	77.66
Time of Peak Discharge	01Jan2000, 02:58
Volume (IN)	0.29
Precipitation Volume (AC - FT)	51.36
Loss Volume (AC - FT)	37.62
Excess Volume (AC - FT)	13.74
Direct Runoff Volume (AC - FT)	13.74
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	6.59
Time of Peak Discharge	01Jan2000, 06:40
Volume (IN)	0.01
Peak Inflow (CFS)	77.66
Time of Peak Inflow	01Jan2000, 02:58
Inflow Volume (AC - FT)	13.74
Maximum Storage (AC - FT)	13.49
Peak Elevation (FT)	4543.54
Discharge Volume (AC - FT)	0.4

Subbasin: Di2

Area (MI²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	62.16
Time of Peak Discharge	01Jan2000, 02:58
Volume (IN)	0.24
Precipitation Volume (AC - FT)	52.32
Loss Volume (AC - FT)	40.84
Excess Volume (AC - FT)	11.48
Direct Runoff Volume (AC - FT)	11.48
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	3.91
Time of Peak Discharge	01Jan2000, 07:02
Volume (IN)	0.04
Peak Inflow (CFS)	62.16
Time of Peak Inflow	01Jan2000, 03:00
Inflow Volume (AC - FT)	13.41
Maximum Storage (AC - FT)	12.28
Peak Elevation (FT)	4592.76
Discharge Volume (AC - FT)	1.7

Subbasin: Di3

Area (MI²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	70.68
Time of Peak Discharge	01Jan2000, 02:46
Volume (IN)	0.33
Precipitation Volume (AC - FT)	34.56
Loss Volume (AC - FT)	23.95
Excess Volume (AC - FT)	10.61
Direct Runoff Volume (AC - FT)	10.61
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	4.71
Time of Peak Discharge	01Jan2000, 06:06
Volume (IN)	0.07
Peak Inflow (CFS)	70.68
Time of Peak Inflow	01Jan2000, 02:50
Inflow Volume (AC - FT)	10.61
Maximum Storage (AC - FT)	7.72
Peak Elevation (FT)	4604.31
Discharge Volume (AC - FT)	2.32

Subbasin: Di4

Area (MI²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	664.34
Time of Peak Discharge	01Jan2000, 03:52
Volume (IN)	0.29
Precipitation Volume (AC - FT)	650.56
Loss Volume (AC - FT)	470.71
Excess Volume (AC - FT)	179.85
Direct Runoff Volume (AC - FT)	179.22
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	11.84
Time of Peak Discharge	01Jan2000, 07:50
Volume (IN)	0.02

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	8.56
Time of Peak Discharge	01Jan2000, 06:46
Volume (IN)	0.05

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	6.59
Time of Peak Discharge	01Jan2000, 06:40
Volume (IN)	0.01

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2

Peak Discharge (CFS)	14.22
Time of Peak Discharge	01Jan2000, 06:08
Peak Inflow (CFS)	14.23
Inflow Volume (AC - FT)	1.93

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge

Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	0
Time of Peak Discharge	31Dec1999, 24:00
Peak Inflow (CFS)	0
Inflow Volume (AC - FT)	0

Project: Rev3

Simulation Run: Storm Event 12 5y6h

Simulation Start: 31 December 1999, 24:00

Simulation End: 1 January 2000, 09:00

HMS Version: 4.9

Executed: 30 March 2022, 12:34

Global Parameter Summary - Subbasin

	Area (MI²)
Element Name	**Area (MI²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard
Di3	16.8	Standard

Di4	64.2	Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	55.24	01Jan2000, 02:34	0.43
Reservoir - Da1	0.3	2.84	01Jan2000, 06:12	0.09
Da2	3.6	263.02	01Jan2000, 03:46	0.37
Reservoir - Da2/3	4.3	12.94	01Jan2000, 08:14	0.02
Da3	0.7	111.44	01Jan2000, 02:54	0.47
Da4	1.7	161.87	01Jan2000, 03:24	0.4
Di1	0.9	141.25	01Jan2000, 02:54	0.47
Reservoir - Di1	0.9	48.28	01Jan2000, 06:42	0.29
Di2	0.9	115.96	01Jan2000, 02:56	0.41
Reservoir - Di2	0.9	4.96	01Jan2000, 06:04	0.05
Di3	0.6	118.22	01Jan2000, 02:44	0.52
Reservoir - Di3	0.6	4.81	01Jan2000, 04:18	0.08
Di4	11.4	1135.48	01Jan2000, 03:44	0.48
Junction - 1	4.6	15.69	01Jan2000, 07:56	0.03
Junction - 2	1.5	9.74	01Jan2000, 06:00	0.06
Junction - 3	0.9	48.28	01Jan2000, 06:42	0.29
Reach - Di3 to Di2	0	32.02	01Jan2000, 04:20	Not specified
Reach - Di2 to Di1	0	60.8	01Jan2000, 06:10	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	55.24
Time of Peak Discharge	01Jan2000, 02:34
Volume (IN)	0.43
Precipitation Volume (AC - FT)	21.6
Loss Volume (AC - FT)	14.74
Excess Volume (AC - FT)	6.86
Direct Runoff Volume (AC - FT)	6.86
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	2.84
Time of Peak Discharge	01Jan2000, 06:12
Volume (IN)	0.09
Peak Inflow (CFS)	55.24
Time of Peak Inflow	01Jan2000, 02:34
Inflow Volume (AC - FT)	6.86
Maximum Storage (AC - FT)	7.9
Peak Elevation (FT)	4681.4
Discharge Volume (AC - FT)	1.38

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	263.02
Time of Peak Discharge	01Jan2000, 03:46
Volume (IN)	0.37
Precipitation Volume (AC - FT)	274.56
Loss Volume (AC - FT)	203.26
Excess Volume (AC - FT)	71.3
Direct Runoff Volume (AC - FT)	71.14
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	12.94
Time of Peak Discharge	01Jan2000, 08:14

Volume (IN)	0.02
Peak Inflow (CFS)	313.13
Time of Peak Inflow	01Jan2000, 03:40
Inflow Volume (AC - FT)	88.61
Maximum Storage (AC - FT)	83.52
Peak Elevation (FT)	4673.42
Discharge Volume (AC - FT)	5.44

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs

Lag	22.2
Unitgraph Type	Standard

Results: Da3

Peak Discharge (CFS)	111.44
Time of Peak Discharge	01Jan2000, 02:54
Volume (IN)	0.47
Precipitation Volume (AC - FT)	50.4
Loss Volume (AC - FT)	32.93
Excess Volume (AC - FT)	17.47
Direct Runoff Volume (AC - FT)	17.47
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs

Lag	46.8
Unitgraph Type	Standard

Results: Da4

Peak Discharge (CFS)	161.87
Time of Peak Discharge	01Jan2000, 03:24
Volume (IN)	0.4
Precipitation Volume (AC - FT)	122.4
Loss Volume (AC - FT)	85.84
Excess Volume (AC - FT)	36.56
Direct Runoff Volume (AC - FT)	36.55
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	141.25
Time of Peak Discharge	01Jan2000, 02:54
Volume (IN)	0.47
Precipitation Volume (AC - FT)	65.28
Loss Volume (AC - FT)	42.61
Excess Volume (AC - FT)	22.67
Direct Runoff Volume (AC - FT)	22.67
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	48.28
Time of Peak Discharge	01Jan2000, 06:42
Volume (IN)	0.29
Peak Inflow (CFS)	141.25
Time of Peak Inflow	01Jan2000, 02:54
Inflow Volume (AC - FT)	29.3
Maximum Storage (AC - FT)	21.02
Peak Elevation (FT)	4545.51
Discharge Volume (AC - FT)	14.08

Subbasin: Di2

Area (MI²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	115.96
Time of Peak Discharge	01Jan2000, 02:56
Volume (IN)	0.41
Precipitation Volume (AC - FT)	66.24
Loss Volume (AC - FT)	46.68
Excess Volume (AC - FT)	19.56
Direct Runoff Volume (AC - FT)	19.56
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	4.96
Time of Peak Discharge	01Jan2000, 06:04
Volume (IN)	0.05
Peak Inflow (CFS)	115.96
Time of Peak Inflow	01Jan2000, 02:58
Inflow Volume (AC - FT)	27.34
Maximum Storage (AC - FT)	20.28
Peak Elevation (FT)	4597.48
Discharge Volume (AC - FT)	2.3

Subbasin: Di3

Area (MI²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	118.22
Time of Peak Discharge	01Jan2000, 02:44
Volume (IN)	0.52
Precipitation Volume (AC - FT)	43.52
Loss Volume (AC - FT)	26.8
Excess Volume (AC - FT)	16.72
Direct Runoff Volume (AC - FT)	16.72
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	4.81
Time of Peak Discharge	01Jan2000, 04:18
Volume (IN)	0.08
Peak Inflow (CFS)	118.22
Time of Peak Inflow	01Jan2000, 02:48
Inflow Volume (AC - FT)	16.72
Maximum Storage (AC - FT)	8.62
Peak Elevation (FT)	4604.7
Discharge Volume (AC - FT)	2.5

Subbasin: Di4

Area (MI^2) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	1135.48
Time of Peak Discharge	01Jan2000, 03:44
Volume (IN)	0.48
Precipitation Volume (AC - FT)	826.88
Loss Volume (AC - FT)	532.47
Excess Volume (AC - FT)	294.41
Direct Runoff Volume (AC - FT)	293.51
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	15.69
Time of Peak Discharge	01Jan2000, 07:56
Volume (IN)	0.03

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	9.74
Time of Peak Discharge	01Jan2000, 06:00
Volume (IN)	0.06

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	48.28
Time of Peak Discharge	01Jan2000, 06:42
Volume (IN)	0.29

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2

Peak Discharge (CFS)	32.02
Time of Peak Discharge	01Jan2000, 04:20
Peak Inflow (CFS)	32.02
Inflow Volume (AC - FT)	7.78

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge

Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	60.8
Time of Peak Discharge	01Jan2000, 06:10
Peak Inflow (CFS)	60.81
Inflow Volume (AC - FT)	6.62

Project: Rev3

Simulation Run: Storm Event 13 10y6h

Simulation Start: 31 December 1999, 24:00

Simulation End: 1 January 2000, 09:00

HMS Version: 4.9

Executed: 30 March 2022, 12:34

Global Parameter Summary - Subbasin

	Area (MI²)
Element Name	**Area (MI²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard
Di3	16.8	Standard

Di4	64.2	Standard

Global Parameter Summary - Reach

	Downstream
Element Name	Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	79.66	01Jan2000, 02:34	0.59
Reservoir - Da1	0.3	3.36	01Jan2000, 06:14	0.1
Da2	3.6	394.44	01Jan2000, 03:42	0.52
Reservoir - Da2/3	4.3	15.4	01Jan2000, 08:18	0.03
Da3	0.7	157.6	01Jan2000, 02:50	0.64
Da4	1.7	232.42	01Jan2000, 03:20	0.56
Di1	0.9	196.12	01Jan2000, 02:52	0.64
Reservoir - Di1	0.9	77.45	01Jan2000, 06:36	0.57
Di2	0.9	169	01Jan2000, 02:54	0.57
Reservoir - Di2	0.9	5.02	01Jan2000, 04:44	0.05
Di3	0.6	158.47	01Jan2000, 02:44	0.7
Reservoir - Di3	0.6	4.92	01Jan2000, 03:38	0.08
Di4	11.4	1572.77	01Jan2000, 03:42	0.65
Junction - 1	4.6	18.66	01Jan2000, 08:00	0.03
Junction - 2	1.5	9.91	01Jan2000, 04:34	0.06
Junction - 3	0.9	77.45	01Jan2000, 06:36	0.57
Reach - Di3 to Di2	0	53.83	01Jan2000, 03:40	Not specified
Reach - Di2 to Di1	0	103	01Jan2000, 04:50	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	79.66
Time of Peak Discharge	01Jan2000, 02:34
Volume (IN)	0.59
Precipitation Volume (AC - FT)	25.44
Loss Volume (AC - FT)	15.97
Excess Volume (AC - FT)	9.47
Direct Runoff Volume (AC - FT)	9.47
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	3.36
Time of Peak Discharge	01Jan2000, 06:14
Volume (IN)	0.1
Peak Inflow (CFS)	79.66
Time of Peak Inflow	01Jan2000, 02:34
Inflow Volume (AC - FT)	9.47
Maximum Storage (AC - FT)	10.34
Peak Elevation (FT)	4682.77
Discharge Volume (AC - FT)	1.66

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	394.44
Time of Peak Discharge	01Jan2000, 03:42
Volume (IN)	0.52
Precipitation Volume (AC - FT)	322.56
Loss Volume (AC - FT)	221.76
Excess Volume (AC - FT)	100.8
Direct Runoff Volume (AC - FT)	100.59
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	15.4
Time of Peak Discharge	01Jan2000, 08:18

Volume (IN)	0.03
Peak Inflow (CFS)	468.34
Time of Peak Inflow	01Jan2000, 03:38
Inflow Volume (AC - FT)	124.44
Maximum Storage (AC - FT)	118.22
Peak Elevation (FT)	4676.09
Discharge Volume (AC - FT)	6.56

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	157.6
Time of Peak Discharge	01Jan2000, 02:50
Volume (IN)	0.64
Precipitation Volume (AC - FT)	59.36
Loss Volume (AC - FT)	35.51
Excess Volume (AC - FT)	23.85
Direct Runoff Volume (AC - FT)	23.85
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	232.42
Time of Peak Discharge	01Jan2000, 03:20
Volume (IN)	0.56
Precipitation Volume (AC - FT)	144.16
Loss Volume (AC - FT)	93.22
Excess Volume (AC - FT)	50.94
Direct Runoff Volume (AC - FT)	50.92
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	196.12
Time of Peak Discharge	01Jan2000, 02:52
Volume (IN)	0.64
Precipitation Volume (AC - FT)	76.32
Loss Volume (AC - FT)	45.81
Excess Volume (AC - FT)	30.51
Direct Runoff Volume (AC - FT)	30.51
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	77.45
Time of Peak Discharge	01Jan2000, 06:36
Volume (IN)	0.57
Peak Inflow (CFS)	196.12
Time of Peak Inflow	01Jan2000, 02:52
Inflow Volume (AC - FT)	50.07
Maximum Storage (AC - FT)	33.09
Peak Elevation (FT)	4548.68
Discharge Volume (AC - FT)	27.59

Subbasin: Di2

Area (MI²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	169
Time of Peak Discharge	01Jan2000, 02:54
Volume (IN)	0.57
Precipitation Volume (AC - FT)	77.76
Loss Volume (AC - FT)	50.64
Excess Volume (AC - FT)	27.12
Direct Runoff Volume (AC - FT)	27.12
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	5.02
Time of Peak Discharge	01Jan2000, 04:44
Volume (IN)	0.05
Peak Inflow (CFS)	179.87
Time of Peak Inflow	01Jan2000, 03:06
Inflow Volume (AC - FT)	40.48
Maximum Storage (AC - FT)	21.17
Peak Elevation (FT)	4597.81
Discharge Volume (AC - FT)	2.47

Subbasin: Di3

Area (MI²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	158.47
Time of Peak Discharge	01Jan2000, 02:44
Volume (IN)	0.7
Precipitation Volume (AC - FT)	51.2
Loss Volume (AC - FT)	28.76
Excess Volume (AC - FT)	22.44
Direct Runoff Volume (AC - FT)	22.44
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	4.92
Time of Peak Discharge	01Jan2000, 03:38
Volume (IN)	0.08
Peak Inflow (CFS)	158.47
Time of Peak Inflow	01Jan2000, 02:48
Inflow Volume (AC - FT)	22.44
Maximum Storage (AC - FT)	9.73
Peak Elevation (FT)	4605.17
Discharge Volume (AC - FT)	2.58

Subbasin: Di4

Area (MI²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	1572.77
Time of Peak Discharge	01Jan2000, 03:42
Volume (IN)	0.65
Precipitation Volume (AC - FT)	966.72
Loss Volume (AC - FT)	571.96
Excess Volume (AC - FT)	394.76
Direct Runoff Volume (AC - FT)	393.6
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	18.66
Time of Peak Discharge	01Jan2000, 08:00
Volume (IN)	0.03

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	9.91
Time of Peak Discharge	01Jan2000, 04:34
Volume (IN)	0.06

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	77.45
Time of Peak Discharge	01Jan2000, 06:36
Volume (IN)	0.57

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2

Peak Discharge (CFS)	53.83
Time of Peak Discharge	01Jan2000, 03:40
Peak Inflow (CFS)	53.84
Inflow Volume (AC - FT)	13.36

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge

Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	103
Time of Peak Discharge	01Jan2000, 04:50
Peak Inflow (CFS)	103
Inflow Volume (AC - FT)	19.53

Project: Rev3

Simulation Run: Storm Event 14 25y6h

Simulation Start: 31 December 1999, 24:00

Simulation End: 1 January 2000, 09:00

HMS Version: 4.9

Executed: 30 March 2022, 12:34

Global Parameter Summary - Subbasin

	Area (MI²)
Element Name	**Area (MI²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard
Di3	16.8	Standard

Di4	64.2 Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	114.44	01Jan2000, 02:32	0.84
Reservoir - Da1	0.3	4.04	01Jan2000, 06:12	0.13
Da2	3.6	597.33	01Jan2000, 03:38	0.76
Reservoir - Da2/3	4.3	18.58	01Jan2000, 08:22	0.03
Da3	0.7	226.36	01Jan2000, 02:50	0.9
Da4	1.7	348.21	01Jan2000, 03:18	0.81
Di1	0.9	282.25	01Jan2000, 02:52	0.9
Reservoir - Di1	0.9	111.31	01Jan2000, 06:34	0.93
Di2	0.9	248.59	01Jan2000, 02:54	0.81
Reservoir - Di2	0.9	5.15	01Jan2000, 03:54	0.05
Di3	0.6	226.42	01Jan2000, 02:42	0.97
Reservoir - Di3	0.6	5.15	01Jan2000, 03:18	0.08
Di4	11.4	2274.41	01Jan2000, 03:38	0.91
Junction - 1	4.6	22.52	01Jan2000, 08:04	0.04
Junction - 2	1.5	10.25	01Jan2000, 03:44	0.07
Junction - 3	0.9	111.31	01Jan2000, 06:34	0.93
Reach - Di3 to Di2	0	98.39	01Jan2000, 03:20	Not specified
Reach - Di2 to Di1	0	184.66	01Jan2000, 03:58	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	114.44
Time of Peak Discharge	01Jan2000, 02:32
Volume (IN)	0.84
Precipitation Volume (AC - FT)	30.88
Loss Volume (AC - FT)	17.39
Excess Volume (AC - FT)	13.49
Direct Runoff Volume (AC - FT)	13.49
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	4.04
Time of Peak Discharge	01Jan2000, 06:12
Volume (IN)	0.13
Peak Inflow (CFS)	114.44
Time of Peak Inflow	01Jan2000, 02:32
Inflow Volume (AC - FT)	13.49
Maximum Storage (AC - FT)	14.16
Peak Elevation (FT)	4684.89
Discharge Volume (AC - FT)	2.02

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	597.33
Time of Peak Discharge	01Jan2000, 03:38
Volume (IN)	0.76
Precipitation Volume (AC - FT)	389.76
Loss Volume (AC - FT)	243.3
Excess Volume (AC - FT)	146.46
Direct Runoff Volume (AC - FT)	146.18
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	18.58
Time of Peak Discharge	01Jan2000, 08:22

Volume (IN)	0.03
Peak Inflow (CFS)	698.86
Time of Peak Inflow	01Jan2000, 03:34
Inflow Volume (AC - FT)	179.77
Maximum Storage (AC - FT)	172.12
Peak Elevation (FT)	4680.24
Discharge Volume (AC - FT)	8.02

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	226.36
Time of Peak Discharge	01Jan2000, 02:50
Volume (IN)	0.9
Precipitation Volume (AC - FT)	72.05
Loss Volume (AC - FT)	38.47
Excess Volume (AC - FT)	33.58
Direct Runoff Volume (AC - FT)	33.58
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	348.21
Time of Peak Discharge	01Jan2000, 03:18
Volume (IN)	0.81
Precipitation Volume (AC - FT)	174.99
Loss Volume (AC - FT)	101.79
Excess Volume (AC - FT)	73.19
Direct Runoff Volume (AC - FT)	73.18
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	282.25
Time of Peak Discharge	01Jan2000, 02:52
Volume (IN)	0.9
Precipitation Volume (AC - FT)	92.64
Loss Volume (AC - FT)	49.65
Excess Volume (AC - FT)	42.99
Direct Runoff Volume (AC - FT)	42.99
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	111.31
Time of Peak Discharge	01Jan2000, 06:34
Volume (IN)	0.93
Peak Inflow (CFS)	299.6
Time of Peak Inflow	01Jan2000, 03:50
Inflow Volume (AC - FT)	82.59
Maximum Storage (AC - FT)	54.14
Peak Elevation (FT)	4554.2
Discharge Volume (AC - FT)	44.79

Subbasin: Di2

Area (MI²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	248.59
Time of Peak Discharge	01Jan2000, 02:54
Volume (IN)	0.81
Precipitation Volume (AC - FT)	94.08
Loss Volume (AC - FT)	55.26
Excess Volume (AC - FT)	38.82
Direct Runoff Volume (AC - FT)	38.82
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	5.15
Time of Peak Discharge	01Jan2000, 03:54
Volume (IN)	0.05
Peak Inflow (CFS)	313.32
Time of Peak Inflow	01Jan2000, 03:02
Inflow Volume (AC - FT)	60.7
Maximum Storage (AC - FT)	22.89
Peak Elevation (FT)	4598.46
Discharge Volume (AC - FT)	2.6

Subbasin: Di3

Area (MI²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	226.42
Time of Peak Discharge	01Jan2000, 02:42
Volume (IN)	0.97
Precipitation Volume (AC - FT)	62.08
Loss Volume (AC - FT)	30.98
Excess Volume (AC - FT)	31.1
Direct Runoff Volume (AC - FT)	31.1
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	5.15
Time of Peak Discharge	01Jan2000, 03:18
Volume (IN)	0.08
Peak Inflow (CFS)	226.42
Time of Peak Inflow	01Jan2000, 02:46
Inflow Volume (AC - FT)	31.1
Maximum Storage (AC - FT)	11.99
Peak Elevation (FT)	4606.14
Discharge Volume (AC - FT)	2.68

Subbasin: Di4

Area (MI²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	2274.41
Time of Peak Discharge	01Jan2000, 03:38
Volume (IN)	0.91
Precipitation Volume (AC - FT)	1173.44
Loss Volume (AC - FT)	619.34
Excess Volume (AC - FT)	554.1
Direct Runoff Volume (AC - FT)	552.63
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	22.52
Time of Peak Discharge	01Jan2000, 08:04
Volume (IN)	0.04

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	10.25
Time of Peak Discharge	01Jan2000, 03:44
Volume (IN)	0.07

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	111.31
Time of Peak Discharge	01Jan2000, 06:34
Volume (IN)	0.93

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2

Peak Discharge (CFS)	98.39
Time of Peak Discharge	01Jan2000, 03:20
Peak Inflow (CFS)	98.41
Inflow Volume (AC - FT)	21.87

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge

Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	184.66
Time of Peak Discharge	01Jan2000, 03:58
Peak Inflow (CFS)	184.69
Inflow Volume (AC - FT)	39.56

Project: Rev3

Simulation Run: Storm Event 15 50y6h

Simulation Start: 31 December 1999, 24:00

Simulation End: 1 January 2000, 09:00

HMS Version: 4.9

Executed: 30 March 2022, 13:06

Global Parameter Summary - Subbasin

	Area (MI²)
Element Name	**Area (MI²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard
Di3	16.8	Standard

Di4	64.2	Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	140.9	01Jan2000, 02:32	1.06
Reservoir - Da1	0.3	4.56	01Jan2000, 06:14	0.14
Da2	3.6	778.9	01Jan2000, 03:36	0.97
Reservoir - Da2/3	4.3	21	01Jan2000, 08:26	0.04
Da3	0.7	285.87	01Jan2000, 02:48	1.12
Da4	1.7	451.94	01Jan2000, 03:18	1.02
Di1	0.9	354.52	01Jan2000, 02:50	1.12
Reservoir - Di1	0.9	244.24	01Jan2000, 05:24	1.4
Di2	0.9	323.62	01Jan2000, 02:52	1.03
Reservoir - Di2	0.9	5.29	01Jan2000, 03:34	0.06
Di3	0.6	285.23	01Jan2000, 02:42	1.21
Reservoir - Di3	0.6	5.35	01Jan2000, 03:12	0.09
Di4	11.4	2902.03	01Jan2000, 03:38	1.14
Junction - 1	4.6	25.46	01Jan2000, 08:06	0.05
Junction - 2	1.5	10.6	01Jan2000, 03:26	0.07
Junction - 3	0.9	244.24	01Jan2000, 05:24	1.4
Reach - Di3 to Di2	0	137.81	01Jan2000, 03:14	Not specified
Reach - Di2 to Di1	0	279.92	01Jan2000, 03:40	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	140.9
Time of Peak Discharge	01Jan2000, 02:32
Volume (IN)	1.06
Precipitation Volume (AC - FT)	35.36
Loss Volume (AC - FT)	18.35
Excess Volume (AC - FT)	17.01
Direct Runoff Volume (AC - FT)	17.01
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	4.56
Time of Peak Discharge	01Jan2000, 06:14
Volume (IN)	0.14
Peak Inflow (CFS)	140.9
Time of Peak Inflow	01Jan2000, 02:32
Inflow Volume (AC - FT)	17.01
Maximum Storage (AC - FT)	17.51
Peak Elevation (FT)	4686.77
Discharge Volume (AC - FT)	2.29

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	778.9
Time of Peak Discharge	01Jan2000, 03:36
Volume (IN)	0.97
Precipitation Volume (AC - FT)	445.44
Loss Volume (AC - FT)	258.18
Excess Volume (AC - FT)	187.26
Direct Runoff Volume (AC - FT)	186.91
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	21
Time of Peak Discharge	01Jan2000, 08:26

Volume (IN)	0.04
Peak Inflow (CFS)	906.16
Time of Peak Inflow	01Jan2000, 03:32
Inflow Volume (AC - FT)	228.65
Maximum Storage (AC - FT)	219.87
Peak Elevation (FT)	4683.91
Discharge Volume (AC - FT)	9.14

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	285.87
Time of Peak Discharge	01Jan2000, 02:48
Volume (IN)	1.12
Precipitation Volume (AC - FT)	82.13
Loss Volume (AC - FT)	40.39
Excess Volume (AC - FT)	41.75
Direct Runoff Volume (AC - FT)	41.75
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	451.94
Time of Peak Discharge	01Jan2000, 03:18
Volume (IN)	1.02
Precipitation Volume (AC - FT)	200.37
Loss Volume (AC - FT)	107.6
Excess Volume (AC - FT)	92.77
Direct Runoff Volume (AC - FT)	92.75
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	354.52
Time of Peak Discharge	01Jan2000, 02:50
Volume (IN)	1.12
Precipitation Volume (AC - FT)	106.08
Loss Volume (AC - FT)	52.22
Excess Volume (AC - FT)	53.86
Direct Runoff Volume (AC - FT)	53.86
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	244.24
Time of Peak Discharge	01Jan2000, 05:24
Volume (IN)	1.4
Peak Inflow (CFS)	451.55
Time of Peak Inflow	01Jan2000, 03:30
Inflow Volume (AC - FT)	111.38
Maximum Storage (AC - FT)	63.24
Peak Elevation (FT)	4556.45
Discharge Volume (AC - FT)	67.11

Subbasin: Di2

Area (MI^2) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	323.62
Time of Peak Discharge	01Jan2000, 02:52
Volume (IN)	1.03
Precipitation Volume (AC - FT)	108
Loss Volume (AC - FT)	58.5
Excess Volume (AC - FT)	49.5
Direct Runoff Volume (AC - FT)	49.5
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	5.29
Time of Peak Discharge	01Jan2000, 03:34
Volume (IN)	0.06
Peak Inflow (CFS)	428.04
Time of Peak Inflow	01Jan2000, 03:00
Inflow Volume (AC - FT)	78.73
Maximum Storage (AC - FT)	24.89
Peak Elevation (FT)	4599.21
Discharge Volume (AC - FT)	2.68

Subbasin: Di3

Area (MI²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	285.23
Time of Peak Discharge	01Jan2000, 02:42
Volume (IN)	1.21
Precipitation Volume (AC - FT)	71.04
Loss Volume (AC - FT)	32.46
Excess Volume (AC - FT)	38.58
Direct Runoff Volume (AC - FT)	38.58
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	5.35
Time of Peak Discharge	01Jan2000, 03:12
Volume (IN)	0.09
Peak Inflow (CFS)	285.23
Time of Peak Inflow	01Jan2000, 02:46
Inflow Volume (AC - FT)	38.58
Maximum Storage (AC - FT)	13.99
Peak Elevation (FT)	4607
Discharge Volume (AC - FT)	2.75

Subbasin: Di4

Area (MI²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	2902.03
Time of Peak Discharge	01Jan2000, 03:38
Volume (IN)	1.14
Precipitation Volume (AC - FT)	1343.68
Loss Volume (AC - FT)	651.03
Excess Volume (AC - FT)	692.65
Direct Runoff Volume (AC - FT)	690.84
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	25.46
Time of Peak Discharge	01Jan2000, 08:06
Volume (IN)	0.05

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	10.6
Time of Peak Discharge	01Jan2000, 03:26
Volume (IN)	0.07

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	244.24
Time of Peak Discharge	01Jan2000, 05:24
Volume (IN)	1.4

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2

Peak Discharge (CFS)	137.81
Time of Peak Discharge	01Jan2000, 03:14
Peak Inflow (CFS)	137.88
Inflow Volume (AC - FT)	29.23

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge

Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	279.92
Time of Peak Discharge	01Jan2000, 03:40
Peak Inflow (CFS)	279.92
Inflow Volume (AC - FT)	57.49

Project: Rev3

Simulation Run: Storm Event 16 100y6h

Simulation Start: 31 December 1999, 24:00

Simulation End: 1 January 2000, 09:00

HMS Version: 4.9

Executed: 30 March 2022, 12:34

Global Parameter Summary - Subbasin

	Area (MI²)
Element Name	**Area (MI²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard
Di3	16.8	Standard

Di4	64.2 Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	176.6	01Jan2000, 02:32	1.31
Reservoir - Da1	0.3	5.08	01Jan2000, 06:14	0.16
Da2	3.6	1001.11	01Jan2000, 03:34	1.22
Reservoir - Da2/3	4.3	23.51	01Jan2000, 08:28	0.04
Da3	0.7	353.39	01Jan2000, 02:48	1.37
Da4	1.7	569.89	01Jan2000, 03:16	1.26
Di1	0.9	441.89	01Jan2000, 02:50	1.37
Reservoir - Di1	0.9	390.77	01Jan2000, 04:28	1.99
Di2	0.9	405.28	01Jan2000, 02:50	1.27
Reservoir - Di2	0.9	5.41	01Jan2000, 03:24	0.06
Di3	0.6	350.82	01Jan2000, 02:42	1.46
Reservoir - Di3	0.6	87.58	01Jan2000, 03:04	0.18
Di4	11.4	3595.23	01Jan2000, 03:36	1.39
Junction - 1	4.6	28.48	01Jan2000, 08:08	0.05
Junction - 2	1.5	92.82	01Jan2000, 03:04	0.11
Junction - 3	0.9	390.77	01Jan2000, 04:28	1.99
Reach - Di3 to Di2	0	138	01Jan2000, 03:12	Not specified
Reach - Di2 to Di1	0	360.5	01Jan2000, 03:28	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	176.6
Time of Peak Discharge	01Jan2000, 02:32
Volume (IN)	1.31
Precipitation Volume (AC - FT)	40.16
Loss Volume (AC - FT)	19.21
Excess Volume (AC - FT)	20.95
Direct Runoff Volume (AC - FT)	20.95
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	5.08
Time of Peak Discharge	01Jan2000, 06:14
Volume (IN)	0.16
Peak Inflow (CFS)	176.6
Time of Peak Inflow	01Jan2000, 02:32
Inflow Volume (AC - FT)	20.95
Maximum Storage (AC - FT)	21.28
Peak Elevation (FT)	4688.87
Discharge Volume (AC - FT)	2.57

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	1001.11
Time of Peak Discharge	01Jan2000, 03:34
Volume (IN)	1.22
Precipitation Volume (AC - FT)	506.88
Loss Volume (AC - FT)	272.21
Excess Volume (AC - FT)	234.67
Direct Runoff Volume (AC - FT)	234.25
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	23.51
Time of Peak Discharge	01Jan2000, 08:28

Volume (IN)	0.04
Peak Inflow (CFS)	1155.07
Time of Peak Inflow	01Jan2000, 03:30
Inflow Volume (AC - FT)	285.41
Maximum Storage (AC - FT)	275.46
Peak Elevation (FT)	4688.19
Discharge Volume (AC - FT)	10.32

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs

Lag	22.2
Unitgraph Type	Standard

Results: Da3

Peak Discharge (CFS)	353.39
Time of Peak Discharge	01Jan2000, 02:48
Volume (IN)	1.37
Precipitation Volume (AC - FT)	93.33
Loss Volume (AC - FT)	42.18
Excess Volume (AC - FT)	51.16
Direct Runoff Volume (AC - FT)	51.16
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs

Lag	46.8
Unitgraph Type	Standard

Results: Da4

Peak Discharge (CFS)	569.89
Time of Peak Discharge	01Jan2000, 03:16
Volume (IN)	1.26
Precipitation Volume (AC - FT)	227.57
Loss Volume (AC - FT)	112.87
Excess Volume (AC - FT)	114.71
Direct Runoff Volume (AC - FT)	114.68
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	441.89
Time of Peak Discharge	01Jan2000, 02:50
Volume (IN)	1.37
Precipitation Volume (AC - FT)	120.48
Loss Volume (AC - FT)	54.53
Excess Volume (AC - FT)	65.95
Direct Runoff Volume (AC - FT)	65.95
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	390.77
Time of Peak Discharge	01Jan2000, 04:28
Volume (IN)	1.99
Peak Inflow (CFS)	619.53
Time of Peak Inflow	01Jan2000, 03:16
Inflow Volume (AC - FT)	140.2
Maximum Storage (AC - FT)	64.79
Peak Elevation (FT)	4556.76
Discharge Volume (AC - FT)	95.3

Subbasin: Di2

Area (MI²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	405.28
Time of Peak Discharge	01Jan2000, 02:50
Volume (IN)	1.27
Precipitation Volume (AC - FT)	122.4
Loss Volume (AC - FT)	61.35
Excess Volume (AC - FT)	61.05
Direct Runoff Volume (AC - FT)	61.05
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	5.41
Time of Peak Discharge	01Jan2000, 03:24
Volume (IN)	0.06
Peak Inflow (CFS)	541.39
Time of Peak Inflow	01Jan2000, 02:54
Inflow Volume (AC - FT)	95.57
Maximum Storage (AC - FT)	26.59
Peak Elevation (FT)	4599.85
Discharge Volume (AC - FT)	2.74

Subbasin: Di3

Area (MI^2) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	350.82
Time of Peak Discharge	01Jan2000, 02:42
Volume (IN)	1.46
Precipitation Volume (AC - FT)	80.64
Loss Volume (AC - FT)	33.78
Excess Volume (AC - FT)	46.86
Direct Runoff Volume (AC - FT)	46.86
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	87.58
Time of Peak Discharge	01Jan2000, 03:04
Volume (IN)	0.18
Peak Inflow (CFS)	350.82
Time of Peak Inflow	01Jan2000, 02:46
Inflow Volume (AC - FT)	46.86
Maximum Storage (AC - FT)	15.7
Peak Elevation (FT)	4607.45
Discharge Volume (AC - FT)	5.71

Subbasin: Di4

Area (MI^2) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	3595.23
Time of Peak Discharge	01Jan2000, 03:36
Volume (IN)	1.39
Precipitation Volume (AC - FT)	1526.08
Loss Volume (AC - FT)	679.52
Excess Volume (AC - FT)	846.56
Direct Runoff Volume (AC - FT)	844.48
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	28.48
Time of Peak Discharge	01Jan2000, 08:08
Volume (IN)	0.05

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	92.82
Time of Peak Discharge	01Jan2000, 03:04
Volume (IN)	0.11

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	390.77
Time of Peak Discharge	01Jan2000, 04:28
Volume (IN)	1.99

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2

Peak Discharge (CFS)	138
Time of Peak Discharge	01Jan2000, 03:12
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	34.52

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge

Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	360.5
Time of Peak Discharge	01Jan2000, 03:28
Peak Inflow (CFS)	360.54
Inflow Volume (AC - FT)	74.22

Project: Rev3

Simulation Run: Storm Event 17 200y6h

Simulation Start: 31 December 1999, 24:00

Simulation End: 1 January 2000, 09:00

HMS Version: 4.9

Executed: 10 May 2022, 23:24

Global Parameter Summary - Subbasin

	Area (MI²)
Element Name	**Area (MI²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

		Loss Rate: Scs	
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard
Di3	16.8	Standard

Di4	64.2 Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	220.48	01Jan2000, 02:32	1.6
Reservoir - Da1	0.3	5.62	01Jan2000, 06:14	0.18
Da2	3.6	1249.94	01Jan2000, 03:32	1.5
Reservoir - Da2/3	4.3	26.09	01Jan2000, 08:30	0.05
Da3	0.7	433.36	01Jan2000, 02:48	1.66
Da4	1.7	710.99	01Jan2000, 03:14	1.55
Di1	0.9	546.31	01Jan2000, 02:50	1.67
Reservoir - Di1	0.9	548.55	01Jan2000, 04:00	2.58
Di2	0.9	501.78	01Jan2000, 02:50	1.55
Reservoir - Di2	0.9	75.72	01Jan2000, 03:16	0.11
Di3	0.6	425.25	01Jan2000, 02:40	1.77
Reservoir - Di3	0.6	189.86	01Jan2000, 02:58	0.34
Di4	11.4	4413.81	01Jan2000, 03:34	1.68
Junction - 1	4.6	31.6	01Jan2000, 08:12	0.06
Junction - 2	1.5	195.2	01Jan2000, 02:58	0.2
Junction - 3	0.9	548.55	01Jan2000, 04:00	2.58
Reach - Di3 to Di2	0	138	01Jan2000, 03:06	Not specified
Reach - Di2 to Di1	0	384.06	01Jan2000, 03:08	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	220.48
Time of Peak Discharge	01Jan2000, 02:32
Volume (IN)	1.6
Precipitation Volume (AC - FT)	45.6
Loss Volume (AC - FT)	20.04
Excess Volume (AC - FT)	25.56
Direct Runoff Volume (AC - FT)	25.56
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	5.62
Time of Peak Discharge	01Jan2000, 06:14
Volume (IN)	0.18
Peak Inflow (CFS)	220.48
Time of Peak Inflow	01Jan2000, 02:32
Inflow Volume (AC - FT)	25.56
Maximum Storage (AC - FT)	25.71
Peak Elevation (FT)	4691.34
Discharge Volume (AC - FT)	2.87

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	1249.94
Time of Peak Discharge	01Jan2000, 03:32
Volume (IN)	1.5
Precipitation Volume (AC - FT)	574.08
Loss Volume (AC - FT)	285.29
Excess Volume (AC - FT)	288.79
Direct Runoff Volume (AC - FT)	288.3
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	26.09
Time of Peak Discharge	01Jan2000, 08:30

Volume (IN)	0.05
Peak Inflow (CFS)	1437.53
Time of Peak Inflow	01Jan2000, 03:28
Inflow Volume (AC - FT)	350.46
Maximum Storage (AC - FT)	339.28
Peak Elevation (FT)	4693.1
Discharge Volume (AC - FT)	11.53

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	433.36
Time of Peak Discharge	01Jan2000, 02:48
Volume (IN)	1.66
Precipitation Volume (AC - FT)	106.03
Loss Volume (AC - FT)	43.87
Excess Volume (AC - FT)	62.15
Direct Runoff Volume (AC - FT)	62.15
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	710.99
Time of Peak Discharge	01Jan2000, 03:14
Volume (IN)	1.55
Precipitation Volume (AC - FT)	258.4
Loss Volume (AC - FT)	117.91
Excess Volume (AC - FT)	140.49
Direct Runoff Volume (AC - FT)	140.46
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	546.31
Time of Peak Discharge	01Jan2000, 02:50
Volume (IN)	1.67
Precipitation Volume (AC - FT)	136.8
Loss Volume (AC - FT)	56.73
Excess Volume (AC - FT)	80.07
Direct Runoff Volume (AC - FT)	80.07
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	548.55
Time of Peak Discharge	01Jan2000, 04:00
Volume (IN)	2.58
Peak Inflow (CFS)	817.2
Time of Peak Inflow	01Jan2000, 03:06
Inflow Volume (AC - FT)	169.67
Maximum Storage (AC - FT)	66.15
Peak Elevation (FT)	4557.03
Discharge Volume (AC - FT)	124.05

Subbasin: Di2

Area (MI²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	501.78
Time of Peak Discharge	01Jan2000, 02:50
Volume (IN)	1.55
Precipitation Volume (AC - FT)	138.72
Loss Volume (AC - FT)	64.09
Excess Volume (AC - FT)	74.63
Direct Runoff Volume (AC - FT)	74.63
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	75.72
Time of Peak Discharge	01Jan2000, 03:16
Volume (IN)	0.11
Peak Inflow (CFS)	639.78
Time of Peak Inflow	01Jan2000, 02:52
Inflow Volume (AC - FT)	113.43
Maximum Storage (AC - FT)	28.8
Peak Elevation (FT)	4600.34
Discharge Volume (AC - FT)	5.24

Subbasin: Di3

Area (MI²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	425.25
Time of Peak Discharge	01Jan2000, 02:40
Volume (IN)	1.77
Precipitation Volume (AC - FT)	91.52
Loss Volume (AC - FT)	35.03
Excess Volume (AC - FT)	56.49
Direct Runoff Volume (AC - FT)	56.49
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	189.86
Time of Peak Discharge	01Jan2000, 02:58
Volume (IN)	0.34
Peak Inflow (CFS)	425.25
Time of Peak Inflow	01Jan2000, 02:44
Inflow Volume (AC - FT)	56.49
Maximum Storage (AC - FT)	16.91
Peak Elevation (FT)	4607.78
Discharge Volume (AC - FT)	11.04

Subbasin: Di4

Area (MI²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	4413.81
Time of Peak Discharge	01Jan2000, 03:34
Volume (IN)	1.68
Precipitation Volume (AC - FT)	1732.8
Loss Volume (AC - FT)	706.57
Excess Volume (AC - FT)	1026.23
Direct Runoff Volume (AC - FT)	1023.8
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	31.6
Time of Peak Discharge	01Jan2000, 08:12
Volume (IN)	0.06

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	195.2
Time of Peak Discharge	01Jan2000, 02:58
Volume (IN)	0.2

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	548.55
Time of Peak Discharge	01Jan2000, 04:00
Volume (IN)	2.58

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2

Peak Discharge (CFS)	138
Time of Peak Discharge	01Jan2000, 03:06
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	38.79

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge

Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	384.06
Time of Peak Discharge	01Jan2000, 03:08
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	89.56

Project: Rev3

Simulation Run: Storm Event 18 500y6h

Simulation Start: 31 December 1999, 24:00

Simulation End: 1 January 2000, 09:00

HMS Version: 4.9

Executed: 11 May 2022, 15:23

Global Parameter Summary - Subbasin

	Area (MI²)
Element Name	**Area (MI²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2/3
Da3	Reservoir - Da2/3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard
Di3	16.8	Standard

Di4	64.2 Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	276.77	01Jan2000, 02:32	2.03
Reservoir - Da1	0.3	44.64	01Jan2000, 05:38	0.55
Da2	3.6	1631.55	01Jan2000, 03:30	1.93
Reservoir - Da2/3	4.3	381.42	01Jan2000, 06:56	0.24
Da3	0.7	552.13	01Jan2000, 02:46	2.11
Da4	1.7	917.22	01Jan2000, 03:14	1.97
Di1	0.9	695.88	01Jan2000, 02:48	2.12
Reservoir - Di1	0.9	667.78	01Jan2000, 03:38	3.36
Di2	0.9	649.41	01Jan2000, 02:50	2
Reservoir - Di2	0.9	270.63	01Jan2000, 03:08	0.33
Di3	0.6	540.01	01Jan2000, 02:40	2.23
Reservoir - Di3	0.6	335.74	01Jan2000, 02:52	0.64
Di4	11.4	5658.58	01Jan2000, 03:34	2.14
Junction - 1	4.6	392.83	01Jan2000, 06:56	0.26
Junction - 2	1.5	523.37	01Jan2000, 03:02	0.45
Junction - 3	0.9	667.78	01Jan2000, 03:38	3.36
Reach - Di3 to Di2	0	138	01Jan2000, 02:58	Not specified
Reach - Di2 to Di1	0	388.29	01Jan2000, 02:56	Not specified

Subbasin: Da1

Area (MI²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	276.77
Time of Peak Discharge	01Jan2000, 02:32
Volume (IN)	2.03
Precipitation Volume (AC - FT)	53.44
Loss Volume (AC - FT)	21.02
Excess Volume (AC - FT)	32.42
Direct Runoff Volume (AC - FT)	32.42
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	44.64
Time of Peak Discharge	01Jan2000, 05:38
Volume (IN)	0.55
Peak Inflow (CFS)	276.77
Time of Peak Inflow	01Jan2000, 02:32
Inflow Volume (AC - FT)	32.42
Maximum Storage (AC - FT)	28.04
Peak Elevation (FT)	4691.79
Discharge Volume (AC - FT)	8.75

Subbasin: Da2

Area (MI²) : 3.6
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	1631.55
Time of Peak Discharge	01Jan2000, 03:30
Volume (IN)	1.93
Precipitation Volume (AC - FT)	672
Loss Volume (AC - FT)	301.09
Excess Volume (AC - FT)	370.91
Direct Runoff Volume (AC - FT)	370.31
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2/3

Downstream : Junction - 1

Results: Reservoir-Da2/3	
Peak Discharge (CFS)	381.42
Time of Peak Discharge	01Jan2000, 06:56

Volume (IN)	0.24
Peak Inflow (CFS)	1872.69
Time of Peak Inflow	01Jan2000, 03:26
Inflow Volume (AC - FT)	449.11
Maximum Storage (AC - FT)	407.83
Peak Elevation (FT)	4697.44
Discharge Volume (AC - FT)	55.29

Subbasin: Da3

Area (MI²) : 0.7
Downstream : Reservoir - Da2/3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	552.13
Time of Peak Discharge	01Jan2000, 02:46
Volume (IN)	2.11
Precipitation Volume (AC - FT)	124.69
Loss Volume (AC - FT)	45.9
Excess Volume (AC - FT)	78.79
Direct Runoff Volume (AC - FT)	78.79
Baseflow Volume (AC - FT)	0

Subbasin: Da4

Area (MI²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	917.22
Time of Peak Discharge	01Jan2000, 03:14
Volume (IN)	1.97
Precipitation Volume (AC - FT)	302.83
Loss Volume (AC - FT)	123.88
Excess Volume (AC - FT)	178.95
Direct Runoff Volume (AC - FT)	178.91
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (MI²) : 0.9

Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	695.88
Time of Peak Discharge	01Jan2000, 02:48
Volume (IN)	2.12
Precipitation Volume (AC - FT)	161.28
Loss Volume (AC - FT)	59.4
Excess Volume (AC - FT)	101.88
Direct Runoff Volume (AC - FT)	101.88
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	667.78
Time of Peak Discharge	01Jan2000, 03:38
Volume (IN)	3.36
Peak Inflow (CFS)	1054.52
Time of Peak Inflow	01Jan2000, 02:56
Inflow Volume (AC - FT)	207.79
Maximum Storage (AC - FT)	67.07
Peak Elevation (FT)	4557.21
Discharge Volume (AC - FT)	161.3

Subbasin: Di2

Area (MI²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	649.41
Time of Peak Discharge	01Jan2000, 02:50
Volume (IN)	2
Precipitation Volume (AC - FT)	163.68
Loss Volume (AC - FT)	67.51
Excess Volume (AC - FT)	96.17
Direct Runoff Volume (AC - FT)	96.17
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	270.63
Time of Peak Discharge	01Jan2000, 03:08
Volume (IN)	0.33
Peak Inflow (CFS)	787.41
Time of Peak Inflow	01Jan2000, 02:52
Inflow Volume (AC - FT)	140.29
Maximum Storage (AC - FT)	31.35
Peak Elevation (FT)	4600.83
Discharge Volume (AC - FT)	15.76

Subbasin: Di3

Area (MI²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	540.01
Time of Peak Discharge	01Jan2000, 02:40
Volume (IN)	2.23
Precipitation Volume (AC - FT)	107.84
Loss Volume (AC - FT)	36.54
Excess Volume (AC - FT)	71.3
Direct Runoff Volume (AC - FT)	71.3
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	335.74
Time of Peak Discharge	01Jan2000, 02:52
Volume (IN)	0.64
Peak Inflow (CFS)	540.01
Time of Peak Inflow	01Jan2000, 02:44
Inflow Volume (AC - FT)	71.3
Maximum Storage (AC - FT)	18.29
Peak Elevation (FT)	4608.14
Discharge Volume (AC - FT)	20.48

Subbasin: Di4

Area (MI²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	5658.58
Time of Peak Discharge	01Jan2000, 03:34
Volume (IN)	2.14
Precipitation Volume (AC - FT)	2042.88
Loss Volume (AC - FT)	739.4
Excess Volume (AC - FT)	1303.48
Direct Runoff Volume (AC - FT)	1300.51
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	392.83
Time of Peak Discharge	01Jan2000, 06:56
Volume (IN)	0.26

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	523.37
Time of Peak Discharge	01Jan2000, 03:02
Volume (IN)	0.45

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	667.78
Time of Peak Discharge	01Jan2000, 03:38
Volume (IN)	3.36

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	950
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	6
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow

Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2

Peak Discharge (CFS)	138
Time of Peak Discharge	01Jan2000, 02:58
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	44.12

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge

Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2690
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	10
Side Slope (FT/FT)	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	388.29
Time of Peak Discharge	01Jan2000, 02:56
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	105.86

APPENDIX E-5

TECHNICAL DOCUMENTS, CONTINUED

Preliminary Hydrology Report

Santa Clara Watershed

Washington County

DRAFT

April 2021

ALPHA ENGINEERING

Table of Contents

Part I. Introduction

Washington County is proposing to install and reestablish a series of detention basins in Dammeron Valley and Diamond Valley in Washington County, Utah and to provide armoring along the Santa Clara River on Shivwits land near Ivins, Utah. The detention basins and armoring will provide flood protection to the local communities and Shivwits tribe farming area. The engineering design is being performed by Alpha Engineering Company (Alpha) out of St. George, Utah.

The project includes the construction of three detention basins on dry washes to the east of Dammeron Valley; the rerouting of existing flows to an adjacent routed channel on the south end of Dammeron Valley; the reestablishment of three existing detention basins in Diamond Valley; the armoring and protection along an existing channel in Diamond Valley; and armoring portions of the south bank of the Santa Clara River just west of the Shivwits tribal community near the Shem Dam. This report is being prepared to analyze the hydrologic design elements associated with the construction and operation of the detention basins and channels at Dammeron Valley and Diamond Valley.

For purposes of this hydrology report, approximated hydraulic features such as auxiliary spillway and top of dam are used to verify the feasibility of the detention basin dam structures and channels. A hydraulic analysis is required to adequately design the hydraulic elements associated with this project, including culvert, channel, spillway, freeboard, and breach analyses. The project locations are shown in **Figure 1**.

This report references the following sources in the analysis of the hydrologic conditions at the Diamond and Dammeron Valley Detention Basin Sites:

- Technical Release 210-60 (TR-60), USDA 2019
- Technical Release 55 (TR-55), USDA 1986
- Technical Release 56 (TR-56), USDA 2014
- Utah Administrative Code Rule R655-11 (UAC), utah.gov 2021
- Hydrometeorological Report 49 (HMR-49), USACE 1984
- PMP Studies by Donald T. Jensen (Jensen), USU 1995 and 2003
- National Engineering Handbook, Section 4 (NEH-4), Mockus 1965 and 1972
- NOAA Atlas 14 (NWS), NWS 2018
- National Land Cover Database (NLCD), MRLC 2011
- National Engineering Handbook Part 630 (NEH), USDA 2019
- Flood Hydrology Manual (USBR), USBR 1989

The following software programs were used in modeling the hydrologic conditions:

- HEC-HMS version 4.8 (HEC-HMS), USACE 2021
- USDA Water Resource Site Analysis version 2005.1.8 (SITES), USDA 2005

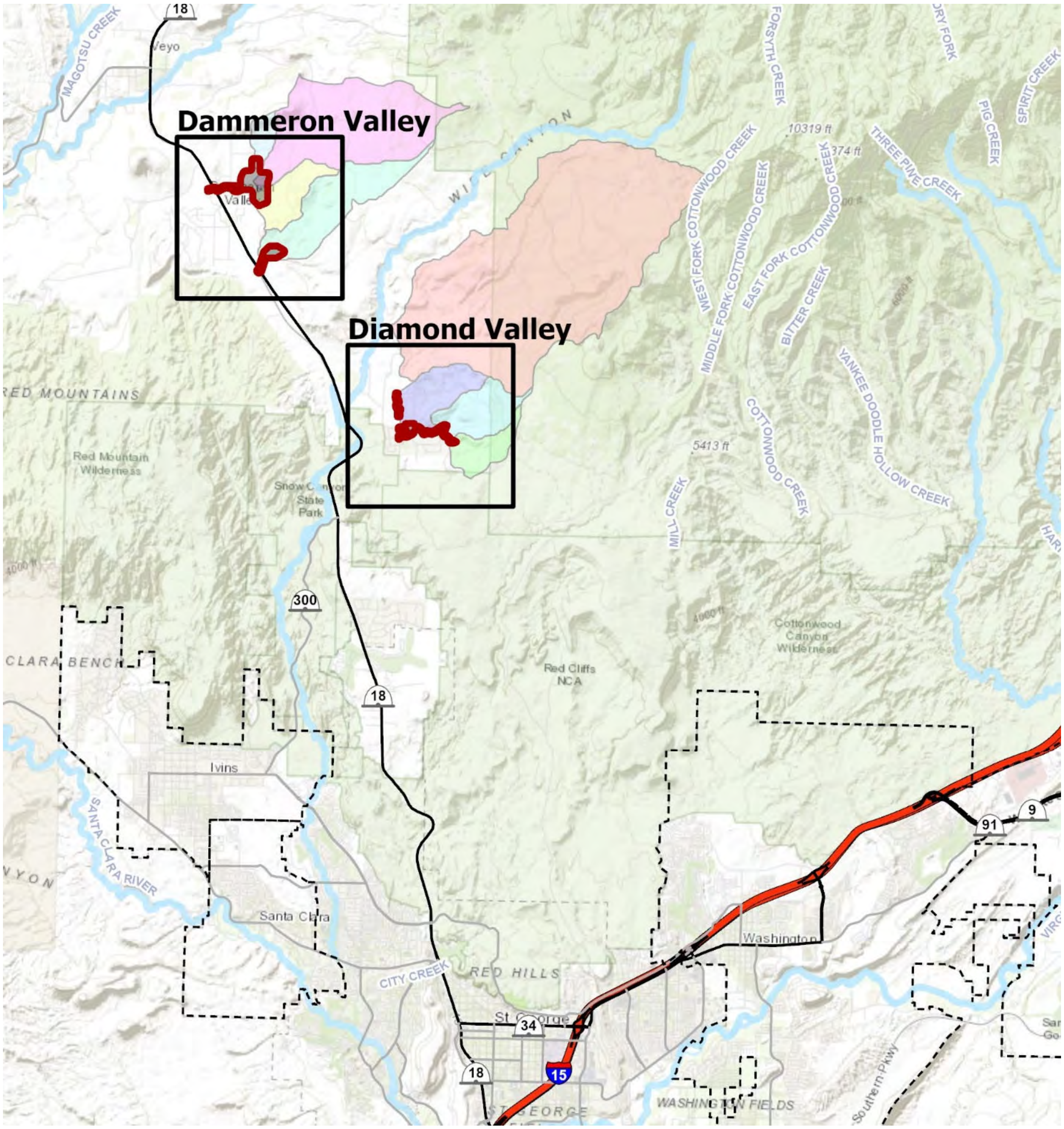

Figure 1 Dammeron Valley and Diamond Valley Location

A. Dammeron Valley

The three detention basins at Dammeron Valley will be new and will include earthen dams with a low-level principal spillway and an auxiliary spillway. The detention basins will not be designed to hold water and will have low-level principal spillways that will drain the basins empty after each storm event. The purpose of the basins is to detain peak flows during large storm events protecting downstream infrastructure. Due to homes located immediately downstream, these dams are classified as High Hazard.

The three detention basins will combine into a single drainage channel that conveys flows through the Dammeron Valley community.

The rerouting of existing flows to an adjacent channel on the south end of Dammeron Valley will include a new channel that will collect flows from the upstream tributary and direct them to an existing channel and culvert location under Highway 18. The Dammeron Valley project elements are shown in **Figure 2**.

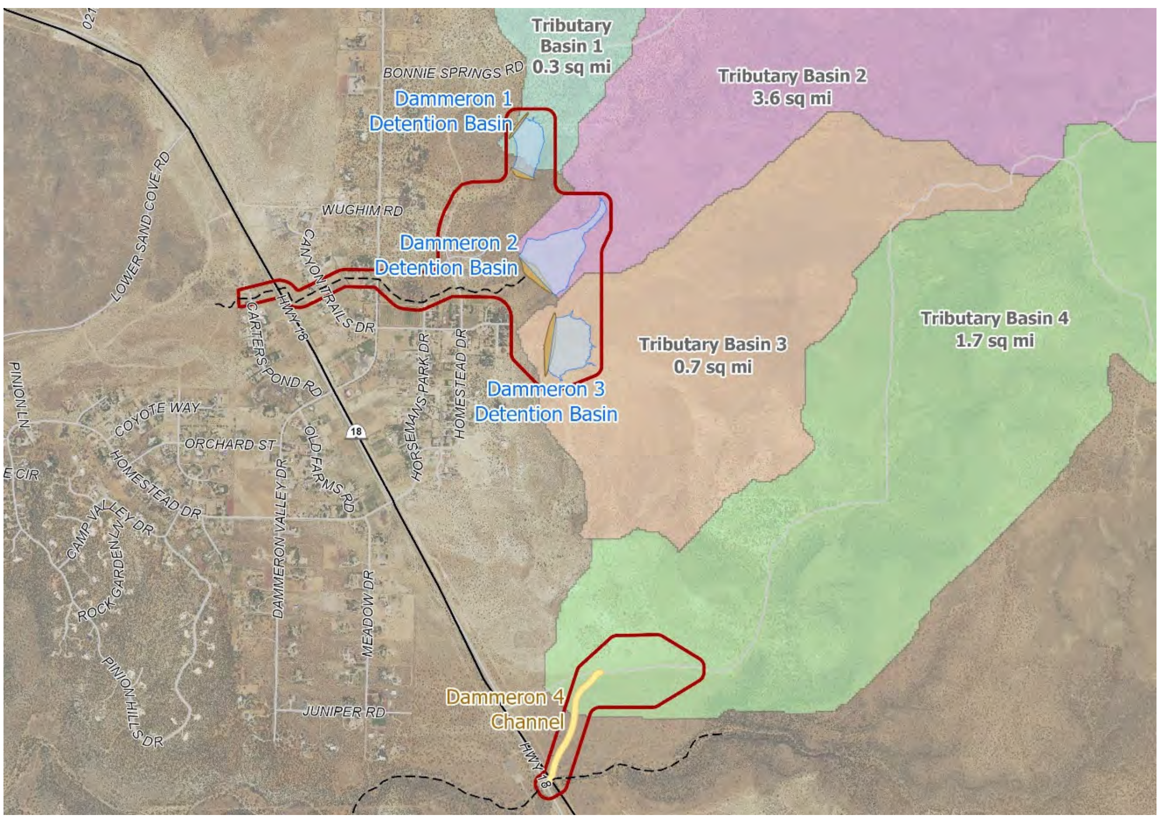

Figure 2 Dammeron Valley Project Elements

B. Diamond Valley

The three detention basins at Dammeron Valley will involve reestablishing existing detention basins and will include earthen dams with a low-level principal spillway and an auxiliary spillway. Two of the detention basins are located above the third detention basin and will also incorporate existing channels as additional auxiliary spillways. The detention basins will not be designed to hold water and will have low-level principal spillways that will drain the basins empty after each storm event. The purpose of the basins is to detain peak flows during large storm events protecting downstream infrastructure. Due to homes located immediately downstream, these dams are classified as High Hazard.

The low-level outlet and new auxiliary spillway for Detention Basins 2 and 3 will discharge into the roadway immediately downstream. The existing channels that will serve as an additional auxiliary for these detention basins will discharge into the detention basin downstream (Detention Basin 3 will discharge into Detention Basin 2 and Detention Basin 2 will discharge into Detention Basin 1). Detention Basin 1 will discharge into the Diamond 4 Channel.

The Diamond Valley project elements, including the portion of existing channel to be armored, are shown in **Figure 3**.

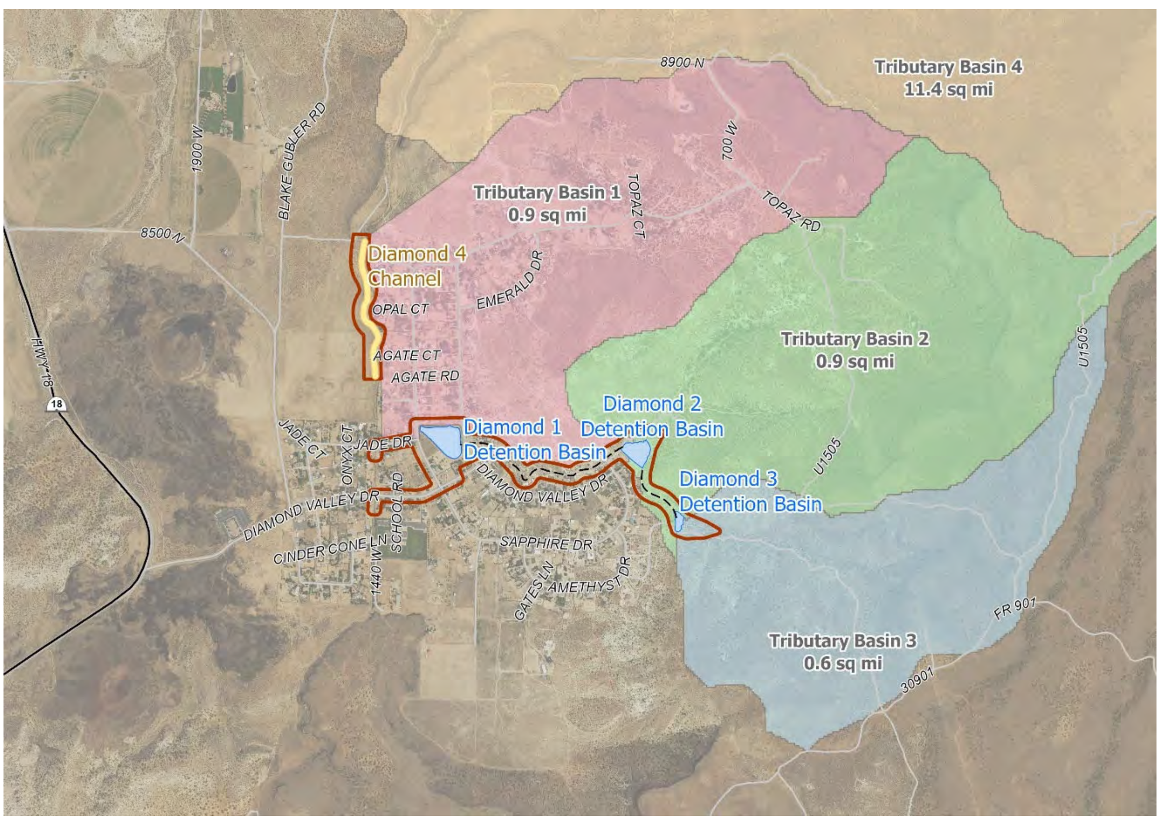

Figure 3 Diamond Valley Project Elements

Part II. Hydrology Analysis

C. Site Location and Existing Conditions

The three Dammeron Valley proposed dams are located approximately ½ mile east of Highway 18 due east of the community of Dammeron Valley in Washington County, Utah, or 37°18’29” North Latitude and 113°39’51” West Longitude. The high-water surface area generated during a storm event with the construction of the three dams is approximately 30 acres and is currently comprised of undisturbed shrub ground cover, natural drainage channels, and dirt roads.

The three Diamond Valley existing detention basins are located approximately 1 mile east of Highway 18 on the east side of the community of Diamond Valley, in Washington County, Utah, or 37°15’05” North Latitude and 113°36’35” West Longitude. The high-water surface area generated with the construction of the three dams is approximately 8 acres and is currently comprised of undisturbed shrub ground cover, natural drainage channels, and dirt roads.

An aerial drone survey was performed across the anticipated footprint of the project and was used to generate a 3D model of the existing surface with an approximate one-foot vertical accuracy and six-inch horizontal accuracy. This surface model was used in designing the different components of the project and are shown at 10-foot contour intervals on **Appendix A, Exhibits 1 and 2**. Exhibits of the tributary drainage basins are shown in **Appendix A, Exhibit 3**.

Using available USGS DEM data, the area upstream of the proposed reservoir was delineated to determine the drainage area tributary to the detention basins and channels. The tributaries are summarized in **Table 1**.

Dam	Tributary Area	Mean Basin Elevation
Dammeron 1 Detention Basin	182 acres	4830’
Dammeron 2 Detention Basin	2,286 acres	5310’
Dammeron 3 Detention Basin	470 acres	4850’
Dammeron 4 Channel	1,104 acres	5150’
Diamond 1 Detention Basin	575 acres	4760’
Diamond 2 Detention Basin	597 acres	4960’
Diamond 3 Detention Basin	386 acres	4980’
Diamond 4 Channel	7,311 acres	5930’

Table 1 Summary of Tributary Areas

The average annual temperature for the area is 53.3°F (NWS, Climate Monitoring) with an average annual precipitation of 15.6 inches (USGS, StreamStats). The Climatic Index calculates to 0.6 (NEH 630, Equation 21-1).

D. Design Criteria

The capacity of the detention basins and channels will be based on the 100-year storm event, and the detention basins will incorporate a low-level outlet at the base elevation of the respective dams. The low-level outlet peak flows will be designed based on downstream capacities of existing drainage infrastructure and coordination with Washington County. The dam structures will further be analyzed as high-hazard dams due to their classification.

The peak allowable flows downstream of the detention basins are summarized in **Table 2**.

Dam	Allowable Flow Downstream
Dammeron 1 Detention Basin Dammeron 2 Detention Basin Dammeron 3 Detention Basin	Combined 30 cfs: Based on correspondence with Washington County and available capacity in downstream drainage infrastructure.
Diamond 1 Detention Basin	50 cfs: Based on available capacity in Diamond 4 Channel and potential for larger storm events in Diamond 4 Channel.
Diamond 2 Detention Basin	10 cfs: Based on available capacity in downstream roadways.
Diamond 3 Detention Basin	10 cfs: Based on available capacity in downstream roadways.

Table 2 Summary of Peak Allowable Flow Downstream

The hydrographs analyzed in this study, as required by Utah Dam Safety and NRCS, are summarized in **Table 3** and include project-specific hydrographs. The Utah State Engineers Office requires hydrograph analyses for probable maximum flood events (general and local storms) and for 100-year events with saturated soil conditions (UAC, Section 11-4A). The NRCS requires hydrograph analyses for the Principal Spillway, Auxiliary Spillway and Freeboard (TR-60, Part 2), which incorporate probable maximum flood precipitation values. Because the capacity of the detention basins and channels will be based on the 100-year storm event with normal soil saturation conditions, a corresponding project-specific hydrograph will also be analyzed.

Hydrograph	Frequency	Duration	Precipitation
NRCS Required Hydrographs			
Principal Spillway Hydrograph	100-year	10-day	TR-60, Fig 2-1 (NWS)
Auxiliary Spillway Hydrographs	Maximum	6- & 24-hour	TR-60, Fig 2-2
Freeboard Hydrographs	Maximum	6- & 24-hour	TR-60, Fig 2-2
Utah State Required Hydrographs			
SEP Hydrographs	Maximum	6- & 72-hour	Jensen
100-year (AMC III) Hydrographs	100-year	6- & 72-hour	NWS
Project-Specific Hydrograph			
100-year (AMC II) Hydrographs	100-year	24-hour	NWS

Table 3 Summary of Design Hydrographs

Each of the above hydrographs are included in this analysis as separate Storm Events. For purposes of this analysis, **Table 4** assigns numbers to each Storm Event. Storm Events 02 through 10 are not required for a hydrologic analysis of the Dammeron 4 Channel and the Diamond 4 Channel since their basis of design is strictly the 100-year storm event.

	Storm Event	Duration	Frequency	AMC
01	100-year 24-hour	24-hour	100-year	II
02	100-year 6-hour AMC III	6-hour	100-year	III
03	100-year 24-hour AMC III	24-hour	100-year	III
04	Local SEP Hydrograph (SEP-L)	6-hour	Maximum	II
05	General SEP Hydrograph (SEP-G)	72-hour	Maximum	II
06	Principal Spillway Hydrograph (PSH)	10-day	100-year	-[1]
07	Local Auxiliary Spillway Hydrograph (ASH-L)	6-hour	Maximum	II
08	General Auxiliary Spillway Hydrograph (ASH-G)	24-hour	Maximum	II
09	Local Freeboard Hydrograph (FBH-L)	6-hour	Maximum	II
10	General Freeboard Hydrograph (FBH-G)	24-hour	Maximum	II

Table 4 Summary of Storm Events

The 100-year 24-hour Hydrograph (Storm Event 01) will be used to size the capacity of the detention basins. The Principal Spillway Hydrograph (Storm Event 06) will be used in designing the principal spillway (low-level outlet) for each dam. The Local Auxiliary Spillway Hydrograph (Storm Event 07) is used to check the stability of auxiliary spillway(s). The most critical of the Auxiliary Spillway, Freeboard and SEP Hydrographs (Storm Events 02 through 05 and 08 through 10) will be used in designing the auxiliary spillway(s) and establishing the top-of-dam elevation.

For purposes of this report, an approximated auxiliary spillway and top of dam is used to verify the feasibility of the detention basin dam structures. A hydraulic analysis is required to adequately design the auxiliary spillway and top of dam, including comprehensive spillway, freeboard and breach analyses.

E. Precipitation Values

The precipitation values for the 100-year storm events (Storm Events 01 through 03) are taken from NWS. For the PSH (Storm Event 06), see also TR-60, Figure 2-1. The precipitation values at the centroid of each drainage basin were taken for each storm frequency. A summary of these values is included in **Appendix B**.

The precipitation values for the SEP storms (Storm Events 04 and 05) are taken from HMR-49 and Jensen. It is noted that HMR-49 outlines the method used in calculating the Probable Maximum Precipitation (PMP) values for this drainage basin. Jensen has been accepted by the Utah State Engineer's Office and further updates the PMP values. PMP values that have been updated by Jensen are referred to as Spillway Evaluation Precipitation (SEP) values and are used in lieu of the PMP values. Calculations for the SEP values are included in **Appendix B**.

[1] As directed in NEH 630.2102(a)(1), Curve Numbers reflected in NEH 630.2102, Table 21-2, are used for the PSH because the precipitation value exceeds 6 inches.

The precipitation value for the ASH and FBH storm events (Storm Events 07 through 10) are taken from TR-60, Figure 2-2. The precipitation values are calculated using the NWS 100-year and Jensen SEP precipitation values. Calculations for the ASH and FBH values are included in **Appendix B**.

The precipitation values for each storm event are summarized in **Table 5**.

	Storm Event	Da1	Da2	Da3	Da4	Di1	Di2	Di3	Di4
01	100-year 24-hour	2.79	2.95	2.76	2.87	2.78	2.88	2.80	3.11
02	100-year 6-hour AMC III	2.51	2.64	2.50	N/A	2.51	2.55	2.52	N/A
03	100-year 24-hour AMC III	2.79	2.95	2.76	N/A	2.78	2.88	2.80	N/A
04	Local SEP Hydrograph (SEP-L)	11.73	9.30	11.73	N/A	11.73	11.73	11.73	N/A
05	General SEP Hydrograph (SEP-G)	14.10	14.05	14.10	N/A	14.10	14.10	14.10	N/A
06	Principal Spillway Hydrograph (PSH)	6.53	7.15	6.43	N/A	6.54	6.78	6.64	N/A
07	Local Auxiliary Spillway Hydrograph (ASH-L)	4.91	4.37	4.90	N/A	4.91	4.94	4.91	N/A
08	General Auxiliary Spillway Hydrograph (ASH-G)	5.73	5.84	5.71	N/A	6.25	6.31	6.27	N/A
09	Local Freeboard Hydrograph (FBH-L)	11.73	9.30	11.73	N/A	11.73	11.73	11.73	N/A
10	General Freeboard Hydrograph (FBH-G)	14.10	14.05	14.10	N/A	14.10	14.10	14.10	N/A

Table 5 Storm Event and Precipitation Values[2]

F. Drainage Basin Parameters

The tributary drainage basins for the project range in size from 0.3 square miles to 11.4 square miles. The basin characteristics are summarized in **Tables 6 and 7** and discussed in following sections.

Basin	Area (sq mi)	CN, AMC II/III	Flow Length (ft)	Ave Slope (%)
Dammeron 1 Detention Basin	0.3	86.8/93.8	2,400	17.1%
Dammeron 2 Detention Basin	3.6	83.9/92.3	24,500	13.1%
Dammeron 3 Detention Basin	0.7	87.9/94.4	8,400	12.6%
Dammeron 4 Channel	1.7	86.2/93.5	20,400	13.6%
Diamond 1 Detention Basin	0.9	87.8/94.3	9,900	14.4%
Diamond 2 Detention Basin	0.9	85.8/93.3	9,600	16.2%
Diamond 3 Detention Basin	0.6	88.9/94.9	8,000	19.1%
Diamond 4 Channel	11.4	88.0/94.4	40,700	19.2%

Table 6 Drainage Basin Characteristics

[2] Precipitation Values are designated in columns 3 through 8 and are reflected in **inches** for drainage basins Da1 (Dammeron 1 Detention Basin), Da2 (Dammeron 2 Detention Basin), Da3 (Dammeron 3 Detention Basin), Da4 (Dammeron 4 Channel), Di1 (Diamond 1 Detention Basin), Di2 (Diamond 2 Detention Basin), Di3 (Diamond 3 Detention Basin), and Di4 (Diamond 4 Channel).

Basin	Lag Time, AMC II/III (hr)	Time of Conc, AMC II/III (hr)	Initial Abst, AMC II/III (in)
Dammeron 1 Detention Basin	0.12/0.09	0.20/0.15	0.30/0.13
Dammeron 2 Detention Basin	1.00/0.72	1.66/1.20	0.38/0.17
Dammeron 3 Detention Basin	0.37/0.28	0.62/0.47	0.28/0.12
Dammeron 4 Channel	0.78/0.58	1.30/0.96	0.32/0.14
Diamond 1 Detention Basin	0.40/0.30	0.67/0.50	0.28/0.12
Diamond 2 Detention Basin	0.40/0.29	0.66/0.49	0.33/0.14
Diamond 3 Detention Basin	0.28/0.22	0.47/0.36	0.25/0.11
Diamond 4 Channel	1.07/0.81	1.78/1.35	0.27/0.12

Table 7 Drainage Basin Parameters

i. Land Use

Land use and soil data were obtained from NLCD and WSS. The basins include larger portions of *42-Evergreen Forest*, *52-Shrub/Scrub*, and *71-Grasslands/Herbaceous* and smaller portions of *21/22-Developed Open Space/Low Intensity*. The soil data for the site mainly classifies the basins to be Hydrologic Soil Group D with small portions of Hydrology Soil Group C. An exhibit of the land use and hydrologic soil groups is included in **Appendix A, Exhibit 4**.

Each basin is assigned a Soil Conservation Service Curve Number (CN) that associates the land use with the soil data. As different types of soil cover exist throughout a subbasin, CNs have been prorated on an area-weighted basis. CNs for each subbasin are taken from NEH, Tables 9-2 and 9-5. Because NLCD land use designations do not directly correspond to NEH land cover descriptions, **Table 8** demonstrates how each correspond for this analysis.

NLCD Land Use Designation	NEH Land Cover Designation
21/22-Developed Open Space/Low Intensity	Open Space, Poor (Table 9-5)
42-Evergreen Forest	Pinyon-Juniper, Poor (Table 9-2)
52-Shrub/Scrub	Desert Shrub, Good (Table 9-2)
71-Grasslands/Herbaceous	Grassland, Good (Table 9-3)

Table 8 NLCD Land Use to NEH Land Cover Designations

CNs for the individual subbasins are summarized in **Table 6** and range between 83.9 and 88.9 for AMC II and between 92.3 and 94.9 for AMC III. CNs used for the PSH (Storm Event 06) are modified per NEH 630.2102, Table 21-2, and range between 70.8 and 78.8. NLCD Land Use descriptions and curve number calculations are included in **Appendix B**.

ii. Lag Times

Lag times and times of concentration for the subbasins were calculated using methodology outlined in NEH Chapter 15, which estimates the lag time, TLAG, and time of concentration, T_c, as:

$$TLAG = \frac{l^{0.8}\left(\left(\frac{1000}{CN} - 10\right) + 1\right)^{0.7}}{1{,}900Y^{0.5}}$$

$$T_c = \frac{TLAG}{0.6}$$

Criteria and calculated lag times and times of concentration for the individual subbasins are summarized in **Table 7**.

iii. Initial Abstraction

Initial abstraction depths for the subbasins were calculated using methodology outlined in TR-55, which estimates the initial abstraction depth, I_a, as:

$$I_a = 0.2 \times \left(\frac{1000}{CN} - 10\right)$$

Initial abstraction depth for the individual subbasins are summarized in **Table 7**.

G. Storm Hydrographs

The PSH Storm Event (Storm Event 06) was modeled using the SITES computer program, which developed the hydrograph (NEH 630.2100). For other storm events, a dimensionless design storm distribution (NEH 630.2103, Figure 21-9) was applied and modeled using HEC-HMS software. The dimensionless storm distribution and calculated storm hydrographs are shown in tabular form with calculations in **Appendix B**.

H. Results

Each of the storm events were setup as separate models using the HEC-HMS computer program, version 4.8. Criterion discussed in this analysis were incorporated into the models. Model output is included in **Appendix C**. The Local Freeboard Hydrograph (and Local SEP Hydrograph, Storm Events 04 and 09) generated the largest flows going into the detention basins. The General Freeboard Hydrograph (and General SEP Hydrograph, Storm Events 05 and 10) generated the largest volumes going into the detention basins. The peak flows generated by each tributary basin for each storm event are summarized in **Table 9**.

	Storm Event	Da1	Da2	Da3	Da4	Di1	Di2	Di3	Di4
01	100-year 24-hour	57	535	130	288	171	162	122	2,225
02	100-year 6-hour AMC III	252	1,945	536	N/A	677	670	500	N/A
03	100-year 24-hour AMC III	75	841	170	N/A	224	224	153	N/A
04	Local SEP Hydrograph (SEP-L)	1,312	6,533	2,658	N/A	3,344	3,275	2,446	N/A
05	General SEP Hydrograph (SEP-G)	136	1,580	317	N/A	407	404	273	N/A
06	Principal Spillway Hydrograph (PSH)	298	2,518	655	N/A	847	860	608	N/A
07	Local Auxiliary Spillway Hydrograph (ASH-L)	475	2,325	941	N/A	1,183	1,120	893	N/A
08	General Auxiliary Spillway Hydrograph (ASH-G)	149	1,520	348	N/A	440	434	306	N/A
09	Local Freeboard Hydrograph (FBH-L)	1,312	6,533	2,658	N/A	3,344	3,275	2,446	N/A
10	General Freeboard Hydrograph (FBH-G)	406	4,406	946	N/A	1,214	1,201	816	N/A

Table 9 Peak Flows by Storm Event[3]

The total inflow volumes for each storm event are summarized in **Table 10**.

	Storm Event	Da1	Da2	Da3	Da4	Di1	Di2	Di3	Di4
01	100-year 24-hour	25	282	59	142	77	74	55	1,166
02	100-year 6-hour AMC III	30	355	71	N/A	92	89	63	N/A
03	100-year 24-hour AMC III	34	411	80	N/A	104	104	72	N/A
04	Local SEP Hydrograph (SEP-L)	161	1,408	382	N/A	907	478	331	N/A
05	General SEP Hydrograph (SEP-G)	199	2,301	469	N/A	603	590	407	N/A
06	Principal Spillway Hydrograph (PSH)	80	1,013	188	N/A	246	246	171	N/A
07	Local Auxiliary Spillway Hydrograph (ASH-L)	55	516	133	N/A	171	163	118	N/A
08	General Auxiliary Spillway Hydrograph (ASH-G)	68	775	162	N/A	208	202	143	N/A
09	Local Freeboard Hydrograph (FBH-L)	161	1,408	382	N/A	490	478	331	N/A
10	General Freeboard Hydrograph (FBH-G)	199	2,301	469	N/A	603	590	407	N/A

Table 10 Inflow Volume by Storm Event[4]

The required volumes for each detention basin during the 100-year 24-hour Storm Event (Storm Event 01) with the low-level outlet releasing flows per **Table 2** in each detention basin and no other flows being released is summarized in **Table 11**.

Dam	Required Volume
Dammeron 1 Detention Basin	20.7 acre-feet
Dammeron 2 Detention Basin	257.8 acre-feet
Dammeron 3 Detention Basin	52.5 acre-feet
Diamond 1 Detention Basin	103.2 acre-feet
Diamond 2 Detention Basin	10.0 acre-feet
Diamond 3 Detention Basin	7.4 acre-feet

Table 11 Required Volumes for Each Detention Basin

[3] Peak Flow values are designated in columns 3 through 8 and are reflected in **cfs** for drainage basins Da1 (Dammeron 1 Detention Basin), Da2 (Dammeron 2 Detention Basin), Da3 (Dammeron 3 Detention Basin), Da4 (Dammeron 4 Channel), Di1 (Diamond 1 Detention Basin), Di2 (Diamond 2 Detention Basin), Di3 (Diamond 3 Detention Basin), and Di4 (Diamond 4 Channel).

[4] Inflow Volume values are designated in columns 3 through 8 and are reflected in **acre-feet** for drainage basins Da1 (Dammeron 1 Detention Basin), Da2 (Dammeron 2 Detention Basin), Da3 (Dammeron 3 Detention Basin), Da4 (Dammeron 4 Channel), Di1 (Diamond 1 Detention Basin), Di2 (Diamond 2 Detention Basin), Di3 (Diamond 3 Detention Basin), and Di4 (Diamond 4 Channel).

The required flow capacity for the two new channels to adequately convey the 100-year 24-hour Storm Event (Storm Event 01) is summarized in **Table 12**. This table also shows the required flow capacity for existing channels downstream of the detention basins.

Channel	Required Flow Capacity
Dammeron 4 Channel	288 cfs
Existing Dammeron Channel Downstream of Dammeron 1, 2 and 3 Detention Basins	30 cfs
Existing Channel Downstream of Diamond 3 Detention Basin conveying flows into Diamond 2 Detention Basin	109 cfs
Existing Channel Downstream of Diamond 2 Detention Basin conveying flows into Diamond 1 Detention Basin	258 cfs
Existing Channel Downstream of Diamond 1 Detention Basin conveying flows into Diamond 4 Channel	50 cfs
Diamond 4 Channel	2,225 cfs

Table 12 Required Flow Capacity for Each Channel

Appendix A. Exhibits

Exhibit 1. Dammeron Valley

Exhibit 2. Diamond Valley

Exhibit 3. Tributary Basins

Exhibit 4. Land Use

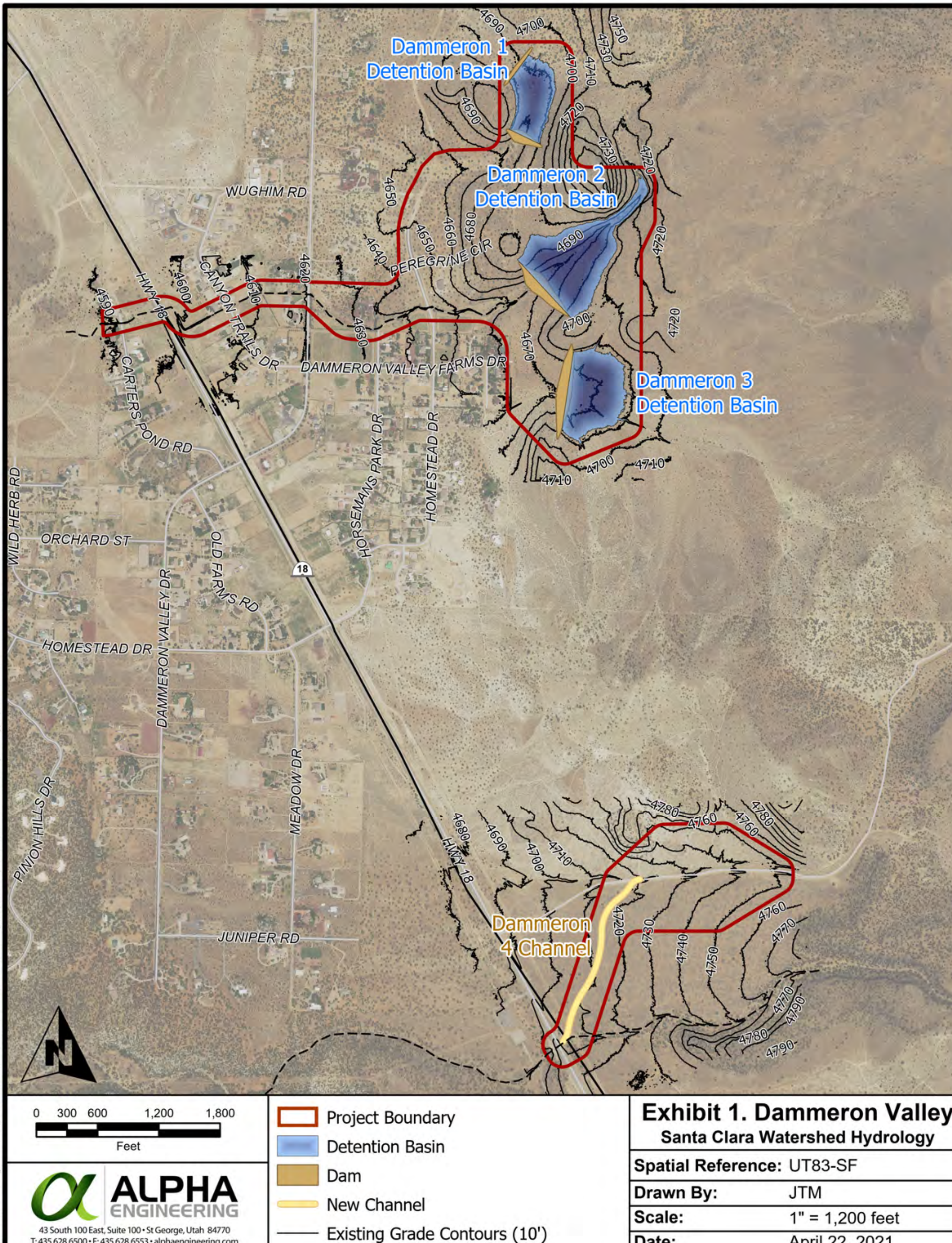

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Exhibit 1. Dammeron Valley
Santa Clara Watershed Hydrology

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 1,200 feet
Date:	April 22, 2021

P:\308-10 Washington County - Santa Clara Watershed Plan EA\Drawings\GIS\ArcGIS Pro\Santa Clara EA Hydrology.aprx, Dammeron Exh1, 4/22/2021 7:33 PM jmadsen

0 200 400 800 1,200

Feet

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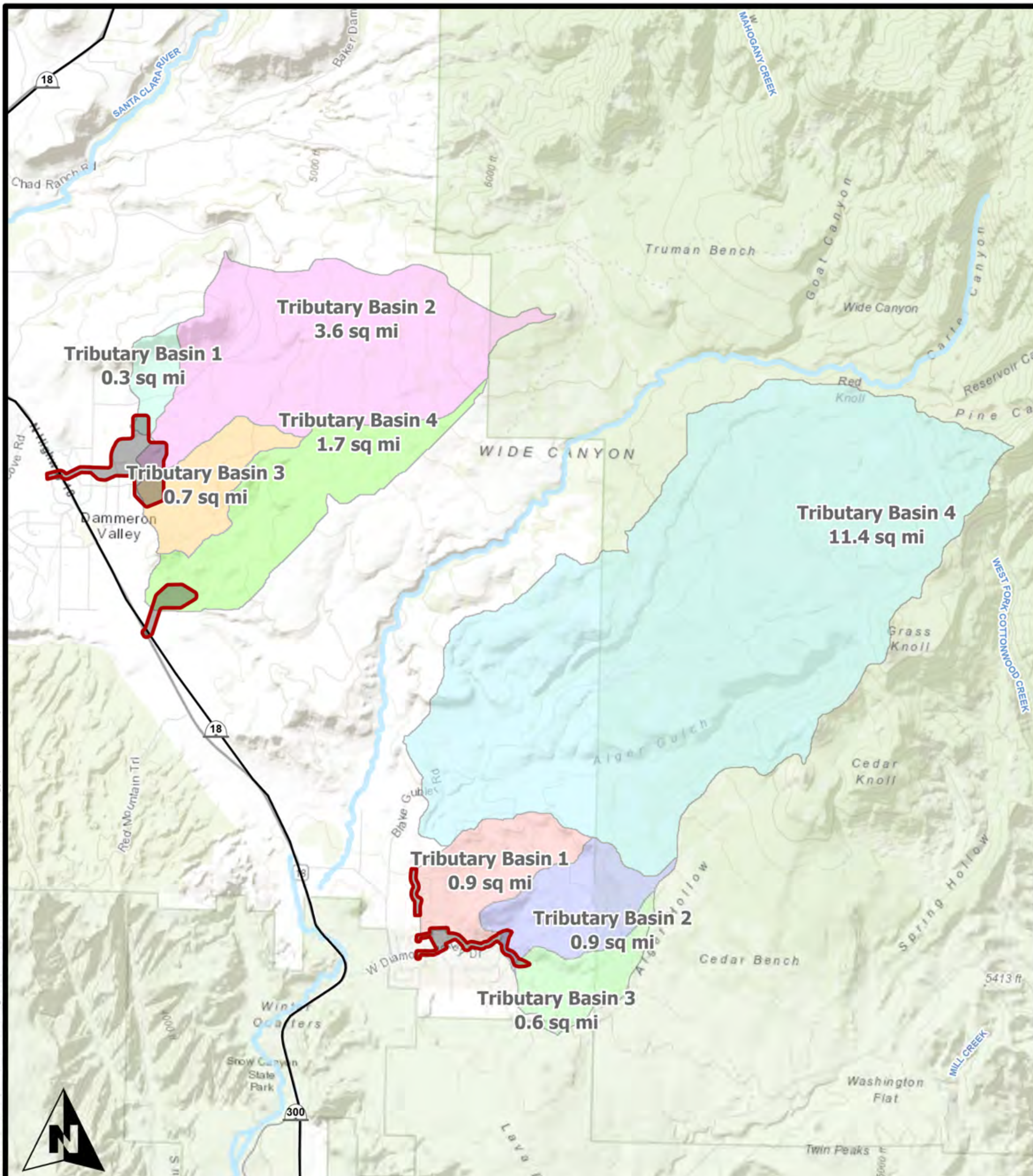
Project Boundary
Detention Basin
Dam
New Channel
Existing Grade Contours (10')

Exhibit 2. Diamond Valley
Santa Clara Watershed Hydrology

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 800 feet
Date:	April 22, 2021

P:\308-10 Washington County - Santa Clara Watershed Plan EA\Drawings\GIS\ArcGIS Pro\Santa Clara EA Hydrology.aprx, Diamond Exh2, 4/22/2021 7:32 PM jmadsen



0 1,500 3,000 6,000 9,000
Feet

Diamond Basin 1 (Di1)	Dammeron Basin 1 (Da1)
Diamond Basin 2 (Di2)	Dammeron Basin 2 (Da2)
Diamond Basin 3 (Di3)	Dammeron Basin 3 (Da3)
Diamond Basin 4 (Di4)	Dammeron Basin 4 (Da4)

Exhibit 3. Tributary Basins

Santa Clara Watershed Hydrology

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 6,000 feet
Date:	April 22, 2021

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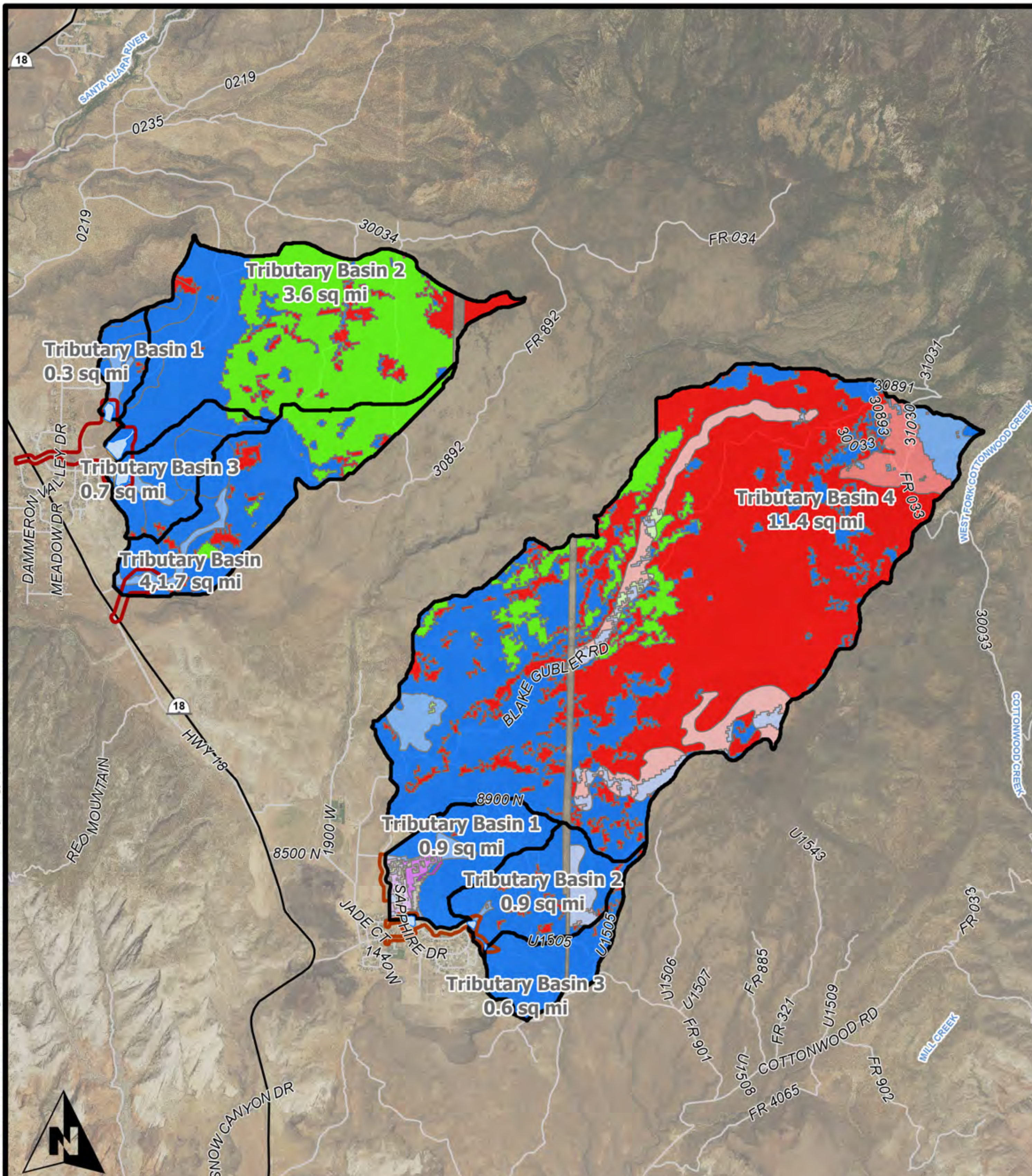

0 1,500 3,000 6,000 9,000

Feet

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- Developed Open Space/Low Intensity (B)
- Developed Open Space/Low Intensity (C)
- Developed Open Space/Low Intensity (D)
- Grasslands/Herbaceous (B)
- Grasslands/Herbaceous (C)
- Grasslands/Herbaceous (D)
- Evergreen Forest (B)
- Evergreen Forest (C)
- Evergreen Forest (D)
- Shrub/Scrub (B)
- Shrub/Scrub (C)
- Shrub/Scrub (D)

Exhibit 4. Land Use

Santa Clara Watershed Hydrology

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 6,000 feet
Date:	April 22, 2021

P:\308-10 Washington County - Santa Clara Watershed Plan EA\Drawings\GIS\ArcGIS Pro\Santa Clara EA Hydrology.aprx, Soils Exh4, 4/22/2021 7:30 PM jmadsen

Appendix B. Calculations

Section 1. Soil Data and Curve Numbers

Section 2. Storm Distributions

Section 3. Precipitation Values

Section 1. Soil Data and Curve Numbers

Dammeron Valley Soil Data and Curve Number Calculations

Output

BasinID	Hyd_Group	Id	gridcode	NLCD_Code	Acres
B3	D	10	42	42	1.73
B3	D	12	52	52	53.09
B3	D	10	42	42	4.03
B3	D	12	52	52	71.11
B3	D	12	52	52	92.50
B3	D	10	42	42	1.11
B3	D	12	52	52	195.34
B3	D	13	71	71	9.44
B3	C	12	52	52	41.35
B2	D	10	42	42	9.74
B2	D	12	52	52	49.75
B2	D	10	42	42	163.79
B2	D	12	52	52	686.05
B2	D	13	71	71	1272.84
B2	D	12	52	52	38.02
B2	D	10	42	42	40.99
B2	D	13	71	71	0.00
B1	D	12	52	52	42.62
B1	D	12	52	52	49.68
B1	C	12	52	52	40.05
B1	D	10	42	42	2.22
B1	D	12	52	52	35.04
B1	D	12	52	52	12.61

vlookup

NLCD	A	B	C	D
21	68	79	86	89
22	68	79	86	89
23	61	75	83	87
41	36	58	73	80
42	58	75	85	89
52	49	68	79	89
71	39	61	74	80
95	30	55	70	77

Output Breakdown

Basin	gridcode	Soil Group	Area_Acres	'ercent of Basi	CN	Weighted_CN
	42	D	2.22	1.22%	89	1.08
Da1	52	C	40.05	21.98%	79	17.36
	52	D	139.96	76.80%	89	68.36
			182.23	**100.00%**		**86.80**
	42	D	214.52	9.39%	89	8.35
Da2	52	D	773.82	33.85%	89	30.13
	71	D	1297.37	56.76%	80	45.41
			2285.71	**100.00%**		**83.89**
	42	D	6.87	1.46%	89	1.30
Da3	52	C	41.35	8.80%	79	6.95
	52	D	412.04	87.72%	89	78.07
	71	D	9.44	2.01%	80	1.61
			469.7	**100.00%**		**87.94**
	42	C	0.06	0.01%	85	0.00
	42	D	73.64	6.67%	89	5.93
Da4	52	C	57.15	5.17%	79	4.09
	52	D	688.54	62.35%	89	55.49
	71	D	284.98	25.80%	80	20.64
			1104.37	**100.00%**		**86.16**

Calculation Table

	Area, sq-mi	CN (AMC II)	CN (AMC III)	Average Slope, %	Length, ft	CN (PSH)
Da1	0.3	86.8	93.8	17.13%	2400	75.6
Da2	3.6	83.9	92.3	13.18%	24500	70.8
Da3	0.7	87.9	94.4	12.64%	8400	76.9
Da4	1.7	86.2	93.5	13.62%	20400	74.4
	Lag Time (AMC II), hr	**Lag Time (AMC III), hr**	**Tc (AMC II), hr**	**Tc (AMC III), hr**	**Initial Abst (AMC II), in**	**Initial Abst (AMC III), in**
Da1	0.12	0.09	0.20	0.15	0.30	0.13
Da2	1.00	0.72	1.66	1.20	0.38	0.17
Da3	0.37	0.28	0.62	0.47	0.28	0.12
Da4	0.78	0.58	1.30	0.96	0.32	0.14

Diamond Valley Soil Data and Curve Number Calculations

Output

FID	Hyd_Group	BasinID	NLCD_Code	Acres
0		B2	52	0.85148197
1		B4	52	0.41308501
2	B	B1	42	385.970001
3	B	B1	52	136.703003
4	B	B1	71	22.8894005
5	B	B2	21	29.5407009
6	B	B2	22	11.8734999
7	B	B2	23	0.66717201
8	B	B2	52	11.9146004
9	B	B2	71	1.11
10	B	B3	52	1.32
11	B	B4	42	6.48
12	B	B4	52	67.41
13	C	B1	41	0.67
14	C	B1	42	209.06
15	C	B1	52	239.35
16	C	B1	71	2.00
17	C	B2	21	26.87
18	C	B2	22	11.68
19	C	B2	23	0.71
20	C	B2	52	40.83
21	C	B4	21	0.55
22	C	B4	22	0.01
23	C	B4	52	9.26
24	D	B1	42	3716.86
25	D	B1	52	2069.34
26	D	B1	71	435.60
27	D	B1	95	5.56
28	D	B2	21	4.63
29	D	B2	22	2.24
30	D	B2	23	1.51
31	D	B2	42	1.11
32	D	B2	52	429.65
33	D	B3	42	7.64
34	D	B3	52	368.93
35	D	B4	21	0.26
36	D	B4	22	0.17
37	D	B4	42	35.96
38	D	B4	52	448.00

vlookup

NLCD	A	B	C	D
21	68	79	86	89
22	68	79	86	89
23	61	75	83	87
41	36	58	73	80
42	58	75	85	89
52	49	68	79	89
71	39	61	74	80
95	30	55	70	77

Output Breakdown

Basin	gridcode	Soil Group	Area_Acres	ercent of Bas	CN	Weighted_CN
Di1	21	C	29.35	5.10%	86	4.39
	21	D	4.63	0.80%	89	0.72
	22	C	14.36	2.50%	86	2.15
	22	D	3.57	0.62%	89	0.55
	23	C	1.35	0.23%	83	0.19
	23	D	2.85	0.50%	87	0.43
	42	D	3.78	0.66%	89	0.58
	52	C	40.83	7.10%	79	5.61
	52	D	469.94	81.70%	89	72.71
	71	B	4.56	0.79%	61	0.48
Total			575.22			87.82
Di3	42	D	8.94	2.32%	89	2.06
	52	B	1.32	0.34%	68	0.23
	52	D	375.25	97.34%	89	86.63
Total			385.51			88.93

Di2	21 C	0.55	0.09%	86	0.08
	21 D	0.26	0.04%	89	0.04
	22 C	0.01	0.00%	86	0.00
	22 D	0.17	0.03%	89	0.03
	42 B	6.48	1.09%	75	0.81
	42 D	35.96	6.02%	89	5.36
	52 B	67.41	11.29%	68	7.68
	52 C	40.83	6.84%	79	5.40
	52 D	445.50	74.60%	89	66.40
Total		597.17			85.79
Di4	41 C	0.67	0.01%	73	0.01
	42 C	246.33	3.37%	85	2.86
	42 D	3924.31	53.68%	89	47.77
	52 C	244.11	3.34%	79	2.64
	52 D	2435.34	33.31%	89	29.65
	71 C	3.57	0.05%	74	0.04
	71 D	449.15	6.14%	80	4.91
	95 D	7.56	0.10%	77	0.08
Total		7311.04			87.96

Calculation Table

	Area, sq-mi	CN (AMC II)	CN (AMC III)	Average Slope, %	Length, ft	CN (PSH)
Di1	0.9	87.8	94.3	14.47%	9900	76.8
Di2	0.9	85.8	93.3	16.26%	9600	73.6
Di3	0.6	88.9	94.9	19.13%	8000	78.8
Di4	11.4	88.0	94.4	19.26%	40700	77.0
	Lag Time (AMC II), hr	**Lag Time (AMC III), hr**	**Tc (AMC II), hr**	**Tc (AMC III), hr**	**Initial Abst (AMC II), in**	**Initial Abst (AMC III), in**
Di1	0.40	0.30	0.67	0.50	0.28	0.12
Di2	0.40	0.29	0.66	0.49	0.33	0.14
Di3	0.28	0.22	0.47	0.36	0.25	0.11
Di4	1.07	0.81	1.78	1.35	0.27	0.12

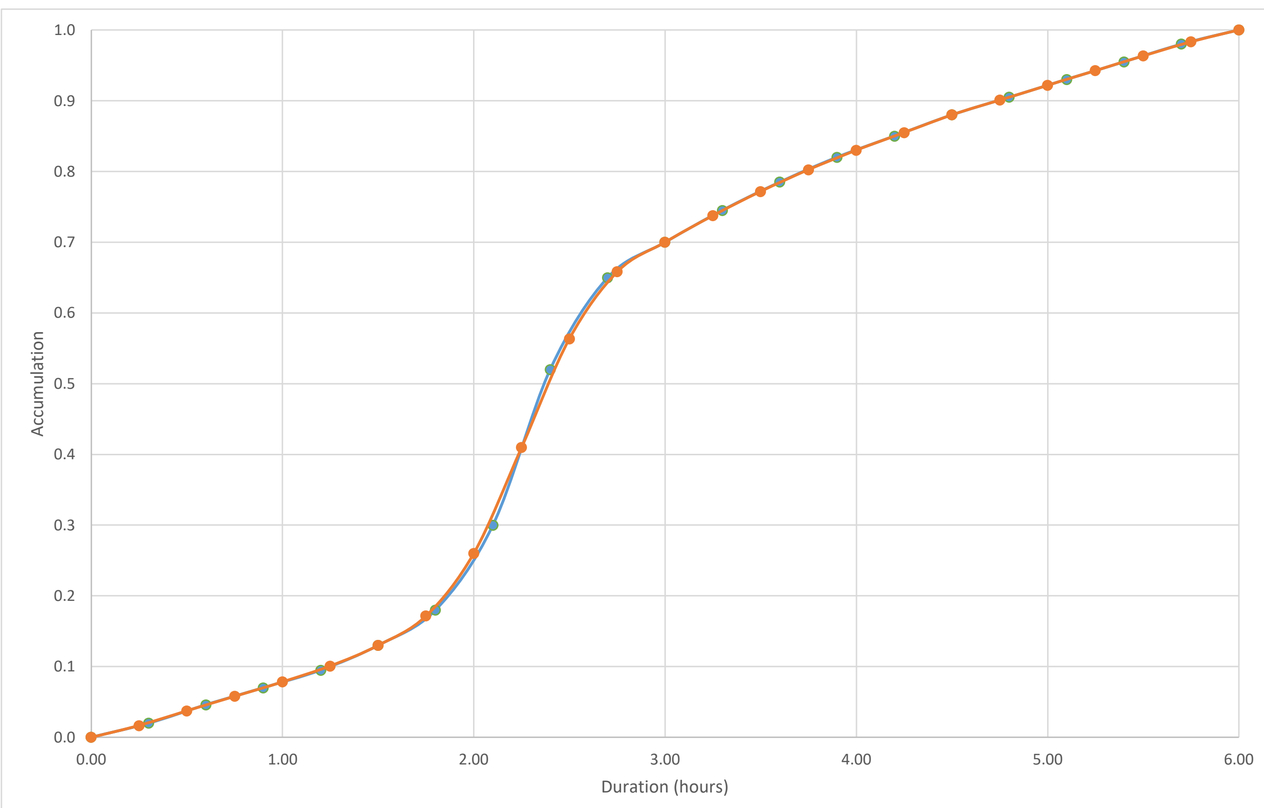
Section 2. Storm Distributions

100-yr 6-hr Hydrograph

Time Step *0.25 hrs*
15 min

Interval Time, hr	Unit Hydrograph	Dammeron 1 Detention Basin	Dammeron 2 Detention Basin	Dammeron 3 Detention Basin	Diamond 1 Detention Basin	Diamond 2 Detention Basin	Diamond 3 Detention Basin
		P = 2.51 in	**P = 2.64 in**	**P = 2.50 in**	**P = 2.51 in**	**P = 2.55 in**	**P = 2.52 in**
0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.00
0.25	0.017	0.04	0.04	0.04	0.04	0.04	0.04
0.50	0.037	0.09	0.10	0.09	0.09	0.10	0.09
0.75	0.058	0.15	0.15	0.15	0.15	0.15	0.15
1.00	0.078	0.20	0.21	0.20	0.20	0.20	0.20
1.25	0.101	0.25	0.27	0.25	0.25	0.26	0.25
1.50	0.130	0.33	0.34	0.33	0.33	0.33	0.33
1.75	0.172	0.43	0.45	0.43	0.43	0.44	0.43
2.00	0.260	0.65	0.69	0.65	0.65	0.66	0.66
2.25	0.410	1.03	1.08	1.03	1.03	1.05	1.03
2.50	0.563	1.41	1.49	1.41	1.41	1.44	1.42
2.75	0.658	1.65	1.74	1.65	1.65	1.68	1.66
3.00	0.700	1.76	1.85	1.75	1.76	1.79	1.76
3.25	0.738	1.85	1.95	1.84	1.85	1.88	1.86
3.50	0.772	1.94	2.04	1.93	1.94	1.97	1.94
3.75	0.803	2.01	2.12	2.01	2.01	2.05	2.02
4.00	0.830	2.08	2.19	2.08	2.08	2.12	2.09
4.25	0.855	2.15	2.26	2.14	2.15	2.18	2.15
4.50	0.880	2.21	2.32	2.20	2.21	2.24	2.22
4.75	0.901	2.26	2.38	2.25	2.26	2.30	2.27
5.00	0.922	2.31	2.43	2.30	2.31	2.35	2.32
5.25	0.943	2.37	2.49	2.36	2.37	2.40	2.38
5.50	0.963	2.42	2.54	2.41	2.42	2.46	2.43
5.75	0.983	2.47	2.60	2.46	2.47	2.51	2.48
6.00	1.000	2.51	2.64	2.50	2.51	2.55	2.52

(NEH 630, Chapter 21, Figure 21-9)

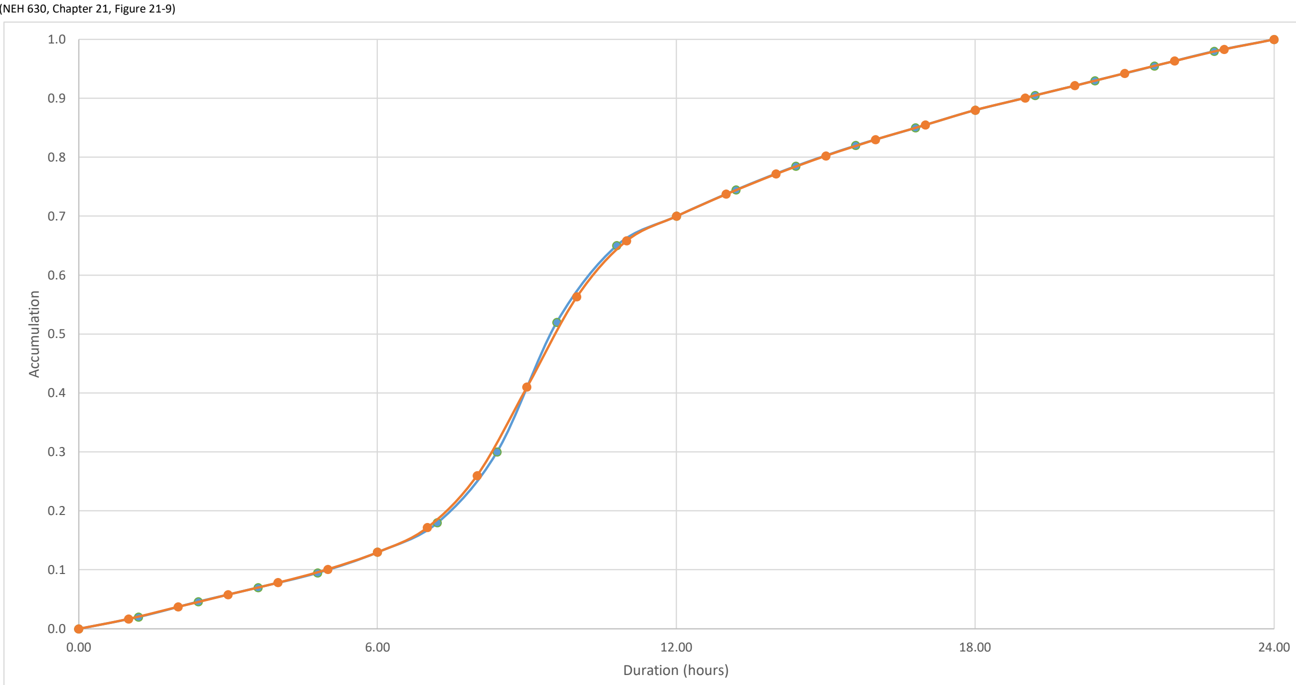


100-yr 24-hr Hydrograph

Time Step *1 hrs*
60 min

Interval Time, hr	Unit Hydrograph	Dammeron 1 Detention Basin	Dammeron 2 Detention Basin	Dammeron 3 Detention Basin	Dammeron 4 Channel	Diamond 1 Detention Basin	Diamond 2 Detention Basin	Diamond 3 Detention Basin	Diamond 4 Channel
		P = 2.79 in	**P = 2.95 in**	**P = 2.76 in**	**P = 2.87 in**	**P = 2.78 in**	**P = 2.88 in**	**P = 2.80 in**	**P = 3.11 in**
0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	0.017	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
2.00	0.037	0.10	0.11	0.10	0.11	0.10	0.11	0.10	0.12
3.00	0.058	0.16	0.17	0.16	0.17	0.16	0.17	0.16	0.18
4.00	0.078	0.22	0.23	0.22	0.22	0.22	0.23	0.22	0.24
5.00	0.101	0.28	0.30	0.28	0.29	0.28	0.29	0.28	0.31
6.00	0.130	0.36	0.38	0.36	0.37	0.36	0.37	0.36	0.40
7.00	0.172	0.48	0.51	0.47	0.49	0.48	0.49	0.48	0.53
8.00	0.260	0.73	0.77	0.72	0.75	0.72	0.75	0.73	0.81
9.00	0.410	1.14	1.21	1.13	1.18	1.14	1.18	1.15	1.28
10.00	0.563	1.57	1.66	1.55	1.62	1.57	1.62	1.58	1.75
11.00	0.658	1.84	1.94	1.82	1.89	1.83	1.90	1.84	2.05
12.00	0.700	1.95	2.07	1.93	2.01	1.95	2.02	1.96	2.18
13.00	0.738	2.06	2.18	2.04	2.12	2.05	2.12	2.07	2.29
14.00	0.772	2.15	2.28	2.13	2.21	2.15	2.22	2.16	2.40
15.00	0.803	2.24	2.37	2.21	2.30	2.23	2.31	2.25	2.50
16.00	0.830	2.32	2.45	2.29	2.38	2.31	2.39	2.32	2.58
17.00	0.855	2.39	2.52	2.36	2.45	2.38	2.46	2.39	2.66
18.00	0.880	2.46	2.60	2.43	2.53	2.45	2.53	2.46	2.74
19.00	0.901	2.51	2.66	2.49	2.59	2.50	2.59	2.52	2.80
20.00	0.922	2.57	2.72	2.54	2.65	2.56	2.65	2.58	2.87
21.00	0.943	2.63	2.78	2.60	2.70	2.62	2.71	2.64	2.93
22.00	0.963	2.69	2.84	2.66	2.76	2.68	2.77	2.70	3.00
23.00	0.983	2.74	2.90	2.71	2.82	2.73	2.83	2.75	3.06
24.00	1.000	2.79	2.95	2.76	2.87	2.78	2.88	2.80	3.11

(NEH 630, Chapter 21, Figure 21-9)

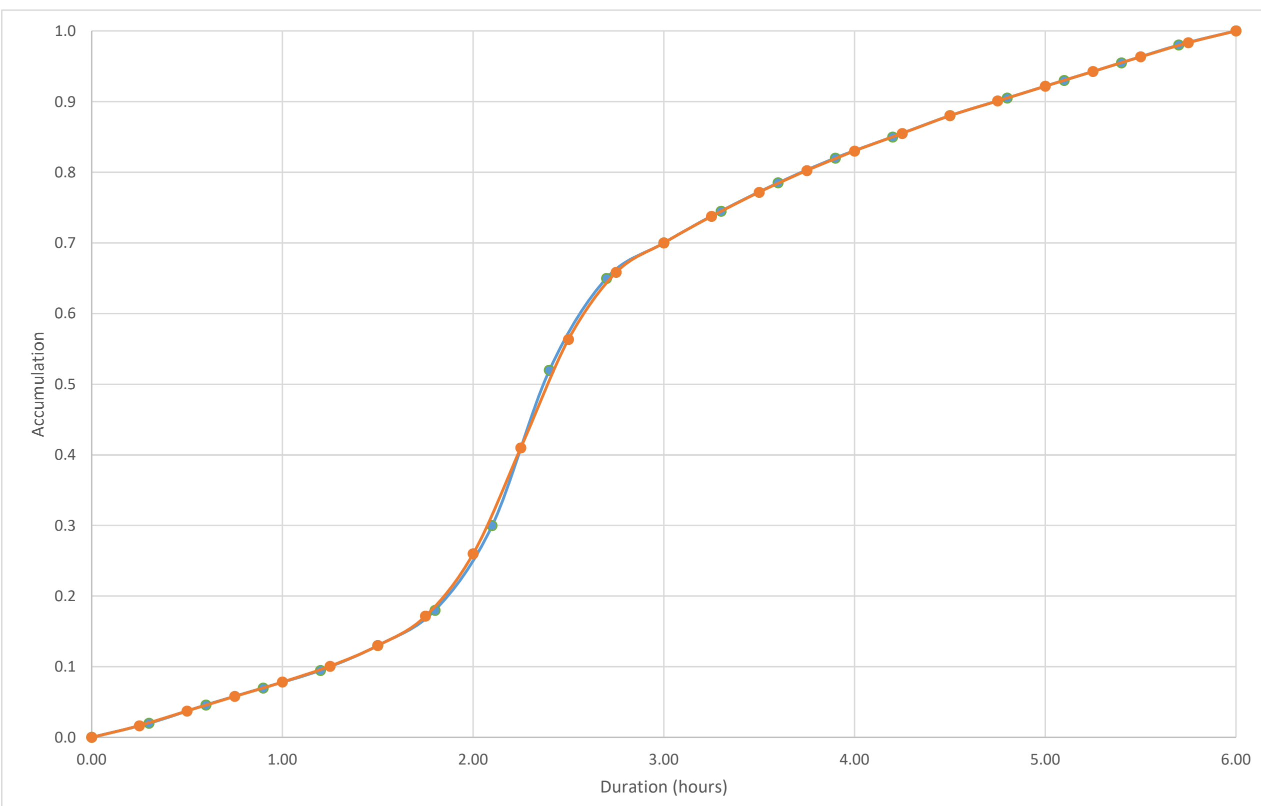


SEP Local (6-hr) Hydrograph

Time Step *0.25 hrs*
15 min

Interval Time, hr	Unit Hydrograph	Dammeron 1 Detention Basin	Dammeron 2 Detention Basin	Dammeron 3 Detention Basin	Diamond 1 Detention Basin	Diamond 2 Detention Basin	Diamond 3 Detention Basin
		P = 11.73 in	P = 9.30 in	P = 11.73 in	P = 11.73 in	P = 11.73 in	P = 11.73 in
0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.00
0.25	0.017	0.20	0.16	0.20	0.20	0.20	0.20
0.50	0.037	0.44	0.35	0.44	0.44	0.44	0.44
0.75	0.058	0.68	0.54	0.68	0.68	0.68	0.68
1.00	0.078	0.92	0.73	0.92	0.92	0.92	0.92
1.25	0.101	1.18	0.94	1.18	1.18	1.18	1.18
1.50	0.130	1.52	1.21	1.52	1.52	1.52	1.52
1.75	0.172	2.01	1.60	2.01	2.01	2.01	2.01
2.00	0.260	3.05	2.42	3.05	3.05	3.05	3.05
2.25	0.410	4.81	3.81	4.81	4.81	4.81	4.81
2.50	0.563	6.61	5.24	6.61	6.61	6.61	6.61
2.75	0.658	7.72	6.12	7.72	7.72	7.72	7.72
3.00	0.700	8.21	6.51	8.21	8.21	8.21	8.21
3.25	0.738	8.65	6.86	8.65	8.65	8.65	8.65
3.50	0.772	9.05	7.18	9.05	9.05	9.05	9.05
3.75	0.803	9.41	7.46	9.41	9.41	9.41	9.41
4.00	0.830	9.74	7.72	9.74	9.74	9.74	9.74
4.25	0.855	10.03	7.95	10.03	10.03	10.03	10.03
4.50	0.880	10.32	8.18	10.32	10.32	10.32	10.32
4.75	0.901	10.57	8.38	10.57	10.57	10.57	10.57
5.00	0.922	10.81	8.57	10.81	10.81	10.81	10.81
5.25	0.943	11.06	8.77	11.06	11.06	11.06	11.06
5.50	0.963	11.30	8.96	11.30	11.30	11.30	11.30
5.75	0.983	11.53	9.15	11.53	11.53	11.53	11.53
6.00	1.000	11.73	9.30	11.73	11.73	11.73	11.73

(NEH 630, Chapter 21, Figure 21-9)

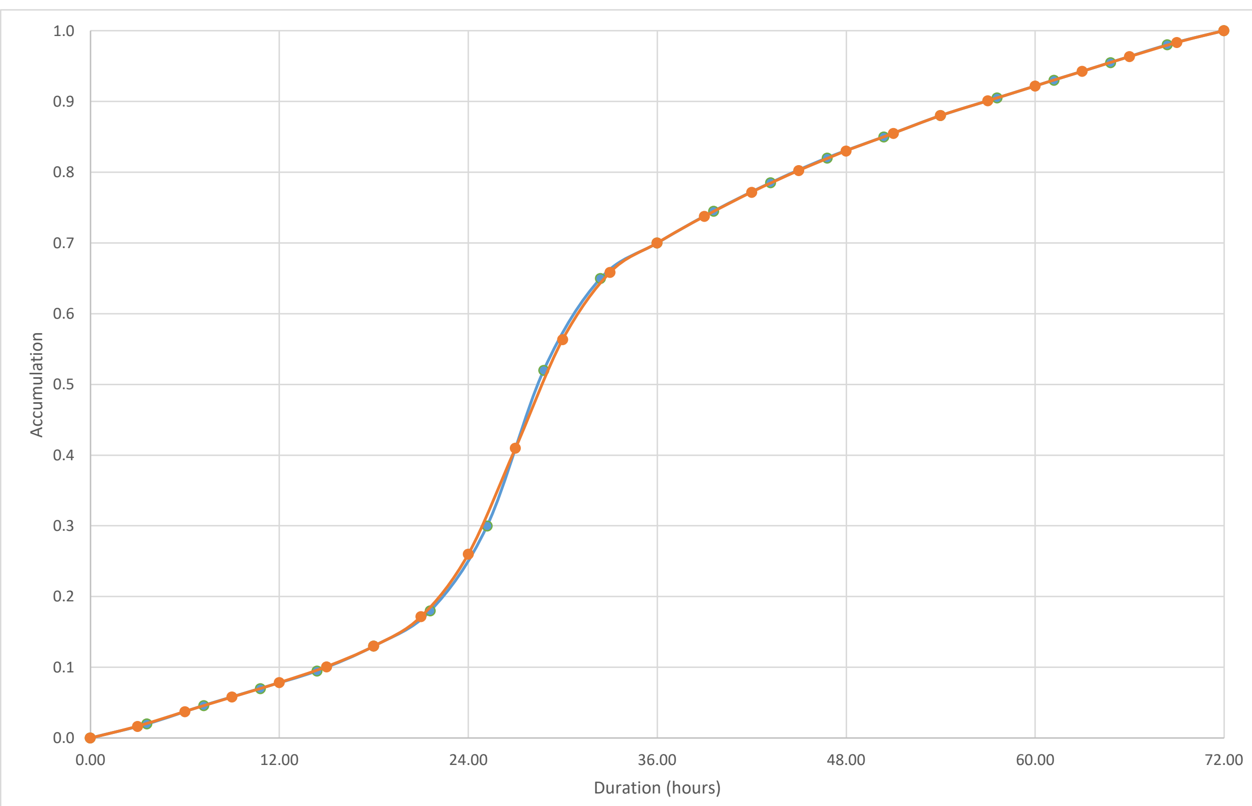


SEP General (72-hr) Hydrograph

Time Step 3 *hrs*
180 *min*

Interval Time, hr	Unit Hydrograph	Dammeron 1 Detention Basin	Dammeron 2 Detention Basin	Dammeron 3 Detention Basin	Diamond 1 Detention Basin	Diamond 2 Detention Basin	Diamond 3 Detention Basin
		P = 14.10 in	P = 14.05 in	P = 14.10 in	P = 14.10 in	P = 14.10 in	P = 14.10 in
0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.00
3.00	0.017	0.24	0.23	0.24	0.24	0.24	0.24
6.00	0.037	0.53	0.52	0.53	0.53	0.53	0.53
9.00	0.058	0.82	0.81	0.82	0.82	0.82	0.82
12.00	0.078	1.10	1.10	1.10	1.10	1.10	1.10
15.00	0.101	1.42	1.42	1.42	1.42	1.42	1.42
18.00	0.130	1.83	1.83	1.83	1.83	1.83	1.83
21.00	0.172	2.42	2.41	2.42	2.42	2.42	2.42
24.00	0.260	3.67	3.65	3.67	3.67	3.67	3.67
27.00	0.410	5.78	5.76	5.78	5.78	5.78	5.78
30.00	0.563	7.94	7.91	7.94	7.94	7.94	7.94
33.00	0.658	9.28	9.25	9.28	9.28	9.28	9.28
36.00	0.700	9.87	9.84	9.87	9.87	9.87	9.87
39.00	0.738	10.40	10.36	10.40	10.40	10.40	10.40
42.00	0.772	10.88	10.84	10.88	10.88	10.88	10.88
45.00	0.803	11.32	11.28	11.32	11.32	11.32	11.32
48.00	0.830	11.70	11.66	11.70	11.70	11.70	11.70
51.00	0.855	12.06	12.01	12.06	12.06	12.06	12.06
54.00	0.880	12.41	12.36	12.41	12.41	12.41	12.41
57.00	0.901	12.70	12.66	12.70	12.70	12.70	12.70
60.00	0.922	13.00	12.95	13.00	13.00	13.00	13.00
63.00	0.943	13.29	13.24	13.29	13.29	13.29	13.29
66.00	0.963	13.58	13.53	13.58	13.58	13.58	13.58
69.00	0.983	13.87	13.82	13.87	13.87	13.87	13.87
72.00	1.000	14.10	14.05	14.10	14.10	14.10	14.10

(NEH 630, Chapter 21, Figure 21-9)



Principal Spillway (10-day) Hydrograph

Time Step *1 hrs*
60 min

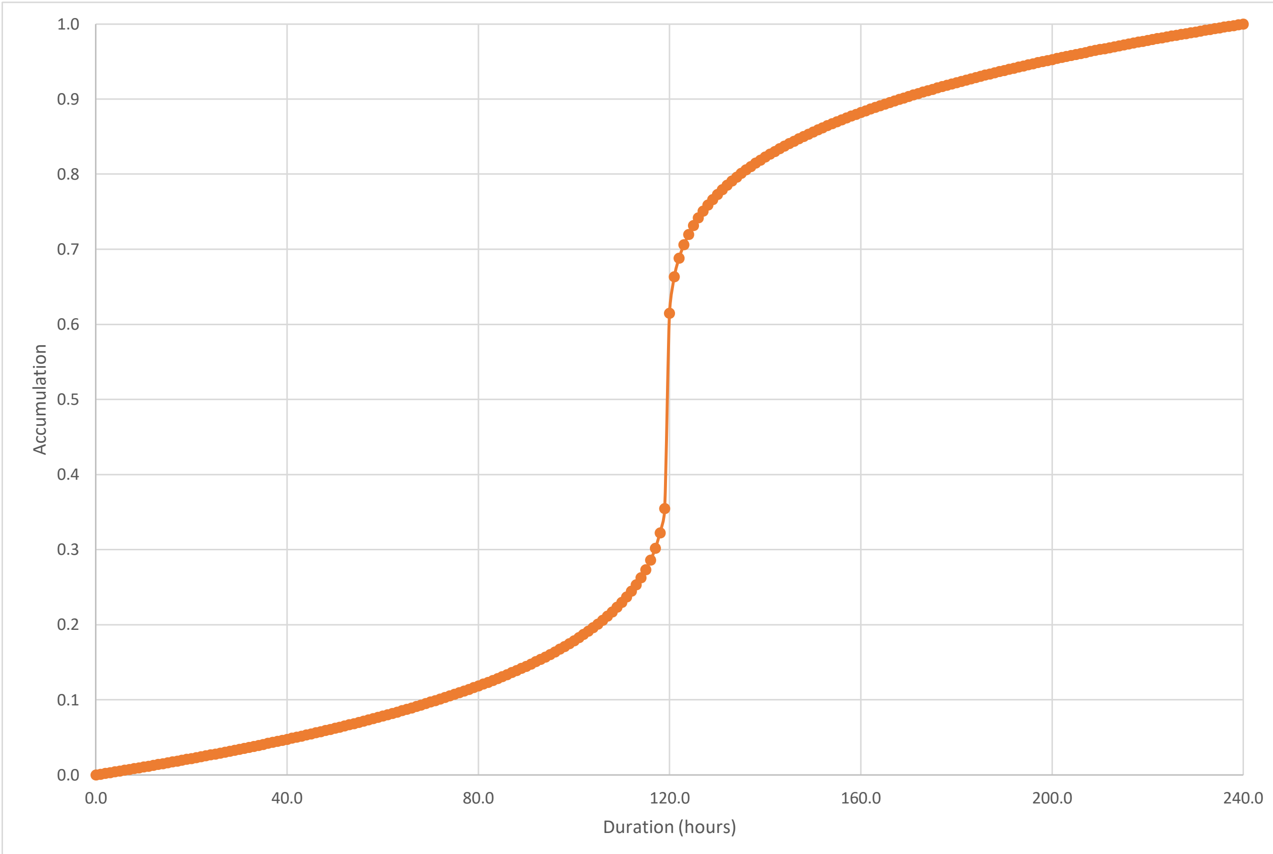
Interval Time, hr	Unit Hydrograph	Dammeron 1 Detention Basin	Dammeron 2 Detention Basin	Dammeron 3 Detention Basin	Diamond 1 Detention Basin	Diamond 2 Detention Basin	Diamond 3 Detention Basin
		P = 6.53 in	**P = 7.15 in**	**P = 6.43 in**	**P = 6.54 in**	**P = 6.78 in**	**P = 6.64 in**
0.0	0.000	0.00	0.00	0.00	0.00	0.00	0.00
1.0	0.001	0.01	0.01	0.01	0.01	0.01	0.01
2.0	0.002	0.01	0.02	0.01	0.01	0.01	0.01
3.0	0.003	0.02	0.02	0.02	0.02	0.02	0.02
4.0	0.004	0.03	0.03	0.03	0.03	0.03	0.03
5.0	0.005	0.03	0.04	0.03	0.03	0.04	0.03
6.0	0.006	0.04	0.05	0.04	0.04	0.04	0.04
7.0	0.007	0.05	0.05	0.05	0.05	0.05	0.05
8.0	0.008	0.05	0.06	0.05	0.05	0.06	0.06
9.0	0.010	0.06	0.07	0.06	0.06	0.06	0.06
10.0	0.011	0.07	0.08	0.07	0.07	0.07	0.07
11.0	0.012	0.08	0.08	0.08	0.08	0.08	0.08
12.0	0.013	0.08	0.09	0.08	0.08	0.09	0.08
13.0	0.014	0.09	0.10	0.09	0.09	0.09	0.09
14.0	0.015	0.10	0.11	0.10	0.10	0.10	0.10
15.0	0.016	0.11	0.12	0.10	0.11	0.11	0.11
16.0	0.017	0.11	0.12	0.11	0.11	0.12	0.11
17.0	0.018	0.12	0.13	0.12	0.12	0.12	0.12
18.0	0.020	0.13	0.14	0.13	0.13	0.13	0.13
19.0	0.021	0.14	0.15	0.13	0.14	0.14	0.14
20.0	0.022	0.14	0.16	0.14	0.14	0.15	0.15
21.0	0.023	0.15	0.17	0.15	0.15	0.16	0.15
22.0	0.024	0.16	0.17	0.16	0.16	0.16	0.16
23.0	0.026	0.17	0.18	0.16	0.17	0.17	0.17
24.0	0.027	0.17	0.19	0.17	0.17	0.18	0.18
25.0	0.028	0.18	0.20	0.18	0.18	0.19	0.19
26.0	0.029	0.19	0.21	0.19	0.19	0.20	0.19
27.0	0.030	0.20	0.22	0.20	0.20	0.21	0.20
28.0	0.032	0.21	0.23	0.20	0.21	0.21	0.21
29.0	0.033	0.21	0.24	0.21	0.22	0.22	0.22
30.0	0.034	0.22	0.24	0.22	0.22	0.23	0.23
31.0	0.035	0.23	0.25	0.23	0.23	0.24	0.24
32.0	0.037	0.24	0.26	0.24	0.24	0.25	0.24
33.0	0.038	0.25	0.27	0.24	0.25	0.26	0.25
34.0	0.039	0.26	0.28	0.25	0.26	0.27	0.26
35.0	0.041	0.27	0.29	0.26	0.27	0.28	0.27
36.0	0.042	0.27	0.30	0.27	0.27	0.28	0.28
37.0	0.043	0.28	0.31	0.28	0.28	0.29	0.29
38.0	0.045	0.29	0.32	0.29	0.29	0.30	0.30
39.0	0.046	0.30	0.33	0.30	0.30	0.31	0.31
40.0	0.048	0.31	0.34	0.31	0.31	0.32	0.32
41.0	0.049	0.32	0.35	0.31	0.32	0.33	0.32
42.0	0.050	0.33	0.36	0.32	0.33	0.34	0.33
43.0	0.052	0.34	0.37	0.33	0.34	0.35	0.34
44.0	0.053	0.35	0.38	0.34	0.35	0.36	0.35
45.0	0.055	0.36	0.39	0.35	0.36	0.37	0.36
46.0	0.056	0.37	0.40	0.36	0.37	0.38	0.37
47.0	0.058	0.38	0.41	0.37	0.38	0.39	0.38
48.0	0.059	0.39	0.42	0.38	0.39	0.40	0.39
49.0	0.061	0.40	0.43	0.39	0.40	0.41	0.40
50.0	0.062	0.41	0.44	0.40	0.41	0.42	0.41
51.0	0.064	0.42	0.46	0.41	0.42	0.43	0.42
52.0	0.065	0.43	0.47	0.42	0.43	0.44	0.43
53.0	0.067	0.44	0.48	0.43	0.44	0.45	0.44
54.0	0.068	0.45	0.49	0.44	0.45	0.46	0.45

55.0	0.070	0.46	0.50	0.45	0.46	0.47	0.46
56.0	0.072	0.47	0.51	0.46	0.47	0.49	0.48
57.0	0.073	0.48	0.52	0.47	0.48	0.50	0.49
58.0	0.075	0.49	0.54	0.48	0.49	0.51	0.50
59.0	0.077	0.50	0.55	0.49	0.50	0.52	0.51
60.0	0.078	0.51	0.56	0.50	0.51	0.53	0.52
61.0	0.080	0.52	0.57	0.52	0.52	0.54	0.53
62.0	0.082	0.53	0.59	0.53	0.54	0.56	0.54
63.0	0.084	0.55	0.60	0.54	0.55	0.57	0.56
64.0	0.086	0.56	0.61	0.55	0.56	0.58	0.57
65.0	0.087	0.57	0.62	0.56	0.57	0.59	0.58
66.0	0.089	0.58	0.64	0.57	0.58	0.60	0.59
67.0	0.091	0.59	0.65	0.59	0.60	0.62	0.60
68.0	0.093	0.61	0.67	0.60	0.61	0.63	0.62
69.0	0.095	0.62	0.68	0.61	0.62	0.64	0.63
70.0	0.097	0.63	0.69	0.62	0.63	0.66	0.64
71.0	0.099	0.65	0.71	0.64	0.65	0.67	0.66
72.0	0.101	0.66	0.72	0.65	0.66	0.68	0.67
73.0	0.103	0.67	0.74	0.66	0.67	0.70	0.68
74.0	0.105	0.69	0.75	0.68	0.69	0.71	0.70
75.0	0.107	0.70	0.77	0.69	0.70	0.73	0.71
76.0	0.110	0.72	0.78	0.70	0.72	0.74	0.73
77.0	0.112	0.73	0.80	0.72	0.73	0.76	0.74
78.0	0.114	0.74	0.81	0.73	0.74	0.77	0.76
79.0	0.116	0.76	0.83	0.75	0.76	0.79	0.77
80.0	0.119	0.77	0.85	0.76	0.78	0.80	0.79
81.0	0.121	0.79	0.86	0.78	0.79	0.82	0.80
82.0	0.123	0.81	0.88	0.79	0.81	0.84	0.82
83.0	0.126	0.82	0.90	0.81	0.82	0.85	0.84
84.0	0.128	0.84	0.92	0.83	0.84	0.87	0.85
85.0	0.131	0.85	0.94	0.84	0.86	0.89	0.87
86.0	0.134	0.87	0.96	0.86	0.87	0.91	0.89
87.0	0.136	0.89	0.97	0.88	0.89	0.92	0.91
88.0	0.139	0.91	0.99	0.89	0.91	0.94	0.92
89.0	0.142	0.93	1.01	0.91	0.93	0.96	0.94
90.0	0.145	0.94	1.03	0.93	0.95	0.98	0.96
91.0	0.148	0.96	1.06	0.95	0.97	1.00	0.98
92.0	0.151	0.98	1.08	0.97	0.99	1.02	1.00
93.0	0.154	1.00	1.10	0.99	1.01	1.04	1.02
94.0	0.157	1.03	1.12	1.01	1.03	1.07	1.04
95.0	0.160	1.05	1.15	1.03	1.05	1.09	1.07
96.0	0.164	1.07	1.17	1.05	1.07	1.11	1.09
97.0	0.167	1.09	1.20	1.08	1.09	1.13	1.11
98.0	0.171	1.12	1.22	1.10	1.12	1.16	1.14
99.0	0.175	1.14	1.25	1.12	1.14	1.19	1.16
100.0	0.179	1.17	1.28	1.15	1.17	1.21	1.19
101.0	0.183	1.19	1.31	1.18	1.20	1.24	1.21
102.0	0.187	1.22	1.34	1.20	1.22	1.27	1.24
103.0	0.191	1.25	1.37	1.23	1.25	1.30	1.27
104.0	0.196	1.28	1.40	1.26	1.28	1.33	1.30
105.0	0.201	1.31	1.44	1.29	1.31	1.36	1.33
106.0	0.206	1.35	1.47	1.32	1.35	1.40	1.37
107.0	0.211	1.38	1.51	1.36	1.38	1.43	1.40
108.0	0.217	1.42	1.55	1.40	1.42	1.47	1.44
109.0	0.223	1.46	1.60	1.44	1.46	1.51	1.48
110.0	0.230	1.50	1.64	1.48	1.50	1.56	1.53
111.0	0.237	1.55	1.69	1.52	1.55	1.61	1.57
112.0	0.245	1.60	1.75	1.57	1.60	1.66	1.62
113.0	0.253	1.65	1.81	1.63	1.66	1.72	1.68
114.0	0.263	1.71	1.88	1.69	1.72	1.78	1.74
115.0	0.274	1.79	1.96	1.76	1.79	1.85	1.82
116.0	0.286	1.87	2.05	1.84	1.87	1.94	1.90
117.0	0.302	1.97	2.16	1.94	1.97	2.05	2.00

118.0	0.322	2.11	2.31	2.07	2.11	2.19	2.14
119.0	0.355	2.32	2.54	2.28	2.32	2.40	2.36
120.0	0.615	4.02	4.40	3.95	4.02	4.17	4.08
121.0	0.663	4.33	4.74	4.27	4.34	4.50	4.40
122.0	0.688	4.49	4.92	4.43	4.50	4.67	4.57
123.0	0.706	4.61	5.05	4.54	4.62	4.79	4.69
124.0	0.720	4.70	5.15	4.63	4.71	4.88	4.78
125.0	0.732	4.78	5.23	4.70	4.78	4.96	4.86
126.0	0.742	4.84	5.30	4.77	4.85	5.03	4.93
127.0	0.751	4.90	5.37	4.83	4.91	5.09	4.99
128.0	0.759	4.95	5.43	4.88	4.96	5.14	5.04
129.0	0.766	5.00	5.48	4.93	5.01	5.19	5.09
130.0	0.773	5.05	5.53	4.97	5.06	5.24	5.13
131.0	0.779	5.09	5.57	5.01	5.10	5.28	5.17
132.0	0.785	5.13	5.61	5.05	5.14	5.32	5.21
133.0	0.791	5.16	5.65	5.08	5.17	5.36	5.25
134.0	0.796	5.20	5.69	5.12	5.21	5.40	5.29
135.0	0.801	5.23	5.73	5.15	5.24	5.43	5.32
136.0	0.806	5.26	5.76	5.18	5.27	5.46	5.35
137.0	0.810	5.29	5.79	5.21	5.30	5.49	5.38
138.0	0.815	5.32	5.82	5.24	5.33	5.52	5.41
139.0	0.819	5.35	5.85	5.26	5.35	5.55	5.44
140.0	0.823	5.37	5.88	5.29	5.38	5.58	5.46
141.0	0.827	5.40	5.91	5.32	5.41	5.60	5.49
142.0	0.830	5.42	5.94	5.34	5.43	5.63	5.51
143.0	0.834	5.45	5.96	5.36	5.45	5.65	5.54
144.0	0.837	5.47	5.99	5.38	5.48	5.68	5.56
145.0	0.841	5.49	6.01	5.41	5.50	5.70	5.58
146.0	0.844	5.51	6.03	5.43	5.52	5.72	5.60
147.0	0.847	5.53	6.06	5.45	5.54	5.74	5.63
148.0	0.850	5.55	6.08	5.47	5.56	5.77	5.65
149.0	0.853	5.57	6.10	5.49	5.58	5.79	5.67
150.0	0.856	5.59	6.12	5.51	5.60	5.81	5.69
151.0	0.859	5.61	6.14	5.52	5.62	5.82	5.70
152.0	0.862	5.63	6.16	5.54	5.64	5.84	5.72
153.0	0.865	5.65	6.18	5.56	5.65	5.86	5.74
154.0	0.867	5.66	6.20	5.58	5.67	5.88	5.76
155.0	0.870	5.68	6.22	5.59	5.69	5.90	5.78
156.0	0.872	5.70	6.24	5.61	5.71	5.91	5.79
157.0	0.875	5.71	6.26	5.63	5.72	5.93	5.81
158.0	0.877	5.73	6.27	5.64	5.74	5.95	5.83
159.0	0.880	5.74	6.29	5.66	5.75	5.96	5.84
160.0	0.882	5.76	6.31	5.67	5.77	5.98	5.86
161.0	0.884	5.78	6.32	5.69	5.78	6.00	5.87
162.0	0.887	5.79	6.34	5.70	5.80	6.01	5.89
163.0	0.889	5.80	6.36	5.72	5.81	6.03	5.90
164.0	0.891	5.82	6.37	5.73	5.83	6.04	5.92
165.0	0.893	5.83	6.39	5.74	5.84	6.06	5.93
166.0	0.895	5.85	6.40	5.76	5.86	6.07	5.95
167.0	0.898	5.86	6.42	5.77	5.87	6.09	5.96
168.0	0.900	5.87	6.43	5.78	5.88	6.10	5.97
169.0	0.902	5.89	6.45	5.80	5.90	6.11	5.99
170.0	0.904	5.90	6.46	5.81	5.91	6.13	6.00
171.0	0.906	5.91	6.47	5.82	5.92	6.14	6.01
172.0	0.907	5.93	6.49	5.83	5.93	6.15	6.03
173.0	0.909	5.94	6.50	5.85	5.95	6.17	6.04
174.0	0.911	5.95	6.52	5.86	5.96	6.18	6.05
175.0	0.913	5.96	6.53	5.87	5.97	6.19	6.06
176.0	0.915	5.97	6.54	5.88	5.98	6.20	6.07
177.0	0.917	5.99	6.55	5.89	6.00	6.22	6.09
178.0	0.918	6.00	6.57	5.91	6.01	6.23	6.10
179.0	0.920	6.01	6.58	5.92	6.02	6.24	6.11
180.0	0.922	6.02	6.59	5.93	6.03	6.25	6.12

181.0	0.924	6.03	6.60	5.94	6.04	6.26	6.13
182.0	0.925	6.04	6.62	5.95	6.05	6.27	6.14
183.0	0.927	6.05	6.63	5.96	6.06	6.29	6.16
184.0	0.929	6.06	6.64	5.97	6.07	6.30	6.17
185.0	0.930	6.07	6.65	5.98	6.08	6.31	6.18
186.0	0.932	6.09	6.66	5.99	6.09	6.32	6.19
187.0	0.934	6.10	6.67	6.00	6.11	6.33	6.20
188.0	0.935	6.11	6.69	6.01	6.11	6.34	6.21
189.0	0.937	6.12	6.70	6.02	6.13	6.35	6.22
190.0	0.938	6.13	6.71	6.03	6.14	6.36	6.23
191.0	0.940	6.14	6.72	6.04	6.15	6.37	6.24
192.0	0.941	6.15	6.73	6.05	6.16	6.38	6.25
193.0	0.943	6.16	6.74	6.06	6.17	6.39	6.26
194.0	0.944	6.16	6.75	6.07	6.17	6.40	6.27
195.0	0.946	6.17	6.76	6.08	6.18	6.41	6.28
196.0	0.947	6.18	6.77	6.09	6.19	6.42	6.29
197.0	0.949	6.19	6.78	6.10	6.20	6.43	6.30
198.0	0.950	6.20	6.79	6.11	6.21	6.44	6.31
199.0	0.951	6.21	6.80	6.12	6.22	6.45	6.32
200.0	0.953	6.22	6.81	6.13	6.23	6.46	6.33
201.0	0.954	6.23	6.82	6.13	6.24	6.47	6.34
202.0	0.955	6.24	6.83	6.14	6.25	6.48	6.34
203.0	0.957	6.25	6.84	6.15	6.26	6.49	6.35
204.0	0.958	6.26	6.85	6.16	6.27	6.50	6.36
205.0	0.960	6.27	6.86	6.17	6.28	6.51	6.37
206.0	0.961	6.27	6.87	6.18	6.28	6.51	6.38
207.0	0.962	6.28	6.88	6.19	6.29	6.52	6.39
208.0	0.963	6.29	6.89	6.19	6.30	6.53	6.40
209.0	0.965	6.30	6.90	6.20	6.31	6.54	6.41
210.0	0.966	6.31	6.91	6.21	6.32	6.55	6.41
211.0	0.967	6.32	6.92	6.22	6.33	6.56	6.42
212.0	0.969	6.32	6.92	6.23	6.33	6.57	6.43
213.0	0.970	6.33	6.93	6.24	6.34	6.57	6.44
214.0	0.971	6.34	6.94	6.24	6.35	6.58	6.45
215.0	0.972	6.35	6.95	6.25	6.36	6.59	6.46
216.0	0.973	6.36	6.96	6.26	6.37	6.60	6.46
217.0	0.975	6.36	6.97	6.27	6.37	6.61	6.47
218.0	0.976	6.37	6.98	6.27	6.38	6.62	6.48
219.0	0.977	6.38	6.99	6.28	6.39	6.62	6.49
220.0	0.978	6.39	6.99	6.29	6.40	6.63	6.49
221.0	0.979	6.39	7.00	6.30	6.40	6.64	6.50
222.0	0.981	6.40	7.01	6.30	6.41	6.65	6.51
223.0	0.982	6.41	7.02	6.31	6.42	6.66	6.52
224.0	0.983	6.42	7.03	6.32	6.43	6.66	6.53
225.0	0.984	6.42	7.03	6.33	6.43	6.67	6.53
226.0	0.985	6.43	7.04	6.33	6.44	6.68	6.54
227.0	0.986	6.44	7.05	6.34	6.45	6.69	6.55
228.0	0.987	6.45	7.06	6.35	6.46	6.69	6.56
229.0	0.988	6.45	7.07	6.36	6.46	6.70	6.56
230.0	0.989	6.46	7.07	6.36	6.47	6.71	6.57
231.0	0.991	6.47	7.08	6.37	6.48	6.72	6.58
232.0	0.992	6.48	7.09	6.38	6.49	6.72	6.58
233.0	0.993	6.48	7.10	6.38	6.49	6.73	6.59
234.0	0.994	6.49	7.11	6.39	6.50	6.74	6.60
235.0	0.995	6.50	7.11	6.40	6.51	6.74	6.61
236.0	0.996	6.50	7.12	6.40	6.51	6.75	6.61
237.0	0.997	6.51	7.13	6.41	6.52	6.76	6.62
238.0	0.998	6.52	7.13	6.42	6.53	6.77	6.63
239.0	0.999	6.52	7.14	6.42	6.53	6.77	6.63
240.0	1.000	6.53	7.15	6.43	6.54	6.78	6.64

* SITES Output

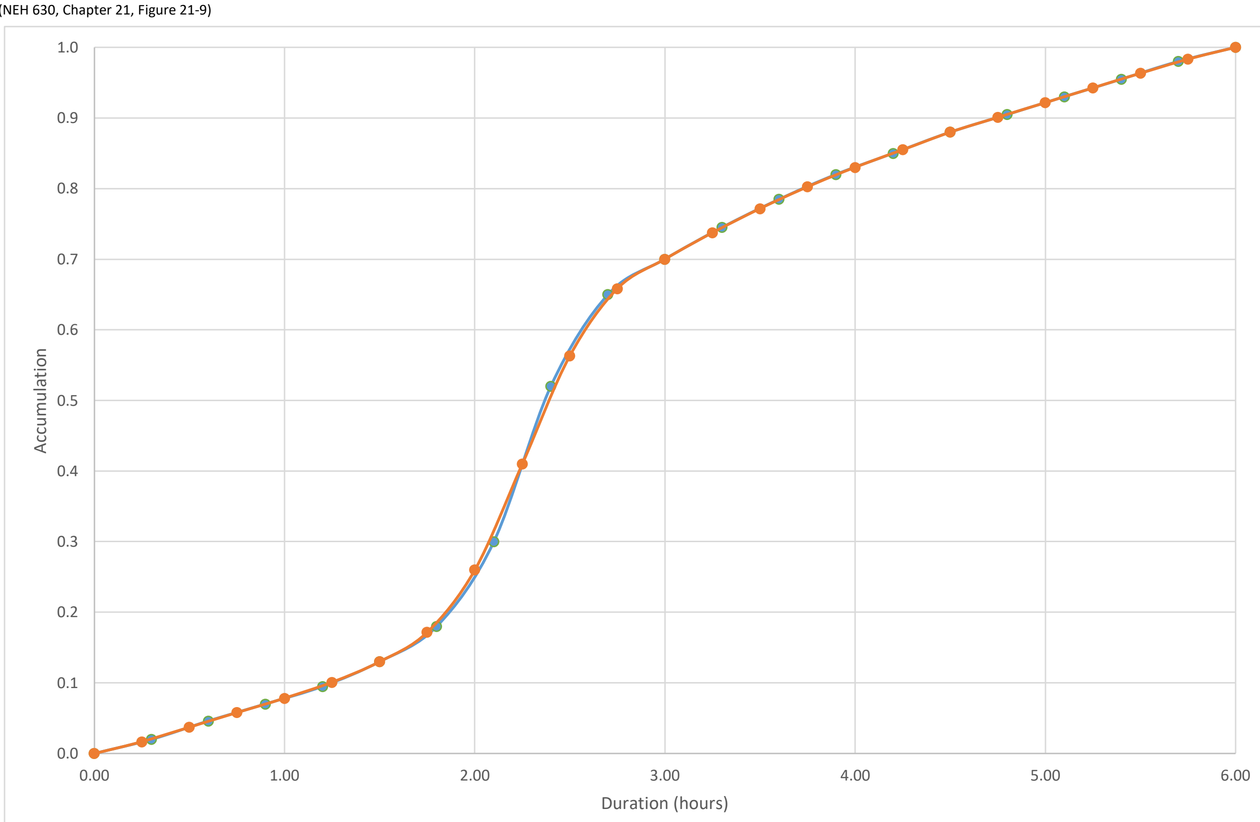

1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Accumulation
0.0
40.0
80.0
120.0
160.0
200.0
240.0
Duration (hours)

Auxiliary Spillway Local (6-hr) Hydrograph

Time Step *0.25 hrs*
15 min

Interval Time, hr	Unit Hydrograph	Dammeron 1 Detention Basin	Dammeron 2 Detention Basin	Dammeron 3 Detention Basin	Diamond 1 Detention Basin	Diamond 2 Detention Basin	Diamond 3 Detention Basin
		P = 4.91 in	P = 4.37 in	P = 4.90 in	P = 4.91 in	P = 4.94 in	P = 4.91 in
0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.00
0.25	0.017	0.08	0.07	0.08	0.08	0.08	0.08
0.50	0.037	0.18	0.16	0.18	0.18	0.18	0.18
0.75	0.058	0.28	0.25	0.28	0.28	0.29	0.28
1.00	0.078	0.38	0.34	0.38	0.38	0.39	0.38
1.25	0.101	0.50	0.44	0.49	0.50	0.50	0.50
1.50	0.130	0.64	0.57	0.64	0.64	0.64	0.64
1.75	0.172	0.84	0.75	0.84	0.84	0.85	0.84
2.00	0.260	1.28	1.14	1.27	1.28	1.28	1.28
2.25	0.410	2.01	1.79	2.01	2.01	2.03	2.01
2.50	0.563	2.77	2.46	2.76	2.77	2.78	2.77
2.75	0.658	3.23	2.88	3.23	3.23	3.25	3.23
3.00	0.700	3.44	3.06	3.43	3.44	3.46	3.44
3.25	0.738	3.62	3.22	3.61	3.62	3.64	3.62
3.50	0.772	3.79	3.37	3.78	3.79	3.81	3.79
3.75	0.803	3.94	3.51	3.93	3.94	3.96	3.94
4.00	0.830	4.08	3.63	4.07	4.08	4.10	4.08
4.25	0.855	4.20	3.74	4.19	4.20	4.22	4.20
4.50	0.880	4.32	3.85	4.31	4.32	4.35	4.32
4.75	0.901	4.42	3.94	4.41	4.42	4.45	4.42
5.00	0.922	4.53	4.03	4.52	4.53	4.55	4.53
5.25	0.943	4.63	4.12	4.62	4.63	4.66	4.63
5.50	0.963	4.73	4.21	4.72	4.73	4.76	4.73
5.75	0.983	4.83	4.30	4.82	4.83	4.86	4.83
6.00	1.000	4.91	4.37	4.90	4.91	4.94	4.91

(NEH 630, Chapter 21, Figure 21-9)

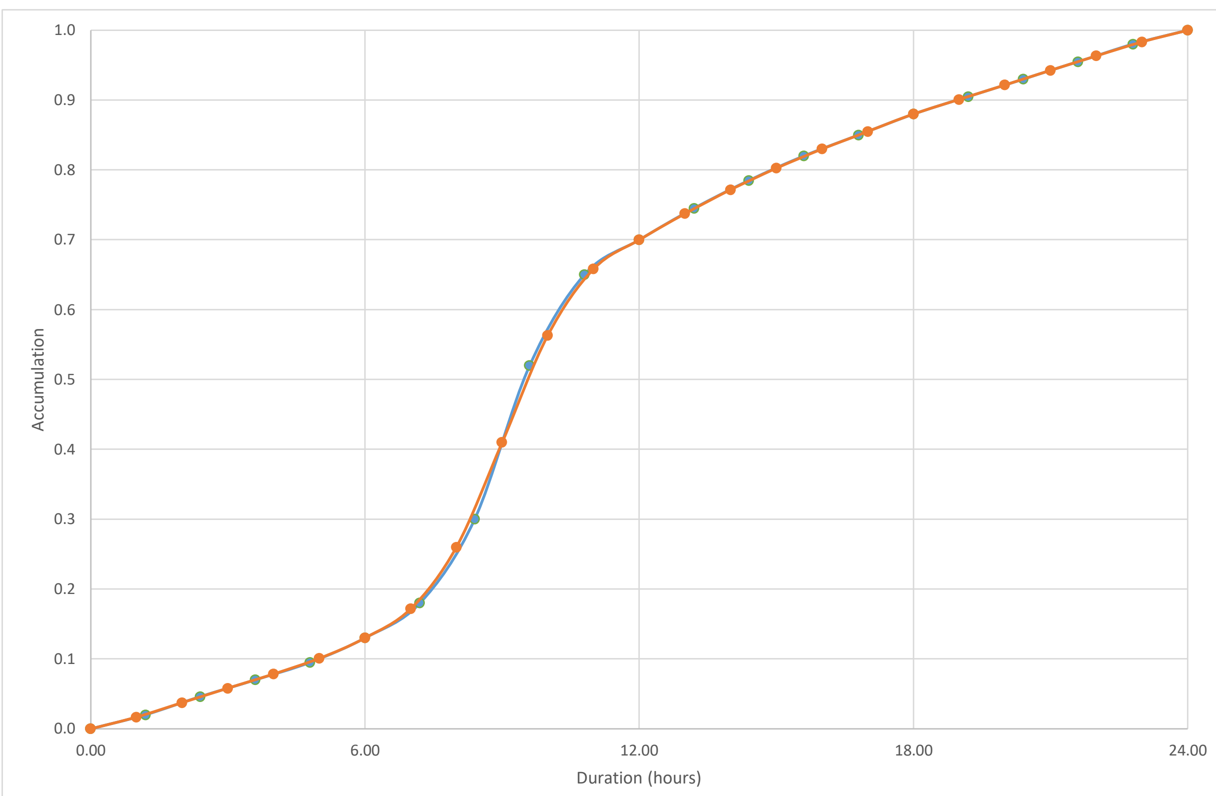


Auxiliary Spillway General (24-hr) Hydrograph

Time Step *1 hrs*
60 min

Interval Time, hr	Unit Hydrograph	Dammeron 1 Detention Basin	Dammeron 2 Detention Basin	Dammeron 3 Detention Basin	Diamond 1 Detention Basin	Diamond 2 Detention Basin	Diamond 3 Detention Basin
		P = 5.73 in	**P = 5.84 in**	**P = 5.71 in**	**P = 5.72 in**	**P = 5.80 in**	**P = 5.74 in**
0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.00
1.00	0.017	0.10	0.10	0.10	0.10	0.10	0.10
2.00	0.037	0.21	0.22	0.21	0.21	0.22	0.21
3.00	0.058	0.33	0.34	0.33	0.33	0.34	0.33
4.00	0.078	0.45	0.46	0.45	0.45	0.45	0.45
5.00	0.101	0.58	0.59	0.58	0.58	0.58	0.58
6.00	0.130	0.74	0.76	0.74	0.74	0.75	0.75
7.00	0.172	0.98	1.00	0.98	0.98	1.00	0.99
8.00	0.260	1.49	1.52	1.48	1.49	1.51	1.49
9.00	0.410	2.35	2.39	2.34	2.35	2.38	2.35
10.00	0.563	3.23	3.29	3.22	3.22	3.27	3.23
11.00	0.658	3.77	3.84	3.76	3.77	3.82	3.78
12.00	0.700	4.01	4.09	4.00	4.00	4.06	4.02
13.00	0.738	4.23	4.31	4.21	4.22	4.28	4.23
14.00	0.772	4.42	4.51	4.41	4.41	4.48	4.43
15.00	0.803	4.60	4.69	4.58	4.59	4.65	4.61
16.00	0.830	4.76	4.85	4.74	4.75	4.81	4.76
17.00	0.855	4.90	4.99	4.88	4.89	4.96	4.91
18.00	0.880	5.04	5.14	5.02	5.03	5.10	5.05
19.00	0.901	5.16	5.26	5.14	5.15	5.22	5.17
20.00	0.922	5.28	5.38	5.26	5.27	5.35	5.29
21.00	0.943	5.40	5.50	5.38	5.39	5.47	5.41
22.00	0.963	5.52	5.63	5.50	5.51	5.59	5.53
23.00	0.983	5.63	5.74	5.61	5.62	5.70	5.64
24.00	1.000	5.73	5.84	5.71	5.72	5.80	5.74

(NEH 630, Chapter 21, Figure 21-9)

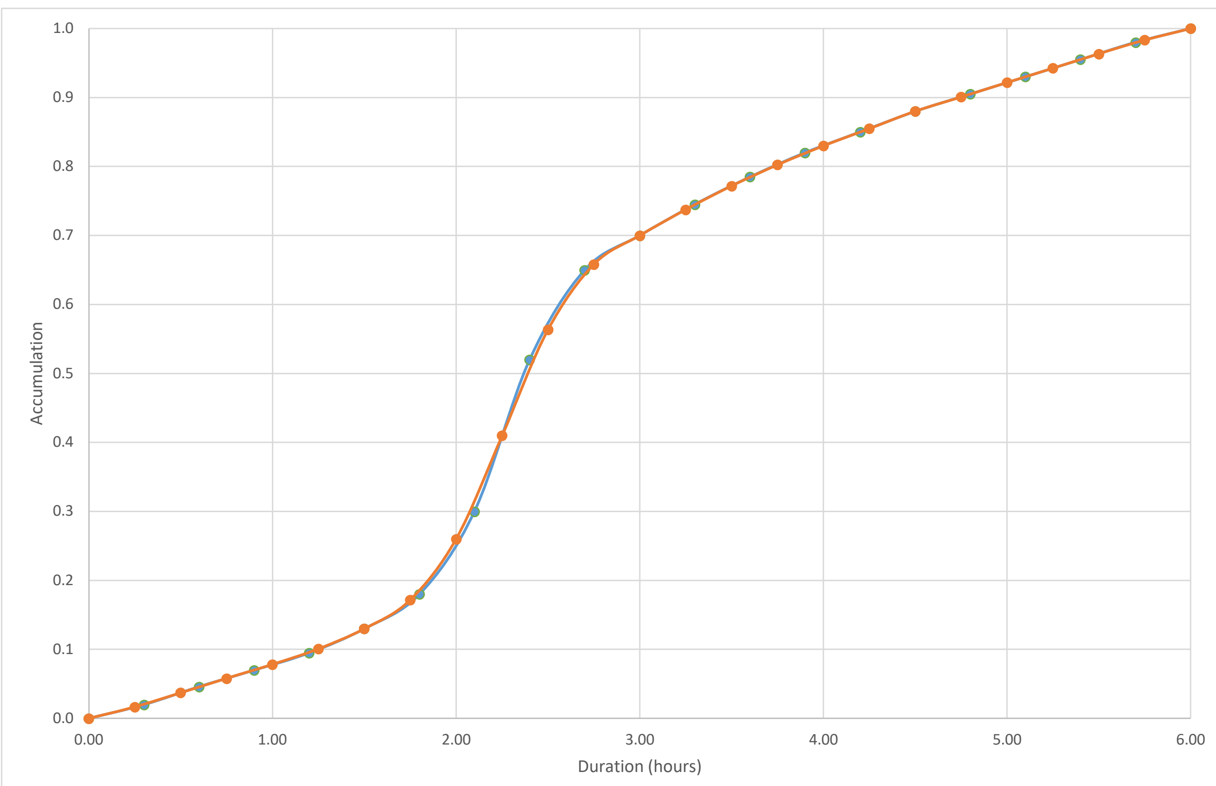


__**Freeboard Local (6-hr) Hydrograph**__

Time Step *0.25 hrs*
15 min

Interval Time, hr	Unit Hydrograph	Dammeron 1 Detention Basin	Dammeron 2 Detention Basin	Dammeron 3 Detention Basin	Diamond 1 Detention Basin	Diamond 2 Detention Basin	Diamond 3 Detention Basin
		P = 11.73 in	**P = 9.30 in**	**P = 11.73 in**	**P = 11.73 in**	**P = 11.73 in**	**P = 11.73 in**
0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.00
0.25	0.017	0.20	0.16	0.20	0.20	0.20	0.20
0.50	0.037	0.44	0.35	0.44	0.44	0.44	0.44
0.75	0.058	0.68	0.54	0.68	0.68	0.68	0.68
1.00	0.078	0.92	0.73	0.92	0.92	0.92	0.92
1.25	0.101	1.18	0.94	1.18	1.18	1.18	1.18
1.50	0.130	1.52	1.21	1.52	1.52	1.52	1.52
1.75	0.172	2.01	1.60	2.01	2.01	2.01	2.01
2.00	0.260	3.05	2.42	3.05	3.05	3.05	3.05
2.25	0.410	4.81	3.81	4.81	4.81	4.81	4.81
2.50	0.563	6.61	5.24	6.61	6.61	6.61	6.61
2.75	0.658	7.72	6.12	7.72	7.72	7.72	7.72
3.00	0.700	8.21	6.51	8.21	8.21	8.21	8.21
3.25	0.738	8.65	6.86	8.65	8.65	8.65	8.65
3.50	0.772	9.05	7.18	9.05	9.05	9.05	9.05
3.75	0.803	9.41	7.46	9.41	9.41	9.41	9.41
4.00	0.830	9.74	7.72	9.74	9.74	9.74	9.74
4.25	0.855	10.03	7.95	10.03	10.03	10.03	10.03
4.50	0.880	10.32	8.18	10.32	10.32	10.32	10.32
4.75	0.901	10.57	8.38	10.57	10.57	10.57	10.57
5.00	0.922	10.81	8.57	10.81	10.81	10.81	10.81
5.25	0.943	11.06	8.77	11.06	11.06	11.06	11.06
5.50	0.963	11.30	8.96	11.30	11.30	11.30	11.30
5.75	0.983	11.53	9.15	11.53	11.53	11.53	11.53
6.00	1.000	11.73	9.30	11.73	11.73	11.73	11.73

(NEH 630, Chapter 21, Figure 21-9)

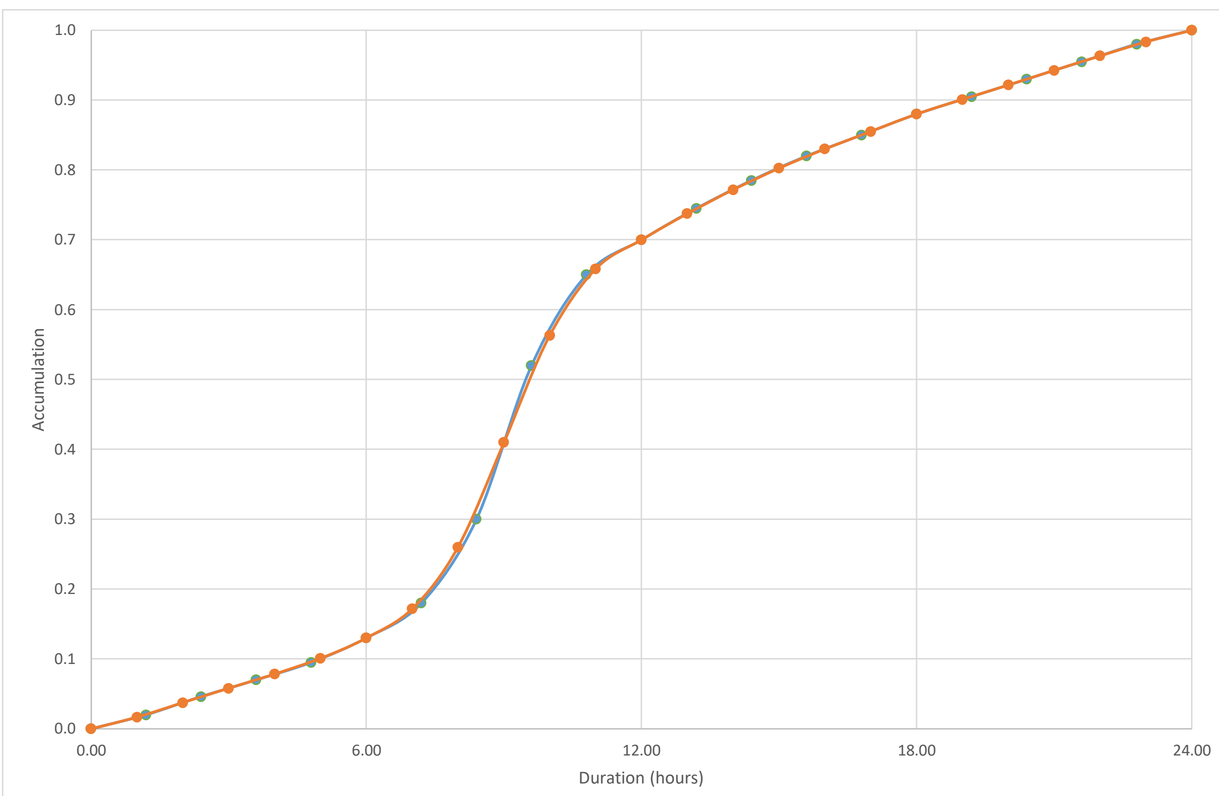


Freeboard General (24-hr) Hydrograph

Time Step *1 hrs*
60 min

Interval Time, hr	Unit Hydrograph	Dammeron 1 Detention Basin	Dammeron 2 Detention Basin	Dammeron 3 Detention Basin	Diamond 1 Detention Basin	Diamond 2 Detention Basin	Diamond 3 Detention Basin
		P = 14.10 in	**P = 14.05 in**	**P = 14.10 in**	**P = 14.10 in**	**P = 14.10 in**	**P = 14.10 in**
0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.00
1.00	0.017	0.24	0.23	0.24	0.24	0.24	0.24
2.00	0.037	0.53	0.52	0.53	0.53	0.53	0.53
3.00	0.058	0.82	0.81	0.82	0.82	0.82	0.82
4.00	0.078	1.10	1.10	1.10	1.10	1.10	1.10
5.00	0.101	1.42	1.42	1.42	1.42	1.42	1.42
6.00	0.130	1.83	1.83	1.83	1.83	1.83	1.83
7.00	0.172	2.42	2.41	2.42	2.42	2.42	2.42
8.00	0.260	3.67	3.65	3.67	3.67	3.67	3.67
9.00	0.410	5.78	5.76	5.78	5.78	5.78	5.78
10.00	0.563	7.94	7.91	7.94	7.94	7.94	7.94
11.00	0.658	9.28	9.25	9.28	9.28	9.28	9.28
12.00	0.700	9.87	9.84	9.87	9.87	9.87	9.87
13.00	0.738	10.40	10.36	10.40	10.40	10.40	10.40
14.00	0.772	10.88	10.84	10.88	10.88	10.88	10.88
15.00	0.803	11.32	11.28	11.32	11.32	11.32	11.32
16.00	0.830	11.70	11.66	11.70	11.70	11.70	11.70
17.00	0.855	12.06	12.01	12.06	12.06	12.06	12.06
18.00	0.880	12.41	12.36	12.41	12.41	12.41	12.41
19.00	0.901	12.70	12.66	12.70	12.70	12.70	12.70
20.00	0.922	13.00	12.95	13.00	13.00	13.00	13.00
21.00	0.943	13.29	13.24	13.29	13.29	13.29	13.29
22.00	0.963	13.58	13.53	13.58	13.58	13.58	13.58
23.00	0.983	13.87	13.82	13.87	13.87	13.87	13.87
24.00	1.000	14.10	14.05	14.10	14.10	14.10	14.10

(NEH 630, Chapter 21, Figure 21-9)



Section 3. Precipitation Values

Precipitation Value - 100-yr Hydrographs (Storm Events 01 through 03)

Description: The NOAA Precipitation Value is taken from the NOAA Precipitation Frequency Data Server (PFDS). The precipitation value for entire the basin area is taken by using the PFDS value at the drainage basin centroid.

NOAA

100-year Point Precipitation Value

	6-hour	24-hour	72-hour	10-day
Dammeron 1 Detention Basin	2.51	2.79	3.63	6.53
Dammeron 2 Detention Basin	2.64	2.95	3.83	7.15
Dammeron 3 Detention Basin	2.50	2.76	3.58	6.43
Dammeron 4 Channel	2.55	2.87	3.73	6.69
Diamond 1 Detention Basin	2.51	2.78	3.62	6.54
Diamond 2 Detention Basin	2.55	2.88	3.75	6.78
Diamond 3 Detention Basin	2.52	2.80	3.66	6.64
Diamond 4 Channel	2.74	3.11	4.07	7.66

Precipitation Value - Local SEP Hydrograph (Storm Event 04)

Description: The Local SEP Value is the Probable Maximum Precipitation to occur ever for a period of 6 hours. It involves evaluation of the average PMP and the areal distribution of the PMP within the drainage area using methods outlined in HMR 49. Donald T. Jensen with Utah State University was commissioned to provide an update to HMR 49 resulting in the *Probable Maximum Precipitation Estimates for Short-Duration, Small-Area Storms in Utah* . The study uses the 1-hour Point PMP Value for 1 mi^2, taken from HMR 49, and applies updated reduction factors for elevation, duration, and area to adjust the value to match the characteristics of the drainage basin.

Local SEP Initial Precipitation Value (1-hr, 1-mi^2):

10.2 in (Fig. 4.5. *HMR 49* , 1984)

Duration and Areal Variation:

Duration: 6 hrs

Dam	Area	Depth-Area-Duration Value[1]	Local SEP Value
Dammeron 1 Detention Basin	0.3 sq-mi	115.0%	11.73 in
Dammeron 2 Detention Basin	3.6 sq-mi	91.2%	9.30 in
Dammeron 3 Detention Basin	0.7 sq-mi	115.0%	11.73 in
Diamond 1 Detention Basin	0.9 sq-mi	115.0%	11.73 in
Diamond 2 Detention Basin	0.9 sq-mi	115.0%	11.73 in
Diamond 3 Detention Basin	0.6 sq-mi	115.0%	11.73 in

[1] Table 15. *Probable Maximum Precipitation for Short-Duration, Short-Area Storms in Utah* , Jensen. 1995, 2002

Precipitation Value - General SEP Hydrograph (Storm Event 05)

Description

The General SEP Value is the Probable Maximum Precipitation to occur ever for a period of 72 hours. It involves evaluation of the Convergance PMP (precipitation resulting from atmospheric processes not affected by terrain) and the Orographic PMP (precipitation resulting from atmospheric processes affected by terrain) using methods outlined in HMR 49. Convergance and orographic precipitation can occur simultaneously. Donald T. Jensen with Utah State University was commissioned to provide an update to HMR 49 resulting in the *2002 Update for Probable Maximum Precipitation, Utah, 72-Hour Estimates, Areas to 5,000 mi^2*. The study updates the 72-hour Point PMP Value for 10 mi^2, as shown in Figure 1 of the said study, from which the SEP value is calculated. This point value includes adjustments from barrier and elevation variations and the orographic component. An area reduction factor is applied to adjust the value to match the size of the drainage basin.

General SEP

Point PMP 72-hr Precipitation Value:

14.1 in

(Fig. 1. *2002 Update for Probably Maximum Precipitation, Utah, 72-Hour Estimates, Areas to 5,000 mi^2*, Jensen. 2003)

Areal Variation

Dam	Area	Depth-Area Value[1]	General SEP Value
Dammeron 1 Detention Basin	0.3 sq-mi	100.0%	14.10 in
Dammeron 2 Detention Basin	3.6 sq-mi	99.6%	14.05 in
Dammeron 3 Detention Basin	0.7 sq-mi	100.0%	14.10 in
Diamond 1 Detention Basin	0.9 sq-mi	100.0%	14.10 in
Diamond 2 Detention Basin	0.9 sq-mi	100.0%	14.10 in
Diamond 3 Detention Basin	0.6 sq-mi	100.0%	14.10 in

[1] Table 1. 2002 Update for Probably Maximum Precipitation, Utah, 72-Hour Estimates, Areas to 5,000 mi2, Jensen. 2003

Precipitation Value - Principal Spillway Hydrographs (Storm Event 06)

Description The PSH Storm Event is the precipitation event used to design the principal spillway as determined by the equations set forth in TR-60, Table Figure 2-1, using the 100-year precipitation value.

10-Day PSH

Dam	10-day P100	10-day PSH Value[1]
Dammeron 1 Detention Basin	6.53 in	6.53 in
Dammeron 2 Detention Basin	7.15 in	7.15 in
Dammeron 3 Detention Basin	6.43 in	6.43 in
Diamond 1 Detention Basin	6.54 in	6.54 in
Diamond 2 Detention Basin	6.78 in	6.78 in
Diamond 3 Detention Basin	6.64 in	6.64 in

[1] TR-60, Figure 2-1

Precipitation Value - Auxiliary Spillway Hydrographs (Storm Events 07 and 08)

Description The ASH Storm Events are the maximum precipitation events used to design the auxiliary spillway and top of dam elevation as determined by the equations set forth in TR-60, Table Figure 2-2, using the SEP precipitation value and the 100-year precipitation value.

Local ASH

Dam	Local P100	Local SEP (PMP)	Local ASH Value[1]
Dammeron 1 Detention Basin	2.51 in	11.73 in	4.91 in
Dammeron 2 Detention Basin	2.64 in	9.30 in	4.37 in
Dammeron 3 Detention Basin	2.50 in	11.73 in	4.90 in
Diamond 1 Detention Basin	2.51 in	11.73 in	4.91 in
Diamond 2 Detention Basin	2.55 in	11.73 in	4.94 in
Diamond 3 Detention Basin	2.52 in	11.73 in	4.91 in

[1] TR-60, Figure 2-2

General ASH

Dam	General P100	General SEP (PMP)	General ASH Value[1]
Dammeron 1 Detention Basin	2.79 in	14.10 in	5.73 in
Dammeron 2 Detention Basin	2.95 in	14.05 in	5.84 in
Dammeron 3 Detention Basin	2.76 in	14.10 in	5.71 in
Diamond 1 Detention Basin	2.78 in	14.10 in	5.72 in
Diamond 2 Detention Basin	2.88 in	14.10 in	5.80 in
Diamond 3 Detention Basin	2.80 in	14.10 in	5.74 in

[1] TR-60, Figure 2-2

Precipitation Value - Freeboard Hydrographs (Storm Events 09 and 10)

Description The FBH Storm Events are the maximum precipitation events used to design the spillway and top of dam elevation as determined by the equations set forth in TR-60, Table Figure 2-2, using the PMP precipitation value (and applying a duration reduction factor for the 24-hour General FBH).

Local FBH

Dam	Local P100	Local SEP (PMP)	Local FBH Value[1]
Dammeron 1 Detention Basin	2.51 in	11.73 in	11.73 in
Dammeron 2 Detention Basin	2.64 in	9.30 in	9.30 in
Dammeron 3 Detention Basin	2.50 in	11.73 in	11.73 in
Diamond 1 Detention Basin	2.51 in	11.73 in	11.73 in
Diamond 2 Detention Basin	2.55 in	11.73 in	11.73 in
Diamond 3 Detention Basin	2.52 in	11.73 in	11.73 in

[1] TR-60, Figure 2-2

General FBH

Dam	General P100	General SEP (PMP)	General FBH Value[1]
Dammeron 1 Detention Basin	2.79 in	14.10 in	14.10 in
Dammeron 2 Detention Basin	2.95 in	14.05 in	14.05 in
Dammeron 3 Detention Basin	2.76 in	14.10 in	14.10 in
Diamond 1 Detention Basin	2.78 in	14.10 in	14.10 in
Diamond 2 Detention Basin	2.88 in	14.10 in	14.10 in
Diamond 3 Detention Basin	2.80 in	14.10 in	14.10 in

[1] TR-60, Figure 2-2

Appendix C. Model Output

Project: Santa Clara E A

Simulation Run: Storm Event 01

Simulation Start: 31 December 1999, 24:00

Simulation End: 2 January 2000, 03:00

HMS Version: 4.8

Executed: 23 April 2021, 02:27

Global Parameter Summary - Subbasin

	Area (ft²)
Element Name	**Area (ft²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2
Da3	Reservoir - Da3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard

Di3	16.8	Standard
Di4	64.2	Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (ft)	Energy Slope	Mannings n	Bottom Width	Side Slope	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	57.25	01Jan2000, 10:00	1.55
Reservoir - Da1	0.3	3.57	02Jan2000, 00:10	0.31
Da2	3.6	534.86	01Jan2000, 10:40	1.47
Reservoir - Da2	3.6	20.82	02Jan2000, 01:42	0.13
Da3	0.7	130.31	01Jan2000, 10:06	1.59
Reservoir - Da3	0.7	6.05	02Jan2000, 00:34	0.22
Da4	1.7	287.91	01Jan2000, 10:24	1.57
Di1	0.9	170.81	01Jan2000, 10:06	1.61
Reservoir - Di1	0.9	52.92	01Jan2000, 23:22	1.54
Di2	0.9	162.26	01Jan2000, 10:08	1.55
Reservoir - Di2	0.9	10.82	01Jan2000, 10:14	0.33
Di3	0.6	122.39	01Jan2000, 10:04	1.71
Reservoir - Di3	0.6	9.74	01Jan2000, 10:10	0.45
Di4	11.4	2225.38	01Jan2000, 10:38	1.92
Junction - 1	4.6	30.38	02Jan2000, 01:22	0.16
Junction - 2	1.5	20.56	01Jan2000, 10:12	0.38
Junction - 3	2.4	71.77	01Jan2000, 23:04	0.81
Reach - Di3 to Di2	0	109.1	01Jan2000, 10:12	Not specified
Reach - Di2 to Di1	0	258.33	01Jan2000, 10:18	Not specified

Subbasin: Da1

Area (ft²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs	
Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	57.25
Time of Peak Discharge	01Jan2000, 10:00
Volume (IN)	1.55
Precipitation Volume (AC - FT)	44.64
Loss Volume (AC - FT)	19.91
Excess Volume (AC - FT)	24.73
Direct Runoff Volume (AC - FT)	24.73
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	3.57
Time of Peak Discharge	02Jan2000, 00:10
Volume (IN)	0.31
Peak Inflow (CFS)	57.25
Time of Peak Inflow	01Jan2000, 10:00
Inflow Volume (AC - FT)	24.73
Maximum Storage (AC - FT)	20.66
Peak Elevation (FT)	4691.77
Discharge Volume (AC - FT)	4.89

Subbasin: Da2

Area (ft²) : 3.6
Downstream : Reservoir - Da2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	534.86
Time of Peak Discharge	01Jan2000, 10:40
Volume (IN)	1.47
Precipitation Volume (AC - FT)	566.4
Loss Volume (AC - FT)	283.9
Excess Volume (AC - FT)	282.5
Direct Runoff Volume (AC - FT)	282.39
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2

Downstream : Junction - 1

Results: Reservoir-Da2	
Peak Discharge (CFS)	20.82
Time of Peak Discharge	02Jan2000, 01:42
Volume (IN)	0.13
Peak Inflow (CFS)	534.86
Time of Peak Inflow	01Jan2000, 10:40
Inflow Volume (AC - FT)	282.39
Maximum Storage (AC - FT)	257.79
Peak Elevation (FT)	4696.98
Discharge Volume (AC - FT)	25.89

Subbasin: Da3

Area (ft²) : 0.7
Downstream : Reservoir - Da3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	130.31
Time of Peak Discharge	01Jan2000, 10:06
Volume (IN)	1.59
Precipitation Volume (AC - FT)	103.04
Loss Volume (AC - FT)	43.5
Excess Volume (AC - FT)	59.54
Direct Runoff Volume (AC - FT)	59.54
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da3

Downstream : Junction - 1

Results: Reservoir-Da3	
Peak Discharge (CFS)	6.05
Time of Peak Discharge	02Jan2000, 00:34
Volume (IN)	0.22
Peak Inflow (CFS)	130.31
Time of Peak Inflow	01Jan2000, 10:06
Inflow Volume (AC - FT)	59.54
Maximum Storage (AC - FT)	52.54
Peak Elevation (FT)	4687.89
Discharge Volume (AC - FT)	8.1

Subbasin: Da4

Area (ft²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	287.91
Time of Peak Discharge	01Jan2000, 10:24
Volume (IN)	1.57
Precipitation Volume (AC - FT)	260.21
Loss Volume (AC - FT)	118.18
Excess Volume (AC - FT)	142.03
Direct Runoff Volume (AC - FT)	142.02
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (ft²) : 0.9
Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	170.81
Time of Peak Discharge	01Jan2000, 10:06
Volume (IN)	1.61
Precipitation Volume (AC - FT)	133.44
Loss Volume (AC - FT)	56.31
Excess Volume (AC - FT)	77.13
Direct Runoff Volume (AC - FT)	77.13
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	52.92
Time of Peak Discharge	01Jan2000, 23:22
Volume (IN)	1.54
Peak Inflow (CFS)	425.38
Time of Peak Inflow	01Jan2000, 10:12
Inflow Volume (AC - FT)	166.14
Maximum Storage (AC - FT)	103.15
Peak Elevation (FT)	4552.26
Discharge Volume (AC - FT)	73.72

Subbasin: Di2

Area (ft²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	162.26
Time of Peak Discharge	01Jan2000, 10:08
Volume (IN)	1.55
Precipitation Volume (AC - FT)	138.24
Loss Volume (AC - FT)	64.01
Excess Volume (AC - FT)	74.23
Direct Runoff Volume (AC - FT)	74.23
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	10.82
Time of Peak Discharge	01Jan2000, 10:14
Volume (IN)	0.33
Peak Inflow (CFS)	270.98
Time of Peak Inflow	01Jan2000, 10:12
Inflow Volume (AC - FT)	111.23
Maximum Storage (AC - FT)	10.04
Peak Elevation (FT)	4599.04
Discharge Volume (AC - FT)	15.97

Subbasin: Di3

Area (ft²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	122.39
Time of Peak Discharge	01Jan2000, 10:04

Volume (IN)	1.71
Precipitation Volume (AC - FT)	89.6
Loss Volume (AC - FT)	34.82
Excess Volume (AC - FT)	54.78
Direct Runoff Volume (AC - FT)	54.78
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3

Peak Discharge (CFS)	9.74
Time of Peak Discharge	01Jan2000, 10:10
Volume (IN)	0.45
Peak Inflow (CFS)	122.39
Time of Peak Inflow	01Jan2000, 10:08
Inflow Volume (AC - FT)	54.78
Maximum Storage (AC - FT)	7.37
Peak Elevation (FT)	4606.37
Discharge Volume (AC - FT)	14.34

Subbasin: Di4

Area (ft²) : 11.4

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs

Lag	64.2
Unitgraph Type	Standard

Results: Di4

Peak Discharge (CFS)	2225.38
Time of Peak Discharge	01Jan2000, 10:38
Volume (IN)	1.92
Precipitation Volume (AC - FT)	1890.88
Loss Volume (AC - FT)	724.3
Excess Volume (AC - FT)	1166.58
Direct Runoff Volume (AC - FT)	1165.99
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1

Peak Discharge (CFS)	30.38
Time of Peak Discharge	02Jan2000, 01:22
Volume (IN)	0.16

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	20.56
Time of Peak Discharge	01Jan2000, 10:12
Volume (IN)	0.38

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	71.77
Time of Peak Discharge	01Jan2000, 23:04
Volume (IN)	0.81

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	950
Energy Slope	0.01
Mannings n	0.04
Bottom Width	6
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2	
Peak Discharge (CFS)	109.1
Time of Peak Discharge	01Jan2000, 10:12
Peak Inflow (CFS)	109.14
Inflow Volume (AC - FT)	37

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	2690
Energy Slope	0.02
Mannings n	0.04
Bottom Width	10
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200

Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	258.33
Time of Peak Discharge	01Jan2000, 10:18
Peak Inflow (CFS)	258.37
Inflow Volume (AC - FT)	88.98

Project: Santa Clara E A

Simulation Run: Storm Event 02

Simulation Start: 31 December 1999, 24:00

Simulation End: 1 January 2000, 09:00

HMS Version: 4.8

Executed: 23 April 2021, 02:27

Global Parameter Summary - Subbasin

	Area (ft²)
Element Name	**Area (ft²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2
Da3	Reservoir - Da3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard

Di3	16.8	Standard
Di4	64.2	Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (ft)	Energy Slope	Mannings n	Bottom Width	Side Slope	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	251.88	01Jan2000, 02:30	1.86
Reservoir - Da1	0.3	50.35	01Jan2000, 04:16	0.59
Da2	3.6	1944.49	01Jan2000, 03:08	1.85
Reservoir - Da2	3.6	571.86	01Jan2000, 05:14	0.51
Da3	0.7	536.12	01Jan2000, 02:38	1.91
Reservoir - Da3	0.7	99.55	01Jan2000, 04:44	0.51
Da4	1.7	1005.93	01Jan2000, 02:58	1.83
Di1	0.9	676.83	01Jan2000, 02:40	1.91
Reservoir - Di1	0.9	242.71	01Jan2000, 06:12	1.01
Di2	0.9	670.41	01Jan2000, 02:40	1.86
Reservoir - Di2	0.9	416.56	01Jan2000, 02:44	0.56
Di3	0.6	500.02	01Jan2000, 02:36	1.97
Reservoir - Di3	0.6	350.55	01Jan2000, 02:38	0.72
Di4	11.4	6042.93	01Jan2000, 03:12	1.91
Junction - 1	4.6	703.57	01Jan2000, 05:14	0.51
Junction - 2	1.5	758.44	01Jan2000, 02:42	0.62
Junction - 3	2.4	791.01	01Jan2000, 02:42	0.77
Reach - Di3 to Di2	0	138	01Jan2000, 02:40	Not specified
Reach - Di2 to Di1	0	386.55	01Jan2000, 02:28	Not specified

Subbasin: Da1

Area (ft²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs	
Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	251.88
Time of Peak Discharge	01Jan2000, 02:30
Volume (IN)	1.86
Precipitation Volume (AC - FT)	40.16
Loss Volume (AC - FT)	10.36
Excess Volume (AC - FT)	29.8
Direct Runoff Volume (AC - FT)	29.8
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	50.35
Time of Peak Discharge	01Jan2000, 04:16
Volume (IN)	0.59
Peak Inflow (CFS)	251.88
Time of Peak Inflow	01Jan2000, 02:30
Inflow Volume (AC - FT)	29.8
Maximum Storage (AC - FT)	21.62
Peak Elevation (FT)	4692.31
Discharge Volume (AC - FT)	9.49

Subbasin: Da2

Area (ft²) : 3.6
Downstream : Reservoir - Da2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	1944.49
Time of Peak Discharge	01Jan2000, 03:08
Volume (IN)	1.85
Precipitation Volume (AC - FT)	506.88
Loss Volume (AC - FT)	152.37
Excess Volume (AC - FT)	354.51
Direct Runoff Volume (AC - FT)	354.48
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2

Downstream : Junction - 1

Results: Reservoir-Da2	
Peak Discharge (CFS)	571.86
Time of Peak Discharge	01Jan2000, 05:14
Volume (IN)	0.51
Peak Inflow (CFS)	1944.49
Time of Peak Inflow	01Jan2000, 03:08
Inflow Volume (AC - FT)	354.48
Maximum Storage (AC - FT)	266.94
Peak Elevation (FT)	4697.64
Discharge Volume (AC - FT)	97.1

Subbasin: Da3

Area (ft²) : 0.7
Downstream : Reservoir - Da3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	536.12
Time of Peak Discharge	01Jan2000, 02:38
Volume (IN)	1.91
Precipitation Volume (AC - FT)	93.33
Loss Volume (AC - FT)	22.21
Excess Volume (AC - FT)	71.13
Direct Runoff Volume (AC - FT)	71.13
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da3

Downstream : Junction - 1

Results: Reservoir-Da3	
Peak Discharge (CFS)	99.55
Time of Peak Discharge	01Jan2000, 04:44
Volume (IN)	0.51
Peak Inflow (CFS)	536.12
Time of Peak Inflow	01Jan2000, 02:38
Inflow Volume (AC - FT)	71.13
Maximum Storage (AC - FT)	54.97
Peak Elevation (FT)	4688.49
Discharge Volume (AC - FT)	18.89

Subbasin: Da4

Area (ft²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	1005.93
Time of Peak Discharge	01Jan2000, 02:58
Volume (IN)	1.83
Precipitation Volume (AC - FT)	227.57
Loss Volume (AC - FT)	61.43
Excess Volume (AC - FT)	166.15
Direct Runoff Volume (AC - FT)	166.15
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (ft²) : 0.9
Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	676.83
Time of Peak Discharge	01Jan2000, 02:40
Volume (IN)	1.91
Precipitation Volume (AC - FT)	120.48
Loss Volume (AC - FT)	28.92
Excess Volume (AC - FT)	91.56
Direct Runoff Volume (AC - FT)	91.56
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	242.71
Time of Peak Discharge	01Jan2000, 06:12
Volume (IN)	1.01
Peak Inflow (CFS)	1056.84
Time of Peak Inflow	01Jan2000, 02:40
Inflow Volume (AC - FT)	184.03
Maximum Storage (AC - FT)	152.12
Peak Elevation (FT)	4557.48
Discharge Volume (AC - FT)	48.42

Subbasin: Di2

Area (ft²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	670.41
Time of Peak Discharge	01Jan2000, 02:40
Volume (IN)	1.86
Precipitation Volume (AC - FT)	122.4
Loss Volume (AC - FT)	33.28
Excess Volume (AC - FT)	89.12
Direct Runoff Volume (AC - FT)	89.12
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	416.56
Time of Peak Discharge	01Jan2000, 02:44
Volume (IN)	0.56
Peak Inflow (CFS)	808.41
Time of Peak Inflow	01Jan2000, 02:42
Inflow Volume (AC - FT)	125.54
Maximum Storage (AC - FT)	14.06
Peak Elevation (FT)	4601.31
Discharge Volume (AC - FT)	26.72

Subbasin: Di3

Area (ft²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	500.02
Time of Peak Discharge	01Jan2000, 02:36

Volume (IN)	1.97
Precipitation Volume (AC - FT)	80.64
Loss Volume (AC - FT)	17.58
Excess Volume (AC - FT)	63.06
Direct Runoff Volume (AC - FT)	63.06
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3

Peak Discharge (CFS)	350.55
Time of Peak Discharge	01Jan2000, 02:38
Volume (IN)	0.72
Peak Inflow (CFS)	500.02
Time of Peak Inflow	01Jan2000, 02:40
Inflow Volume (AC - FT)	63.06
Maximum Storage (AC - FT)	10.72
Peak Elevation (FT)	4608.17
Discharge Volume (AC - FT)	23.06

Subbasin: Di4

Area (ft²) : 11.4

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs

Lag	64.2
Unitgraph Type	Standard

Results: Di4

Peak Discharge (CFS)	6042.93
Time of Peak Discharge	01Jan2000, 03:12
Volume (IN)	1.91
Precipitation Volume (AC - FT)	1526.08
Loss Volume (AC - FT)	361.92
Excess Volume (AC - FT)	1164.16
Direct Runoff Volume (AC - FT)	1163.89
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1

Peak Discharge (CFS)	703.57
Time of Peak Discharge	01Jan2000, 05:14
Volume (IN)	0.51

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	758.44
Time of Peak Discharge	01Jan2000, 02:42
Volume (IN)	0.62

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	791.01
Time of Peak Discharge	01Jan2000, 02:42
Volume (IN)	0.77

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	950
Energy Slope	0.01
Mannings n	0.04
Bottom Width	6
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2	
Peak Discharge (CFS)	138
Time of Peak Discharge	01Jan2000, 02:40
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	36.41

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	2690
Energy Slope	0.02
Mannings n	0.04
Bottom Width	10
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200

Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	386.55
Time of Peak Discharge	01Jan2000, 02:28
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	92.4

Project: Santa Clara E A

Simulation Run: Storm Event 03

Simulation Start: 31 December 1999, 24:00

Simulation End: 2 January 2000, 03:00

HMS Version: 4.8

Executed: 23 April 2021, 02:26

Global Parameter Summary - Subbasin

	Area (ft²)
Element Name	**Area (ft²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2
Da3	Reservoir - Da3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard

Di3	16.8	Standard
Di4	64.2	Standard

Global Parameter Summary - Reach

	Downstream
Element Name	**Downstream**
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (ft)	Energy Slope	Mannings n	Bottom Width	Side Slope	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	74.57	01Jan2000, 10:00	2.13
Reservoir - Da1	0.3	16.58	01Jan2000, 13:14	0.86
Da2	3.6	841.16	01Jan2000, 10:16	2.14
Reservoir - Da2	3.6	213.51	01Jan2000, 14:28	0.8
Da3	0.7	170.52	01Jan2000, 10:02	2.16
Reservoir - Da3	0.7	34.7	01Jan2000, 14:38	0.76
Da4	1.7	399.11	01Jan2000, 10:10	2.1
Di1	0.9	223.93	01Jan2000, 10:02	2.17
Reservoir - Di1	0.9	98.5	01Jan2000, 15:48	2.22
Di2	0.9	223.55	01Jan2000, 10:02	2.17
Reservoir - Di2	0.9	11.09	01Jan2000, 10:06	0.37
Di3	0.6	152.92	01Jan2000, 10:00	2.24
Reservoir - Di3	0.6	12.01	01Jan2000, 10:06	0.49
Di4	11.4	2671.19	01Jan2000, 10:20	2.18
Junction - 1	4.6	264.38	01Jan2000, 14:30	0.8
Junction - 2	1.5	23.11	01Jan2000, 10:06	0.42
Junction - 3	2.4	117.53	01Jan2000, 15:48	1.1
Reach - Di3 to Di2	0	138	01Jan2000, 10:08	Not specified
Reach - Di2 to Di1	0	349.47	01Jan2000, 10:10	Not specified

Subbasin: Da1

Area (ft²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1

Peak Discharge (CFS)	74.57
Time of Peak Discharge	01Jan2000, 10:00
Volume (IN)	2.13
Precipitation Volume (AC - FT)	44.64
Loss Volume (AC - FT)	10.55
Excess Volume (AC - FT)	34.09
Direct Runoff Volume (AC - FT)	34.09
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1

Peak Discharge (CFS)	16.58
Time of Peak Discharge	01Jan2000, 13:14
Volume (IN)	0.86
Peak Inflow (CFS)	74.57
Time of Peak Inflow	01Jan2000, 10:00
Inflow Volume (AC - FT)	34.09
Maximum Storage (AC - FT)	21.26
Peak Elevation (FT)	4692.13
Discharge Volume (AC - FT)	13.83

Subbasin: Da2

Area (ft²) : 3.6
Downstream : Reservoir - Da2

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs

Lag	60
Unitgraph Type	Standard

Results: Da2

Peak Discharge (CFS)	841.16
Time of Peak Discharge	01Jan2000, 10:16
Volume (IN)	2.14
Precipitation Volume (AC - FT)	566.4
Loss Volume (AC - FT)	155.84
Excess Volume (AC - FT)	410.56
Direct Runoff Volume (AC - FT)	410.55
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2

Downstream : Junction - 1

Results: Reservoir-Da2	
Peak Discharge (CFS)	213.51
Time of Peak Discharge	01Jan2000, 14:28
Volume (IN)	0.8
Peak Inflow (CFS)	841.16
Time of Peak Inflow	01Jan2000, 10:16
Inflow Volume (AC - FT)	410.55
Maximum Storage (AC - FT)	262.44
Peak Elevation (FT)	4697.32
Discharge Volume (AC - FT)	154.15

Subbasin: Da3

Area (ft²) : 0.7
Downstream : Reservoir - Da3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	170.52
Time of Peak Discharge	01Jan2000, 10:02
Volume (IN)	2.16
Precipitation Volume (AC - FT)	103.04
Loss Volume (AC - FT)	22.56
Excess Volume (AC - FT)	80.48
Direct Runoff Volume (AC - FT)	80.48
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da3

Downstream : Junction - 1

Results: Reservoir-Da3	
Peak Discharge (CFS)	34.7
Time of Peak Discharge	01Jan2000, 14:38
Volume (IN)	0.76
Peak Inflow (CFS)	170.52
Time of Peak Inflow	01Jan2000, 10:02
Inflow Volume (AC - FT)	80.48
Maximum Storage (AC - FT)	53.89
Peak Elevation (FT)	4688.22
Discharge Volume (AC - FT)	28.42

Subbasin: Da4

Area (ft²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	399.11
Time of Peak Discharge	01Jan2000, 10:10
Volume (IN)	2.1
Precipitation Volume (AC - FT)	252.96
Loss Volume (AC - FT)	62.62
Excess Volume (AC - FT)	190.34
Direct Runoff Volume (AC - FT)	190.34
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (ft²) : 0.9
Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	223.93
Time of Peak Discharge	01Jan2000, 10:02
Volume (IN)	2.17
Precipitation Volume (AC - FT)	133.44
Loss Volume (AC - FT)	29.4
Excess Volume (AC - FT)	104.04
Direct Runoff Volume (AC - FT)	104.04
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	98.5
Time of Peak Discharge	01Jan2000, 15:48
Volume (IN)	2.22
Peak Inflow (CFS)	572.13
Time of Peak Inflow	01Jan2000, 10:04
Inflow Volume (AC - FT)	236.93
Maximum Storage (AC - FT)	146.12
Peak Elevation (FT)	4557.16
Discharge Volume (AC - FT)	106.7

Subbasin: Di2

Area (ft²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	223.55
Time of Peak Discharge	01Jan2000, 10:02
Volume (IN)	2.17
Precipitation Volume (AC - FT)	138.24
Loss Volume (AC - FT)	34.03
Excess Volume (AC - FT)	104.21
Direct Runoff Volume (AC - FT)	104.21
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	11.09
Time of Peak Discharge	01Jan2000, 10:06
Volume (IN)	0.37
Peak Inflow (CFS)	361.55
Time of Peak Inflow	01Jan2000, 10:04
Inflow Volume (AC - FT)	156.73
Maximum Storage (AC - FT)	10.76
Peak Elevation (FT)	4599.76
Discharge Volume (AC - FT)	17.7

Subbasin: Di3

Area (ft²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	152.92
Time of Peak Discharge	01Jan2000, 10:00

Volume (IN)	2.24
Precipitation Volume (AC - FT)	89.6
Loss Volume (AC - FT)	17.85
Excess Volume (AC - FT)	71.75
Direct Runoff Volume (AC - FT)	71.75
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3

Peak Discharge (CFS)	12.01
Time of Peak Discharge	01Jan2000, 10:06
Volume (IN)	0.49
Peak Inflow (CFS)	152.92
Time of Peak Inflow	01Jan2000, 10:04
Inflow Volume (AC - FT)	71.75
Maximum Storage (AC - FT)	8.09
Peak Elevation (FT)	4607.04
Discharge Volume (AC - FT)	15.84

Subbasin: Di4

Area (ft²) : 11.4

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs

Lag	64.2
Unitgraph Type	Standard

Results: Di4

Peak Discharge (CFS)	2671.19
Time of Peak Discharge	01Jan2000, 10:20
Volume (IN)	2.18
Precipitation Volume (AC - FT)	1696.32
Loss Volume (AC - FT)	368.07
Excess Volume (AC - FT)	1328.25
Direct Runoff Volume (AC - FT)	1328.17
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1

Peak Discharge (CFS)	264.38
Time of Peak Discharge	01Jan2000, 14:30
Volume (IN)	0.8

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	23.11
Time of Peak Discharge	01Jan2000, 10:06
Volume (IN)	0.42

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	117.53
Time of Peak Discharge	01Jan2000, 15:48
Volume (IN)	1.1

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	950
Energy Slope	0.01
Mannings n	0.04
Bottom Width	6
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2	
Peak Discharge (CFS)	138
Time of Peak Discharge	01Jan2000, 10:08
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	52.52

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	2690
Energy Slope	0.02
Mannings n	0.04
Bottom Width	10
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200

Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	349.47
Time of Peak Discharge	01Jan2000, 10:10
Peak Inflow (CFS)	349.51
Inflow Volume (AC - FT)	132.86

Project: Santa Clara E A

Simulation Run: Storm Event 04

Simulation Start: 31 December 1999, 24:00

Simulation End: 1 January 2000, 09:00

HMS Version: 4.8

Executed: 23 April 2021, 02:25

Global Parameter Summary - Subbasin

	Area (ft²)
Element Name	**Area (ft²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2
Da3	Reservoir - Da3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard

Di3	16.8	Standard
Di4	64.2	Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (ft)	Energy Slope	Mannings n	Bottom Width	Side Slope	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	1312.24	01Jan2000, 02:30	10.09
Reservoir - Da1	0.3	1306.32	01Jan2000, 02:32	8.81
Da2	3.6	6533.46	01Jan2000, 03:24	7.33
Reservoir - Da2	3.6	6057.94	01Jan2000, 03:42	5.98
Da3	0.7	2657.47	01Jan2000, 02:42	10.22
Reservoir - Da3	0.7	2032.06	01Jan2000, 03:02	8.81
Da4	1.7	4804.31	01Jan2000, 03:08	10
Di1	0.9	3344.14	01Jan2000, 02:44	10.21
Reservoir - Di1	0.9	2934.27	01Jan2000, 03:04	10.79
Di2	0.9	3275.07	01Jan2000, 02:44	9.95
Reservoir - Di2	0.9	2974.93	01Jan2000, 02:50	7.63
Di3	0.6	2446.04	01Jan2000, 02:38	10.35
Reservoir - Di3	0.6	2119.49	01Jan2000, 02:46	8.29
Di4	11.4	27796.15	01Jan2000, 03:26	10.22
Junction - 1	4.6	7912.97	01Jan2000, 03:30	6.59
Junction - 2	1.5	5080.73	01Jan2000, 02:48	7.89
Junction - 3	2.4	7834.66	01Jan2000, 02:54	8.98
Reach - Di3 to Di2	0	138	01Jan2000, 01:52	Not specified
Reach - Di2 to Di1	0	381.34	01Jan2000, 01:44	Not specified

Subbasin: Da1

Area (ft^2) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs

Lag	7.2
Unitgraph Type	Standard

Results: Da1

Peak Discharge (CFS)	1312.24
Time of Peak Discharge	01Jan2000, 02:30
Volume (IN)	10.09
Precipitation Volume (AC - FT)	187.68
Loss Volume (AC - FT)	26.27
Excess Volume (AC - FT)	161.41
Direct Runoff Volume (AC - FT)	161.41
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1

Peak Discharge (CFS)	1306.32
Time of Peak Discharge	01Jan2000, 02:32
Volume (IN)	8.81
Peak Inflow (CFS)	1312.24
Time of Peak Inflow	01Jan2000, 02:30
Inflow Volume (AC - FT)	161.41
Maximum Storage (AC - FT)	26.71
Peak Elevation (FT)	4694.85
Discharge Volume (AC - FT)	140.99

Subbasin: Da2

Area (ft²) : 3.6
Downstream : Reservoir - Da2

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs

Lag	60
Unitgraph Type	Standard

Results: Da2

Peak Discharge (CFS)	6533.46
Time of Peak Discharge	01Jan2000, 03:24
Volume (IN)	7.33
Precipitation Volume (AC - FT)	1785.6
Loss Volume (AC - FT)	376.17
Excess Volume (AC - FT)	1409.43
Direct Runoff Volume (AC - FT)	1407.63
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2

Downstream : Junction - 1

Results: Reservoir-Da2	
Peak Discharge (CFS)	6057.94
Time of Peak Discharge	01Jan2000, 03:42
Volume (IN)	5.98
Peak Inflow (CFS)	6533.46
Time of Peak Inflow	01Jan2000, 03:24
Inflow Volume (AC - FT)	1407.63
Maximum Storage (AC - FT)	317.9
Peak Elevation (FT)	4700.13
Discharge Volume (AC - FT)	1147.85

Subbasin: Da3

Area (ft²) : 0.7
Downstream : Reservoir - Da3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	2657.47
Time of Peak Discharge	01Jan2000, 02:42
Volume (IN)	10.22
Precipitation Volume (AC - FT)	437.92
Loss Volume (AC - FT)	56.33
Excess Volume (AC - FT)	381.59
Direct Runoff Volume (AC - FT)	381.59
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da3

Downstream : Junction - 1

Results: Reservoir-Da3	
Peak Discharge (CFS)	2032.06
Time of Peak Discharge	01Jan2000, 03:02
Volume (IN)	8.81
Peak Inflow (CFS)	2657.47
Time of Peak Inflow	01Jan2000, 02:42
Inflow Volume (AC - FT)	381.59
Maximum Storage (AC - FT)	99.41
Peak Elevation (FT)	4691.4
Discharge Volume (AC - FT)	329.06

Subbasin: Da4

Area (ft²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	4804.31
Time of Peak Discharge	01Jan2000, 03:08
Volume (IN)	10
Precipitation Volume (AC - FT)	1063.52
Loss Volume (AC - FT)	156.3
Excess Volume (AC - FT)	907.22
Direct Runoff Volume (AC - FT)	907.08
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (ft²) : 0.9
Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	3344.14
Time of Peak Discharge	01Jan2000, 02:44
Volume (IN)	10.21
Precipitation Volume (AC - FT)	563.04
Loss Volume (AC - FT)	72.92
Excess Volume (AC - FT)	490.12
Direct Runoff Volume (AC - FT)	490.12
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	2934.27
Time of Peak Discharge	01Jan2000, 03:04
Volume (IN)	10.79
Peak Inflow (CFS)	3724.14
Time of Peak Inflow	01Jan2000, 02:44
Inflow Volume (AC - FT)	657.14
Maximum Storage (AC - FT)	205.14
Peak Elevation (FT)	4560.03
Discharge Volume (AC - FT)	517.89

Subbasin: Di2

Area (ft²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	3275.07
Time of Peak Discharge	01Jan2000, 02:44
Volume (IN)	9.95
Precipitation Volume (AC - FT)	563.04
Loss Volume (AC - FT)	85.21
Excess Volume (AC - FT)	477.83
Direct Runoff Volume (AC - FT)	477.83
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	2974.93
Time of Peak Discharge	01Jan2000, 02:50
Volume (IN)	7.63
Peak Inflow (CFS)	3413.07
Time of Peak Inflow	01Jan2000, 02:46
Inflow Volume (AC - FT)	540.01
Maximum Storage (AC - FT)	31.1
Peak Elevation (FT)	4603.8
Discharge Volume (AC - FT)	366.16

Subbasin: Di3

Area (ft²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	2446.04
Time of Peak Discharge	01Jan2000, 02:38

Volume (IN)	10.35
Precipitation Volume (AC - FT)	375.36
Loss Volume (AC - FT)	44.04
Excess Volume (AC - FT)	331.32
Direct Runoff Volume (AC - FT)	331.32
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	2119.49
Time of Peak Discharge	01Jan2000, 02:46
Volume (IN)	8.29
Peak Inflow (CFS)	2446.04
Time of Peak Inflow	01Jan2000, 02:42
Inflow Volume (AC - FT)	331.32
Maximum Storage (AC - FT)	27.33
Peak Elevation (FT)	4610.73
Discharge Volume (AC - FT)	265.16

Subbasin: Di4

Area (ft²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	27796.15
Time of Peak Discharge	01Jan2000, 03:26
Volume (IN)	10.22
Precipitation Volume (AC - FT)	7131.84
Loss Volume (AC - FT)	905.09
Excess Volume (AC - FT)	6226.75
Direct Runoff Volume (AC - FT)	6215.3
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	7912.97
Time of Peak Discharge	01Jan2000, 03:30
Volume (IN)	6.59

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	5080.73
Time of Peak Discharge	01Jan2000, 02:48
Volume (IN)	7.89

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	7834.66
Time of Peak Discharge	01Jan2000, 02:54
Volume (IN)	8.98

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	950
Energy Slope	0.01
Mannings n	0.04
Bottom Width	6
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2	
Peak Discharge (CFS)	138
Time of Peak Discharge	01Jan2000, 01:52
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	62.18

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	2690
Energy Slope	0.02
Mannings n	0.04
Bottom Width	10
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200

Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	381.34
Time of Peak Discharge	01Jan2000, 01:44
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	166.98

Project: Santa Clara E A

Simulation Run: Storm Event 05

Simulation Start: 31 December 1999, 24:00

Simulation End: 4 January 2000, 03:00

HMS Version: 4.8

Executed: 23 April 2021, 02:24

Global Parameter Summary - Subbasin

	Area (ft²)
Element Name	**Area (ft²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2
Da3	Reservoir - Da3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard

Di3	16.8	Standard
Di4	64.2	Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (ft)	Energy Slope	Mannings n	Bottom Width	Side Slope	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	135.45	02Jan2000, 06:00	12.43
Reservoir - Da1	0.3	135.4	02Jan2000, 06:00	11.16
Da2	3.6	1579.63	02Jan2000, 06:06	11.99
Reservoir - Da2	3.6	1579.02	02Jan2000, 06:10	10.64
Da3	0.7	317.07	02Jan2000, 06:00	12.57
Reservoir - Da3	0.7	316.94	02Jan2000, 06:02	11.17
Da4	1.7	761.62	02Jan2000, 06:02	12.35
Di1	0.9	407.43	02Jan2000, 06:00	12.56
Reservoir - Di1	0.9	786.98	02Jan2000, 06:04	25.36
Di2	0.9	403.66	02Jan2000, 06:00	12.29
Reservoir - Di2	0.9	161.5	02Jan2000, 06:02	2.58
Di3	0.6	273	02Jan2000, 06:00	12.7
Reservoir - Di3	0.6	134.92	02Jan2000, 06:00	3.58
Di4	11.4	5139.33	02Jan2000, 06:04	12.59
Junction - 1	4.6	2030	02Jan2000, 06:02	10.76
Junction - 2	1.5	296.4	02Jan2000, 06:02	2.98
Junction - 3	2.4	1083.38	02Jan2000, 06:02	11.37
Reach - Di3 to Di2	0	138	02Jan2000, 00:12	Not specified
Reach - Di2 to Di1	0	380.49	02Jan2000, 00:32	Not specified

Subbasin: Da1

Area (ft²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs	
Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	135.45
Time of Peak Discharge	02Jan2000, 06:00
Volume (IN)	12.43
Precipitation Volume (AC - FT)	225.6
Loss Volume (AC - FT)	26.72
Excess Volume (AC - FT)	198.88
Direct Runoff Volume (AC - FT)	198.88
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	135.4
Time of Peak Discharge	02Jan2000, 06:00
Volume (IN)	11.16
Peak Inflow (CFS)	135.45
Time of Peak Inflow	02Jan2000, 06:00
Inflow Volume (AC - FT)	198.88
Maximum Storage (AC - FT)	22.24
Peak Elevation (FT)	4692.62
Discharge Volume (AC - FT)	178.59

Subbasin: Da2

Area (ft²) : 3.6
Downstream : Reservoir - Da2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	1579.63
Time of Peak Discharge	02Jan2000, 06:06
Volume (IN)	11.99
Precipitation Volume (AC - FT)	2697.6
Loss Volume (AC - FT)	396.04
Excess Volume (AC - FT)	2301.55
Direct Runoff Volume (AC - FT)	2301.36
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2

Downstream : Junction - 1

Results: Reservoir-Da2	
Peak Discharge (CFS)	1579.02
Time of Peak Discharge	02Jan2000, 06:10
Volume (IN)	10.64
Peak Inflow (CFS)	1579.63
Time of Peak Inflow	02Jan2000, 06:06
Inflow Volume (AC - FT)	2301.36
Maximum Storage (AC - FT)	275.87
Peak Elevation (FT)	4698.28
Discharge Volume (AC - FT)	2043.63

Subbasin: Da3

Area (ft²) : 0.7
Downstream : Reservoir - Da3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	317.07
Time of Peak Discharge	02Jan2000, 06:00
Volume (IN)	12.57
Precipitation Volume (AC - FT)	526.4
Loss Volume (AC - FT)	57.19
Excess Volume (AC - FT)	469.21
Direct Runoff Volume (AC - FT)	469.21
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da3

Downstream : Junction - 1

Results: Reservoir-Da3	
Peak Discharge (CFS)	316.94
Time of Peak Discharge	02Jan2000, 06:02
Volume (IN)	11.17
Peak Inflow (CFS)	317.07
Time of Peak Inflow	02Jan2000, 06:00
Inflow Volume (AC - FT)	469.21
Maximum Storage (AC - FT)	57.39
Peak Elevation (FT)	4689.1
Discharge Volume (AC - FT)	417

Subbasin: Da4

Area (ft²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	761.62
Time of Peak Discharge	02Jan2000, 06:02
Volume (IN)	12.35
Precipitation Volume (AC - FT)	1278.4
Loss Volume (AC - FT)	159.06
Excess Volume (AC - FT)	1119.34
Direct Runoff Volume (AC - FT)	1119.33
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (ft²) : 0.9
Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	407.43
Time of Peak Discharge	02Jan2000, 06:00
Volume (IN)	12.56
Precipitation Volume (AC - FT)	676.8
Loss Volume (AC - FT)	74.04
Excess Volume (AC - FT)	602.76
Direct Runoff Volume (AC - FT)	602.76
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	786.98
Time of Peak Discharge	02Jan2000, 06:04
Volume (IN)	25.36
Peak Inflow (CFS)	787.43
Time of Peak Inflow	02Jan2000, 06:00
Inflow Volume (AC - FT)	1351.03
Maximum Storage (AC - FT)	166.07
Peak Elevation (FT)	4558.21
Discharge Volume (AC - FT)	1217.52

Subbasin: Di2

Area (ft²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	403.66
Time of Peak Discharge	02Jan2000, 06:00
Volume (IN)	12.29
Precipitation Volume (AC - FT)	676.8
Loss Volume (AC - FT)	86.76
Excess Volume (AC - FT)	590.04
Direct Runoff Volume (AC - FT)	590.04
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	161.5
Time of Peak Discharge	02Jan2000, 06:02
Volume (IN)	2.58
Peak Inflow (CFS)	541.66
Time of Peak Inflow	02Jan2000, 06:02
Inflow Volume (AC - FT)	878.39
Maximum Storage (AC - FT)	12.58
Peak Elevation (FT)	4600.68
Discharge Volume (AC - FT)	123.73

Subbasin: Di3

Area (ft²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	273
Time of Peak Discharge	02Jan2000, 06:00

Volume (IN)	12.7
Precipitation Volume (AC - FT)	451.2
Loss Volume (AC - FT)	44.65
Excess Volume (AC - FT)	406.55
Direct Runoff Volume (AC - FT)	406.55
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	134.92
Time of Peak Discharge	02Jan2000, 06:00
Volume (IN)	3.58
Peak Inflow (CFS)	273
Time of Peak Inflow	02Jan2000, 06:04
Inflow Volume (AC - FT)	406.55
Maximum Storage (AC - FT)	9.39
Peak Elevation (FT)	4607.6
Discharge Volume (AC - FT)	114.67

Subbasin: Di4

Area (ft²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	5139.33
Time of Peak Discharge	02Jan2000, 06:04
Volume (IN)	12.59
Precipitation Volume (AC - FT)	8572.8
Loss Volume (AC - FT)	918.84
Excess Volume (AC - FT)	7653.96
Direct Runoff Volume (AC - FT)	7652.99
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	2030
Time of Peak Discharge	02Jan2000, 06:02
Volume (IN)	10.76

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	296.4
Time of Peak Discharge	02Jan2000, 06:02
Volume (IN)	2.98

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	1083.38
Time of Peak Discharge	02Jan2000, 06:02
Volume (IN)	11.37

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	950
Energy Slope	0.01
Mannings n	0.04
Bottom Width	6
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2	
Peak Discharge (CFS)	138
Time of Peak Discharge	02Jan2000, 00:12
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	288.35

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	2690
Energy Slope	0.02
Mannings n	0.04
Bottom Width	10
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200

Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	380.49
Time of Peak Discharge	02Jan2000, 00:32
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	748.26

Project: Santa Clara E A

Simulation Run: Storm Event 06

Simulation Start: 31 December 1999, 24:00

Simulation End: 11 January 2000, 03:00

HMS Version: 4.8

Executed: 23 April 2021, 02:22

Global Parameter Summary - Subbasin

	Area (ft²)
Element Name	**Area (ft²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2
Da3	Reservoir - Da3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard

Di3	16.8 Standard
Di4	64.2 Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (ft)	Energy Slope	Mannings n	Bottom Width	Side Slope	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	298.2	05Jan2000, 24:00	5.01
Reservoir - Da1	0.3	296.76	05Jan2000, 24:00	4.33
Da2	3.6	2518.19	06Jan2000, 00:36	5.27
Reservoir - Da2	3.6	2460.06	06Jan2000, 00:44	3.98
Da3	0.7	654.86	06Jan2000, 00:04	5.03
Reservoir - Da3	0.7	624.8	06Jan2000, 00:12	3.94
Da4	1.7	1259.56	06Jan2000, 00:24	4.94
Di1	0.9	847.03	06Jan2000, 00:06	5.12
Reservoir - Di1	0.9	555.88	06Jan2000, 01:10	8.38
Di2	0.9	859.93	06Jan2000, 00:06	5.13
Reservoir - Di2	0.9	613.43	06Jan2000, 00:08	3.07
Di3	0.6	607.65	06Jan2000, 00:02	5.35
Reservoir - Di3	0.6	466.88	06Jan2000, 00:04	3.54
Di4	11.4	7383.52	06Jan2000, 00:40	5.14
Junction - 1	4.6	2797.32	06Jan2000, 00:42	4
Junction - 2	1.5	1075.68	06Jan2000, 00:06	3.26
Junction - 3	2.4	1131.29	06Jan2000, 00:06	5.18
Reach - Di3 to Di2	0	138	05Jan2000, 23:44	Not specified
Reach - Di2 to Di1	0	384.43	05Jan2000, 23:30	Not specified

Subbasin: Da1

Area (ft²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs	
Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	298.2
Time of Peak Discharge	05Jan2000, 24:00
Volume (IN)	5.01
Precipitation Volume (AC - FT)	104.48
Loss Volume (AC - FT)	24.36
Excess Volume (AC - FT)	80.12
Direct Runoff Volume (AC - FT)	80.12
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	296.76
Time of Peak Discharge	05Jan2000, 24:00
Volume (IN)	4.33
Peak Inflow (CFS)	298.2
Time of Peak Inflow	05Jan2000, 24:00
Inflow Volume (AC - FT)	80.12
Maximum Storage (AC - FT)	23.11
Peak Elevation (FT)	4693.06
Discharge Volume (AC - FT)	69.28

Subbasin: Da2

Area (ft²) : 3.6
Downstream : Reservoir - Da2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38
Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	2518.19
Time of Peak Discharge	06Jan2000, 00:36
Volume (IN)	5.27
Precipitation Volume (AC - FT)	1372.8
Loss Volume (AC - FT)	360.03
Excess Volume (AC - FT)	1012.77
Direct Runoff Volume (AC - FT)	1012.75
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2

Downstream : Junction - 1

Results: Reservoir-Da2	
Peak Discharge (CFS)	2460.06
Time of Peak Discharge	06Jan2000, 00:44
Volume (IN)	3.98
Peak Inflow (CFS)	2518.19
Time of Peak Inflow	06Jan2000, 00:36
Inflow Volume (AC - FT)	1012.75
Maximum Storage (AC - FT)	282.1
Peak Elevation (FT)	4698.72
Discharge Volume (AC - FT)	765.07

Subbasin: Da3

Area (ft²) : 0.7
Downstream : Reservoir - Da3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	654.86
Time of Peak Discharge	06Jan2000, 00:04
Volume (IN)	5.03
Precipitation Volume (AC - FT)	240.05
Loss Volume (AC - FT)	52.45
Excess Volume (AC - FT)	187.61
Direct Runoff Volume (AC - FT)	187.61
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da3

Downstream : Junction - 1

Results: Reservoir-Da3	
Peak Discharge (CFS)	624.8
Time of Peak Discharge	06Jan2000, 00:12
Volume (IN)	3.94
Peak Inflow (CFS)	654.86
Time of Peak Inflow	06Jan2000, 00:04
Inflow Volume (AC - FT)	187.61
Maximum Storage (AC - FT)	59.95
Peak Elevation (FT)	4689.74
Discharge Volume (AC - FT)	147.06

Subbasin: Da4

Area (ft²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	1259.56
Time of Peak Discharge	06Jan2000, 00:24
Volume (IN)	4.94
Precipitation Volume (AC - FT)	592.05
Loss Volume (AC - FT)	144.41
Excess Volume (AC - FT)	447.64
Direct Runoff Volume (AC - FT)	447.64
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (ft²) : 0.9
Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	847.03
Time of Peak Discharge	06Jan2000, 00:06
Volume (IN)	5.12
Precipitation Volume (AC - FT)	313.92
Loss Volume (AC - FT)	68.02
Excess Volume (AC - FT)	245.9
Direct Runoff Volume (AC - FT)	245.9
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	555.88
Time of Peak Discharge	06Jan2000, 01:10
Volume (IN)	8.38
Peak Inflow (CFS)	1227.03
Time of Peak Inflow	06Jan2000, 00:06
Inflow Volume (AC - FT)	402.11
Maximum Storage (AC - FT)	160.85
Peak Elevation (FT)	4557.94
Discharge Volume (AC - FT)	402.08

Subbasin: Di2

Area (ft²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	859.93
Time of Peak Discharge	06Jan2000, 00:06
Volume (IN)	5.13
Precipitation Volume (AC - FT)	325.44
Loss Volume (AC - FT)	79.06
Excess Volume (AC - FT)	246.38
Direct Runoff Volume (AC - FT)	246.38
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	613.43
Time of Peak Discharge	06Jan2000, 00:08
Volume (IN)	3.07
Peak Inflow (CFS)	997.93
Time of Peak Inflow	06Jan2000, 00:08
Inflow Volume (AC - FT)	304.07
Maximum Storage (AC - FT)	14.98
Peak Elevation (FT)	4601.71
Discharge Volume (AC - FT)	147.21

Subbasin: Di3

Area (ft²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	607.65
Time of Peak Discharge	06Jan2000, 00:02

Volume (IN)	5.35
Precipitation Volume (AC - FT)	212.48
Loss Volume (AC - FT)	41.42
Excess Volume (AC - FT)	171.06
Direct Runoff Volume (AC - FT)	171.06
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3

Peak Discharge (CFS)	466.88
Time of Peak Discharge	06Jan2000, 00:04
Volume (IN)	3.54
Peak Inflow (CFS)	607.65
Time of Peak Inflow	06Jan2000, 00:06
Inflow Volume (AC - FT)	171.06
Maximum Storage (AC - FT)	11.31
Peak Elevation (FT)	4608.42
Discharge Volume (AC - FT)	113.29

Subbasin: Di4

Area (ft²) : 11.4

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs

Lag	64.2
Unitgraph Type	Standard

Results: Di4

Peak Discharge (CFS)	7383.52
Time of Peak Discharge	06Jan2000, 00:40
Volume (IN)	5.14
Precipitation Volume (AC - FT)	3970.24
Loss Volume (AC - FT)	844.95
Excess Volume (AC - FT)	3125.29
Direct Runoff Volume (AC - FT)	3125.18
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1

Peak Discharge (CFS)	2797.32
Time of Peak Discharge	06Jan2000, 00:42
Volume (IN)	4

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	1075.68
Time of Peak Discharge	06Jan2000, 00:06
Volume (IN)	3.26

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	1131.29
Time of Peak Discharge	06Jan2000, 00:06
Volume (IN)	5.18

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	950
Energy Slope	0.01
Mannings n	0.04
Bottom Width	6
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2	
Peak Discharge (CFS)	138
Time of Peak Discharge	05Jan2000, 23:44
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	57.69

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	2690
Energy Slope	0.02
Mannings n	0.04
Bottom Width	10
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200

Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	384.43
Time of Peak Discharge	05Jan2000, 23:30
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	156.21

Project: Santa Clara E A

Simulation Run: Storm Event 07

Simulation Start: 31 December 1999, 24:00

Simulation End: 1 January 2000, 09:00

HMS Version: 4.8

Executed: 23 April 2021, 02:21

Global Parameter Summary - Subbasin

Area (ft²)

Element Name	Area (ft²)
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

Downstream

Element Name	Downstream
Da1	Reservoir - Da1
Da2	Reservoir - Da2
Da3	Reservoir - Da3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

Transform: Scs

Element Name	Lag	Unitgraph Type
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard

Di3	16.8 Standard
Di4	64.2 Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (ft)	Energy Slope	Mannings n	Bottom Width	Side Slope	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	474.65	01Jan2000, 02:32	3.47
Reservoir - Da1	0.3	330.12	01Jan2000, 02:46	2.2
Da2	3.6	2324.75	01Jan2000, 03:28	2.69
Reservoir - Da2	3.6	1432.7	01Jan2000, 04:32	1.34
Da3	0.7	940.91	01Jan2000, 02:44	3.56
Reservoir - Da3	0.7	599.38	01Jan2000, 03:10	2.16
Da4	1.7	1619.14	01Jan2000, 03:12	3.4
Di1	0.9	1183.36	01Jan2000, 02:46	3.56
Reservoir - Di1	0.9	653.22	01Jan2000, 04:38	3.45
Di2	0.9	1120	01Jan2000, 02:48	3.39
Reservoir - Di2	0.9	870.53	01Jan2000, 02:50	1.55
Di3	0.6	892.46	01Jan2000, 02:38	3.68
Reservoir - Di3	0.6	745.44	01Jan2000, 02:42	1.97
Di4	11.4	9656.43	01Jan2000, 03:30	3.58
Junction - 1	4.6	1746.25	01Jan2000, 04:32	1.52
Junction - 2	1.5	1581.32	01Jan2000, 02:46	1.72
Junction - 3	2.4	1622.05	01Jan2000, 02:46	2.37
Reach - Di3 to Di2	0	138	01Jan2000, 02:34	Not specified
Reach - Di2 to Di1	0	388.98	01Jan2000, 02:24	Not specified

Subbasin: Da1

Area (ft²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs	
Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	474.65
Time of Peak Discharge	01Jan2000, 02:32
Volume (IN)	3.47
Precipitation Volume (AC - FT)	78.56
Loss Volume (AC - FT)	23.1
Excess Volume (AC - FT)	55.46
Direct Runoff Volume (AC - FT)	55.46
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	330.12
Time of Peak Discharge	01Jan2000, 02:46
Volume (IN)	2.2
Peak Inflow (CFS)	474.65
Time of Peak Inflow	01Jan2000, 02:32
Inflow Volume (AC - FT)	55.46
Maximum Storage (AC - FT)	23.27
Peak Elevation (FT)	4693.13
Discharge Volume (AC - FT)	35.12

Subbasin: Da2

Area (ft²) : 3.6
Downstream : Reservoir - Da2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	2324.75
Time of Peak Discharge	01Jan2000, 03:28
Volume (IN)	2.69
Precipitation Volume (AC - FT)	839.04
Loss Volume (AC - FT)	321.75
Excess Volume (AC - FT)	517.29
Direct Runoff Volume (AC - FT)	516.52
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2

Downstream : Junction - 1

Results: Reservoir-Da2	
Peak Discharge (CFS)	1432.7
Time of Peak Discharge	01Jan2000, 04:32
Volume (IN)	1.34
Peak Inflow (CFS)	2324.75
Time of Peak Inflow	01Jan2000, 03:28
Inflow Volume (AC - FT)	516.52
Maximum Storage (AC - FT)	274.73
Peak Elevation (FT)	4698.2
Discharge Volume (AC - FT)	257.75

Subbasin: Da3

Area (ft²) : 0.7
Downstream : Reservoir - Da3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	940.91
Time of Peak Discharge	01Jan2000, 02:44
Volume (IN)	3.56
Precipitation Volume (AC - FT)	182.93
Loss Volume (AC - FT)	50.05
Excess Volume (AC - FT)	132.89
Direct Runoff Volume (AC - FT)	132.89
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da3

Downstream : Junction - 1

Results: Reservoir-Da3	
Peak Discharge (CFS)	599.38
Time of Peak Discharge	01Jan2000, 03:10
Volume (IN)	2.16
Peak Inflow (CFS)	940.91
Time of Peak Inflow	01Jan2000, 02:44
Inflow Volume (AC - FT)	132.89
Maximum Storage (AC - FT)	59.76
Peak Elevation (FT)	4689.69
Discharge Volume (AC - FT)	80.48

Subbasin: Da4

Area (ft²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	1619.14
Time of Peak Discharge	01Jan2000, 03:12
Volume (IN)	3.4
Precipitation Volume (AC - FT)	445.17
Loss Volume (AC - FT)	136.63
Excess Volume (AC - FT)	308.54
Direct Runoff Volume (AC - FT)	308.49
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (ft²) : 0.9
Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	1183.36
Time of Peak Discharge	01Jan2000, 02:46
Volume (IN)	3.56
Precipitation Volume (AC - FT)	235.68
Loss Volume (AC - FT)	64.74
Excess Volume (AC - FT)	170.94
Direct Runoff Volume (AC - FT)	170.94
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	653.22
Time of Peak Discharge	01Jan2000, 04:38
Volume (IN)	3.45
Peak Inflow (CFS)	1563.36
Time of Peak Inflow	01Jan2000, 02:46
Inflow Volume (AC - FT)	303.4
Maximum Storage (AC - FT)	163.13
Peak Elevation (FT)	4558.06
Discharge Volume (AC - FT)	165.51

Subbasin: Di2

Area (ft²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	1120
Time of Peak Discharge	01Jan2000, 02:48
Volume (IN)	3.39
Precipitation Volume (AC - FT)	237.12
Loss Volume (AC - FT)	74.29
Excess Volume (AC - FT)	162.83
Direct Runoff Volume (AC - FT)	162.83
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	870.53
Time of Peak Discharge	01Jan2000, 02:50
Volume (IN)	1.55
Peak Inflow (CFS)	1258
Time of Peak Inflow	01Jan2000, 02:50
Inflow Volume (AC - FT)	213.47
Maximum Storage (AC - FT)	16.05
Peak Elevation (FT)	4602.16
Discharge Volume (AC - FT)	74.35

Subbasin: Di3

Area (ft²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	892.46
Time of Peak Discharge	01Jan2000, 02:38

Volume (IN)	3.68
Precipitation Volume (AC - FT)	157.12
Loss Volume (AC - FT)	39.51
Excess Volume (AC - FT)	117.61
Direct Runoff Volume (AC - FT)	117.61
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3

Peak Discharge (CFS)	745.44
Time of Peak Discharge	01Jan2000, 02:42
Volume (IN)	1.97
Peak Inflow (CFS)	892.46
Time of Peak Inflow	01Jan2000, 02:42
Inflow Volume (AC - FT)	117.61
Maximum Storage (AC - FT)	12.55
Peak Elevation (FT)	4608.95
Discharge Volume (AC - FT)	63.17

Subbasin: Di4

Area (ft²) : 11.4

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs

Lag	64.2
Unitgraph Type	Standard

Results: Di4

Peak Discharge (CFS)	9656.43
Time of Peak Discharge	01Jan2000, 03:30
Volume (IN)	3.58
Precipitation Volume (AC - FT)	2985.28
Loss Volume (AC - FT)	804.94
Excess Volume (AC - FT)	2180.34
Direct Runoff Volume (AC - FT)	2175.79
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1

Peak Discharge (CFS)	1746.25
Time of Peak Discharge	01Jan2000, 04:32
Volume (IN)	1.52

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	1581.32
Time of Peak Discharge	01Jan2000, 02:46
Volume (IN)	1.72

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	1622.05
Time of Peak Discharge	01Jan2000, 02:46
Volume (IN)	2.37

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	950
Energy Slope	0.01
Mannings n	0.04
Bottom Width	6
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2	
Peak Discharge (CFS)	138
Time of Peak Discharge	01Jan2000, 02:34
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	50.64

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	2690
Energy Slope	0.02
Mannings n	0.04
Bottom Width	10
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200

Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	388.98
Time of Peak Discharge	01Jan2000, 02:24
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	132.4

Project: Santa Clara E A

Simulation Run: Storm Event 08

Simulation Start: 31 December 1999, 24:00

Simulation End: 2 January 2000, 03:00

HMS Version: 4.8

Executed: 23 April 2021, 02:20

Global Parameter Summary - Subbasin

Area (ft²)

Element Name	Area (ft²)
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

Downstream

Element Name	Downstream
Da1	Reservoir - Da1
Da2	Reservoir - Da2
Da3	Reservoir - Da3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

Transform: Scs

Element Name	Lag	Unitgraph Type
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard

Di3	16.8	Standard
Di4	64.2	Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (ft)	Energy Slope	Mannings n	Bottom Width	Side Slope	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	149.14	01Jan2000, 10:00	4.24
Reservoir - Da1	0.3	148.44	01Jan2000, 10:02	2.97
Da2	3.6	1520.45	01Jan2000, 10:32	4.04
Reservoir - Da2	3.6	1352.53	01Jan2000, 11:10	2.7
Da3	0.7	347.57	01Jan2000, 10:04	4.33
Reservoir - Da3	0.7	332.1	01Jan2000, 10:14	2.93
Da4	1.7	771.85	01Jan2000, 10:18	4.17
Di1	0.9	440.33	01Jan2000, 10:04	4.33
Reservoir - Di1	0.9	660.79	01Jan2000, 11:12	6.73
Di2	0.9	434	01Jan2000, 10:04	4.2
Reservoir - Di2	0.9	190.66	01Jan2000, 10:08	0.9
Di3	0.6	305.8	01Jan2000, 10:02	4.47
Reservoir - Di3	0.6	166.93	01Jan2000, 10:04	1.32
Di4	11.4	5121.68	01Jan2000, 10:32	4.37
Junction - 1	4.6	1663	01Jan2000, 11:08	2.75
Junction - 2	1.5	357.03	01Jan2000, 10:06	1.07
Junction - 3	2.4	769.72	01Jan2000, 11:04	3.19
Reach - Di3 to Di2	0	138	01Jan2000, 08:42	Not specified
Reach - Di2 to Di1	0	381.31	01Jan2000, 08:38	Not specified

Subbasin: Da1

Area (ft²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs	
Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	149.14
Time of Peak Discharge	01Jan2000, 10:00
Volume (IN)	4.24
Precipitation Volume (AC - FT)	91.68
Loss Volume (AC - FT)	23.81
Excess Volume (AC - FT)	67.87
Direct Runoff Volume (AC - FT)	67.87
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	148.44
Time of Peak Discharge	01Jan2000, 10:02
Volume (IN)	2.97
Peak Inflow (CFS)	149.14
Time of Peak Inflow	01Jan2000, 10:00
Inflow Volume (AC - FT)	67.87
Maximum Storage (AC - FT)	22.32
Peak Elevation (FT)	4692.66
Discharge Volume (AC - FT)	47.57

Subbasin: Da2

Area (ft²) : 3.6
Downstream : Reservoir - Da2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	1520.45
Time of Peak Discharge	01Jan2000, 10:32
Volume (IN)	4.04
Precipitation Volume (AC - FT)	1121.28
Loss Volume (AC - FT)	345.58
Excess Volume (AC - FT)	775.7
Direct Runoff Volume (AC - FT)	775.45
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2

Downstream : Junction - 1

Results: Reservoir-Da2	
Peak Discharge (CFS)	1352.53
Time of Peak Discharge	01Jan2000, 11:10
Volume (IN)	2.7
Peak Inflow (CFS)	1520.45
Time of Peak Inflow	01Jan2000, 10:32
Inflow Volume (AC - FT)	775.45
Maximum Storage (AC - FT)	274.1
Peak Elevation (FT)	4698.15
Discharge Volume (AC - FT)	517.56

Subbasin: Da3

Area (ft²) : 0.7
Downstream : Reservoir - Da3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	347.57
Time of Peak Discharge	01Jan2000, 10:04
Volume (IN)	4.33
Precipitation Volume (AC - FT)	213.17
Loss Volume (AC - FT)	51.45
Excess Volume (AC - FT)	161.72
Direct Runoff Volume (AC - FT)	161.72
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da3

Downstream : Junction - 1

Results: Reservoir-Da3	
Peak Discharge (CFS)	332.1
Time of Peak Discharge	01Jan2000, 10:14
Volume (IN)	2.93
Peak Inflow (CFS)	347.57
Time of Peak Inflow	01Jan2000, 10:04
Inflow Volume (AC - FT)	161.72
Maximum Storage (AC - FT)	57.53
Peak Elevation (FT)	4689.13
Discharge Volume (AC - FT)	109.48

Subbasin: Da4

Area (ft²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	771.85
Time of Peak Discharge	01Jan2000, 10:18
Volume (IN)	4.17
Precipitation Volume (AC - FT)	519.52
Loss Volume (AC - FT)	141.02
Excess Volume (AC - FT)	378.5
Direct Runoff Volume (AC - FT)	378.49
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (ft²) : 0.9
Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	440.33
Time of Peak Discharge	01Jan2000, 10:04
Volume (IN)	4.33
Precipitation Volume (AC - FT)	274.56
Loss Volume (AC - FT)	66.57
Excess Volume (AC - FT)	207.99
Direct Runoff Volume (AC - FT)	207.99
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	660.79
Time of Peak Discharge	01Jan2000, 11:12
Volume (IN)	6.73
Peak Inflow (CFS)	820.33
Time of Peak Inflow	01Jan2000, 10:04
Inflow Volume (AC - FT)	457.42
Maximum Storage (AC - FT)	163.3
Peak Elevation (FT)	4558.07
Discharge Volume (AC - FT)	322.88

Subbasin: Di2

Area (ft²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	434
Time of Peak Discharge	01Jan2000, 10:04
Volume (IN)	4.2
Precipitation Volume (AC - FT)	278.4
Loss Volume (AC - FT)	76.83
Excess Volume (AC - FT)	201.57
Direct Runoff Volume (AC - FT)	201.57
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	190.66
Time of Peak Discharge	01Jan2000, 10:08
Volume (IN)	0.9
Peak Inflow (CFS)	572
Time of Peak Inflow	01Jan2000, 10:06
Inflow Volume (AC - FT)	298.87
Maximum Storage (AC - FT)	12.78
Peak Elevation (FT)	4600.76
Discharge Volume (AC - FT)	43.02

Subbasin: Di3

Area (ft²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	305.8
Time of Peak Discharge	01Jan2000, 10:02

Volume (IN)	4.47
Precipitation Volume (AC - FT)	183.68
Loss Volume (AC - FT)	40.55
Excess Volume (AC - FT)	143.13
Direct Runoff Volume (AC - FT)	143.13
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3

Peak Discharge (CFS)	166.93
Time of Peak Discharge	01Jan2000, 10:04
Volume (IN)	1.32
Peak Inflow (CFS)	305.8
Time of Peak Inflow	01Jan2000, 10:06
Inflow Volume (AC - FT)	143.13
Maximum Storage (AC - FT)	9.62
Peak Elevation (FT)	4607.7
Discharge Volume (AC - FT)	42.26

Subbasin: Di4

Area (ft²) : 11.4

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs

Lag	64.2
Unitgraph Type	Standard

Results: Di4

Peak Discharge (CFS)	5121.68
Time of Peak Discharge	01Jan2000, 10:32
Volume (IN)	4.37
Precipitation Volume (AC - FT)	3483.84
Loss Volume (AC - FT)	827.57
Excess Volume (AC - FT)	2656.27
Direct Runoff Volume (AC - FT)	2655.03
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1

Peak Discharge (CFS)	1663
Time of Peak Discharge	01Jan2000, 11:08
Volume (IN)	2.75

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	357.03
Time of Peak Discharge	01Jan2000, 10:06
Volume (IN)	1.07

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	769.72
Time of Peak Discharge	01Jan2000, 11:04
Volume (IN)	3.19

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	950
Energy Slope	0.01
Mannings n	0.04
Bottom Width	6
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2	
Peak Discharge (CFS)	138
Time of Peak Discharge	01Jan2000, 08:42
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	97.3

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	2690
Energy Slope	0.02
Mannings n	0.04
Bottom Width	10
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200

Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	381.31
Time of Peak Discharge	01Jan2000, 08:38
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	249.39

Project: Santa Clara E A

Simulation Run: Storm Event 09

Simulation Start: 31 December 1999, 24:00

Simulation End: 1 January 2000, 09:00

HMS Version: 4.8

Executed: 23 April 2021, 02:20

Global Parameter Summary - Subbasin

	Area (ft²)
Element Name	**Area (ft²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2
Da3	Reservoir - Da3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard

Di3	16.8	Standard
Di4	64.2	Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (ft)	Energy Slope	Mannings n	Bottom Width	Side Slope	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	1312.24	01Jan2000, 02:30	10.09
Reservoir - Da1	0.3	1306.32	01Jan2000, 02:32	8.81
Da2	3.6	6533.46	01Jan2000, 03:24	7.33
Reservoir - Da2	3.6	6057.94	01Jan2000, 03:42	5.98
Da3	0.7	2657.47	01Jan2000, 02:42	10.22
Reservoir - Da3	0.7	2032.06	01Jan2000, 03:02	8.81
Da4	1.7	4804.31	01Jan2000, 03:08	10
Di1	0.9	3344.14	01Jan2000, 02:44	10.21
Reservoir - Di1	0.9	2934.27	01Jan2000, 03:04	10.79
Di2	0.9	3275.07	01Jan2000, 02:44	9.95
Reservoir - Di2	0.9	2974.93	01Jan2000, 02:50	7.63
Di3	0.6	2446.04	01Jan2000, 02:38	10.35
Reservoir - Di3	0.6	2119.49	01Jan2000, 02:46	8.29
Di4	11.4	27796.15	01Jan2000, 03:26	10.22
Junction - 1	4.6	7912.97	01Jan2000, 03:30	6.59
Junction - 2	1.5	5080.73	01Jan2000, 02:48	7.89
Junction - 3	2.4	7834.66	01Jan2000, 02:54	8.98
Reach - Di3 to Di2	0	138	01Jan2000, 01:52	Not specified
Reach - Di2 to Di1	0	381.34	01Jan2000, 01:44	Not specified

Subbasin: Da1

Area (ft²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs	
Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	1312.24
Time of Peak Discharge	01Jan2000, 02:30
Volume (IN)	10.09
Precipitation Volume (AC - FT)	187.68
Loss Volume (AC - FT)	26.27
Excess Volume (AC - FT)	161.41
Direct Runoff Volume (AC - FT)	161.41
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	1306.32
Time of Peak Discharge	01Jan2000, 02:32
Volume (IN)	8.81
Peak Inflow (CFS)	1312.24
Time of Peak Inflow	01Jan2000, 02:30
Inflow Volume (AC - FT)	161.41
Maximum Storage (AC - FT)	26.71
Peak Elevation (FT)	4694.85
Discharge Volume (AC - FT)	140.99

Subbasin: Da2

Area (ft²) : 3.6
Downstream : Reservoir - Da2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	6533.46
Time of Peak Discharge	01Jan2000, 03:24
Volume (IN)	7.33
Precipitation Volume (AC - FT)	1785.6
Loss Volume (AC - FT)	376.17
Excess Volume (AC - FT)	1409.43
Direct Runoff Volume (AC - FT)	1407.63
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2

Downstream : Junction - 1

Results: Reservoir-Da2	
Peak Discharge (CFS)	6057.94
Time of Peak Discharge	01Jan2000, 03:42
Volume (IN)	5.98
Peak Inflow (CFS)	6533.46
Time of Peak Inflow	01Jan2000, 03:24
Inflow Volume (AC - FT)	1407.63
Maximum Storage (AC - FT)	317.9
Peak Elevation (FT)	4700.13
Discharge Volume (AC - FT)	1147.85

Subbasin: Da3

Area (ft²) : 0.7
Downstream : Reservoir - Da3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	2657.47
Time of Peak Discharge	01Jan2000, 02:42
Volume (IN)	10.22
Precipitation Volume (AC - FT)	437.92
Loss Volume (AC - FT)	56.33
Excess Volume (AC - FT)	381.59
Direct Runoff Volume (AC - FT)	381.59
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da3

Downstream : Junction - 1

Results: Reservoir-Da3	
Peak Discharge (CFS)	2032.06
Time of Peak Discharge	01Jan2000, 03:02
Volume (IN)	8.81
Peak Inflow (CFS)	2657.47
Time of Peak Inflow	01Jan2000, 02:42
Inflow Volume (AC - FT)	381.59
Maximum Storage (AC - FT)	99.41
Peak Elevation (FT)	4691.4
Discharge Volume (AC - FT)	329.06

Subbasin: Da4

Area (ft²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	4804.31
Time of Peak Discharge	01Jan2000, 03:08
Volume (IN)	10
Precipitation Volume (AC - FT)	1063.52
Loss Volume (AC - FT)	156.3
Excess Volume (AC - FT)	907.22
Direct Runoff Volume (AC - FT)	907.08
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (ft²) : 0.9
Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	3344.14
Time of Peak Discharge	01Jan2000, 02:44
Volume (IN)	10.21
Precipitation Volume (AC - FT)	563.04
Loss Volume (AC - FT)	72.92
Excess Volume (AC - FT)	490.12
Direct Runoff Volume (AC - FT)	490.12
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	2934.27
Time of Peak Discharge	01Jan2000, 03:04
Volume (IN)	10.79
Peak Inflow (CFS)	3724.14
Time of Peak Inflow	01Jan2000, 02:44
Inflow Volume (AC - FT)	657.14
Maximum Storage (AC - FT)	205.14
Peak Elevation (FT)	4560.03
Discharge Volume (AC - FT)	517.89

Subbasin: Di2

Area (ft²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	3275.07
Time of Peak Discharge	01Jan2000, 02:44
Volume (IN)	9.95
Precipitation Volume (AC - FT)	563.04
Loss Volume (AC - FT)	85.21
Excess Volume (AC - FT)	477.83
Direct Runoff Volume (AC - FT)	477.83
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	2974.93
Time of Peak Discharge	01Jan2000, 02:50
Volume (IN)	7.63
Peak Inflow (CFS)	3413.07
Time of Peak Inflow	01Jan2000, 02:46
Inflow Volume (AC - FT)	540.01
Maximum Storage (AC - FT)	31.1
Peak Elevation (FT)	4603.8
Discharge Volume (AC - FT)	366.16

Subbasin: Di3

Area (ft²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	2446.04
Time of Peak Discharge	01Jan2000, 02:38

Volume (IN)	10.35
Precipitation Volume (AC - FT)	375.36
Loss Volume (AC - FT)	44.04
Excess Volume (AC - FT)	331.32
Direct Runoff Volume (AC - FT)	331.32
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3

Peak Discharge (CFS)	2119.49
Time of Peak Discharge	01Jan2000, 02:46
Volume (IN)	8.29
Peak Inflow (CFS)	2446.04
Time of Peak Inflow	01Jan2000, 02:42
Inflow Volume (AC - FT)	331.32
Maximum Storage (AC - FT)	27.33
Peak Elevation (FT)	4610.73
Discharge Volume (AC - FT)	265.16

Subbasin: Di4

Area (ft²) : 11.4

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs

Lag	64.2
Unitgraph Type	Standard

Results: Di4

Peak Discharge (CFS)	27796.15
Time of Peak Discharge	01Jan2000, 03:26
Volume (IN)	10.22
Precipitation Volume (AC - FT)	7131.84
Loss Volume (AC - FT)	905.09
Excess Volume (AC - FT)	6226.75
Direct Runoff Volume (AC - FT)	6215.3
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1

Peak Discharge (CFS)	7912.97
Time of Peak Discharge	01Jan2000, 03:30
Volume (IN)	6.59

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	5080.73
Time of Peak Discharge	01Jan2000, 02:48
Volume (IN)	7.89

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	7834.66
Time of Peak Discharge	01Jan2000, 02:54
Volume (IN)	8.98

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	950
Energy Slope	0.01
Mannings n	0.04
Bottom Width	6
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2	
Peak Discharge (CFS)	138
Time of Peak Discharge	01Jan2000, 01:52
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	62.18

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	2690
Energy Slope	0.02
Mannings n	0.04
Bottom Width	10
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200

Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	381.34
Time of Peak Discharge	01Jan2000, 01:44
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	166.98

Project: Santa Clara E A

Simulation Run: Storm Event 10

Simulation Start: 31 December 1999, 24:00

Simulation End: 2 January 2000, 03:00

HMS Version: 4.8

Executed: 23 April 2021, 02:10

Global Parameter Summary - Subbasin

	Area (ft²)
Element Name	**Area (ft²)**
Da1	0.3
Da2	3.6
Da3	0.7
Da4	1.7
Di1	0.9
Di2	0.9
Di3	0.6
Di4	11.4

	Downstream
Element Name	**Downstream**
Da1	Reservoir - Da1
Da2	Reservoir - Da2
Da3	Reservoir - Da3
Di1	Reservoir - Di1
Di2	Reservoir - Di2
Di3	Reservoir - Di3

	Loss Rate: Scs		
Element Name	**Percent Impervious Area**	**Curve Number**	**Initial Abstraction**
Da1	0	86.8	0.3
Da2	0	83.9	0.38
Da3	0	87.9	0.28
Da4	0	86.2	0.32
Di1	0	87.8	0.28
Di2	0	85.8	0.33
Di3	0	88.9	0.25
Di4	0	88	0.27

	Transform: Scs	
Element Name	**Lag**	**Unitgraph Type**
Da1	7.2	Standard
Da2	60	Standard
Da3	22.2	Standard
Da4	46.8	Standard
Di1	24	Standard
Di2	24	Standard

Di3	16.8 Standard
Di4	64.2 Standard

Global Parameter Summary - Reach

Element Name	Downstream Downstream
Reach - Di3 to Di2	Reservoir - Di2
Reach - Di2 to Di1	Reservoir - Di1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (ft)	Energy Slope	Mannings n	Bottom Width	Side Slope	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - Di3 to Di2	Muskingum Cunge	Trapezoid	950	0.01	0.04	6	2	Combined Inflow	Automatic DX and DT	Index Flow	100	20	30
Reach - Di2 to Di1	Muskingum Cunge	Trapezoid	2690	0.02	0.04	10	2	Combined Inflow	Automatic DX and DT	Index Flow	200	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Da1	0.3	405.71	01Jan2000, 10:00	12.43
Reservoir - Da1	0.3	405.38	01Jan2000, 10:00	11.16
Da2	3.6	4405.78	01Jan2000, 10:24	11.98
Reservoir - Da2	3.6	4400.91	01Jan2000, 10:28	10.64
Da3	0.7	945.46	01Jan2000, 10:02	12.57
Reservoir - Da3	0.7	944.39	01Jan2000, 10:04	11.17
Da4	1.7	2196.07	01Jan2000, 10:14	12.35
Di1	0.9	1213.78	01Jan2000, 10:02	12.56
Reservoir - Di1	0.9	1586.8	01Jan2000, 10:08	20.75
Di2	0.9	1200.54	01Jan2000, 10:02	12.29
Reservoir - Di2	0.9	957.73	01Jan2000, 10:04	5.36
Di3	0.6	816.31	01Jan2000, 10:00	12.7
Reservoir - Di3	0.6	677.84	01Jan2000, 10:02	6.21
Di4	11.4	14279.43	01Jan2000, 10:26	12.58
Junction - 1	4.6	5594.84	01Jan2000, 10:08	10.75
Junction - 2	1.5	1635.08	01Jan2000, 10:02	5.7
Junction - 3	2.4	3220.7	01Jan2000, 10:04	11.34
Reach - Di3 to Di2	0	138	01Jan2000, 06:52	Not specified
Reach - Di2 to Di1	0	380.2	01Jan2000, 07:06	Not specified

Subbasin: Da1

Area (ft²) : 0.3
Downstream : Reservoir - Da1

Loss Rate: Scs

Percent Impervious Area	0
Curve Number	86.8
Initial Abstraction	0.3

Transform: Scs	
Lag	7.2
Unitgraph Type	Standard

Results: Da1	
Peak Discharge (CFS)	405.71
Time of Peak Discharge	01Jan2000, 10:00
Volume (IN)	12.43
Precipitation Volume (AC - FT)	225.6
Loss Volume (AC - FT)	26.72
Excess Volume (AC - FT)	198.88
Direct Runoff Volume (AC - FT)	198.88
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da1

Downstream : Junction - 1

Results: Reservoir-Da1	
Peak Discharge (CFS)	405.38
Time of Peak Discharge	01Jan2000, 10:00
Volume (IN)	11.16
Peak Inflow (CFS)	405.71
Time of Peak Inflow	01Jan2000, 10:00
Inflow Volume (AC - FT)	198.88
Maximum Storage (AC - FT)	23.61
Peak Elevation (FT)	4693.3
Discharge Volume (AC - FT)	178.54

Subbasin: Da2

Area (ft²) : 3.6
Downstream : Reservoir - Da2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	83.9
Initial Abstraction	0.38

Transform: Scs	
Lag	60
Unitgraph Type	Standard

Results: Da2	
Peak Discharge (CFS)	4405.78
Time of Peak Discharge	01Jan2000, 10:24
Volume (IN)	11.98
Precipitation Volume (AC - FT)	2697.6
Loss Volume (AC - FT)	396.04
Excess Volume (AC - FT)	2301.55
Direct Runoff Volume (AC - FT)	2300.94
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da2

Downstream : Junction - 1

Results: Reservoir-Da2	
Peak Discharge (CFS)	4400.91
Time of Peak Discharge	01Jan2000, 10:28
Volume (IN)	10.64
Peak Inflow (CFS)	4405.78
Time of Peak Inflow	01Jan2000, 10:24
Inflow Volume (AC - FT)	2300.94
Maximum Storage (AC - FT)	293.6
Peak Elevation (FT)	4699.54
Discharge Volume (AC - FT)	2042.34

Subbasin: Da3

Area (ft²) : 0.7
Downstream : Reservoir - Da3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.9
Initial Abstraction	0.28

Transform: Scs	
Lag	22.2
Unitgraph Type	Standard

Results: Da3	
Peak Discharge (CFS)	945.46
Time of Peak Discharge	01Jan2000, 10:02
Volume (IN)	12.57
Precipitation Volume (AC - FT)	526.4
Loss Volume (AC - FT)	57.19
Excess Volume (AC - FT)	469.21
Direct Runoff Volume (AC - FT)	469.21
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Da3

Downstream : Junction - 1

Results: Reservoir-Da3	
Peak Discharge (CFS)	944.39
Time of Peak Discharge	01Jan2000, 10:04
Volume (IN)	11.17
Peak Inflow (CFS)	945.46
Time of Peak Inflow	01Jan2000, 10:02
Inflow Volume (AC - FT)	469.21
Maximum Storage (AC - FT)	62.17
Peak Elevation (FT)	4690.29
Discharge Volume (AC - FT)	416.85

Subbasin: Da4

Area (ft²) : 1.7

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	86.2
Initial Abstraction	0.32

Transform: Scs	
Lag	46.8
Unitgraph Type	Standard

Results: Da4	
Peak Discharge (CFS)	2196.07
Time of Peak Discharge	01Jan2000, 10:14
Volume (IN)	12.35
Precipitation Volume (AC - FT)	1278.4
Loss Volume (AC - FT)	159.06
Excess Volume (AC - FT)	1119.34
Direct Runoff Volume (AC - FT)	1119.31
Baseflow Volume (AC - FT)	0

Subbasin: Di1

Area (ft²) : 0.9
Downstream : Reservoir - Di1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.8
Initial Abstraction	0.28

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di1	
Peak Discharge (CFS)	1213.78
Time of Peak Discharge	01Jan2000, 10:02
Volume (IN)	12.56
Precipitation Volume (AC - FT)	676.8
Loss Volume (AC - FT)	74.04
Excess Volume (AC - FT)	602.76
Direct Runoff Volume (AC - FT)	602.76
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di1

Downstream : Junction - 3

Results: Reservoir-Di1	
Peak Discharge (CFS)	1586.8
Time of Peak Discharge	01Jan2000, 10:08
Volume (IN)	20.75
Peak Inflow (CFS)	1593.78
Time of Peak Inflow	01Jan2000, 10:02
Inflow Volume (AC - FT)	1132.99
Maximum Storage (AC - FT)	180.89
Peak Elevation (FT)	4558.99
Discharge Volume (AC - FT)	995.95

Subbasin: Di2

Area (ft²) : 0.9
Downstream : Reservoir - Di2

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	85.8
Initial Abstraction	0.33

Transform: Scs	
Lag	24
Unitgraph Type	Standard

Results: Di2	
Peak Discharge (CFS)	1200.54
Time of Peak Discharge	01Jan2000, 10:02
Volume (IN)	12.29
Precipitation Volume (AC - FT)	676.8
Loss Volume (AC - FT)	86.76
Excess Volume (AC - FT)	590.04
Direct Runoff Volume (AC - FT)	590.04
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di2

Downstream : Junction - 2

Results: Reservoir-Di2	
Peak Discharge (CFS)	957.73
Time of Peak Discharge	01Jan2000, 10:04
Volume (IN)	5.36
Peak Inflow (CFS)	1338.54
Time of Peak Inflow	01Jan2000, 10:04
Inflow Volume (AC - FT)	794.01
Maximum Storage (AC - FT)	16.38
Peak Elevation (FT)	4602.31
Discharge Volume (AC - FT)	257.19

Subbasin: Di3

Area (ft²) : 0.6
Downstream : Reservoir - Di3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88.9
Initial Abstraction	0.25

Transform: Scs	
Lag	16.8
Unitgraph Type	Standard

Results: Di3	
Peak Discharge (CFS)	816.31
Time of Peak Discharge	01Jan2000, 10:00

Volume (IN)	12.7
Precipitation Volume (AC - FT)	451.2
Loss Volume (AC - FT)	44.65
Excess Volume (AC - FT)	406.55
Direct Runoff Volume (AC - FT)	406.55
Baseflow Volume (AC - FT)	0

Reservoir: Reservoir-Di3

Downstream : Junction - 2

Results: Reservoir-Di3	
Peak Discharge (CFS)	677.84
Time of Peak Discharge	01Jan2000, 10:02
Volume (IN)	6.21
Peak Inflow (CFS)	816.31
Time of Peak Inflow	01Jan2000, 10:04
Inflow Volume (AC - FT)	406.55
Maximum Storage (AC - FT)	12.26
Peak Elevation (FT)	4608.83
Discharge Volume (AC - FT)	198.87

Subbasin: Di4

Area (ft²) : 11.4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	88
Initial Abstraction	0.27

Transform: Scs	
Lag	64.2
Unitgraph Type	Standard

Results: Di4	
Peak Discharge (CFS)	14279.43
Time of Peak Discharge	01Jan2000, 10:26
Volume (IN)	12.58
Precipitation Volume (AC - FT)	8572.8
Loss Volume (AC - FT)	918.84
Excess Volume (AC - FT)	7653.96
Direct Runoff Volume (AC - FT)	7650.94
Baseflow Volume (AC - FT)	0

Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	5594.84
Time of Peak Discharge	01Jan2000, 10:08
Volume (IN)	10.75

Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	1635.08
Time of Peak Discharge	01Jan2000, 10:02
Volume (IN)	5.7

Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	3220.7
Time of Peak Discharge	01Jan2000, 10:04
Volume (IN)	11.34

Reach: Reach-Di3 to Di2

Downstream : Reservoir - Di2

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	950
Energy Slope	0.01
Mannings n	0.04
Bottom Width	6
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	100
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di3 to Di2	
Peak Discharge (CFS)	138
Time of Peak Discharge	01Jan2000, 06:52
Peak Inflow (CFS)	138
Inflow Volume (AC - FT)	203.96

Reach: Reach-Di2 to Di1

Downstream : Reservoir - Di1

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	2690
Energy Slope	0.02
Mannings n	0.04
Bottom Width	10
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	200

Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-Di2 to Di1

Peak Discharge (CFS)	380.2
Time of Peak Discharge	01Jan2000, 07:06
Peak Inflow (CFS)	380
Inflow Volume (AC - FT)	530.21

REQUEST FOR AQUATIC RESOURCES DELINEATION VERIFICATION

OR JURISDICTIONAL DETERMINATION

A separate jurisdictional determination (JD) is not necessary to process a permit. An Approved Jurisdictional Determination (AJD) is required to definitively determine the extent of waters of the U.S. and is generally used to disclaim jurisdiction over aquatic resources that are not waters of the U.S., in cases where the review area contains no aquatic resources, and in cases when the recipient wishes to challenge the water of the U.S. determination on appeal. Either an Aquatic Resources Delineation Verification or a Preliminary Jurisdictional Determination (PJD) may be used when the recipient wishes to assume that aquatic resources are waters of the U.S. for the purposes of permitting. In some circumstances an AJD may require more information, a greater level of effort, and more time to produce. If you are unsure which product to request, please speak with your project manager or call the Sacramento District's general information line at (916) 557-5250.

I am requesting the product indicated below from the U.S. Army Corps of Engineers, Sacramento District, for the review area located at:

Street Address: Numerous Review Areas in Washington County (see attached location document and maps) City: N/A County: Washington
State: Utah Zip: N/A Section: see attached Township: see attached Range: see attached
Latitude (decimal degrees): see attached Longitude (decimal degrees): see attached
The approximate size of the review area for the JD is 360 acres. **(Please attach location map)**

Choose one:
- ○ I own the review area
- ○ I hold an easement or development rights over the review area
- ○ I lease the review area
- ○ I plan to purchase the review area
- ◉ I am an agent/consultant acting on behalf of the requestor
- ○ Other: ____

Choose one product:
- ○ I am requesting an Aquatic Resources Delineation Verification
- ◉ I am requesting an Approved JD
- ○ I am requesting a Preliminary JD
- ○ I am requesting additional information to inform my decision about which product to request

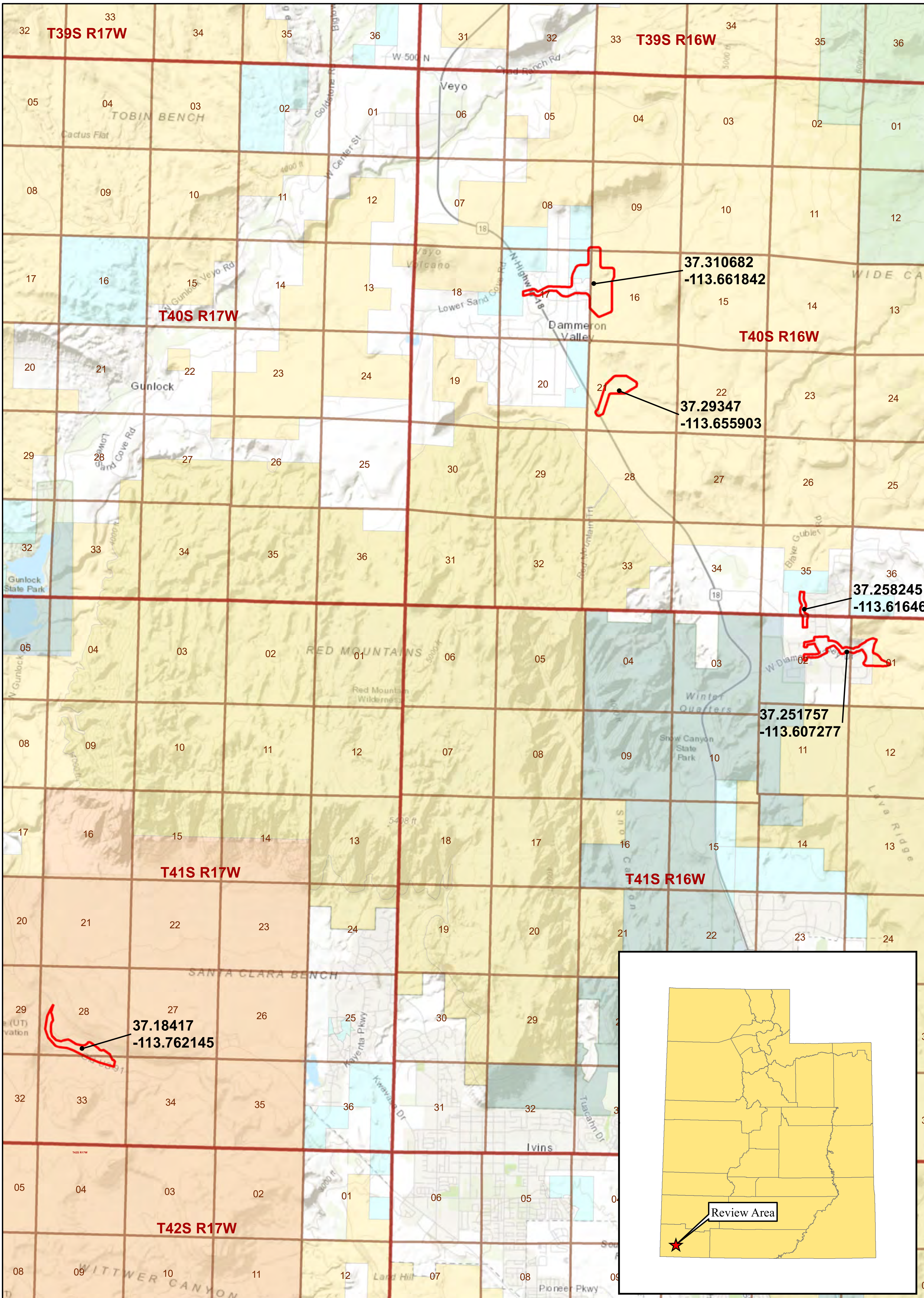
Reason for request: (check all that apply)
- [x] I need information concerning aquatic resources within the review area for planning purposes.
- [ ] I intend to construct/develop a project or perform activities in this review area which would be designed to avoid all aquatic resources.
- [ ] I intend to construct/develop a project or perform activities in this review area which would be designed to avoid those aquatic resources determined to be waters of the U.S.
- [ ] I intend to construct/develop a project or perform activities in this review area which may require authorization from the Corps; this request is accompanied by my permit application.
- [ ] I intend to construct/develop a project or perform activities in a navigable water of the U.S. which is included on the district's list of navigable waters under Section 10 of the Rivers and Harbors Act of 1899 and/or is subject to the ebb and flow of the tide.
- [ ] My lender, insurer, investors, local unit of government, etc. has indicated that an aquatic resources delineation verification is inadequate and is requiring a jurisdictional determination.
- [ ] I intend to contest jurisdiction over particular aquatic resources and request the Corps confirm that these aquatic resources are or are not waters of the U.S.
- [ ] I believe that the review area may be comprised entirely of dry land.
- [x] Other: intend to construct within the review area and need the corp's determination as to what features are jurisdictional

Attached Information:
- [x] Maps depicting the general location and aquatic resources within the review area consistent with Map and Drawing Standards for the South Pacific Division Regulatory Program (Public Notice February 2016, http://www.spd.usace.army.mil/Missions/Regulatory/Public-Notices-and-References/Article/651327/updated-map-and-drawing-standards/)
- [x] Aquatic Resources Delineation Report, if available, consistent with the Sacramento District's Minimum Standards for Acceptance (Public Notice January 2016, http://1.usa.gov/1V68IYa)

By signing below, you are indicating that you have the authority, or are acting as the duly authorized agent of a person or entity with such authority, to and do hereby grant Corps personnel right of entry to legally access the review area. Your signature shall be an affirmation that you possess the requisite property rights for this request on the subject property.

*Signature: ____ Date: 10/13/2021
Name: Todd Edwards Company name: Washington County
Address: 197 East Tabernacle Street
St. George, UT 84790
Telephone: 435-773-3599 Email: todd.edwards@washco.utah.gov

***Authorities:** Rivers and Harbors Act, Section 10, 33 USC 403; Clean Water Act, Section 404, 33 USC 1344; Marine Protection, Research, and Sanctuaries Act, Section 103, 33 USC 1413; Regulatory Program of the U.S. Army Corps of Engineers; Final Rule for 33 CFR Parts 320-332.
Principal Purpose: The information that you provide will be used in evaluating your request to determine whether there are any aquatic resources within the project area subject to federal jurisdiction under the regulatory authorities referenced above.
Routine Uses: This information may be shared with the Department of Justice and other federal, state, and local government agencies, and the public, and may be made available as part of a public notice as required by federal law. Your name and property location where federal jurisdiction is to be determined will be included in the approved jurisdictional determination (AJD), which will be made available to the public on the District's website and on the Headquarters USACE website.
Disclosure: Submission of requested information is voluntary; however, if information is not provided, the request for an AJD cannot be evaluated nor can an AJD be issued.



Santa Clara Watershed EA
SPK 2021-00134

Drawn By: C Melisi
Date: 10/11/2021

Project Location

No.	Revision	Date	By	Appr.

0 0.5 1 2 3
Miles

Transcon environmental | Planners & Scientists

Legend

Review Area

Land Jurisdiction

- Bureau of Land Management
- Indian Reservation
- US Forest Service
- School and Institutional Trust Lands Administration
- Utah State Parks
- Private

APPENDIX E-6

TECHNICAL DOCUMENTS, CONTINUED

Plan of Development

Santa Clara Watershed EA

Geotechnical Investigations Reclamation

Washington County

National Resource Conservation Service

Submitted to
Bureau of Land Management
345 East Riverside Drive
St. George, Utah 84790

Submitted by
Washington County
197 East Tabernacle Street
St. George, Utah 84770

June 2021

ALPHA ENGINEERING

RB&G ENGINEERING, INC.

Table of Contents

Part I. Introduction

A. Background

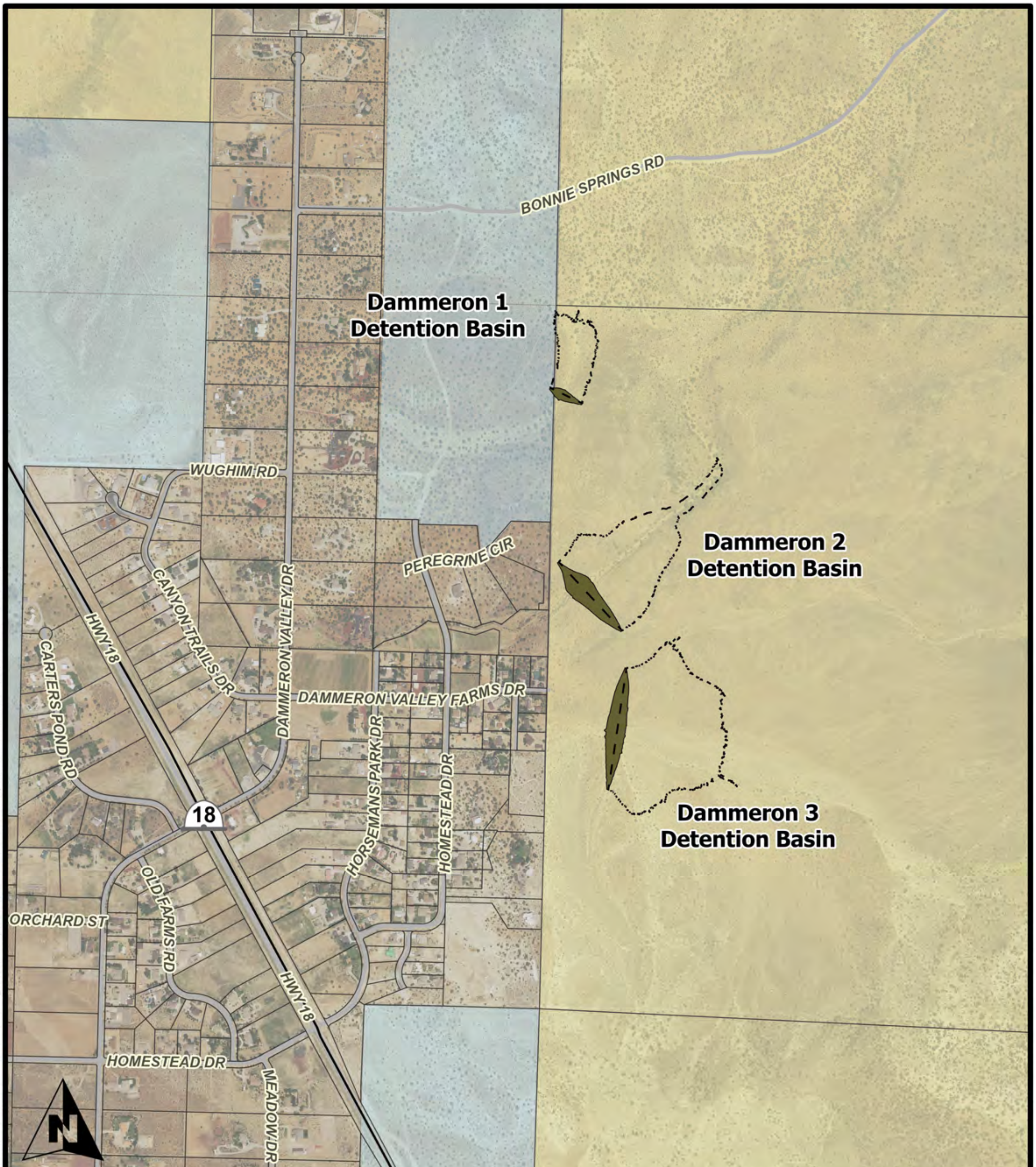
Washington County (County) is proposing to construct three new detention basins and rehabilitate three existing detention basins with associated facilities on property partially owned by the Bureau of Land Management (BLM) located upstream of the Dammeron Valley and Diamond Valley communities in Washington County, Utah. As proposed, the detention basins would be constructed by the County.

The project will protect downstream properties from flood damage during large storm events. The components of the project include (see **Figure 1** and **Figure 2**):

- Dams
- Low Level Outlets (Open)
- Principal Spillways
- Auxiliary Spillways
- Pipelines
- Channel Armoring

The dams will be designed to maximize storage capacity with principal/auxiliary spillways to sustain the improvements during storm events. In order to construct the dam, the County will require access onto BLM property to perform geotechnical investigative test pits and borings (see **Exhibits 1 and 2, Appendix B**).

This Plan of Development (POD) includes descriptions of and guidelines for the reclamation from the geotechnical investigations. The County would perform the investigations and reclamation in conformity with the approved POD.



0 340 670 1,300 2,000

Feet

High Water

Dam Location

Land Ownership

Federal

Private

State

Tribal

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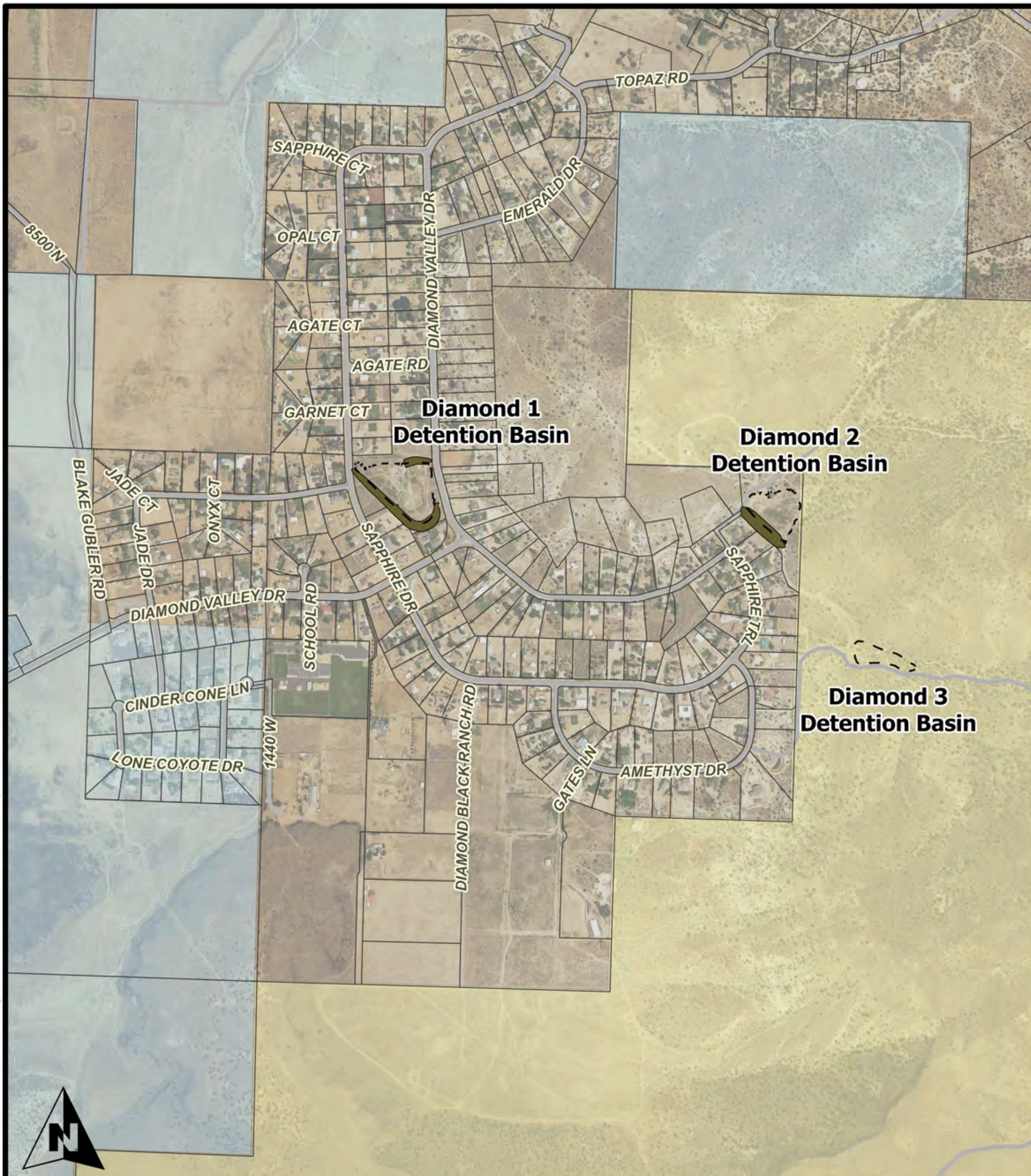
Dammeron Valley

Figure 1

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 1,000 feet
Date:	June 2, 2021

P:\308-10 Washington County - Santa Clara Watershed Plan EA\Drawings\GIS\ArcGIS Pro\Santa Clara EA POD.aprx, Damm Exhibit 85x11, 6/3/2021 9:47 AM jmadsen



0 340 670 1,300 2,000

Feet

High Water

Dam Location

Land Ownership

Federal

Private

State

Tribal

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Diamond Valley

Figure 2

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1" = 1,000 feet
Date:	June 2, 2021

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Part II. Purpose and Need for Facility

The primary purpose of the project is to protect the downstream residents and improvements. This purpose would be achieved by limiting and storing detained flows within the detention basins. Flows will be released from the detention basins at a rate not to exceed the capacity of existing downstream drainage infrastructure.

The three new Dammeron Valley detention basins will be installed on previously undisturbed and non-detained drainage tributary basins. The three existing Diamond Valley detention basins will consist of rehabilitating existing detention basins. The rehabilitated basins are currently filled with sediment deposits and do not provide flood protection as originally intended with the dams. This project will remove the sediment deposits and re-install the dams to bring them up to current safety standards.

As part of this project, improvements will be made to armor existing channels that are downstream of the detention basins. The armoring will protect the existing channels from erosion.

Before final design can be completed on the detention basins, a geotechnical investigation will be required. The investigations will cause disturbance on BLM property. A Standard From 299 (SF-299) has been submitted to the BLM indicating the investigation requirements. The submitted SF-299 is being attached as **Appendix C**.

Part III. Project Description and Land Ownership

A. Project Description and Land Ownership

The proposed detention basins and appurtenant elements are located on privately- and BLM-owned lands. Permanent facilities would consist of six earthen dams, principal and auxiliary spillways, and pipelines. The project layout with land ownership is shown on **Figures 2a and 2b**.

B. Right of Way

The submitted SF-299 (**Appendix C**) indicates the Right of Way requirements for the project geotechnical investigations. The County has received resolution approval from the County Commission to proceed with the work and filing of SF-299 (**Appendix D**). A short-term ROW has been applied for and accepted by the BLM (**Appendix E**).

C. Government Agencies Involved

The government agencies potentially involved include:

- Washington County
- Natural Resource Conservation Service
- Bureau of Land Management
- Community of Dammeron Valley
- Community of Diamond Valley
- Utah State Division of Water Rights, Dam Safety

Part IV. Facility Construction & Design

A. Schedule

Construction would commence after necessary permits are obtained for the geotechnical investigations and are expected to last approximately four weeks. Construction of the detention basins is expected to occur in 2022.

B. Geotechnical Investigation

The scope of work and field activities are summarized in **Exhibits 1 and 2** (**Appendix A**) and the attached SF-299 (**Appendix C**).

C. Resource Value and Environmental Concerns

The environmental concerns are discussed in the attached SF-299 (**Appendix C**). Best Management Practices (**Appendix A**) will be followed during the investigations.

D. Termination and Restoration

After the geotechnical investigations have been completed or if the project is to be terminated or abandoned after the site has been disturbed, a joint inspection would be held with the authorized officer(s) of the BLM prior to termination. The County will make all feasible efforts to restore the conditions to the original environment where any disturbance has taken place. This will include re-contouring the ground to existing conditions and re-seeding with an approved seed mix. The joint inspection will identify additional restoration measures that may be required in determining an acceptable and specific rehabilitation plan for the area.

Appendix A. Best Management Practices

Best Management Practices

As part of standard operating procedures, standard BMPs would be implemented throughout the project in order to reduce potential adverse environmental impacts. Most of the impacts are short term and generally occur during the construction period. Project design and implementation of site-specific or selectively recommended BMPs would minimize the effect of the project where the potential for long-term, adverse impacts may occur.

STANDARD BMPs
1. All construction vehicle movement outside of the right-of-way would be restricted to pre-designated access, contractor acquired access, or public roads.
2. The limits of construction activities would be predetermined, with activity restricted to and confined within those limits. No paint or permanent discoloring agents would be applied to rocks or vegetation to indicate survey or construction activity limits. The right-of-way boundary would be flagged in environmentally sensitive areas described in the plan of development to alert construction personnel that those areas would be avoided.
3. In construction areas where re-contouring is not required, vegetation would be left in place wherever possible to avoid excessive root damage and allow for re-sprouting.
4. In construction areas where ground disturbance is significant or where re-contouring is required, surface restoration would occur as required by the landowner or land management agency. The method of restoration typically would consist of returning disturbed areas to their natural contour (to the extent practical) and reseeding or re-vegetating with native plants. Seed viability would be tested and seed mixes would be certified to contain no noxious weeds.
5. Prior to construction, all construction personnel would be instructed on the protection of cultural, paleontological, and ecological resources. To assist in this effort, the construction contract would address (a) federal and state laws regarding antiquities, fossils, and plants and wildlife, including collection and removal; and (b) the importance of these resources and the purpose and necessity of protecting them.
6. An initial intensive cultural resource inventory survey would be conducted prior to construction. Impact avoidance and mitigation measures developed in consultation with appropriate land management and regulatory agencies and other interested parties would be implemented subsequent to the completion of the NEPA compliance document.
7. Any cultural and/or paleontological resource discovered during construction by the COUNTY or any person working on their behalf on public or federal land would be reported immediately to the authorized officer. The County would suspend operations in the area until an evaluation is completed to prevent the loss of cultural or scientific values.
8. All construction and maintenance activities would be conducted in a manner that would minimize disturbance to vegetation, drainage channels, and intermittent and perennial stream banks. In addition, dust-control measures would be utilized as necessary during construction in sensitive areas. Any used existing roads would be left in a condition equal to or better than their condition prior to construction.

STANDARD BMPs
9. All requirements of those entities having jurisdiction over air quality matters would be adhered to and any necessary permits for construction activities would be obtained. Open burning of construction trash (cleared trees, etc.) would not be allowed on BLM- or USFS-administered lands.
10. Fences and gates, if damaged or destroyed by construction activities, would be repaired or replaced to their original pre-disturbed condition as required by the landowner or the land management agency. Temporary gates would be installed only with the permission of the landowner or the land management agency.
11. Totally enclosed containment would be provided for all hazardous materials (if needed) and trash. All construction waste including trash, litter, garbage, other solid waste, petroleum products, and other potentially hazardous materials would be removed to a disposal facility authorized to accept such materials.
12. Third-party environmental contractors would be used throughout the construction effort, from clearing through rehabilitation.
13. The County would trim trees in preference to cutting trees, and would cut trees in preference to bulldozing them.
14. Construction holes left open overnight would be covered to prevent livestock or wildlife from harm.
15. The contractor would clean off-road equipment (power or high-pressure cleaning) of all mud, dirt, and plant parts prior to moving equipment onto public land.

ADDITIONAL STIPULATIONS

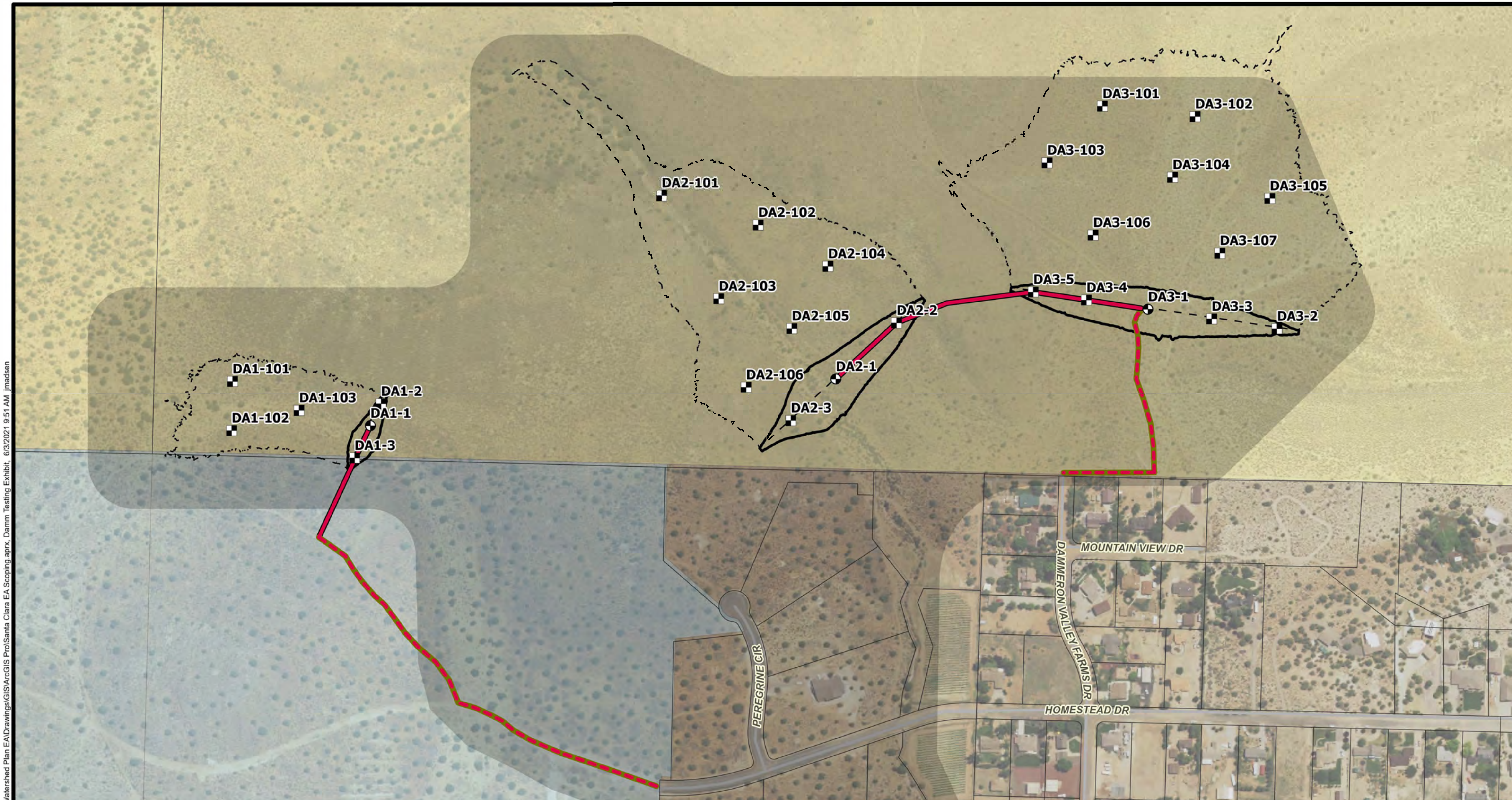
The following additional stipulations would be implemented throughout the construction and operation of the project and would be included as part of the standard operating procedures.

STIPULATIONS – STANDARD OPERATING PROCEDURES
1. County would construct, operate, and maintain the facilities, improvements, and structures within this ROW in strict conformity with the plan of development as it is approved. Any relocation, additional construction, or use that is not in accord with the approved plan of development would not be initiated without the prior written approval of the authorized officer. A copy of the complete ROW grant or acknowledgment, including all stipulations and approved plan of development, would be made available on the ROW area during construction, operation, and maintenance to the authorized officer. Noncompliance with the above shall be grounds for an immediate temporary suspension of activities if it constitutes a threat to public health and safety or a material threat to the environment.
2. This plan of development describes in detail the construction, operation, maintenance of the ROW and its associated improvements and/or facilities. An approved plan of development may be referred to for interpretation of the right-of-way grant.
3. County would contact the authorized officer at least 10 days prior to the anticipated start of construction and/or any surface-disturbing activities. The authorized officer may require and

STIPULATIONS – STANDARD OPERATING PROCEDURES
schedule a preconstruction conference with the County prior to commencement of construction and/or surface-disturbing activities on the ROW. The County, its contractor(s), or agents involved with the construction and/or surface-disturbing activities on the ROW should attend this conference to review the stipulations of the grant and the plan(s) of development.
4. County would designate a representative(s) who would have the authority to act upon and implement instructions from the authorized officer within a reasonable time when construction or other surface-disturbing activities are underway.
5. County would protect all survey monuments found within the right-of-way. Survey monuments include but are not limited to General Land Office and BLM Cadastral Survey Corners, reference corners, witness points, U.S. Coastal and Geodetic benchmarks and triangulation stations, military control monuments, and recognizable civil (both public and private) survey monuments. In the event of obliteration or disturbance of any of the above, the County would immediately report the incident, in writing, to the authorized officer and the respective installing authority, if known. Where General Land Office or BLM ROW monuments or references are obliterated during operations, County shall secure the services of a registered land surveyor or a BLM cadastral surveyor to restore the disturbed monuments and references using surveying procedures found in the *Manual of Surveying Instructions for the Survey of the Public Lands of the United States*, latest edition. County shall record such survey in the appropriate county and send a copy to the authorized officer. If the BLM cadastral surveyors or other federal surveyors are used to restore the disturbed survey monument, County would be responsible for the survey cost.
6. The County or the successor in interest shall comply with Title VI of the Civil Rights Act of 1964 (42 U.S.C. 2000d et. seq.) and the regulations of the Secretary of Interior issued pursuant hereto.
7. County would mark the exterior boundaries of the ROW with a stake and/or lath. The intervals may be varied at the time of staking at the discretion of the authorized officer. The tops of the stakes and/or laths would be painted and the laths flagged in a distinctive color as determined by the holder. The survey station numbers would be marked on the boundary stakes and/or laths at the entrance to and exit from public land. Holder would maintain all boundary stakes and/or laths in place until final cleanup and restoration are completed and approved by the authorized officer. The stakes and/or laths would then be removed at the direction of the authorized officer.
8. County would conduct all activities associated with the construction, operation, and maintenance of the right-of-way within the authorized limits of the ROW and approved plan of development.
9. County would survey and clearly mark the centerline and/or exterior limits of the ROW, as determined by the authorized officer.
10. All design, material, and construction, operation, maintenance, and termination practices would be in accordance with safe and proven engineering practices.
11. County would inform the authorized officer within 48 hours of any accidents on federal lands that require reporting to the Department of Transportation as required by 49 CFR Part 195.
12. During conditions of extreme fire danger, operations may be suspended or limited in certain areas.
13. County would be liable for damage or injury to the United States to the extent provided by 43 CFR Sec. 2803.1-4. County would be held to a standard of strict liability for damage or injury to the

STIPULATIONS – STANDARD OPERATING PROCEDURES
United States resulting from fire or soil movement (including landslides and slumps as well as wind and water-caused movement of particles) caused or substantially aggravated by any of the following within the ROW or permit area: • Activities of the holder including but not limited to construction, operation and maintenance of the facility. • Activities of other parties acting under color of authority from the County, including but not limited to: - land clearing - earth-disturbing and earth-moving work - blasting
14. Within 30 days of completion, County would submit to the authorized officer, as-built drawings and a certification of construction verifying that the facility has been constructed (and tested) in accordance with the design, plans, specifications, and applicable laws and regulations.
15. Construction sites would be maintained in a sanitary condition at all times; waste materials at those sites would be disposed of promptly at an appropriate waste disposal site. "Waste" means all discarded matter including but not limited to human waste, debris, garbage, refuse, oil drums, petroleum products, ashes, and equipment.
16. Prior to preconstruction activities on the subject parcel, County would identify all noxious weeds present. A list of the weeds would be provided to the authorized officer. A determination would be made by the authorized officer of any noxious weeds that may require flagging for treatment. County shall treat the noxious weeds as required by the authorized officer.
17. County would clean off-road equipment (power or high-pressure cleaning) of all mud, dirt, and plant parts prior to moving equipment onto public land authorized under this lease.
18. Gravel and/or fill material to be placed in relatively weed-free areas must come from weed-free sources. Prior to obtaining gravel and/or fill material, the authorized officer would inspect the source for weeds and determine adequacy of site.
19. County would identify a road maintenance program, which would include monitoring for noxious weeds. If County identifies any noxious weeds, County would notify the authorized officer immediately. A treatment program would be identified and County would be responsible for weed abatement.

Appendix B. Test Pit Exhibits



0 150 300 600
Feet

ALPHA ENGINEERING
43 South 100 East, Suite 100 • St George, Utah 84770
T: 435.628.6500 • F: 435.628.6553 • alphaengineering.com

Proposed Boring Location
Proposed Test Pit Location
New Road
Existing Road
High Water
Dam Location

EA Boundary
Land Ownership
Federal
Private
State
Tribal

N

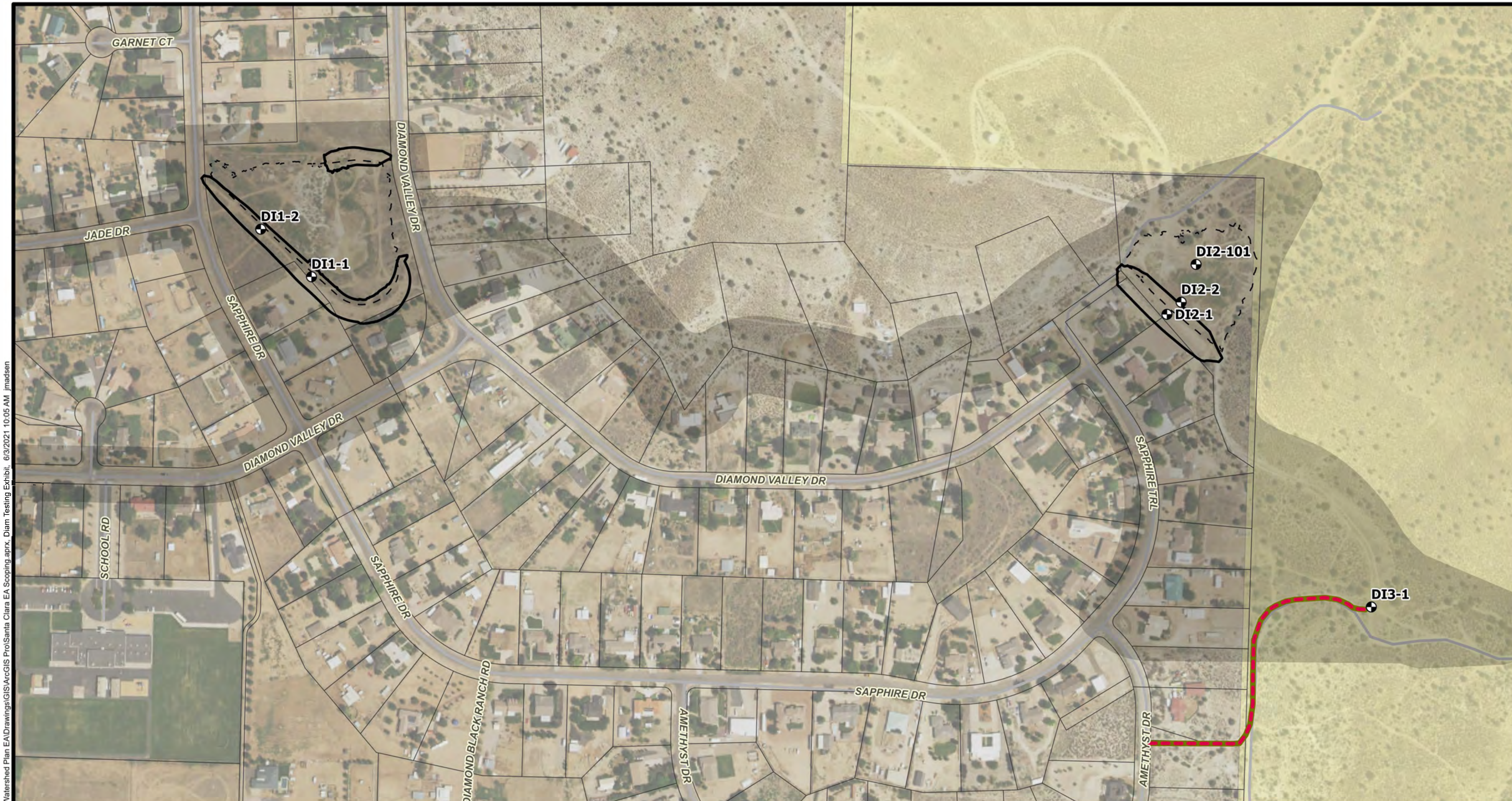
Exhibit 1

Dammeron Valley Test Hole Locations

Santa Clara Watershed EA

Spatial Reference:	Utah State Plane NAD 83, feet
Drawn By:	JTM
Scale:	1" = 300 feet
Date:	April 2, 2021

P:\308-10 Washington County - Santa Clara Watershed Plan EA\Drawings\GIS\ArcGIS Pro\Santa Clara EA Scoping.aprx, Damm Testing Exhibit, 6/3/2021 9:51 AM jmadsen



0 150 300 600
Feet

Proposed Boring Location
New Road
Existing Road
High Water
Dam Location
EA Boundary

Land Ownership
Federal
Private
State
Tribal

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Exhibit 2

Diamond Valley Test Hole Locations

Santa Clara Watershed EA

Spatial Reference:	Utah State Plane NAD 83, feet
Drawn By:	JTM
Scale:	1" = 300 feet
Date:	April 2, 2021

Appendix C. SF-299

STANDARD FORM 299 (REV. 3/2020)

APPLICATION FOR TRANSPORTATION, UTILITY SYSTEMS, TELECOMMUNICATIONS AND FACILITIES ON FEDERAL LANDS AND PROPERTY

FORM APPROVED
OMB Control Number: 0596-0249
Expiration Date: 2/28/2023

FOR AGENCY USE ONLY
Application Number
Date Filed

NOTE: Before completing and filing the application for an authorization (easement, right-of-way, lease, license or permit), the applicant should completely review this package, including instructions, and schedule a pre-application meeting with representatives of the agency responsible for processing the application. Each agency may have specific and unique requirements to be met in preparing and processing the application. Many times, with the help of the agency representative, the application can be completed at the pre-application meeting.

1. Name and address of applicant	2. Name and address of authorized agent if different from item 1	3. Applicant telephone number and email:
Washington County c/o Todd Edwards, City Engineer 197 East Tabernacle St. George, Utah 84770	Alpha Engineering c/o Brent Gardner 43 South 100 East Suite 100 St. George, Utah 84770	(435) 256-6333 todd.edwards@washco.utah.gov Authorized agent telephone number and email: (435) 628-6500 brentgardner@alphaengineer.com

4. As applicant are you? *(check one)*

a. ☐ Individual
b. ☐ Corporation*
c. ☐ Partnership/Association*
d. ☐ State Government/State Agency
e. ☑ Local Government
f. ☐ Federal Agency

** If checked, complete supplemental page*

5. Specify what application is for: *(check one)*

a. ☑ New authorization
b. ☐ Renewing existing authorization number
c. ☐ Amend existing authorization number
d. ☐ Assign existing authorization number
e. ☐ Existing use for which no authorization has been received *
f. ☐ Other*

** If checked, provide details under item 7*

6. If an individual, or partnership, are you a citizen(s) of the United States? ☐ Yes ☐ No

7. Project description *(describe in detail)*: (a) Type of use or occupancy, *(e.g., canal, pipeline, road, telecommunications);* (b) related structures and facilities; (c) physical specifications *(Length, width, grading, etc.)*; (d) term of days/years needed; (e) time of year of use or operation; (f) Volume or amount of product to be transported; (g) duration and timing of construction; and (h) temporary work areas needed for activity/construction *(Attach additional sheets, if additional space is needed.)*

a) The proposed use is for drilling and test pits to examine soil conditions for three potential future debris basins in the Dammeron Valley area and one potential site in Diamond Valley.
b) Drill rig and trackhoe will be mobilized to the debris basin sites.
c) One bore will be done on the Diamond Valley site on BLM Ground (see attached map). There are 24 proposed test pit sites (20'x20') and 3 bore sites proposed in the Dammeron Valley area (see attached map).
d) The easement will be temporary for drilling and access to the drilling and test pit sites. Should be completed within 60 days of approval.
e) During the fall of 2021.
f) Drill rig and trackhoe to perform test pits and borings will be the only material needed.
g) It is estimated to be completed within 60 days of the permit being issued.
h) Figures attached show locations and temporary access roads. The test pits will disturb an area approximately 20'x20' in size. The drill rig will bore holes approximately 4" in diameter with minimal surface disturbance.

8. Attach a map covering area and show location of project proposal.

9. State or Local government approval: ☐ Attached ☐ Applied for ☑ Not Required

10. Nonrefundable application fee: ☐ Attached ☐ Not required ☑ To be determined by agency

11. Does project cross international boundary or affect international waterways? ☐ Yes ☑ No *(if "yes," indicate on map)*

12. Give statement of your technical and financial capability to construct, operate, maintain, and terminate system for which authorization is being requested.

Washington County has partnered with the NRCS to fund this project and therefore can meet all financial and operational obligations. They have performed multiple projects locally that are located on property managed by the BLM.

13a. Describe other alternative locations considered.
Washington County has evaluated multiple debris basin sites in the area. Coordination with BLM was made on the sites chosen. It may be found during the drilling and test pit exploration that these sites are not suitable for the debris basins. Other alternatives may be considered at that point in time.

b. Why were these alternatives not selected?
The alternatives at this point are not suitable for dams or dam sites are too large.

c. Give explanation as to why it is necessary to use or occupy Federal assets (lands or buildings).
The debris basins sites chosen serve a larger area affected by flooding. Exploration of the sites will determine the suitability of the soils.

14. List authorizations and pending applications filed for similar projects which may provide information to the authorizing agency. *(Specify number, date, code, or name)*
Washington County has other authorizations in the general area for other projects which are on file.

15. Provide statement of need for project, including the economic feasibility and items such as: (a) cost of proposal (construction, operation, and maintenance); (b) estimated cost of next best alternative; and (c) expected public benefits.
a) The estimated cost for drilling and test pits is $95,000.
b) The next best alternative is $130,000.
c) Exploration will determine feasibility of the sites.

16. Describe probable effects on the population in the area, including the social and economic aspects, and the rural lifestyles.
The proposed debris basins will provide flood protection and routing of storms through multiple subdivisions and homes.

17. Describe likely environmental effects that the proposed project will have on: (a) air quality; (b) visual impact; (c) surface and ground water quality and quantity; (d) the control or structural change on any stream or other body of water; (e) existing noise levels; and (f) the surface of the land, including vegetation, permafrost, soil, and soil stability; and, (g) historic or archaeological resources or properties.
a) The project will have no long term impacts on air quality. b) The drill holes and test put will be below ground. c) The project will have no long term impacts on water quality. d) The exploration will not change ephemeral stream. e) Noise levels will temporarily increase for a few weeks. f) The project will have little effect to vegetation. g) No archaeological sites are visible.

18. Describe the probable effects that the proposed project will have on (a) populations of fish, plant life, wildlife, and marine life, including threatened and endangered species; and (b) marine mammals, including hunting, capturing, collecting, or killing these animals.
We anticipate no probable effects on fish, wildlife, or marine life or hunting, capturing or killing of these animals. There will be minimal disturbance to plant life with the placement of access roads on previously disturbed trails.

19. State whether any hazardous material, as defined in this paragraph, would be used, produced, transported or stored on or in a federal building or federal lands or would be used in connection with the proposed use or occupancy. "Hazardous material" shall mean (a) any hazardous substance under section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9601(14); (b) any pollutant or contaminant under section 101(33) of CERCLA, 42 U.S.C. § 9601(33); (c) any petroleum product or its derivative, including fuel oil, and waste oils; and (d) any hazardous substance, extremely hazardous substance, toxic substance, hazardous waste, ignitable, reactive or corrosive materials, pollutant, contaminant, element, compound, mixture, solution or substance that may pose a present or potential hazard to human health or the environment under any applicable environmental laws. The holder shall not store any hazardous materials at the site without prior written approval from the authorized officer. This approval shall not be unreasonably withheld. If the authorized officer provides approval, this permit shall include (or in the case of approval provided after this permit is issued, shall be amended to include) specific terms addressing the storage of hazardous materials, including the specific type of materials to be stored, the volume, the type of storage, and a spill plan. Such terms shall be proposed by the holder and are subject to approval by the authorized officer.
It is anticipated that no hazardous materials will be stored on site.

20. Name all the Federal Department(s)/Agency(ies) where this application is being filed.
Bureau of Land Management

I HEREBY CERTIFY, That I am of legal age and authorized to do business in the State and that I have personally examined the information contained in the application and believe that the information submitted is correct to the best of my knowledge.

Signature of Applicant	Date
Todd Edwards — Digitally signed by Todd Edwards Date: 2021.05.19 15:51:43 -06'00'	May 19, 2021

Title 18, U.S.C. Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious, or fraudulent statements or representations as to any matter within its jurisdiction.

GENERAL INFORMATION
ALASKA NATIONAL INTEREST LANDS

This application will be used when applying for a right-of-way, permit, license, lease, or certificate for the use of Federal lands which lie within conservation system units and National Recreation or Conservation Areas as defined in the Alaska National Interest lands Conservation Act. Conservation system units include the National Park System, National Wildlife Refuge System, National Wild and Scenic Rivers System, National Trails System, National Wilderness Preservation System, and National Forest Monuments.

Transportation utility systems telecommunication installations facility uses for which the application may be used are:

1. Canals, ditches, flumes, laterals, pipes, pipelines, tunnels, and other systems for the transportation of water.

2. Pipelines and other systems for the transportation of liquids other than water, including oil, natural gas, synthetic liquid and gaseous fuels, and any refined product produced therefrom.

3. Pipelines, slurry and emulsion systems, and conveyor belts for transportation of solid materials.

4. Systems for the transmission and distribution of electric energy.

5. Wired and wireless systems for transmission or reception of radio, television, telephone, telegraph, and other electronic signals, and other means of communications.

6. Improved right-of-way for snow machines, air cushion vehicles, and all-terrain vehicles.

7. Roads, highways, railroads, tunnels, tramways, airports, landing strips, docks, and other systems of general transportation.

This application must be filed simultaneously with each Federal department or agency requiring authorization to establish and operate your proposal.

In Alaska, the following agencies will help the applicant file an application and identify the other agencies the applicant should contact and possibly file with:

Department of Agriculture
Regional Forester, Forest Service (USFS)
P.O. Box 21628
Juneau, Alaska 99802-1628
Telephone: (907) 586-7847
(or a local Forest Service Office)

Department of the Interior
Bureau of Indian Affairs (BIA)
Alaska Regional Office
709 West 9th Street
Juneau, Alaska 99802
Telephone: (907) 586-7177

Department of the Interior
Alaska State Office
Bureau of Land Management
222 West 7th Avenue #13
Anchorage, Alaska 99513
Public Room: 907-271-5960
FAX: 907-271-3684
(or a local BLM Office)

U.S. Fish & Wildlife Service (FWS)
Office of the Regional Director
1011 East Tudor Road
Anchorage, Alaska 99503
Telephone: (907) 786-3440

National Park Service (NPS)
Alaska Regional Office
240 West 5th Avenue
Anchorage, Alaska 99501
Telephone: (907) 644-3510

Note - Filings with any Interior agency may be filed with any office noted above or with the Office of the Secretary of the Interior, Regional Environmental Officer, P.O. Box 120, 1675 C Street, Anchorage, Alaska 99513.

Department of Transportation
Federal Aviation Administration
Alaska Region AAL-4, 222 West 7th Ave., Box 14
Anchorage, Alaska 99513-7587
Telephone: (907) 271-5285

NOTE - The Department of Transportation has established the above central filing point for agencies within that Department. Affected agencies are: Federal Aviation Administration (FAA), Coast Guard (USCG), Federal Highway Administration (FHWA), Federal Railroad Administration (FRA).

OTHER THAN ALASKA NATIONAL INTEREST LANDS

Use of this form is not limited to National Interest Conservation Lands of Alaska.

Individual department/agencies may authorize the use of this form by applicants for transportation, utility systems, telecommunication installations and facilities on other Federal lands outside those areas described above.

For proposals located outside of Alaska, applications will be filed at the local agency office or at a location specified by the responsible Federal agency.

SPECIFIC INSTRUCTIONS
(Items not listed are self-explanatory)

7 Attach preliminary site and facility construction plans. The responsible agency will provide instructions whenever specific plans are required.

8 Generally, the map must show the section(s), township(s), and range(s) within which the project is to be located. Show the proposed location of the project on the map as accurately as possible. Some agencies require detailed survey maps. The responsible agency will provide additional instructions.

9, 10, and 12 The responsible agency will provide additional instructions.

13 Providing information on alternate locations in as much detail as possible, discussing why certain locations were rejected and why it is necessary to use Federal assets will assist the agency(ies) in processing your application and reaching a final decision. Include only reasonable alternate locations as related to current technology and economics.

14 The responsible agency will provide instructions.

15 Generally, a simple statement of the purpose of the proposal will be sufficient. However, major proposals located in critical or sensitive areas may require a full analysis with additional specific information. The responsible agency will provide additional instructions.

16 through 19 Providing this information with as much detail as possible will assist the Federal agency(ies) in processing the application and reaching a decision. When completing these items, you should use a sound judgment in furnishing relevant information. For example, if the project is not near a stream or other body of water, do not address this subject. The responsible agency will provide additional instructions.

Application must be signed by the applicant or applicant's authorized representative.

EFFECT OF NOT PROVIDING INFORMATION

Disclosure of the information is voluntary. If all the information is not provided, the proposal or application may be rejected.

DATA COLLECTION STATEMENT

The Federal agencies collect this information from proponents and applicants requesting a right-of-way, permit, license, lease, or certification for use of Federal assets. The Federal agencies use this information to evaluate a proponent's or applicant's proposal to use Federal assets.

BURDEN STATEMENT

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0249. The time required to complete this information collection is estimated to average 8 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. The authority to collect this information is derived from 47 U.S.C. 1455(c)(3) and 16 U.S.C. 3210.

USDA NONDISCRIMINATION STATEMENT

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call toll free (866) 632-9992 (voice). TDD users can contact USDA through local relay or the Federal relay at (800) 877-8339 (TDD) or (866) 377-8642 (relay voice). USDA is an equal opportunity provider and employer.

The Privacy Act of 1974 (5 U.S.C. 552a) and the Freedom of Information Act (5 U.S.C. 552) govern the confidentiality to be provided for information received by the Forest Service.

SUPPLEMENTAL

NOTE: The responsible agency(ies) will provide instructions	CHECK APPROPRIATE BLOCK	
I - PRIVATE CORPORATIONS	ATTACHED	FILED *
a. Articles of Incorporation	☐	☐
b. Corporation Bylaws	☐	☐
c. A certification from the State showing the corporation is in good standing and is entitled to operate within the State	☐	☐
d. Copy of resolution authorizing filing	☐	☐
e. The name and address of each shareholder owning 3 percent or more of the shares, together with the number and percentage of any class of voting shares of the entity which such shareholder is authorized to vote and the name and address of each affiliate of the entity together with, in the case of an affiliate controlled by the entity, the number of shares and the percentage of any class of voting stock of that affiliate owned, directly or indirectly, by that entity, and in the case of an affiliate which controls that entity, the number of shares and the percentage of any class of voting stock of that entity owned, directly or indirectly, by the affiliate.	☐	☐
f. If application is for an oil or gas pipeline, describe any related right-of-way or temporary use permit applications, and identify previous applications.	☐	☐
g. If application is for an oil and gas pipeline, identify all Federal lands by agency impacted by proposal.	☐	☐
II - PUBLIC CORPORATIONS		
a. Copy of law forming corporation	☐	☑
b. Proof of organization	☐	☑
c. Copy of Bylaws	☐	☑
d. Copy of resolution authorizing filing	☐	☑
e. If application is for an oil or gas pipeline, provide information required by item "I - f" and "I - g" above.	☐	☐
III - PARTNERSHIP OR OTHER UNINCORPORATED ENTITY		
a. Articles of association, if any	☐	☐
b. If one partner is authorized to sign, resolution authorizing action is	☐	☐
c. Name and address of each participant, partner, association, or other	☐	☐
d. If application is for an oil or gas pipeline, provide information required by item "I - f" and "I - g" above.	☐	☐

* If the required information is already filed with the agency processing this application and is current, check block entitled "Filed." Provide the file identification information *(e.g., number, date, code, name)*. If not on file or current, attach the requested information.

Appendix D. County Signed Resolution

RESOLUTION NO. R-2021-2776

A RESOLUTION AUTHORIZING FILING OF BUREAU OF LAND MANAGEMENT (BLM) STANDARD FORM 299, AN APPLICATION BY WASHINGTON COUNTY TO DRILL TEST PITS ON BLM LAND

(Re: Potential Future Construction of Detention Basins in Dammeron Valley and Diamond Valley)

WHEREAS, Washington County (the County) Public Works Department is reviewing potential locations for detention basins in Dammeron Valley and Diamond Valley, and wants to perform soils testing on various sites by drilling test pits;

WHEREAS, some of the proposed drilling and test pit sites are located on BLM property, and the County needs to apply for permission to perform the work through the BLM application process (Application Standard Form 299 attached);

WHEREAS, it is in the best interest of the residents of Washington County that the attached Application be executed and submitted;

NOW, THEREFORE, BE IT RESOLVED BY THE WASHINGTON COUNTY COMMISSION that the attached Application Standard Form 299 shall be executed and submitted to the BLM, and the Public Works Department is further authorized to submit any additional or supplemental information requested by the BLM to support the Application.

VOTED UPON AND PASSED BY THE WASHINGTON COUNTY COMMISSION AT A REGULAR MEETING OF THE WASHINGTON COUNTY COMMISSION HELD ON THE 1st day of JUNE, 2021.

WASHINGTON COUNTY

GIL ALMQUIST, Chair
Washington County Commission

ATTEST:

Kim M. Hafen
Washington County Clerk-Auditor

Commissioner Almquist voted Aye
Commissioner Cox voted Aye
Commissioner Iverson voted Aye

Approved as to form:

Deputy County Attorney

Appendix E. BLM Short-Term ROW Application Acceptance

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Color Country District Office-St George Field Office
345 E Riverside Dr
St George UT 84790
https://www.blm.gov/office/st-george-field-office

June 2, 2021

In Reply Refer To:
2920 (UTC030)
UTU-95649

DECISION

Washington County	:	Permit Application
Attn: Todd Edwards, City Engineer	:	Serial No. UTU-95649
197 East Tabernacle	:	
St. George, UT 84770	:	

Application Accepted

On May 19, 2021, you filed an application for a short-term Right-of-Way (ROW) to conduct soil testing using drilling and pits on lands administered by the BLM- St. George Field Office. After further examination, your request is more appropriate for a 2920 Land Use Permit and will be processed accordingly. Your application has been accepted and assigned serial number UTU-95593. The following public lands are affected by your application:

(Diamond Valley)
Salt Lake Meridian, Utah
T. 41 S, R. 16 W.,
sec. 1, NE¼SW¼.

(Dammeron Valley)
Salt Lake Meridian, Utah
T. 40 S, R. 16 W.,
sec. 16, W½.

Processing Fee Category

According to Federal regulations contained in 43 CFR 2804.14, BLM is required to be reimbursed for the costs incurred in processing an application. In accordance with 43 CFR 2804.16, we have determined that Washington County is exempt from paying cost recovery fees for this application.

Our goal is to process your application in 60 days or less. BLM regulations at 43 CFR 2804.25 state that the BLM will notify you if processing the application will take more than 60 days. At this time we anticipate the processing time for this application to be 60-90 days.

If you have any questions regarding your application, please contact Shawnna Dao by email at sdao@blm.gov.

Sincerely,

Dawna E. F— Rowley
Acting For Keith Rigtrup
Field Office Manager

APPENDIX E-7A

TECHNICAL DOCUMENTS, CONTINUED

Draft - For Review

GEOTECHNICAL INVESTIGATION REPORT
FOR PRELIMINARY DESIGN

SANTA CLARA WATERSHED DETENTION BASINS

Washington County, Utah

Prepared for:
Alpha Engineering Company

December 2021

RB&G ENGINEERING, INC.

202001-039

RB&G ENGINEERING, INC.

December 17, 2021

Alpha Engineering Company
Attn: Brent Gardner
43 South 100 East, Suite 100
St. George, UT 84770

Re: Santa Clara Watershed Detention Basins
Geotechnical Investigation Report for Preliminary Design

Dear Mr. Gardner:

A Geotechnical Investigation Report for Preliminary Design has been completed for the Santa Clara Watershed Detention Basins to be located in Washington County, Utah. The results of this study are summarized in the report transmitted herewith.

We appreciate the opportunity of providing this service for you. If there are any questions relating to the information contained herein, please call.

Sincerely,

RB&G ENGINEERING, INC.

Brandon D. Horrocks, P.E.

GEOTECHNICAL INVESTIGATION REPORT
FOR PRELIMINARY DESIGN

Santa Clara Watershed Detention Basins

Washington County, Utah

Prepared for:
Alpha Engineering Company

December 2021

RB&G ENGINEERING, INC.

Table of Contents

Figures

Appendix A – Concept Design Drawings

Dammeron Valley Detention Basins – Conceptual Designs
Diamond Valley Detention Basins – Conceptual Designs

Appendix B – Test Hole Logs and Photos

Descriptive Correlations of Relative Density and Consistency
Unified Soil Classification System
Test Hole Logs
Sample Photos

Appendix C - Laboratory Testing

Summary of Test Data Table
Consolidation Tests
Direct Shear Tests
Moisture-Density Relationship Tests

Appendix D – Sedimentation Calculations

RB&G
ENGINEERING, INC.

SANTA CLARA WATERSHED
DETENTION BASINS

GEOTECHNICAL INVESTIGATION REPORT FOR PRELIMINARY DESIGN
WASHINGTON COUNTY, UTAH

1. INTRODUCTION

This report describes the results of geotechnical investigations performed for the Santa Clara Watershed Plan - Environmental Assessment (EA). The proposed watershed improvement project is being sponsored by Washington County and is being funded by the National Resources Conservation Service (NRCS).

The purpose of this study was to evaluate subsurface conditions at locations where new and rehabilitated detention basins are being considered in Diamond Valley and Dammeron Valley, in Washington County, Utah. The recommendations provided in this report are intended for preliminary evaluations of the project. It is anticipated that additional geotechnical investigation and analyses will be performed during final design of the project.

One objective of the project is to reduce the impacts of flooding within developed areas in Diamond Valley and Dammeron Valley. Detention basins are being considered to reduce flood risk at the locations shown on the Vicinity Map on Figure 1.

Construction of three new detention basins in Dammeron Valley is being considered for the project. The locations of the planned detention basins are shown on Figure 2. It is envisioned that earthfill dams will be constructed to create the detention basins. Conceptual design of the detention basins is summarized in the table below:

Table 1.1 – Proposed Dammeron Valley Detention Basins

Detention Basin	Approx. Storage Capacity (ac-ft)	Maximum Dam Height* (ft)
Dammeron 1	21	23
Dammeron 2	258	38
Dammeron 3	53	23

*Assumes dam crest will be 5 feet above the auxiliary spillway

Rehabilitation of three existing detention basins is being considered in Diamond Valley. These detention basins are shown as Existing Diamond 1, Diamond 2, and Diamond 3 Detention Basins on Figure 3. Conceptual designs provided to us indicate that the rehabilitated Diamond 1 and Diamond 2 detention basins will be approximately equal in size to the existing basins. It is our understanding that the dam for the Diamond 3 basin will primarily function as a diversion to route storm flows to the northwest into the Diamond 2 detention basin. The planned size of the Diamond 3 dam had not been determined when this report was prepared. We have assumed that the Diamond 3 dam will be less than 20 feet high.

Drawings illustrating the conceptual design of the planned detention basins are included in Appendix A of this report.

This report uses the terms "left" and "right" to designate areas along the proposed detention basin dam alignments. Where used, these terms are from a reference point of looking in a downstream direction, i.e., the southern abutment of the Dammeron 3 Detention Basin dam is the left abutment.

2. GEOLOGIC AND EXISTING SITE CONDITIONS

2.1 Regional Geology

The project area is located near the southwestern corner of Utah and is located within the transition zone between the Basin and Range Physiographic Province to the west and the Colorado Plateau Province to the east. The Basin and Range province is typified by a series of northerly trending uplifted mountain ranges and down dropped valleys (horsts and grabens) created by normal faulting resulting from extensional forces. The Colorado Plateau to the east is an area of much greater stability with significantly less seismic activity.

The transitional zone is an area of relatively complex geology with bedrock varying in age from the Proterozoic (greater than 542million years ago (mya)) as seen in the Beaver Dam

Mountains to the west, to younger Quaternary age (less than 0.5 mya) basalt flows. Most of the colorful red-rock scenery is found in the Triassic and Jurassic age sedimentary deposits. The region owes the majority of its present-day structure to geological events younger than ~100 mya (later Cretaceous).

The region went through a period of compressional activity which pushed and compressed western Utah toward eastern Utah, generating folds and overthrust faulting. Periods of compressional activity occurred during the Sevier Orogeny (~100 mya) and Laramide Orogeny (70 mya). During the Tertiary period (Oligocene - early Miocene) a large igneous intrusion pushed up into the southwestern Utah overlying bedrock as a large shallow mushroom shaped intrusion (20.5 mya). This created an uplifted dome where the overlying fractured rock more readily eroded away leaving behind the Pine Valley Mountains. The Pine Valley laccolith is the largest lacolith in America (Cook, 1957, 1960b, Biek and others, 2007). During this time compressional forces began to be replaced by extensional forces resulting in volcanism and Basin and Range faulting.

The transition zone is broken up by numerous northerly trending faults. This zone of faults makeup the southern end of the Intermountain Seismic Belt (ISB) which trends from western Montana into northern Arizona (Smith and Arabasz, 1991). This relatively narrow belt generates a significant amount of seismic activity with numerous active and potentially active faults. The ISB within southwestern Utah is generally considered to be constrained on the east side by the Hurricane fault zone and on the west side by the Gunlock and Grand Wash fault zone. The Gunlock fault, Washington fault, and Hurricane fault are located about 5.5 miles west, 14 miles southeast, and 20 miles east of the project area, respectively.

Dammeron and Diamond valleys are located southwest of the Pine Valley mountains and east of the Gunlock Fault. Several basalt flows and cinder cones are present within the vicinity of the project area. Volcanism in the region is inactive; however, seismic activity continues. Since 1962, Basin and Range extensional faulting has generated 5 earthquakes with magnitudes of at least 5 within 50 miles of the project area[1]. The second largest earthquake recorded in Utah since 1850, which occurred in Pine Valley in November 1902 had an estimated magnitude of 6.3. The Pine Valley earthquake epicenter was about 8.5 miles northeast of Dammeron Valley.

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[1] *Utah Earthquakes (1850-2016) and Quaternary Faults*; Bowman, S.D. and Arabasz, W.J.; Utah Geological Survey Map 277, 2017.

2.2 Dammeron Valley

The topography in the Dammeron Valley area generally slopes towards the southwest. The Dammeron Valley detention basins are planned to be constructed across drainages at the locations shown on Figure 2. The topography at the proposed dam alignments slopes down towards the drainage channels at a rate of between about 5 and 20%. The drainage channel grades within the proposed detention basis are generally less than about 5%.

The surficial geology, as mapped by R. F. Biek et. al.[2] for the proposed Dammeron Valley detention basins is shown on Figure 4a.

The western portion of the Dammeron 1 detention basin and dam is located in an area mapped as Quaternary alluvial and eolian deposits (Qae), consisting of gravel, sand, and silt deposited in small channels and alluvial flats, with some windblown deposits. The Cretaceous age Cedar Mountain Formation (Kcm) is mapped near the right abutment of the dam alignment. Cedar Mountain Formation bedrock may underlie the alluvium on the western side of the planned detention basin.

The southeastern portion of the Dammeron 1 detention basin and the majority of the dam is within an area mapped as Quaternary age Dameron[3] Valley East lava flow and cinder cone (Qbde). The thickness of the lava flow is generally 10 to 20 feet thick. The lava flow deposits were encountered in test holes performed for the detention basin and are shown on the logs as basalt deposits.

As shown on Figure 4a, Dammeron 2 Detention Basin is in an area mapped as Quaternary age Dameron Valley and Saddle Mountain lava flows and cinder cones (Qbde and Qbsm). As stated above, the Dameron Valley lava flow deposit is typically 10 to 20 feet thick. The Saddle Mountain deposit is typically 20 to 40 feet thick.

The northern end of the proposed Dammeron 3 detention basin and dam is in an area mapped as Dameron Valley lava flow and cinder cone deposits. The central portion of the dam and basin is in an area mapped as Quaternary alluvium and colluvium (Qac).
Fingers of the Jurassic age Co-op Creek Limestone Member of the Carmel Formation (Jcc) are mapped near the south end of the proposed alignment. The Jcc formation consists of limestone and may also contain calcareous shale, platy limestone, fine grained sandstone, and some gypsiferous mudstone and siltstone.

[2] *Geologic Map of the St. George and East Part of the Clover Mountains 30'x60' Quadrangles, Washington and Iron Counties, Utah*; Biek, R. F. et. al.; 2009.
[3] Spelling of the lava flow as shown on the geologic map.

2.3 Diamond Valley

The existing Diamond 1 and 2 detention basins shown in Figure 3 are retained by dams with maximum heights of about 10 and 15 feet, respectively. It appears that about 10 feet of native soil materials have been excavated from within the Diamond 1 basin to increase the storage capacity. It is our understanding that the existing Diamond 3 site also functions as a small detention basin. It appears that the Diamond 3 basin was constructed by creating a small berm using materials excavated from within the basin. We have been unable to find any construction drawings or other records of construction for the existing detention basins during this study.

As stated previously, the planned Diamond 3 dam will direct flows towards the Diamond 2 detention basin. Outflows from the Diamond 2 detention basin currently flow within a man-made channel in a westerly direction to the Diamond 1 detention basin. It is our understanding that the existing Diamond 1 basin does not currently have an outflow channel.

The Diamond Valley community is built predominately on alluvial valley fill deposits. Along the north and east sides of the study area are hills of Jurassic to Cretaceous age bedrock which appears to dip down gently toward the northeast at about 3 degrees.

As shown on Figure 4b, the existing Diamond 1 Detention Basin is in an area mapped as Quaternary alluvial and eolian deposits (Qae), consisting of gravel, sand, and silt deposited in small channels and alluvial flats. The east side of the basin is near the mapped boundary of the Jurassic age Sinawava Member of the Temple Cap Sandstone (Jts) formation, which contains mudstone, siltstone and silty sandstone materials.

Diamond 2 Detention Basin is within an old faulted wash. The majority of the existing dam footprint and basin are in an area mapped as Holocene to upper Pleistocene age alluvial and colluvial deposits (Qac), described as clay to boulder sized sediment. The material underlying the upper portion of the existing dam abutments and upper portion of the basin is mapped as Co-op Creek Limestone (Jcc). The fault line which trends northeast/southwest through the center of the dam and basin is the Wide Canyon Fault. This fault is listed on the Utah Quaternary Fault and Fold Database, but it is not listed on the USGS Quaternary Fault and Fold Database. The fault is believed to older than 750,000 years old and is not considered to be active.

The proposed Diamond 3 Detention Basin is in an area mapped similar to the Diamond 2 site, with Co-op Creek Limestone mapped near both abutments and alluvial and colluvial deposits mapped in the center of the dam and basin.

The Utah Geologic Survey published a series of Geologic Hazard maps for the St. George–Hurricane Metropolitan Area in 2008. Most of the project area is beyond the northern limit of the 2008 study area; however, Diamond 3 Detention Basin is within the study area. The hazard map shows the area as having a high risk for flooding associated with flash floods and debris flows, and reducing this risk is the primary purpose of the proposed project. Rock fall hazard, with rock debris usually less than 1.5 feet in size, is shown as moderate due to the existing relatively steep slopes in the Diamond 3 basin area. Soils in this area are classified by the NRCS as having a low susceptibility for expansive volumetric changes. The bedrock units are classified as having a moderate shrink/swell susceptibility, with collapse potential which can be greater than 3%. While the soils in this area are not mapped as having a significant amount of gypsum, the bedrock unit surrounding the area does contain some medium-thin beds and veins of gypsum which could also be found in the alluvial material.

The area is mapped as being surrounded by hard bedrock on the geologic hazard maps, while the bottom of the basin is mapped as having buried bedrock likely more than 10 feet deep. The map identifies the alluvial deposits (Qac) as being susceptible to hazards associated with piping and erosion of the soil.

2.4 Geologic Hazards

The Dammeron Valley and Diamond Valley areas are subject to flash flooding and debris flows and reducing the risk of these hazards is the primary purpose of the Santa Clara Watershed project. Design recommendations for the detention basins are discussed in Section 5 of this report.

In addition to flooding and debris flow, the potential geologic hazards which appear to pose the greatest risk to the proposed detention basins are surface and internal erosion. Design recommendations to mitigate these risks are also discussed in Section 5 of this report. Based on the results of geotechnical investigations, which are discussed in Sections 3 and 4 of this report, the risk of inadequate debris basin performance due to soil or rock volumetric changes (shrinkage, collapse, or swell) and dissolution of soluble minerals (gypsum) appears to be low.

A probabilistic seismic hazard analysis was performed using the USGS Dynamic: Conterminous U.S Unified Hazard Tool. The Peak Ground Acceleration (PGA) in the project area for Site Class B/C boundary conditions is 0.30g for an earthquake event having a return period of 5,000 years. Seismic considerations are not expected to significantly control the design of the detention basins planned for this project. Additional discussion of seismic hazards is included in Section 5 of this report.

3. FIELD AND LABORATORY TESTING PROCEDURES

Subsurface investigations for the project were performed at the locations shown on Figures 2 and 3. Test hole logs and sample photos are included in Appendix B. The test hole numbers shown on the site plan and logs have a prefix DA1, DA2 or DA3 (Dammeron Valley 1,2, or 3) and DI1, DI2, or DI3 (Diamond Valley 1, 2, or 3) to indicate the basin where the hole was performed. The test holes were numbered in accordance with NRCS standards, with test holes XXX-1 through 99 performed along the proposed dam alignment and test holes XXX-101 through 199 performed within the proposed detention basins to investigate potential borrow areas.

Investigations performed for this study assumed that earthfill materials would be obtained from within the proposed detention basins or from previously developed commercial sources. We envision that the majority of the materials to be used for construction of detention dams will be obtained from within the basins, and processed filter and drain materials will be obtained from commercial sources. Riprap may be obtained from a combination of available materials within the basins or commercial sources. The subsurface testing program was developed in coordination with the project sponsor and funding agency considering the planned construction, the detail required for conceptual level EA design, and funding constraints.

The borings were drilled using a CME 55 rotary drill rig. A tri-cone rock bit and HW or NW casing, with water as the drilling fluid, were used to advance the borings through overburden materials. Drilling and sampling were performed using NWJ drilling rods.

Disturbed samples were obtained within overburden materials by driving a 2- or 2.5-inch outside diameter split spoon sampling tube through a distance of 18 inches using a 140-pound weight dropped from a distance of 30 inches. The sampler size is indicated on the boring logs. Based on energy evaluations conducted approximately annually in general accordance with ASTM D4633, the automatic trip hammer used for sampling with the CME-55 drill rig delivers an average energy greater than 80 percent of the theoretical maximum energy.

The number of hammer blows required to drive the sampling spoon through each 6 inches of penetration is shown on the boring logs. The sum of the last two blow counts, which represents the number of blows recorded while driving the sampling spoon through 12 inches, is defined as the penetration value, *N*.

Penetration values corrected for sampler size, overburden, and hammer energy provide a good indication of the in-place density of sandy soils; however, they only provide an indication of the relative stiffness of cohesive material, since the penetration resistance of materials of this type is a function of moisture content. Considerable care must be exercised when interpreting the penetration value in gravelly-type soils, particularly where the size of the granular particles exceeds the inside diameter of the sampling spoon. The penetration value generally provides a good indication of the in-place density of gravelly-type material if the spoon can be driven through the full 18 inches with reasonable sample recovery.

Corrections applied to the blow counts to determine the corrected standard penetration, $(N_1)_{60}$ values, shown on the boring logs were as follows:

- Sampler size correction for 2.5-inch OD sampler (where applicable): multiply by 0.938.
- Hammer energy correction from 80% hammer energy ratio to 60% standard energy ratio: multiply by 1.33.
- Overburden correction: multiply by $C_N = (P_a / \sigma'_v)^{0.5} \leq 1.7$
  where: P_a = atmospheric pressure, approximated as 2000 psf,
  σ'_v = effective vertical stress, calculated using assumed average total soil unit weights of 120 pcf, and hydrostatic pore pressure calculated from the measured or estimated groundwater level.

The Standard Penetration Test (SPT) corrections listed above are basic corrections based on generalized interpretations and assumptions. Different and/or additional corrections may be appropriate for specific design applications.

Relatively undisturbed samples were obtained at select locations by pushing a thin-walled sampling tube into the subsurface material using the hydraulic pressure on the drill rig. The locations at which the undisturbed samples were obtained are shown on the boring logs.

Miniature vane shear and pocket penetrometer tests were performed on some of the cohesive samples retrieved from the borings. Miniature vane shear tests, which provide an indication of undrained shear strength, were generally performed on samples with strengths less than about 1,000 psf. Pocket penetrometer tests, which provide an indication of the unconfined compressive strength, were performed on some of the stiffer samples obtained.

Relative stiffness and density descriptors noted on the boring logs were determined from the field and laboratory tests following the descriptive correlations of relative density and consistency table included in Appendix B. In describing the stiffness of cohesive soils, preference was given to torvane and pocket penetrometer test results prior to SPT blow counts.

Each sample obtained in the field was classified according to the Unified Soil Classification System. The symbol designating soil type according to this system is presented on the boring logs. A description of the Unified Soil Classification System is included in Appendix B, and the meanings of the various symbols shown on the logs can be obtained from this figure.

Bedrock materials encountered within the borings were continuously cored using an NQ wireline system. The precent of the core run recovered and the Rock Quality Designation (RQD) values measured during the subsurface investigations are shown on the boring logs. The RQD is the percentage of intact core pieces at least 4 inches in length recovered from a single core run. A correlation of rock quality with RQD values is provided in Appendix B.

Constant head open-hole permeability testing was performed within subsurface materials during the investigations. The tests were performed by drilling ahead of the casing, filling the casing with water, and recording the rate at which water was added to maintain the water level at the top of the casing. Permeability values were calculated using the methods described in *Design of Small Dams* (USBR, 1987).

Test pits were excavated using a John Deere 160 excavator operated by Probitas Inc. The test pits were excavated to depths between 10 and 15 feet below the existing ground surface except where excavation was impractical due to the presence of bedrock or dense gravelly materials.

Laboratory testing was performed in accordance with ASTM International standards, except that tests to determine water soluble solids were performed in accordance with a Bureau of Reclamation standard since ASTM does not have a comparable test method. Tests performed during the investigations include:

- Moisture Content (ASTM D2216)
- Sieve Analysis (ASTM C117, C136)
- Atterberg Limits (ASTM D4318)
- Unconfined Compression (ASTM D7012)
- Dispersive Clay (Pinhole, ASTM D4647)
- Consolidation (ASTM D2435)
- Direct Shear (ASTM D3080)

- Moisture Density Relationship (Proctor, ASTM D698)
- Permeability (ASTM D5084)
- Water Soluble Solids (USBR 5450)

The results of the laboratory testing are included in Appendix C.

4. SUBSURFACE SOIL AND WATER CONDITIONS

Ground water was not encountered within any of the test holes performed for this study, except that water was measured 28 feet below the ground surface in Boring DA1-1. The water measured in Boring DA1-1 may have been influenced by drill water used during the drilling work.

As shown on the test hole logs, cobbles and boulders were encountered in many of the test holes. The test results discussed below do not generally include the cobble and boulder size fractions of the materials. Estimates of the sizes and fractions of the cobbles and boulders are shown on test pit logs.

4.1 Dammeron 1 Detention Basin

The Dammeron 1 Detention Basin dam alignment was investigated by drilling Boring DA1-1 near the bottom of the drainage channel to a depth of 30 feet below the existing ground surface, excavating Test Pit DA1-2 within the left abutment area, and excavating Test Pit DA1-3 within the right abutment area. Test Pits DA1-101 through -103 were excavated within the proposed basin to investigate potential borrow materials.

Basalt rock was encountered about 6 and 3 feet below the ground surface in DA1-1 and DA1-2, respectfully. Bedrock was not encountered within the other test holes performed at this site.

Recovery, which was between 19 and 100%, and RQD values, which were between 0 and 57%, measured from the basalt core obtained from Boring DA1-1 indicate the rock quality is very poor to fair, and is highly fractured and/or fissured. The hydraulic conductivity values calculated from the permeability tests were between 210 and 3,300 ft/yr.. Basalt deposits are generally highly fractured and fissured due to the volcanic deposition and cooling process. In our experience, the hydraulic conductivity values are relatively low to moderate compared to other basalt deposits. It appears likely that many of the fractures/fissures at this site are infilled with soil or other mineral deposits. Laboratory testing performed on samples of the basalt are summarized below:

Table 4-1 DA1 Site - Basalt Rock Properties

Soil Property	No. of Tests	Range	Average
Dry Unit Weight (pcf)	2	136.3 – 139.1	137.7
Moisture Content (%)	2	0.4 – 0.5	0.5
Unconfined Compressive Strength (psi)	2	4,840 – 8.730	6,785
In-Situ Hydraulic Conductivity (ft/yr)	5	210 – 3,300	1,400

The overburden soils encountered in the test holes at this site were predominantly mixtures of sands and gravels with low to medium plastic fines; however, deposits of fat clay (CH) several feet thick were encountered in Test Pits DA1-101 and 102. Laboratory testing performed on samples of overburden are summarized below:

Table 4-2 DA1 Site Overburden Material Properties

Soil Property	No. of Tests	Range	Average
Fat Clay Samples			
Moisture Content (%)	2	15.0 – 19.5	17.3
Liquid Limit (%)	2	53 – 55	54
Plasticity Index (%)	2	27 – 34	31
Gravel Content (%)	2	1 - 2	2
Sand Content (%)	2	7 – 22	15
Silt/Clay Content (%)	2	77 -91	84
Dispersive Clay	2	Non-Dispersive (ND-1 & ND-2)	N/A
Sand and Gravel Samples			
Moisture Content (%)	5	2.6 – 14.4	8.2
Liquid Limit (%)	4 1	24 – 62 Non-plastic	38 N/A
Plasticity Index (%)	4	4 – 37	15
Gravel Content (%)	5	6 – 41	23
Sand Content (%)	5	37 – 60	52
Silt/Clay Content (%)	5	16 – 40	25
Water Soluble Solids (%)	3	0.27 – 1.15	0.57
Dispersive Clay	2	Non-Dispersive (ND-1)	N/A
In-Situ Hydraulic Conductivity (ft/yr)	2	32 - 650	340
Laboratory Hydraulic Conductivity – Remolded and Compacted Sample (cm/sec)	2	2.62×10^{-8} – 1.09×10^{-5}	5.5×10^{-6}
Moisture Density Relationship – Standard **Maximum Laboratory Density (pcf)** **Optimum Moisture Content**	2	102.3 – 106.6 16.3 – 20.8	104.5 18.6
Direct Shear Friction Angle – Remolded and Compacted Sample **Cohesion**	2	24.5 – 28.0 4.5 – 7.2	26.3 5.9

4.2 Dammeron 2 Detention Basin

The Dammeron 2 Detention Basin dam alignment was investigated by drilling Boring DA2-1 near the bottom of the drainage channel to a depth of 30 feet below the existing ground surface, excavating Test Pit DA2-2 within the left abutment area, and excavating Test Pit DA2-3 within the right abutment area. Test Pits DA2-101 through -106 were excavated within the proposed basin to investigate potential borrow materials.

The overburden soils encountered in the test holes along the dam alignment were predominantly mixtures of sands and gravels with non-plastic fines. Laboratory testing performed on samples of overburden are summarized below:

Table 4-3 DA2 Site Overburden Material Properties

Soil Property	No. of Tests	Range	Average
Moisture Content (%)	3	6.1 – 14.4	10.0
Liquid Limit (%)	1 4	33 Non-plastic	33 N/A
Plasticity Index (%)	1	13	13
Gravel Content (%)	5	17 – 46	37
Sand Content (%)	5	31 – 53	45
Silt/Clay Content (%)	5	4 – 39	18
Water Soluble Solids (%)	1	0.1	0.1
Dispersive Clay	1	Non-Dispersive (ND-1)	N/A
In-Situ Hydraulic Conductivity (ft/yr)	5	52 – 520	270
Maximum Laboratory Density (pcf)	2	84.3 – 100.2	92.3
Optimum Moisture Content	2	20.2 – 32.5	26.4
Moisture Density Relationship – Standard **Maximum Laboratory Density (pcf)** **Optimum Moisture Content**	2	 81.1 – 100.2 20.2 – 35.1	 90.7 27.7

Basalt rock was encountered 22 feet below the ground surface in DA2-1. Bedrock was not encountered within the other test holes performed along the dam alignment; however, basalt rock was encountered within 2 feet of the ground surface within all six test pits excavated within the proposed basin.

Recovery, which was between 28 and 100%, and RQD values, which were between 0 and 92%, measured from the basalt core obtained from Boring DA2-1 indicate the rock is relatively intact to highly fractured and/or fissured. A hydraulic conductivity test was performed within the zone between 20 and 27 feet below the ground surface. The hydraulic conductivity of the zone could not be determined because the flow into the formation exceeded the capacity of the pumping equipment being used (17.7 gal/min).

The basalt core obtained from a depth of 25 feet in Boring DA2-1 had a moisture content of 0.7%, dry unit weight of 170.2 pcf, and unconfined compressive strength of 14,630 psi.

4.3 Dammeron 3 Detention Basin

The Dammeron 3 Detention Basin dam alignment was investigated by drilling Boring DA3-1 near the bottom of the drainage channel to a depth of 32.5 feet below the existing ground surface and excavating Test Pits DA3-2 through -5 at the locations shown on Figure 2. Test Pits DA3-101 through -107 were excavated within the proposed basin to investigate potential borrow materials.

The overburden soils encountered in the test holes were predominantly mixtures of sands and gravels with low to medium plastic fines. Clay layers up to about 4 feet thick were encountered at the ground surface in several of the test pits. Laboratory testing performed on samples of overburden are summarized below:

Table 4-4 DA3 Site Overburden Material Properties

Soil Property	No. of Tests	Range	Average
Moisture Content (%)	14	2.6 – 10.1	6.4
Liquid Limit (%)	10 8	20 – 57 Non-plastic	33 N/A
Plasticity Index (%)	10	4 – 34	15
Gravel Content (%)	18	1 – 60	25
Sand Content (%)	18	2 – 71	43
Silt/Clay Content (%)	18	5 – 97	32
Water Soluble Solids (%)	8	0.1 – 2.96	0.66
Dispersive Clay	5 1	Non-Dispersive (ND-1) Dispersive (D-1)	N/A N/A
In-Situ Hydraulic Conductivity (ft/yr)	6	0 – 850	110
Laboratory Hydraulic Conductivity – Remolded and Compacted Sample (cm/sec)	2	6.91×10^{-7} – 5.23×10^{-5}	2.65×10^{-5}
Maximum Laboratory Density (pcf)	8	96.8 – 128.7	110.5
Optimum Moisture Content	8	8.7 – 20.6	14.7
Direct Shear Friction Angle – Remolded and Compacted Sample **Cohesion**	2	28.0 – 29.7 0 – 1.9	28.9 1.0
Swell Potential from Consolidation Test	1	0.1%	0.1%

4.4 Diamond 1 Detention Basin

The Diamond 1 Detention Basin dam alignment was investigated by drilling Borings DI1-1 and -2 through the existing embankment at the locations shown on Figure 3. It is our understanding that there are no drawings from construction of the existing detention basin, and the project conceptual design includes removing and reconstructing the existing embankment. It is likely that the reconstructed embankment will be slightly upstream of the existing embankment due to property constraints.

The soil materials encountered at the site predominantly consisted of sandy and clayey soils. Laboratory testing performed on samples from this site are summarized below:

Table 4-5 DI1 Site Material Properties

Soil Property	No. of Tests	Range	Average
Moisture Content (%)	7	8.4 – 13.8	11.2
In-Situ Dry Unit Weight (pcf)	4	101.7 – 124.3	111.8
Liquid Limit (%)	6 1	17 – 28 Non-plastic	24 N/A
Plasticity Index (%)	6	3 – 12	8
Gravel Content (%)	7	0 – 1	0
Sand Content (%)	7	17 – 64	42
Silt/Clay Content (%)	7	35 – 83	58
Water Soluble Solids (%)	2	0.36 – 0.39	0.38
Dispersive Clay	2	Non-Dispersive (ND-2)	N/A
In-Situ Hydraulic Conductivity (ft/yr)	10	5 – 780	230
Swell/Collapse Potential from Consolidation Test	2	<0.1%	<0.1%

4.5 Diamond 2 Detention Basin

It is our understanding that there are no drawings from construction of the existing Diamond 2 Detention Basin, and the project conceptual design includes removing the existing embankment and constructing a new embankment upstream of the existing. Moving the embankment is envisioned due to property constraints. The Diamond 2 Detention Basin dam alignment was investigated by drilling Boring DI2-1 through the existing embankment, drilling DI2-2 at the assumed alignment of the new embankment, and drilling DI2-101 within the detention basin at the locations shown on Figure 3.

The soil materials encountered at the site predominantly consisted of clayey materials; however, gravelly materials were encountered within Boring DI2-101. Laboratory testing performed on samples from this site are summarized below:

Table 4-6 DI2 Site Material Properties

Soil Property	No. of Tests	Range	Average
Clayey Samples			
Moisture Content (%)	7	8.0 – 26.6	14.8
In-Situ Dry Unit Weight (pcf)	1	100.7	100.7
Liquid Limit (%)	7	24 – 30	26
Plasticity Index (%)	7	9 – 15	11
Gravel Content (%)	7	0 – 10	5
Sand Content (%)	7	42 – 51	45
Silt/Clay Content (%)	7	46 – 56	50
Water Soluble Solids (%)	1	0.35	0.35
Dispersive Clay	2	Non-Dispersive (ND-1)	N/A
In-Situ Hydraulic Conductivity (ft/yr)	6	42 – 6,400	1,400
Gravel Sample			
Moisture Content (%)	1	8.7	8.7
Liquid Limit (%)	1	Non-plastic	N/A
Gravel Content (%)	1	65	65
Sand Content (%)	1	25	25
Silt/Clay Content (%)	1	10	10
Water Soluble Solids (%)	1	0.09	0.09

4.6 Diamond 3 Detention Basin

The proposed Diamond 3 Detention Basin dam alignment was investigated by drilling Boring DI3-1 at the location shown on Figure 3. The soil materials encountered at the site consisted predominantly of clayey materials. Laboratory testing performed on samples from this site are summarized below:

Table 4-7 DI3 Site Material Properties

Soil Property	No. of Tests	Range	Average
Moisture Content (%)	2	15.1 – 24.0	19.6
In-Situ Dry Unit Weight (pcf)	1	98.8	98.8
Liquid Limit (%)	2	32 – 34	33
Plasticity Index (%)	2	18	18
Gravel Content (%)	2	0 – 35	18
Sand Content (%)	2	29 – 35	32
Silt/Clay Content (%)	2	36 – 65	51
Swell/Collapse Potential from Consolidation Test	1	<0.1%	<0.1%
In-Situ Hydraulic Conductivity (ft/yr)	6	5 – 4,800	2,300

Based on discussions with Mr. John Cazier, who has lived in Diamond Valley for about 30 years and is the current Water Manager for the Diamond Valley Acres Water Company, we understand that a detention basin was constructed at this site by the Bureau of Land Management at least 30 years ago. From site observations, it appears that the detention basin was created by constructing a berm a few feet high using soils excavated from within the basin. The relatively high hydraulic conductivity values within the upper 15 feet of Boring DI3-1 may, in part, be due to the presence of recently (less than 100 years) deposited sediments. However, from site topography and observations, we believe it is unlikely that the recent sediments are 15 feet deep. Mr. Crazier reported that less than 5 feet of sediment has accumulated within the basin.

5. PRELIMINARY ANALYSES AND DESIGN RECOMMENDATIONS

The analyses and design recommendations presented in this section are intended to be used for conceptual design and EA level project cost estimates. Additional investigations and analyses will be required during final design of the project.

5.1 Sedimentation

As discussed previously in this report, the proposed locations of the sediment basins are subject to flash floods and debris flows. Initial estimates of sediment accumulation have been developed for preliminary design of the project. Sedimentation was estimated using historical data conveyed by the Diamond Valley Water Manager and the following three methods:

- 1968 Pacific Southwest Inter-Agency Committee Sediment Yield Classification Procedure,
- 1973 USDA Soil Conservation Service Sediment Yield Rate Map, and
- 1982 Strand and Pemberton method developed for the semiarid climate of the southwestern United States.

5.1.1 Sediment Yield Classification Procedure

The Pacific Southwest Inter-Agency Committee developed a sediment yield classification procedure that estimates sediment yield as a function of nine individual drainage basin characteristics. Each characteristic is given a subjective numerical rating based on observation and experience. Sediment yield per unit area of drainage basin is estimated based on the category determined by the sum of the classification ratings.

The classifications estimated for the Dammeron and Diamond Valley sites are shown in the calculations included in Appendix D. Based on the analyses performed, we estimate that average annual sediment yields within the project area will be 0.2-0.5 ac-ft/mi^2.

5.1.2 Sediment Yield Rate Map

An estimated sediment yield rate map for the State of Utah was prepared by the USDA Soil Conservation Service in 1973. This map is a general area map with cautions that it is not to be used for specific sites since large variations may occur in the delineated areas. A copy of the map with the project area enlarged is included in Appendix D. The Dammeron Valley sites are in an area mapped as Yield Class 3 (0.5 – 1.0 ac-ft/mi^2 per year) and Yield Class 5 (0.1 – 0.2 ac-ft/mi^2 per year). The Diamond Valley sites are in an area mapped as Yield Class 3 (0.5 – 1.0 ac-ft/mi^2 per year) and Yield Class 4 (0.2 – 0.5 ac-ft/mi^2 per year).

5.1.3 Strand and Pemberton Method

An empirical method to estimate sediment yield within the semiarid western United States was developed by Stand and Pemberton in 1982. The estimated sediment yield is calculated using the following equation:

$$Q = 1.84A_d^{-0.24}$$

Where Q = annual sediment yield, acre-feet/mi^2
A_d = drainage area, square miles

This method results in estimated annual average sediment yield rates between 1.4 and 2.5 ac-ft/mi^2. The sediment yield rates calculated using this method are significantly higher than the rates estimated by the methods described above.

5.1.4 Recommended Sediment Yield

Based upon the analyses performed, we recommend that the design of the Dammeron Valley detention basins assume the average annual sediment yield will be 0.5 ac-ft/mi^2. This value is the upper value estimated using the Sediment Yield Classification Procedure, which considered site specific characteristics of the Dammeron Valley project drainage basins. The sediment yield rates calculated using the Strand and Pemberton method are significantly higher than the rates estimated by the other two methods described above and, in our opinion, are less credible than those estimated using site specific data.

Actual sediment accumulation within detention basins is dependent upon the volume of sediment transported (sediment yield), the characteristics of the sediment load, the flow velocity through the detention basin, and other factors. The detention basins planned for this project will have low-level un-gated principal spillways. Gravel and sand particles will likely be retained within the basins; however, fine clay particles will likely remain in suspension and be transported through the basin spillways.

The existing alluvial materials within the proposed basin footprints are likely representative of the sediment materials which will accumulate within the basins during the life of the facilities. As described in Section 4 of this report, the existing overburden soils at the Dammeron Valley sites were predominantly granular soils. Laboratory testing performed on samples obtained from the Dammeron Valley sites had an average of 32% fines passing a No. 200 sieve. Since it is likely that the majority of the fines will not be deposited within the detention basins, we recommend a trap efficiency of 70% be assumed for the Dammeron Valley detention basins.

We were unable to locate written records providing indication for sediment accumulation at the existing Diamond Valley sites. Based on verbal reports from Mr. Crazier, we understand that sediment accumulation in the existing detention basins has not significantly reduced the basin capacities. We understand that soil materials have been borrowed from the DI1 and DI2 sites periodically, but the primary purpose of the borrow work was to obtain materials for use at other sites. The borrow has not been considered necessary to remove accumulated sediments. Based on our analyses and reported historical sediment accumulation, we recommend that an annual sediment yield of 0.25 ac-ft/mi^2 be assumed for the Diamond Valley detention basins.

From aerial photos, it appears that the area at the DI3 basin where sediments have accumulated is about 0.35 acres. Assuming an average sediment depth of 5 feet results in a total estimated sediment accumulation of 1.8 ac-ft. We understand the DI3 basin has been in place for at least 30 years.

The materials at the Diamond Valley sites had more fine-grained soils compared to the Dammeron Valley sites. Laboratory testing performed on samples obtained from the Diamond Valley sites, neglecting the existing embankment soils, had an average of 54% fines passing a No. 200 sieve. We recommend that a trap efficiency of 50% be assumed for the Diamond 1 and 2 Detention Basins.

It is our understanding that the Diamond 3 Detention Basin will function as a diversion structure, and outflows from the basin will be approximately equal to inflows during design storm events. We recommend that the Diamond 3 Detention Basin be designed assuming that 25% of the sediment load will be trapped in the basin, 25% will be trapped in the Diamond 2 Detention Basin, and 50% will be transported through the basins without being trapped.

Based on the analyses and recommendations described above, we recommend the design of the detention basins assume the following sediment accumulation rates:

Table 5-1 Recommended Design Sediment Accumulation

Site	Approx. Drainage Basin Area (mi^2)	Estimated Average Annual Sediment Accumulation (ac-ft)	Estimated 50-yr Sediment Accumulation (ac-ft)
Dammeron 1	0.28	0.11	5.5
Dammeron 2	3.6	1.4	70
Dammeron 3	0.73	0.27	14
Diamond 1	0.90	0.11	5.5
Diamond 2	0.93	0.15	7.5*
Diamond 3	0.60	0.04	2.0

*Includes 2 ac-ft from the Diamond 3 drainage area

5.2 Available Borrow Materials

This section describes available borrow materials based on the preliminary investigations that have been performed. Additional investigations to further define the characteristics of available borrow materials should be performed during final design of the project.

Earthfill materials generally having 20 to 80% plastic fines are available for use as borrow from the Dammeron 1 Detention Basin site. As discussed previously in this report, fat clay was encountered in the lower portion of Test Pits DA1-101 and -102. Use of the fat clay for construction of dam embankments is not recommended. We estimate that 20,000 yd^3 of earthfill generally having 20 to 80% passing a No. 200 sieve is available for use from the DA1 site. Processing the earthfill materials to remove cobbles and boulders will be required.

Basalt rock, which was not practicable to excavate, was encountered within the test pits performed within the Dammeron 2 Detention Basin site. Assuming the basalt is at least 10 feet thick, we estimate that 85,000 yd^3 of basalt is available to borrow for use as riprap or rockfill within the DA2 detention basin site. Assuming that blasting will be required to efficiently borrow the basalt materials, we recommend that all rock needed for construction of the project be borrowed and stockpiled prior to DA2 Detention Basin foundation treatment or embankment construction. We recommend that the limits of the basalt borrow area be at least 100 feet from the planned footprint of the dam embankment. Investigations to evaluate the quantity and quality of the basalt should be performed during final design. In our experience, basalt deposits in southwestern Utah are suitable for use as riprap.

Earthfill materials, which are predominantly gravelly soils, are available for use as borrow from the Dammeron 3 Detention Basin site. We estimate that 200,000 yd^3 of gravelly soil is available to be borrowed from within the DA3 site. Processing the materials to remove cobbles and boulders will be required.

The existing embankment fill at the Diamond 1 and 2 Detention Basin sites, which is predominantly clayey and sandy soil, is suitable for re-use during construction of the embankments. Native deposits encountered within the existing foundations was also predominantly clayey and sandy, and it is likely that additional earthfill materials can be borrowed from within the basins for use as embankment fill. The results of the investigations indicate that less processing to remove oversize rocks will be required at the Diamond Valley sites compared to the Dammeron Valley sites.

5.3 Foundation Treatment

5.3.1 Dammeron Valley Sites

Basalt and other fractured rock within the dam embankment footprints should be treated to prevent internal erosion caused by soil particles migrating into open bedrock features under hydraulic gradients. The risk of internal erosion is reduced where gravelly soils are present on top of the rock materials since investigations indicate few, if any, open bedrock features are large enough to allow movement of gravel size particles. If particle movement begins to occur in areas where gravelly soils are present, the gravel will likely collect near the top of the openings. Sand will nest on the gravelly matrix, then finer particles will nest on the sand.

Conceptual design cross sections for the Dammeron Valley Detention Basins are shown on Figures 5 and 6. Figure 5 is a recommended conceptual cross section for areas where the bedrock is more than 10 feet below the existing ground surface and Figure 6 is a conceptual cross section for areas where the bedrock is within 10 feet of the existing ground surface.

In areas where the bedrock is at least 10 feet below the native ground surface, we recommend that a keyway trench beneath the dam centerline, as shown on Figure 5, be included in the conceptual design. The keyway trench depth should be equal to the maximum height of the dam divided by five, i.e. the trench depth is 6 feet for a dam with a maximum height of 30 feet. The keyway trench should have side slopes no steeper than 1H:1V with a base width of at least 15 feet.

In areas where the bedrock is within 10 feet of the existing ground surface, we recommend that the overburden soils be removed beneath the center and upstream portions of the dam as shown on Figure 6. For conceptual design, we recommend that it be assumed that a 4-inch thick layer of unreinforced concrete will be constructed on top of the bedrock to mitigate the potential for internal erosion into open rock features. We recommend that this cross section be assumed for the western two-thirds of the DA1 dam and southern one-half of the DA3 dam.

5.3.1 Diamond Valley Sites

We recommend that the cross section shown on Figure 5 be used for conceptual design of the Diamond Valley Detention Basin dams, except that the keyway depth should be as described below.

Hydraulic conductivity test results indicate that the native soils at the DI1 and DI2 sites are relatively impervious. We recommend that a 3-foot deep keyway be included in the conceptual designs for these detention basin dams.

Soils classifying as lean clay were encountered within the upper 14 feet at the Diamond 3 Detention Basin site. The hydraulic conductivities within the upper 15 feet were between 2,500 and 4,800 ft/yr, which are significantly higher than values typically calculated for lean clay soils. The hydraulic conductivities may be an indication of recently deposited soil and/or fissures within the clay deposits. Additional foundation investigations at this site should be performed during final design. Assuming the detention basin dam will be about 15 feet high at this site, we recommend that an 8-foot deep keyway be assumed beneath the DI3 detention basin dam for preliminary design. This recommended conceptual design keyway depth is about 50% of the planned dam height.

5.4 Embankment Design

Considering the foundation conditions and available borrow materials at these sites, we recommend that conceptual design assume that earthfill type embankment dams be constructed, as shown on Figures 5 and 6. It will be noted from the figures that the recommended embankment cross section has a low-permeable soil core and granular shells.

We recommend that the low-permeable core be clayey materials having 20 to 80% passing a No. 200 sieve and shell materials be granular soils having 5 to 50% passing a No. 200 sieve. Many of the samples tested from the Dammeron Valley sites had 20 to 50% plastic fines passing a No. 200 sieve and could be used for either embankment zone.

Materials sampled from Test Pit DA2-2, located on the southeast side of the proposed Dammeron 2 Detention Basin dam, appeared to be from volcanic origin. The moisture-density relationship test (Proctor) performed in the laboratory on a sample obtained from a depth of 6 feet resulted in a maximum dry density of 84.3 pcf and optimum moisture of 32.5%. The material was classified as sand with gravel (SP). The test results indicate high water absorption potential. As noted on Figures 5 and 6, we recommend that earthfill materials have a dry unit weight of at least 90 pcf. This requirement will require use of the higher quality materials available from the project area, which will have better strength characteristics compared to the lighter materials.

For these detention basins, which will not have a normal storage, it is very unlikely that steady-state reservoir full seepage conditions will develop. We recommend that conceptual design of the embankments have 3H:1V (Horizontal:Vertical) upstream and downstream slopes with a toe drain beneath the downstream embankment toe. This cross section is expected to perform satisfactorily for the proposed detention basins.

Consideration has been given to designing downstream slopes as steep as 2H:1V. For downstream embankment slopes steeper than 3H:1V, we recommend that internal drainage be provided, as shown on Figure 7. Evaluations we have performed indicate that the 3H:1V design is more cost efficient; however, the steeper downstream slope with internal drainage option may be the preferred alternative if property limits are not conducive to an embankment with 3H:1V downstream slopes. The 2H:1V with internal drainage option may be the preferred alternative for the Diamond Valley detention basin dams where private property is present at the downstream toes of the existing dams.

We recommend a toe drain, as shown on Figures 5, 6, and 7, be included in the conceptual dam designs. The toe drain will improve the safety of the dams by reducing the risk of saturation within embankment and near-surface foundation materials. The toe drain installed beneath the downstream toe should connect to an outfall which daylights downstream of the dams.

The following embankment crest widths are recommended for the proposed single-purpose detention basin dams. These recommended crest widths meet State of Utah and NRCS design criteria:

Table 5-2 Recommended Embankment Crest Widths

Maximum Height of Dam (H, ft)	Minimum Crest Width (ft)
< 25	12
25 – 45	14
>45	H/5 + 5

5.5 Seismic Hazards and Liquefaction

Utah State and NRCS design rules allow seismic design of detention basis to assume the basins will be filled to the lowest ungated outlet or principal spillway. We understand that the principal spillways for these detention basins will be near the bottom of the basins; therefore, the basins will be assumed to be dry for seismic design.

The potential for liquefaction to result in significant strength loss beneath the detention basin dams is low since 1) It is unlikely that the foundation soils will be saturated during an earthquake event, and 2) SPT testing indicated that native soil deposits are generally in a state dense enough to prevent strength loss by liquefaction.

Based on the results of the investigations performed for this study and the intended use of the detention basins, no mitigation of liquefaction or other seismic hazards is necessary at these sites.

5.6 Spillway and Appurtenant Design Recommendations

We understand that each of the proposed detention basins will likely be constructed with a low-level principal spillway conduit and an auxiliary open channel spillway. Where possible, the spillway conduits and channels should be constructed on bedrock to reduce the potential for issues related to settlement and erosion. Foundation conditions at the following locations appear to be favorable for construction of the spillways. Where feasible, we recommend the spillways be located at the locations indicated on the table below:

Table 5-3 Recommended Spillway Locations

Site	Low-Level Principal Spillway	Auxiliary Spillway
Dammeron 1	Near Boring DA1-1	Near left abutment
Dammeron 2	Near Boring DA2-1	Near right abutment
Dammeron 3	Near Test Pit DA3-3	Near left abutment

As indicated above, the spillway locations listed above are suggested for foundation considerations. Hydraulic design considerations may necessitate that alternate locations be considered.

Subsurface investigations indicate that it is not feasible to construct the Diamond Valley spillways on bedrock foundations. Open spillway channels in Diamond Valley will likely need to be armored to protect against erosion. Armoring will likely be required for the Dammeron 2 site as well. Depending upon the properties of the rock formations at the Dammeron 1 and 3 sites, armoring may not be required, but construction of auxiliary spillways may require excavation of rock materials.

6. COST ESTIMATES

It is our understanding that hydraulic evaluations are being performed to refine the detention basin sizes needed to meet the project objectives. Cost estimates for the embankments will be provided when estimated project quantities are better defined. For conceptual design of these detention basins, we recommend the following unit costs be assumed:

Table 5-4 Recommended Assumed Unit Costs

Item	Unit Cost
Excavation, Common	$10/yd^3$
Excavation, Rock	$25/yd^3$
Rock Foundation Treatment	$40/yd^2$
Earthfill, processed to remove oversize rocks (obtained on-site)	$15/yd^3$
Filter Sand and Gravel Drain	$100/yd^3$
Riprap (obtained on-site)	$50/yd^3$
Dental Concrete	$400/yd^3$

7. ADDITIONAL STUDIES REQUIRED FOR FINAL DESIGN

Geotechnical engineering work required for final design of the detention basins includes:

- Additional foundation investigations. Borings are recommended at each abutment of all dams planned for the project. Borings are also recommended at maximum spacing of 200 feet along the dam alignments. Additional test holes will be required to investigate foundation conditions for outlets and spillways.

- Laboratory testing to evaluate properties of foundation and embankment materials.
- Final seepage and stability analyses.
- Final embankment design.
- Final design report.
- Preparation of design drawings and specifications.

We envision that the final design work will be performed after the Environmental Assessment is complete.

8. LIMITATIONS

The information presented herein is based upon the results of limited field and laboratory tests. It should be recognized that soil materials are inherently heterogeneous and that conditions may exist throughout the project area which were not defined during these investigations. This report is intended for conceptual design of the detention basins. Additional or revised recommendations compared to those described in this report may be appropriate as additional investigations and design evaluations are performed for the project.

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APPENDIX E-7B

TECHNICAL DOCUMENTS, CONTINUED

FIGURES

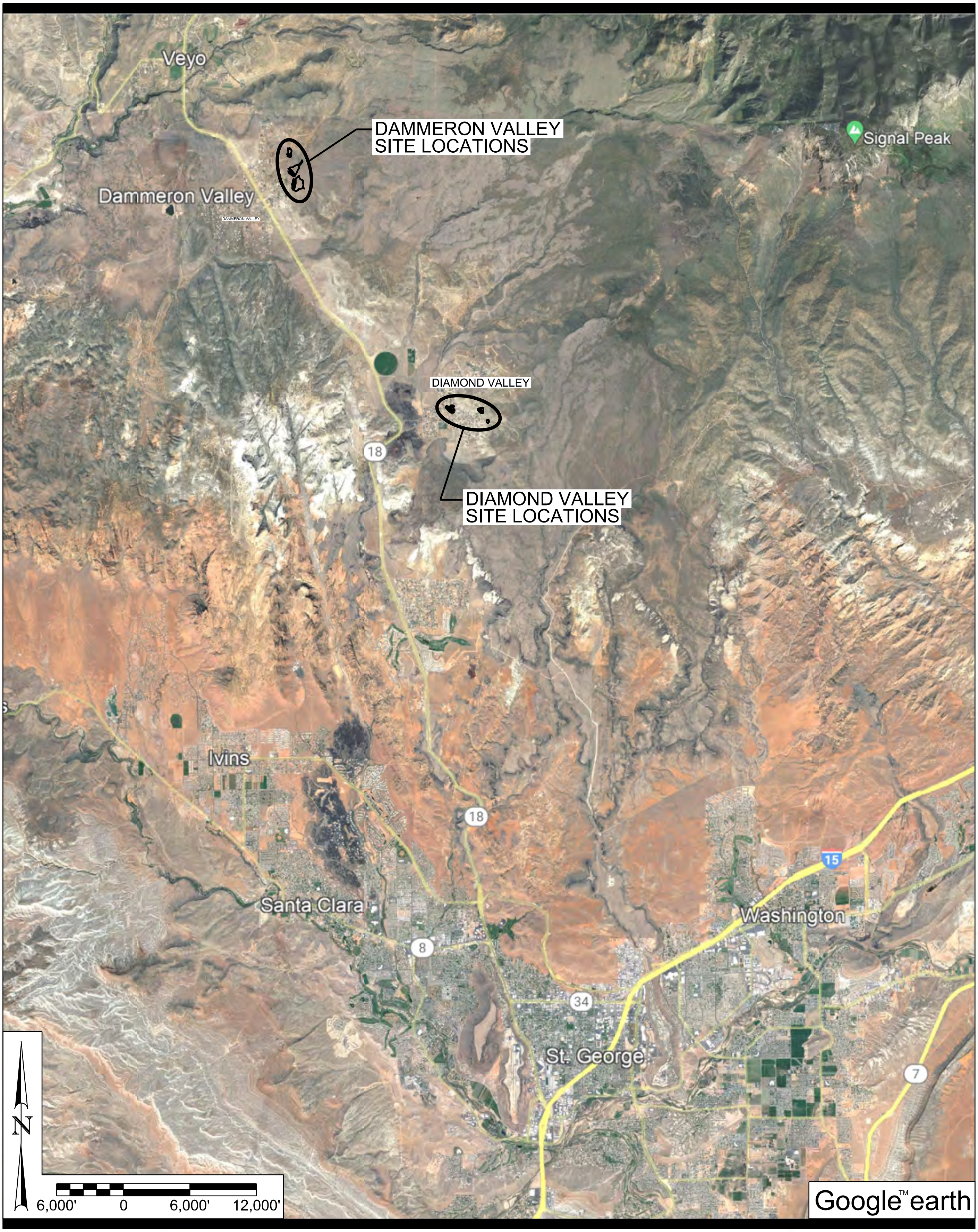

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Figure 1 VICINITY MAP

Santa Clara Watershed EA

Washington County, Utah

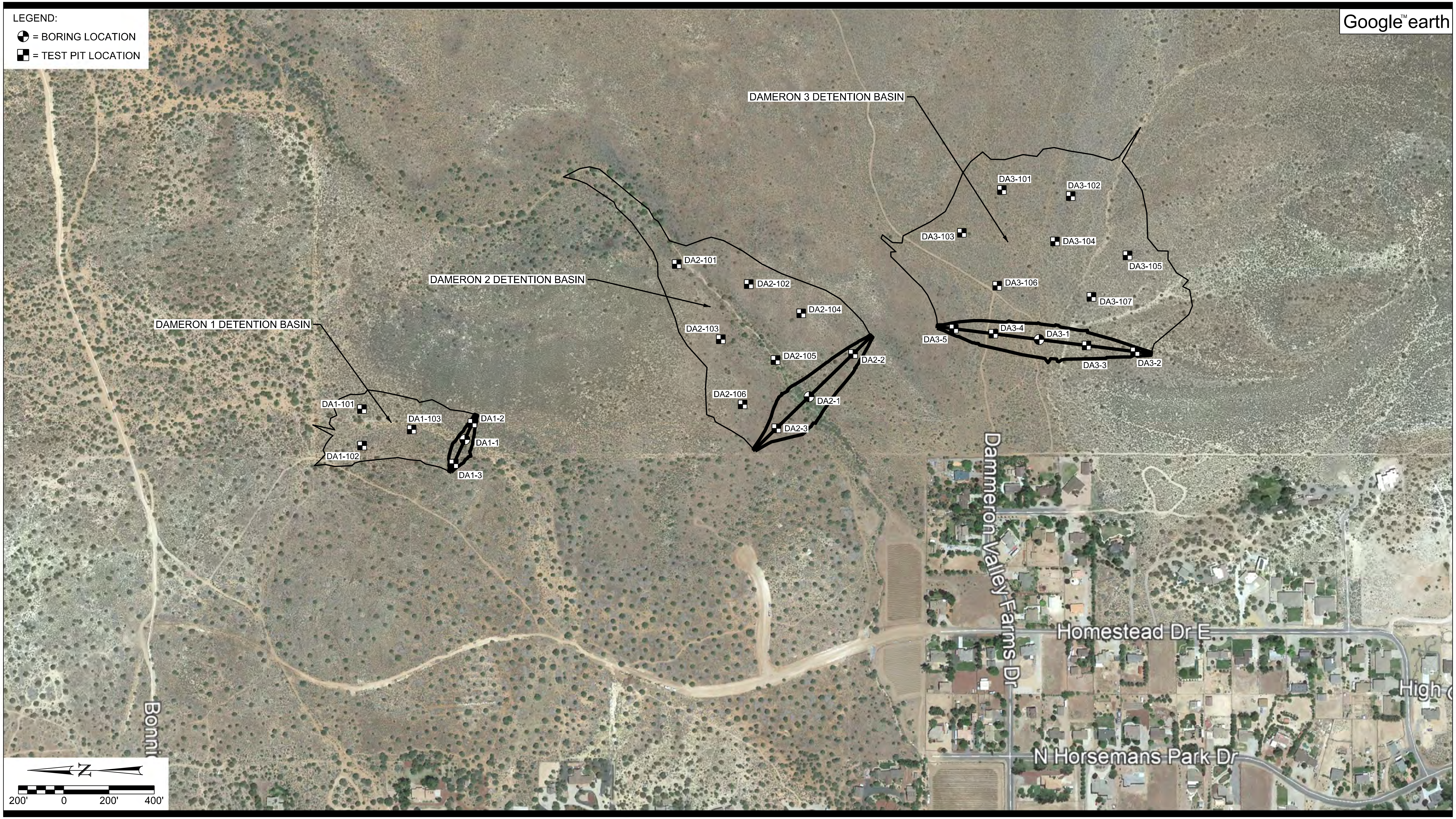

Figure 2

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SANTA CLARA WATERSHED EA - DAMMERON VALLEY
Washington County, Utah

Site Plan & Test Hole Locations

Figure 3

RB&G ENGINEERING, INC.

SANTA CLARA WATERSHED EA - DIAMOND VALLEY
WASHINGTON COUNTY, UTAH

Site Plan & Test Hole Locations

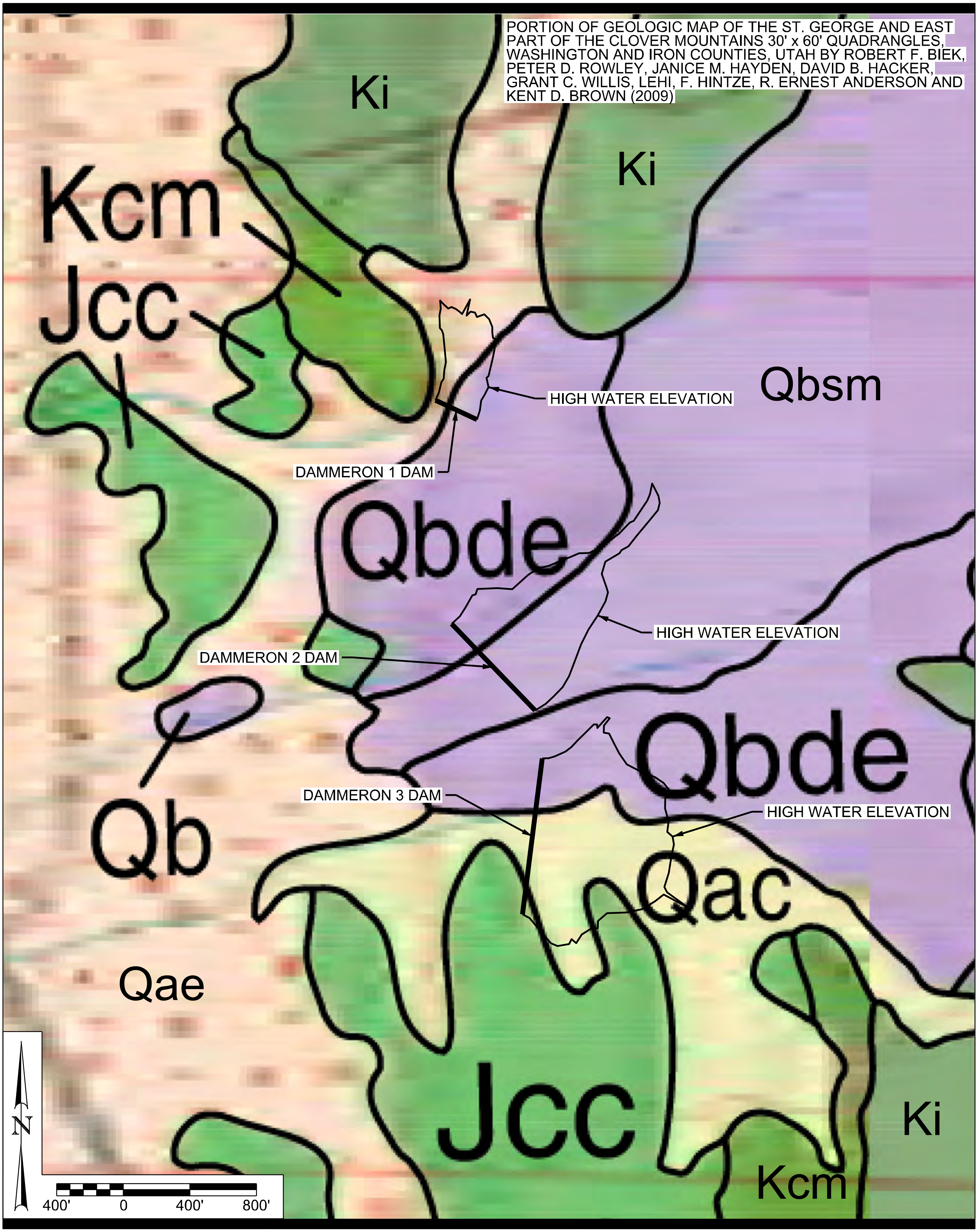

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Figure 4a GEOLOGIC MAP

Santa Clara Watershed EA

Washington County, Utah

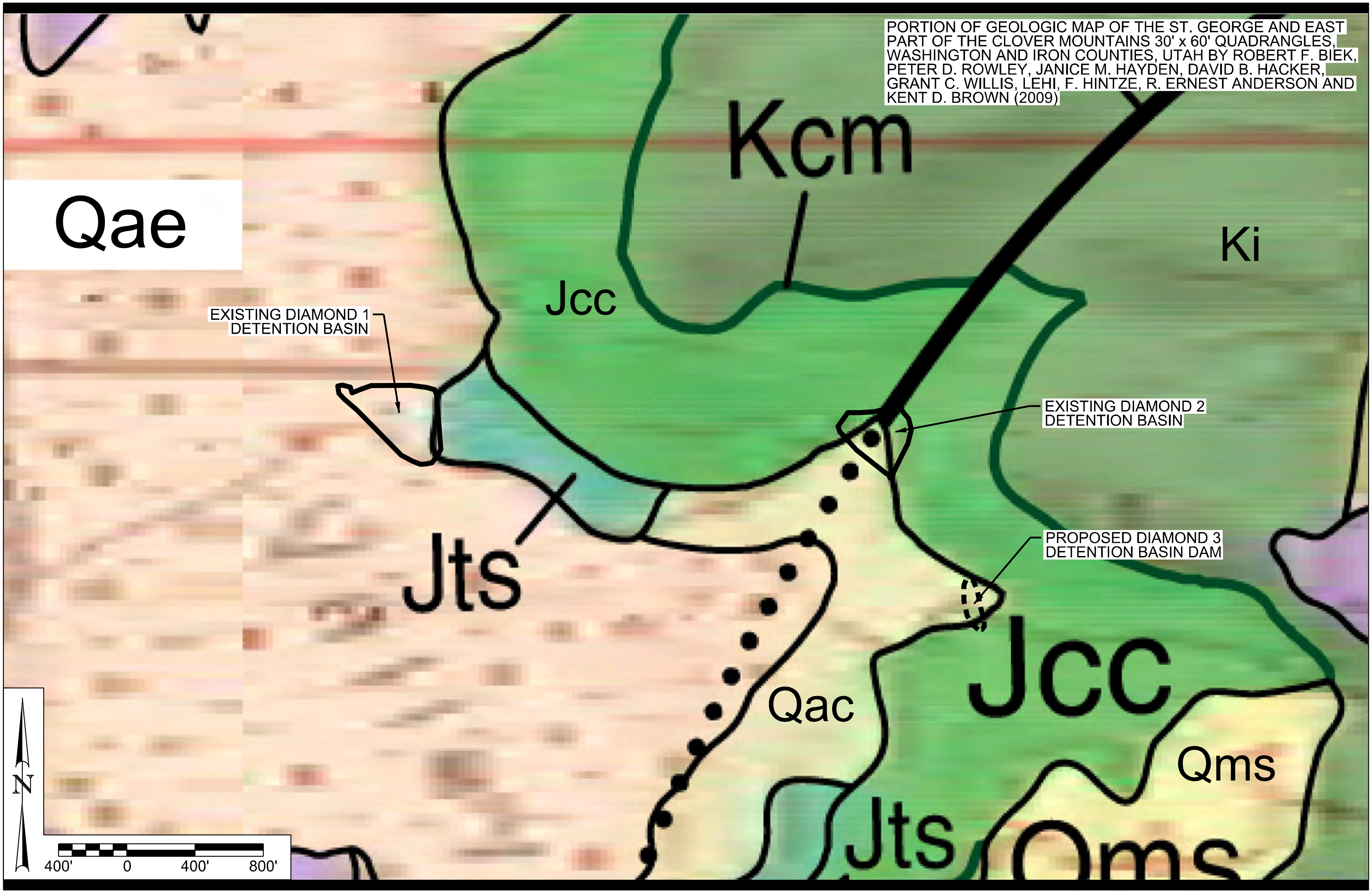

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Figure 4b GEOLOGIC MAP

Santa Clara Watershed EA

Washington County, Utah

Qac, Qaco

Alluvium and colluvium (Holocene to upper Pleistocene) – Poorly to moderately sorted, generally poorly stratified, clay- to boulder-size, locally derived sediment deposited principally in swales, small drainages, and the upper reaches of large streams by fluvial, slope-wash, and creep processes; gradational with both alluvium and colluvium; older deposits (Qaco) include gypcrete (silt to small boulders cemented by gypsum) along the Moenkopi outcrop belt just west of St. George that is as much as 10 feet (3 m) thick; older deposits form inactive surfaces commonly incised by younger (Qac) deposits; generally less than 30 feet (9 m) thick.

Qae, Qaeo

Alluvium and eolian sand (Holocene to upper Pleistocene) – Moderately sorted gravel, sand, and silt deposited in small channels and on alluvial flats, and well-sorted, fine- to medium-grained, reddish-brown eolian sand locally reworked by alluvial processes; younger deposits (Qae) form active depositional surfaces, whereas older deposits (Qaeo) typically form incised, inactive surfaces; as much as about 20 feet (6 m) thick.

Qb, Qbc

Basaltic lava flows and cinder deposits, undivided (Pleistocene) – Isolated basaltic lava flows (Qb) and cinder deposits (Qbc) of uncertain correlation along the Virgin River near Hurricane, and along the Santa Clara River near Veyo and Central.

Qbde, Qbdec

Dameron Valley East lava flow and cinder cone (middle Pleistocene) – Dark-gray trachybasalt (Qbde) with small olivine phenocrysts in an aphanitic groundmass; erupted from a vent at a cinder cone (Qbdec) about 2 miles (3 km) southeast of Veyo; yielded an $^{40}Ar/^{39}Ar$ plateau age of 0.59 $\pm$ 0.02 Ma (0.59 $\pm$ 0.03 Ma isochron) (UGS and NMGRL, 2008); lava flow is generally 10 to 20 feet (3–6 m) thick.

Qbsm, Qbsmc

Saddle Mountain lava flow and cinder cone (middle Pleistocene) – Dark-gray, fine-grained lava flow (Qbsm) that ranges in composition from basalt to trachybasalt to basaltic trachyandesite; contains small olivine and plagioclase phenocrysts; erupted from a vent at a cinder cone (Qbsmc) about 6 miles (10 km) east of Veyo; yielded an $^{40}Ar/^{39}Ar$ preferred isochron age of 0.47 $\pm$ 0.12 Ma (0.74 $\pm$ 0.07 Ma low-confidence plateau) (UGS and NMGRL, 2008); lava flow is generally 20 to 40 feet (6–12 m) thick.

Qms **Landslides** (Holocene to middle[?] Pleistocene) – Poorly sorted, clay- to boulder-size, locally derived material deposited by rotational and translational landslide movement; characterized by hummocky topography and small ponds, numerous internal scarps, and chaotic bedding attitudes; basal slip surfaces most commonly form in the Shnabkaib Member of the Moenkopi Formation, the Petrified Forest Member of the Chinle Formation, the Co-op Creek Limestone Member of the Carmel Formation, the Dakota Formation, and the upper unit of the Straight Cliffs Formation, and the slides incorporate these and overlying map units; the Petrified Forest Member and Dakota Formation especially form large, complex mass movements; undivided as to inferred age because new research shows that even landslides having subdued morphology (suggesting that they are older, weathered, and have not experienced recent large-scale movement) may continue to exhibit slow creep or are capable of renewed movement if stability thresholds are exceeded (Ashland, 2003); generally several tens of feet thick, but some deposits may exceed 200 feet (60 m) thick.

Ki **Iron Springs Formation** (Upper Cretaceous, Santonian or lower Campanian to Cenomanian) – Interbedded, ledge-forming, calcareous, cross-bedded, fine- to medium-grained sandstone and less-resistant, poorly exposed sandstone, siltstone, and mudstone; contains a few thin sandy coquina beds, minor carbonaceous shale, and uncommon pebbly sandstone; lower part contains numerous light-gray to reddish-brown smectitic mudstone intervals; the formation is variously colored grayish orange, pale yellowish orange, dark yellowish orange, white, pale reddish brown, and greenish gray and is locally stained by iron-manganese oxides; Liesegang banding is locally common in the sandstone beds; sandstone beds range from quartz arenite to litharenite (Fillmore, 1991; Goldstrand, 1992); deposited principally in braided-stream and floodplain environments (Johnson, 1984; Fillmore, 1991), but Eaton and others (1997) noted that brackish-water molluscan faunas collected about 1000 feet (300 m) above the base of the formation in the Pine Valley Mountains probably indicate the maximum transgression of the Cretaceous seaway; map unit tentatively correlated to the Dakota Formation (as used here), Tropic Shale, and Straight Cliffs Formation of the Markagunt Plateau (Eaton, 1999); age from Goldstrand (1994); about 3500 to 4000 feet (1070–1220 m) thick in the Pine Valley Mountains (Cook, 1960b) and about 3000 feet (900 m) thick near Gunlock (Hintze, 1986).

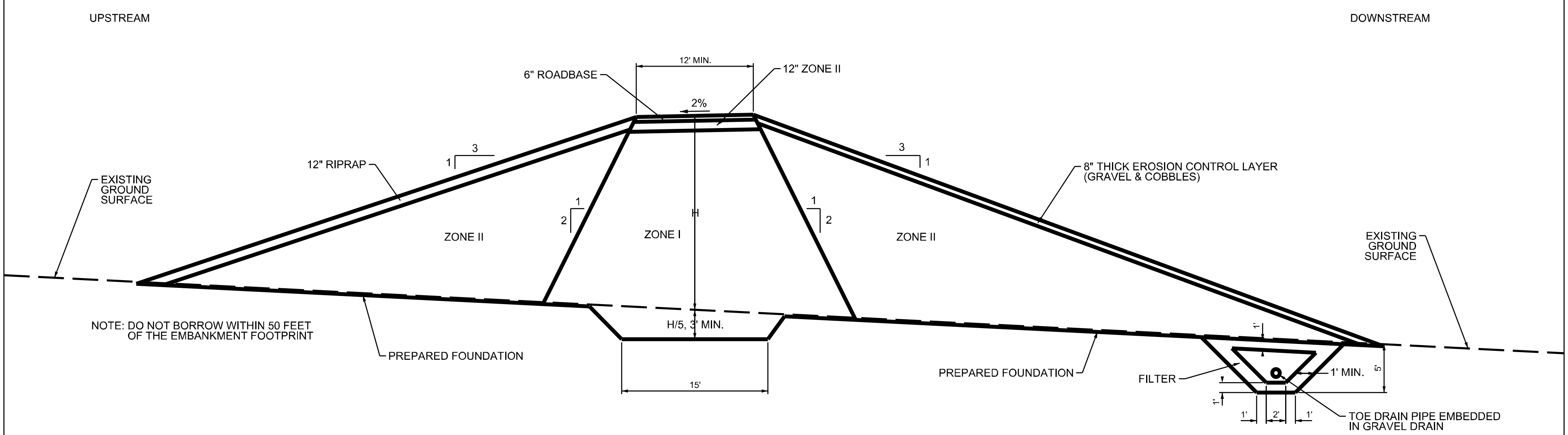
Jts **Sinawava Member** (Middle Jurassic, Bajocian) – Slope-forming, moderate-reddish-brown mudstone, siltstone, and fine-grained silty sandstone; west of the Hurricane Cliffs, contains several white, gray, and pink alabaster gypsum beds as much as 10 feet (3 m) thick and several thin intervals with white and pinkish-gray chert nodules that may be silicified bentonite; western exposures also contain numerous thin, greenish-gray mudstone (altered volcanic ash) beds with common biotite; a ledge-forming, pinkish-gray to light-greenish-gray, calcareous, medium- to coarse-grained, locally pebbly sandstone is present about one-third up the section in the Harrisburg Junction quadrangle (Biek, 2003a); forms narrow, but prominent, deep-reddish-brown, vegetated slope at the top of the Navajo Sandstone in the Zion National Park area; elsewhere forms conspicuous bright-red and gray slopes that weather to soft, gypsiferous soils; upper contact is gradational and interfingering with the White Throne Member in the Zion National Park area, but unconformable with light-gray calcareous shale and micritic limestone of the Co-op Creek Limestone Member to the west; deposited in coastal-sabkha and tidal-flat environments (Blakey, 1994; Peterson, 1994); member mapped as a colored line where too thin to show separately; Kowallis and others (2001) reported several $^{40}Ar/^{39}Ar$ ages of 170 to 169 million years old for altered volcanic ash beds within the formation that were likely derived from a magmatic arc in what is now southern California and western Nevada; thins abruptly over the crest of the Pintura anticline; thickens west and south from less than 10 feet (< 3 m) thick in the Kolob Canyons part of Zion National Park to about 400 feet (120 m) thick near Gunlock.

Kcm **Cedar Mountain Formation, undivided** (Cretaceous, Cenomanian to Albian) – Consists of two units in southwest Utah (Hylland, 2000; Biek and Hylland, 2007) in ascending order: **Conglomerate unit** – Thick-bedded, yellowish-brown, channel-form conglomerate, pebbly sandstone, and pebbly gritstone; clasts are subrounded to rounded, pebble- to small-cobble-size quartzite, chert, and limestone; locally stained reddish brown to dark yellowish brown; best developed on the Upper Kolob Plateau east of Kolob Reservoir, on the east flank of the Pine Valley Mountains, and in the Gunlock-Veyo area, where it is 30 to 100 feet (10–30 m) thick, but nearly everywhere present as a thin, commonly less than 1-foot-thick (0.3 m), pebbly conglomerate deposited on paleotopography developed on top of the various members of the Carmel Formation. **Mudstone unit** – Gray to variegated smectitic mudstone with minor light-gray to yellowish-gray fine-grained sandstone that weathers to poorly exposed slopes; near the base of this predominantly mudstone interval on the Upper Kolob Plateau there is a distinctive, 1- to 4-foot-thick (0.3–1.2 m), locally ledge-forming, pale-olive to greenish-gray, thin- to medium-bedded, fine- to medium-grained sandstone containing subangular, reddish-brown chert granules; upper contact is poorly exposed and corresponds to a color and lithologic change, from comparatively brightly colored smectitic mudstone below to gray and light-yellowish-brown mudstone and fine-grained sandstone above; less than a few tens of feet thick.

Unconformably overlain by the Dakota Formation east of the Hurricane fault (see, for example, Kirkland and others, 1997) and by the Iron Springs Formation west of the fault; deposited in river-channel and floodplain environments on a broad, coastal plain (Tschudy and others, 1984; Kirkland and others, 1997); Biek and Hylland (2007) reported a single-crystal $^{40}Ar/^{39}Ar$ age of 97.9 $\pm$ 0.5 Ma (earliest Cenomanian) on sanidine from a volcanic ash in Cedar Mountain mudstone immediately above the conglomerate bed in the Straight Canyon quadrangle east of Zion National Park; Dyman and others (2002) obtained an $^{40}Ar/^{39}Ar$ age of 101.7 $\pm$ 0.42 Ma (latest Albian) on sanidine from a stratigraphically similar mudstone near Gunlock, the same 20-foot-thick (6 m), moderate-red bentonitic bed near the Gunlock Reservoir for which Hintze and others (1994) reported an anomalously young fission-track age of 80 $\pm$ 10 Ma; pollen analyses indicate an Albian age for the mudstone and underlying conglomerate (Doelling and Davis, 1989; Hylland, 2000).

Correlation of these strata to the Cedar Mountain Formation of central Utah is controversial (see, for example, Titus and others, 2005). The conglomeratic member was previously mapped as the lower part of the Dakota Formation, and the mudstone unit (in the Gunlock area) as an Upper Cretaceous bentonite, but the lithology, age, and stratigraphic position of these beds suggest correlation to the Cedar Mountain Formation of central Utah; specifically, the mudstone unit appears to be time-correlative with the Mussentuchit Member of the Cedar Mountain Formation of central and eastern Utah (Cifelli and others 1997; Kirkland and Madsen, 2007); ongoing detrital zircon studies may help resolve the provenance and correlation of the underlying conglomeratic unit; where conglomerate is thickest, it likely represents deposits of a major Cedar Mountain river channel, whereas thin conglomerate deposits may represent terrace remnants of this river system or possibly younger gravels that were reworked in the early Late Cretaceous; 0 to about 100 feet (0–30 m) thick.

Jcc **Co-op Creek Limestone Member** (Middle Jurassic, Bajocian) – Divisible into two informal unmapped units: **Upper unit** – Thin- to medium-bedded, light-gray, yellowish-gray, or yellowish-brown micritic limestone and, especially in the upper part, oolitic and sandy limestone; forms sparsely vegetated, ledgy slopes and cliffs; locally contains abundant *Isocrinus* sp. columnals, pelecypods, and gastropods. **Lower unit** – Mostly thinly laminated to thin-bedded, light-gray micritic limestone, calcareous shale, platy limestone, and, near the base, lesser gypsum and fine-grained sandstone; forms steep, vegetated slopes; contact with upper unit is gradational and corresponds to a subtle break in slope and vegetation patterns. Contact with Crystal Creek Member is sharp and planar and corresponds to a prominent color change from yellowish- and brownish-gray to reddish-brown, with fossiliferous sandy limestone and micritic limestone giving way to gypsiferous mudstone and siltstone; locally, moderate-reddish-brown blebs of jasper and an oyster coquina are present in uppermost mudstones of the Co-op Creek Limestone; in the west half of the map area, locally unconformably overlain by the conglomerate unit of the Cedar Mountain Formation; Kowallis and others (2001) reported several $^{40}Ar/^{39}Ar$ ages of 168 to 167 million years old for altered volcanic ash beds within the lower unit in southwest Utah that were likely derived from a magmatic arc in what is now southern California and western Nevada; deposited in a shallow-marine environment (Imlay, 1980; Blakey and others, 1983); generally thins to the west, but ranges from about 285 to 580 feet (87–177 m) thick.



ZONE I: 4" MINUS COHESIVE SOIL HAVING 20%-80% PASSING NO. 200 SIEVE, LIQUID LIMIT 20-50, AND DRY UNIT WEIGHT 90 PCF OR GREATER.

ZONE II: 4" MINUS GRANULAR SOIL HAVING 5%-50% PASSING NO. 200 SIEVE, AND DRY UNIT WEIGHT 90 PCF OR GREATER.

NOT TO SCALE

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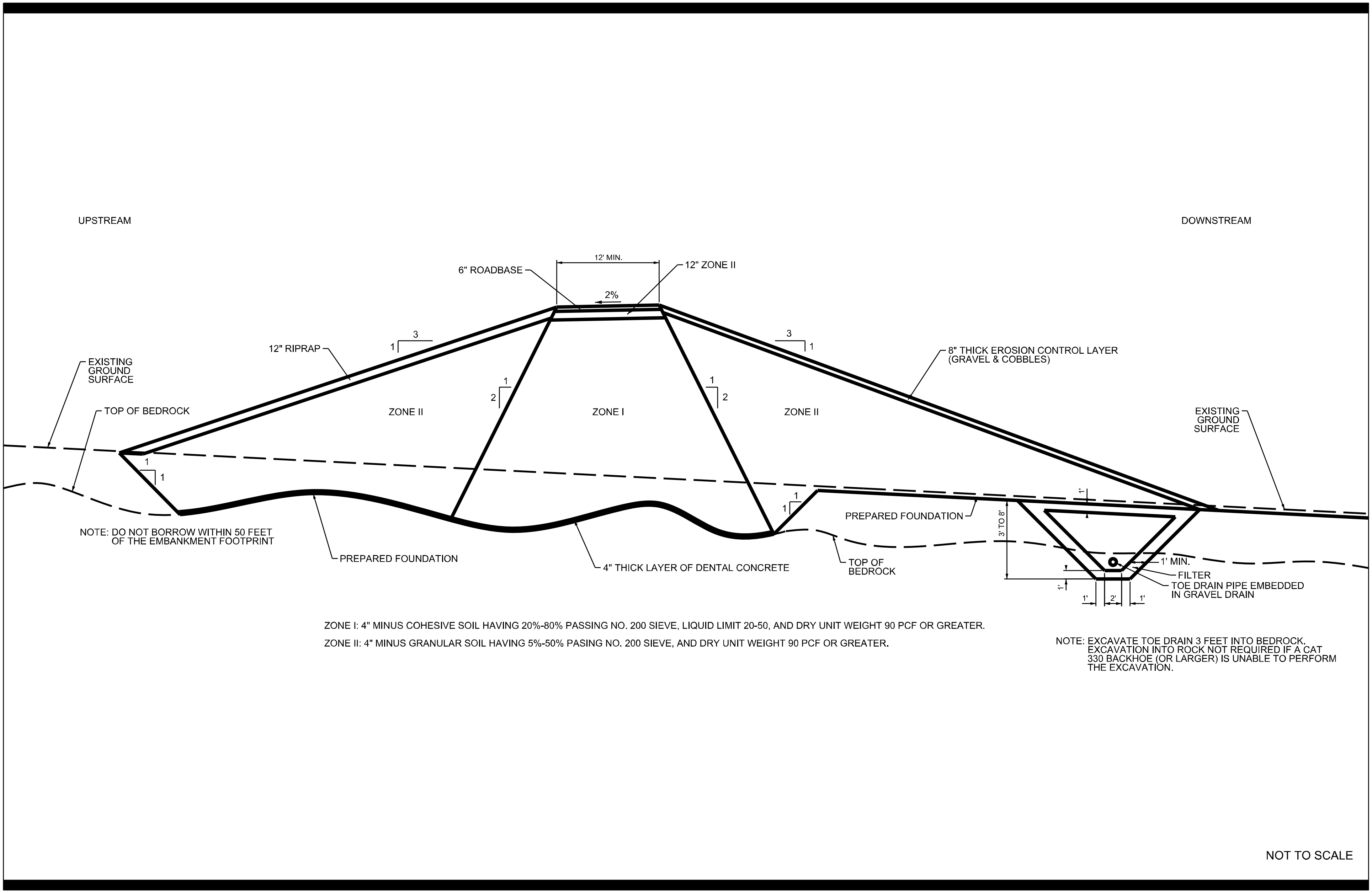
Figure 5 CONCEPTUAL EMBANKMENT CROSS SECTION - BEDROCK MORE THAN 10' BELOW EXISTING GROUND SURFACE

SANTA CLARA WATERSHED EA - DAMERRON VALLEY DETENTION BASINS

Washington County, Utah

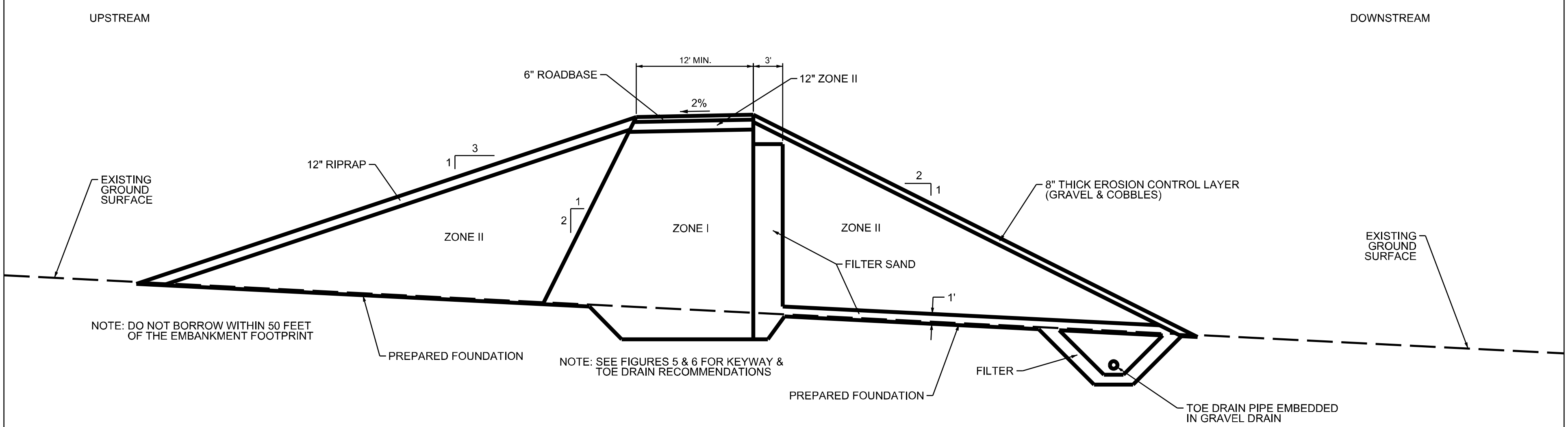


RB&G ENGINEERING, INC.

Figure 6 CONCEPTUAL EMBANKMENT CROSS SECTION - BEDROCK LESS THAN 10' BELOW EXISTING GROUND SURFACE

SANTA CLARA WATERSHED EA - DAMERRON VALLEY DETENTION BASINS

Washington County, Utah



ZONE I: 4" MINUS COHESIVE SOIL HAVING 20%-80% PASSING NO. 200 SIEVE, LIQUID LIMIT 20-50, AND DRY UNIT WEIGHT 90 PCF OR GREATER.

ZONE II: 4" MINUS GRANULAR SOIL HAVING 5%-50% PASSING NO. 200 SIEVE, AND DRY UNIT WEIGHT 90 PCF OR GREATER.

NOT TO SCALE

RB&G ENGINEERING, INC.

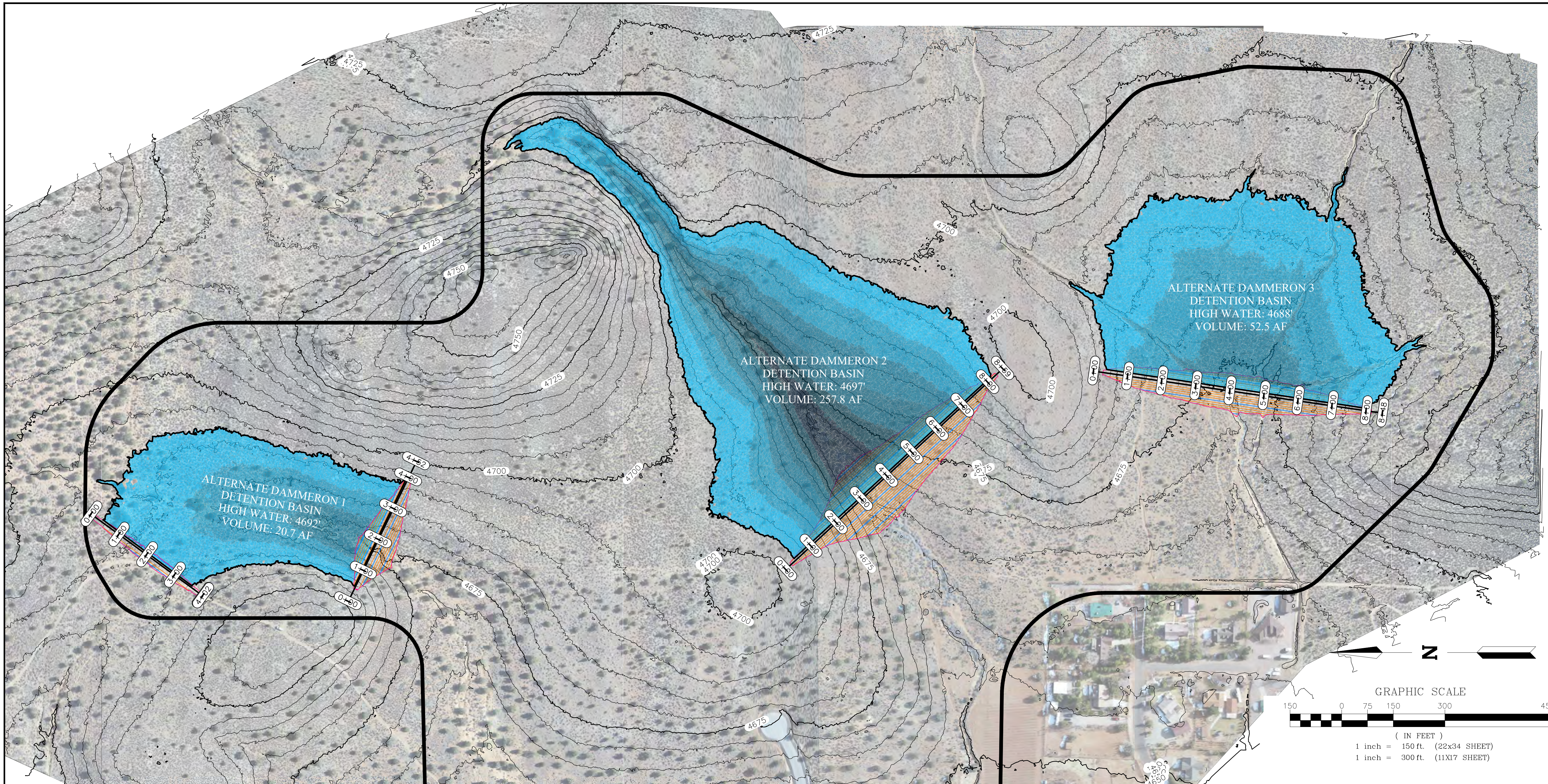
Figure 7 CONCEPTUAL ALTERNATIVE EMBANKMENT CROSS SECTION - 2H:1V DOWNSTREAM SLOPE

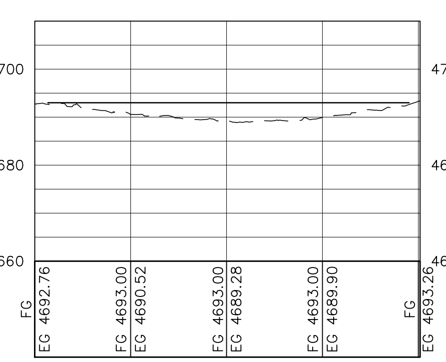
SANTA CLARA WATERSHED EA - DAMERRON VALLEY DETENTION BASINS

Washington County, Utah

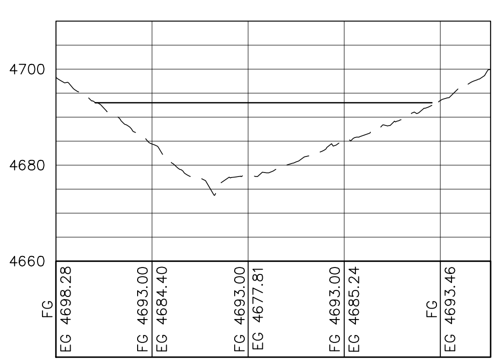
APPENDIX A

Conceptual Design

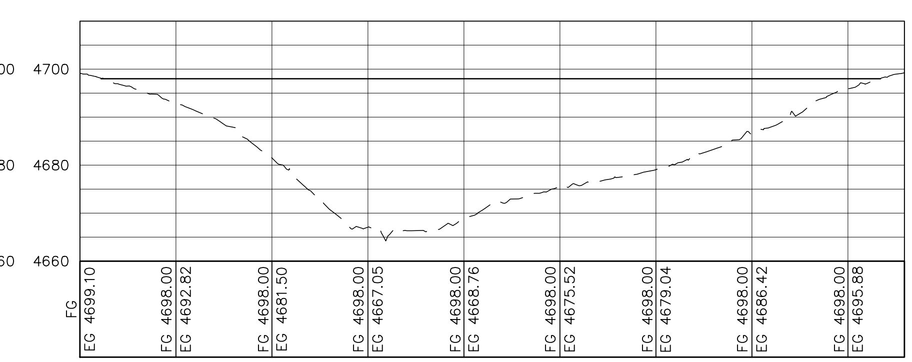




DAMMERON 1 NORTH DETENTION BASIN DAM CENTERLINE
SCALE: 1" = 200' (11x17) 5x VERTICAL EXAGGERATION



DAMMERON 1 SOUTH DETENTION BASIN DAM CENTERLINE
SCALE: 1" = 200' (11x17) 5x VERTICAL EXAGGERATION



DAMMERON 2 DETENTION BASIN DAM CENTERLINE
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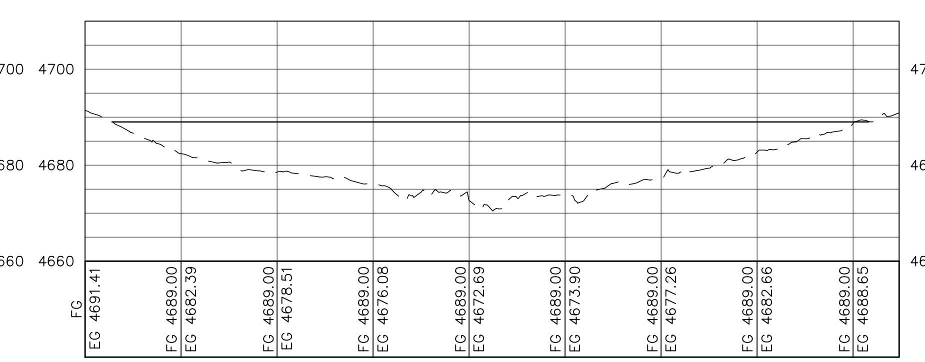

DAMMERON 3 DETENTION BASIN DAM CENTERLINE
SCALE: 1" = 200' (11x17) 5x VERTICAL EXAGGERATION

NO.	DATE	BY	DESCRIPTION

REVISIONS

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T: 435.628.6500 • F: 435.628.6553 • alphaengineering.com

TITLE
DETENTION BASINS 1 THROUGH 3 DAM CENTERLINE SECTIONS

PROJECT
DAMMERON VALLEY
SANTA CLARA WATERSHED EA

PROJECT # 308-10
NAME JTM
DATE DECEMBER 13, 2021
SCALE AS NOTED
SHEET 1
1 OF 2
FILE 308-10 EXH Dammeron.dwg

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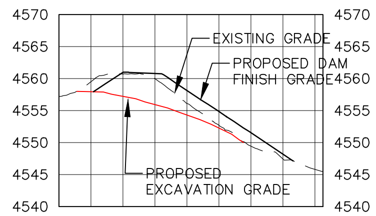

DAM 1 SECTION A–A
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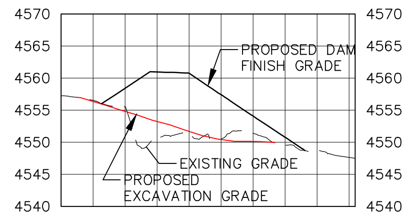
VERTICAL SCALE: 1" = 30'



DAM 1 SECTION B–B
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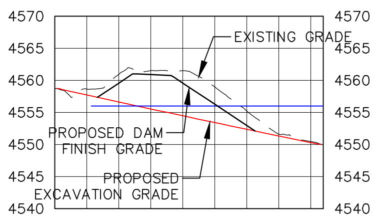
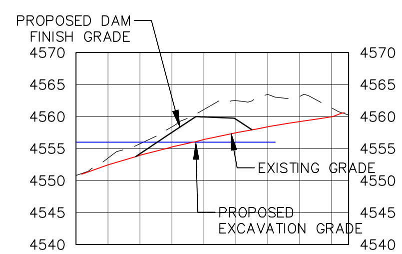
VERTICAL SCALE: 1" = 30'



DAM 1 SECTION C–C
HORIZONTAL SCALE: 1" = 60'
VERTICAL SCALE: 1" = 30'



AREA1 SECTION D–D
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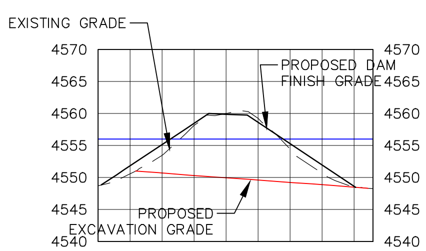
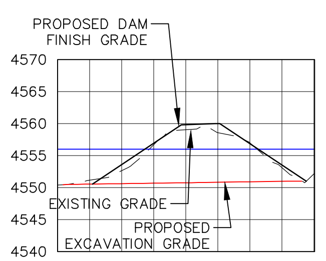
VERTICAL SCALE: 1" = 30'



AREA 1 SECTION E–E
HORIZONTAL SCALE: 1" = 60'
VERTICAL SCALE: 1" = 30'



AREA 1 SECTION F–F
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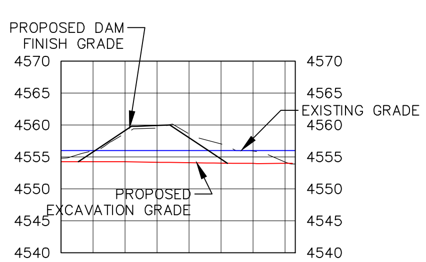
VERTICAL SCALE: 1" = 30'



AREA 1 SECTION G–G
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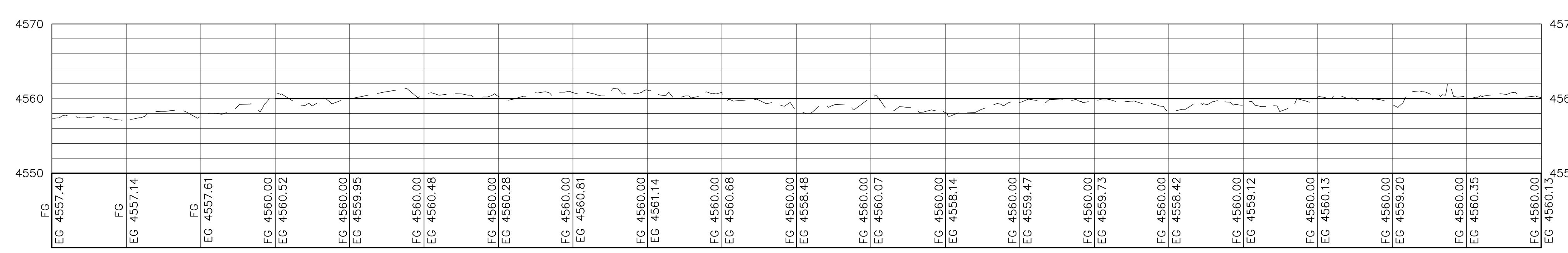
VERTICAL SCALE: 1" = 30'



DIAMOND 1 EXISTING DETENTION BASIN DAM CENTERLINE
SCALE: 1" = 50' (11x17) 5x VERTICAL EXAGGERATION

NO.	DATE	BY	DESCRIPTION

REVISIONS

ALPHA ENGINEERING
43 South 100 East, Suite 100 • St George, Utah 84770
T: 435.628.6500 • F: 435.628.6553 • alphaengineering.com

TITLE
EXISTING DETENTION BASIN 1 DAM CROSS & CENTERLINE SECTIONS

PROJECT
DIAMOND VALLEY
SANTA CLARA WATERSHED EA

PROJECT # 308-10
NAME CWL
DATE MARCH 22, 2021
SCALE AS NOTED

SHEET
1
1 OF 2

FILE 308-10 Diamond Valley MST.dwg

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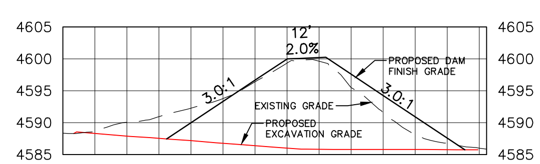

DAM 2 SECTION A–A
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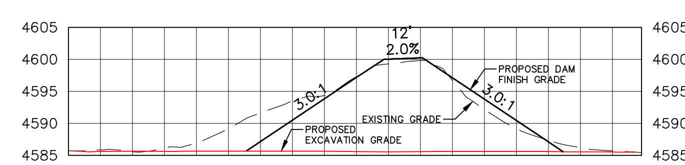
VERTICAL SCALE: 1" = 30'



DAM 2 SECTION B–B
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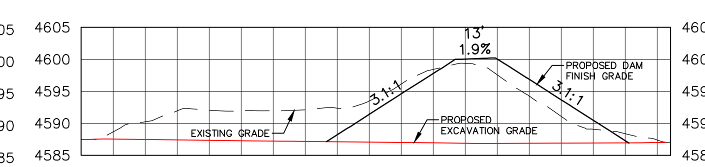
VERTICAL SCALE: 1" = 30'



DAM 2 SECTION C–C
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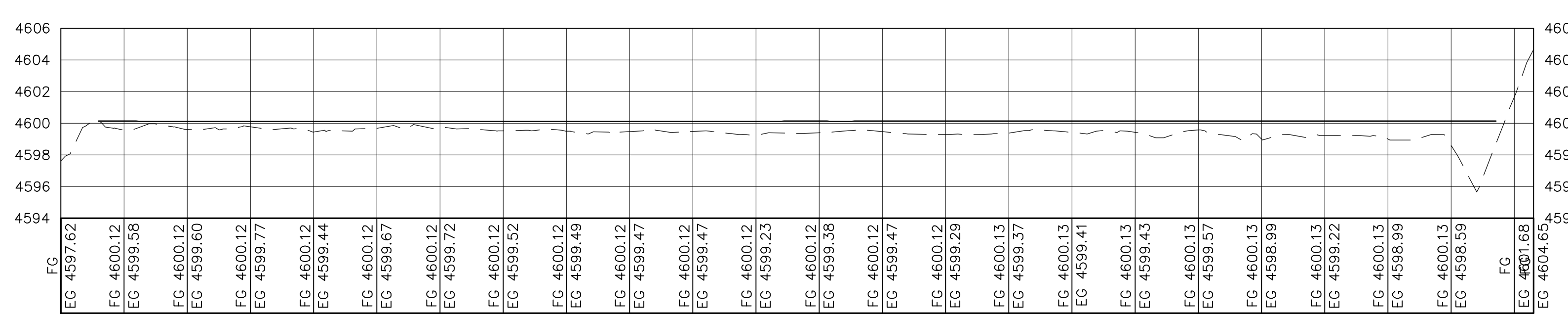
VERTICAL SCALE: 1" = 30'



DIAMOND 2 EXISTING DETENTION BASIN DAM CENTERLINE
SCALE: 1" = 50' (11x17) 5x VERTICAL EXAGGERATION

NO.	DATE	BY	DESCRIPTION

REVISIONS

ALPHA ENGINEERING
43 South 100 East, Suite 100 • St George, Utah 84770
T: 435.628.6500 • F: 435.628.6553 • alphaengineering.com

TITLE
EXISTING DETENTION BASINS 2 & 3
DAM CROSS & CENTERLINE SECTIONS

PROJECT
DIAMOND VALLEY
SANTA CLARA WATERSHED EA

PROJECT # 308-10
NAME CWL
DATE MARCH 22, 2021
SCALE AS NOTED
SHEET 2
2 OF 2
FILE 308-10 EXH Diamond.dwg

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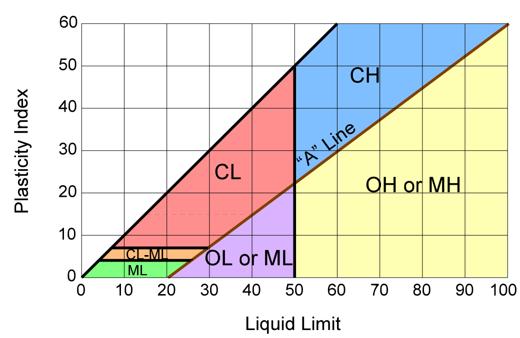
APPENDIX B

Boring Logs and Photos

Unified Soil Classification System

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
COARSE-GRAINED SOILS *more than half of material is larger than No. 200 sieve*	**Gravels** *more than half of coarse fraction is larger than No. 4 sieve size*	**Clean Gravels** *little or no fines*	**GW**		Well graded gravels, gravel-sand mixtures, little or no fines	*For laboratory classification of coarse-grained soils*	$C_u = \frac{D_{60}}{D_{10}}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$	Greater than 4 Between 1 and 3
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines	Determine percentage of gravel and sand from grain-size curve.	Not meeting all gradation requirements for GW	
		Gravels With Fines *appreciable amount of fines*	**GM***	**d** **u**	Silty gravels, poorly graded gravel-sand-silt mixtures	Depending on percentage of fines (*fraction smaller than No. 200 sieve size*), coarse-grained soils are classified as follows:	Atterberg limits below "A" line, or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring uses of dual symbols
			GC		Clayey gravels, poorly graded gravel-sand-clay mixtures		Atterberg limits above "A" line, or PI greater	
	Sands *more than half of coarse fraction is smaller than No. 4 sieve size*	**Clean Sands** *little or no fines*	**SW**		Well graded sands, gravelly sands, little or no fines	**Less than 5%** GW, GP, SW, SP	$C_u = \frac{D_{60}}{D_{10}}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$	Greater than 6 Between 1 and 3
			SP		Poorly graded sands, gravelly sands, little or no fines	**More than 12%** GM, GC, SM, SC	Not meeting all gradation requirements for SW	
		Sands with Fines *appreciable amount of fines*	**SM***	**d** **u**	Silty sands, poorly graded sand-silt mixtures	**5% to 12%** Borderline cases requiring use of dual symbols**	Atterberg limits below "A" line, or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring uses of dual symbols
			SC		Clayey sands, poorly graded sand-clay mixtures		Atterberg limits above "A" line, or PI greater	
FINE-GRAINED SOILS *more than half of material is smaller than No. 200 sieve*	**Silts and Clays** *liquid limit is less than 50*		**ML**		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	*For laboratory classification of fine-grained soils* (see Plasticity Chart)		
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silt-clays of low plasticity			
	Silts and Clays *liquid limit is greater than 50*		**MH**		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
HIGHLY ORGANIC SOILS			**Pt**		Peat and other highly organic soils			



Plasticity Chart

*Division of GM and SM groups into subdivisions of d and u for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when liquid limit is 28 or less and the PI is 6 or less, the suffix u used when liquid limit is greater than 28.

***Borderline classification*: Soils possessing characteristics of two groups are designated by combinations of group symbols. (For example GW-GC, well graded gravel-sand mixture with clay biner.)

Relative Density of Cohesionless Soils			
$(N_1)_{60}$ (blows/ft)		Relative Density	Field Test with 1/2-inch steel rod
≤ 35% Gravel	>35% Gravel		
<5	<18	very loose	Very easily penetrated when pushed by hand
5-10	18-26	loose	Easily penetrated when pushed by hand
11-30	27-49	medium dense	Easily penetrated when driven with 5-lb hammer
31-50	50-75	dense	Penetrated 1 ft with difficulty when driven with 5-lb hammer
>50	>75	very dense	Penetrated less than 3 in. when driven with 5-lb hammer

Consistency of Cohesive Soils				
N_{60} (blows/ft)	Consistency	Shear Strength (tsf)[1]	Unconfined Compressive Strength (tsf)[2]	Field Test
<2	very soft	<0.12	<0.25	Easily penetrated several inches by fist
2-4	soft	0.12-0.25	0.25-0.50	Easily penetrated several inches by thumb
5-8	firm	0.25-0.50	0.50-1.0	Penetrated several inches by thumb with moderate effort
9-15	stiff	0.5-1.0	1.0-2.0	Readily indented by thumb but penetrated only with great effort
16-30	very stiff	1.0-2.0	2.0-4.0	Readily indented with thumbnail
>30	hard	>2.0	>4.0	Indented with difficulty by thumbnail

[1] *Torvane test is an indicator of shear strength*

[2] *Pocket penetrometer is a general indicator of unconfined compressive strength*

Rock Quality	
Description of Rock Quality	Rock Quality Designation (RQD)
Very Poor	< 25%
Poor	25 - 50%
Fair	50 - 75%
Good	75 - 90%
Excellent	75 - 90%

DRILL HOLE LOG

BORING NO. DA1-1

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY
CLIENT: ALPHA ENGINEERING COMPANY
LOCATION: SEE SITE PLAN
DRILLING METHOD: 20-CME-55 / NW CASING TO 6', NQ CORE
DRILLER: L.P.
DEPTH TO WATER - INITIAL: ∇ 28.0' **AFTER 24 HOURS:** N.M.

PROJECT NUMBER: 202001-039
DATE STARTED: 10/13/21
DATE COMPLETED: 10/13/21
GROUND ELEVATION:
LOGGED BY: W.R., M.S.H., J.B.

Elev. (ft)	Depth (ft)	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description	Permeability (ft/yr)	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
		11	3,3,3,(13)	CL	brown, wet to sl. moist, firm — SANDY LEAN CLAY trace gravels, trace organics, cobbles at surface	650 (2 oz/min)								
	5	13	10,55,83,(99+)	SM	white to lt. brown, moist, very dense — SILTY SAND plastic fines	23 (2 oz/min)		13.0	31	7	6	54	40	SS
		11	Core 54,23	-	dk. gray	210 (27 oz/min)	139.1	0.5						UC 8,730 psi
	10	14	Core 51,0	-	dk. gray									
		37	Core 62,10	-	dk. gray	2,700 (4.4 gal/min)	136.3	0.4						UC 4,840 psi
	15	11	Core 19,0	-	dk. gray — VESICULAR BASALT	440 (1.0 gal/min)								
	20	14	Core 100,0	-	dk. gray									
		43	Core 95,57	-	dk. gray	540 (1.6 gal/min)								
∇	25	31	Core 52,32	-	dk. gray	3,300 (11.8 gal/min)								
	30				BOTTOM OF HOLE									

202004-002 AV WATKINS SIPHON REPLACEMENT SANTA_CLARA_WS_DA.GPJ US EVAL.GDT 12/10/21

RB&G ENGINEERING, INC.

LEGEND:

2" OD Split Spoon (SPT)
2.5" OD Split Spoon
3" OD Split Spoon

Split Spoon Sample
Core
Thin-Walled Tube Sample

2,3,2,(6) ← Blow Count per 6" / $(N_1)_{60}$ Value
T 0.45 ← Torvane (tsf)
PP 2.0 ← Pocket Penetrometer (tsf)
* With Liners
VST 2.30 ← Vane Shear Test (tsf)
Pushed
T 0.45 ← Torvane (tsf)
PP 2.0 ← Pocket Penetrometer (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
Chem. = pH, Resistivity, Sulfate, Chloride
Hyd. = Hydrometer
DC = Dispersive Clay
SS = Soluble Salts

TEST PIT LOG

TEST PIT NO. DA1-2

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY
CLIENT: ALPHA ENGINEERING COMPANY
LOCATION: SEE SITE PLAN
DIGGING METHOD: JOHN DEERE 160 EXCAVATOR
OPERATOR: D. BUNDY
DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039
DATE STARTED: 10/4/21
DATE COMPLETED: 10/4/21
GROUND ELEVATION: NOT MEASURED
LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
						CL	red-brown, dry	GRAVELLY LEAN CLAY surface cobbles								
			■		Bulk	GC	white-brown, sl. moist	CLAYEY GRAVEL W/SAND cobbles, small boulders		5.9	35	12	41	37	22	DS Soluble Salts
						-	white-gray	BASALT								
								BOTTOM OF PIT								
	5															
	10															

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA1-3

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY

SHEET 1 OF 1

CLIENT: ALPHA ENGINEERING COMPANY

PROJECT NUMBER: 202001-039

LOCATION: SEE SITE PLAN

DATE STARTED: 10/4/21

DIGGING METHOD: JOHN DEERE 160 EXCAVATOR

DATE COMPLETED: 10/4/21

OPERATOR: D. BUNDY

GROUND ELEVATION: NOT MEASURED

DEPTH TO WATER - INITIAL: DRY' **AFTER 24 HOURS:** N.M.

LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Rec. (in)	See Legend	USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
						CL	red-brown, dry	LEAN CLAY								
					Bulk	SC-SM	yellow-white, dry	SILTY CLAYEY SAND W/GRAVEL		2.6	25	4	28	56	16	Proctor Perm.* DC DS Soluble Salts
	5				Bulk	GM	lt. red, sl. moist	SILTY GRAVEL W/SAND ~30% 2"-6" cobbles								
					Bulk	GC	red-brown, sl. moist	CLAYEY GRAVEL W/SAND 50% 3" cobbles								
	10					CL	red-brown, sl. moist	SANDY LEAN CLAY W/GRAVEL 10% 6"-12" cobbles								
					Bulk	GM	red-brown, sl. moist	SILTY GRAVEL W/SAND 25% <5" cobbles								
					Bulk	CL	red-brown, sl. moist	SANDY LEAN CLAY								
								BOTTOM OF PIT *1.09 x 10-5 cm/sec								

TP_LOGV1 SANTA_CLARA_WS_DA_TP.GPJ US EVAL.GDT 12/10/21

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated Undrained Triaxial
- CU = Consolidated Undrained Triaxial
- HYD = Hydrometer
- DC = Dispersive Clay
- Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA1-101

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY
CLIENT: ALPHA ENGINEERING COMPANY
LOCATION: SEE SITE PLAN
DIGGING METHOD: JOHN DEERE 160 EXCAVATOR
OPERATOR: D. BUNDY
DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039
DATE STARTED: 10/4/21
DATE COMPLETED: 10/4/21
GROUND ELEVATION: NOT MEASURED
LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
						CL	red-brown, dry — SANDY LEAN CLAY								
					Bulk	CL	red-brown, dry — LEAN CLAY W/SAND								
						GP	red-brown, sl. moist — 6"-12" COBBLES								
						CL	red-brown, sl. moist — LEAN CLAY								
					Bulk	SM	yellow-white, sl. moist — SILTY SAND W/GRAVEL		5.2		NP	20	60	20	
	5				Bulk	SP-SM	lt. red, sl. moist — SAND W/SILT & GRAVEL								
					Bulk	CH	brown-gray, sl. moist — FAT CLAY W/SAND		15.0	55	34	1	22	77	DC
	10				Bulk	CH	brown-gray, sl. moist								
	15						BOTTOM OF PIT								

TP_LOGV1 SANTA_CLARA_WS_DA_TP.GPJ US EVAL.GDT 12/10/21

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA1-102

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY
CLIENT: ALPHA ENGINEERING COMPANY
LOCATION: SEE SITE PLAN
DIGGING METHOD: JOHN DEERE 160 EXCAVATOR
OPERATOR: D. BUNDY
DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039
DATE STARTED: 10/4/21
DATE COMPLETED: 10/4/21
GROUND ELEVATION: NOT MEASURED
LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
					Bulk	CL	red-brown, dry	SANDY LEAN CLAY pinholes								
					Bulk	CL	white-brown, sl. moist	SANDY LEAN CLAY								
	5				Bulk	SC	brown-gray, sl. moist	CLAYEY SAND W/GRAVEL		14.4	62	37	21	53	26	Proctor Perm.* DS
	10				Bulk	CH	gray, sl. moist	SANDY FAT CLAY								
					Bulk	CH	brown-gray, sl. moist	FAT CLAY								
					Bulk	GP-GM	yellow-white, sl. moist	GRAVEL W/SILT & SAND 30% <6" cobbles								
	15							BOTTOM OF PIT *2.62 x 10-8 cm/sec								

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA1-103

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY
CLIENT: ALPHA ENGINEERING COMPANY
LOCATION: SEE SITE PLAN
DIGGING METHOD: JOHN DEERE 160 EXCAVATOR
OPERATOR: D. BUNDY
DEPTH TO WATER - INITIAL: DRY' **AFTER 24 HOURS:** N.M.

PROJECT NUMBER: 202001-039
DATE STARTED: 10/4/21
DATE COMPLETED: 10/4/21
GROUND ELEVATION: NOT MEASURED
LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
					Bulk	CL-ML	red-brown, dry	SANDY SILTY CLAY								
						CL	red-brown, sl. moist	GRAVELLY LEAN CLAY 20% 2"-6" cobbles								
	5					ML	yellow-white, sl. moist	SANDY SILT W/GRAVEL								
						GM	yellow-white, sl. moist	SILTY GRAVEL W/SAND 50% cobbles								
						GC	yellow-white, sl. moist	CLAYEY GRAVEL W/SAND 40% 2"-6" cobbles								
	10					GM	yellow-white, sl. moist	SILTY GRAVEL W/SAND 30% <4" cobbles								
								BOTTOM OF PIT								

TP_LOGV1 SANTA_CLARA_WS_DA_TP.GPJ US EVAL.GDT 12/10/21

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; *0.45* ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. DA2-1

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY

CLIENT: ALPHA ENGINEERING COMPANY

PROJECT NUMBER: 202001-039

LOCATION: SEE SITE PLAN

DATE STARTED: 10/12/21

DRILLING METHOD: 20-CME-55 / NW CASING TO 22', NQ CORE

DATE COMPLETED: 10/12/21

DRILLER: L.P.

GROUND ELEVATION:

DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

LOGGED BY: W.R., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Permeability (ft/yr)	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
				15	5,12,24,(77)	CL	brown, dry to wet, hard	SANDY LEAN CLAY W/GRAVEL organics	110 (2 oz/min)								
				2	100/4"	GP	gray, wet, very dense	BASALT COBBLES	52 (4 oz/min)								
	5			14	36,42,34,(99+)	SP-SM	purple-red, very moist, very dense	SAND W/SILT & GRAVEL	160 (24 oz/min)		15.5		NP	40	49	11	SS
	10			11	17,25,31,(94)	SP-SM	purple-red, moist, very dense										
				8	14,15,14,(43)	GP-GM	dk. red, wet, med. dense	GRAVEL W/SILT & SAND	520 (1.0 gal/min)								
	15			6	8,16,25,(55)	SP-SM	dk. red, wet, very dense	SAND W/SILT & GRAVEL	330 0.8 gal/min)		16.4		NP	39	53	8	
	20			8	27,70/6"	GP-GM	dk. red, moist, very dense	GRAVEL W/SILT & SAND									
				7	Core *28,20*	-	gray	VESICULAR BASALT	>4,500 (>17.7 gal/min)								
	25			40	Core *110,92*	-	gray	PORPHYRITIC BASALT some vesicles		170.2	0.7						UC 14,630 psi
				33	Core *92,0*	-	gray	PORPHYRITIC BASALT									
	30							BOTTOM OF HOLE									

202004-002 AV WATKINS SIPHON REPLACEMENT SANTA_CLARA_WS_DA.GPJ US EVAL.GDT 12/10/21

RB&G ENGINEERING, INC.

LEGEND:

- 2" OD Split Spoon (SPT)
- 2.5" OD Split Spoon
- 3" OD Split Spoon

Split Spoon Sample — 2,3,2,(6) ← Blow Count per 6" / ← $(N_1)_{60}$ Value; *T 0.45* ← Torvane (tsf); *PP 2.0* ← Pocket Penetrometer (tsf); * With Liners

Core — VST 2.30 ← Vane Shear Test (tsf)

Thin-Walled Tube Sample — Pushed; *T 0.45* ← Torvane (tsf); *PP 2.0* ← Pocket Penetrometer (tsf)

OTHER TESTS

UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
Chem. = pH, Resistivity, Sulfate, Chloride
Hyd. = Hydrometer
DC = Dispersive Clay
SS = Soluble Salts

TEST PIT LOG

TEST PIT NO. DA2-2

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY

CLIENT: ALPHA ENGINEERING COMPANY

LOCATION: SEE SITE PLAN

DIGGING METHOD: JOHN DEERE 160 EXCAVATOR

OPERATOR: R. PIPER

DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039

DATE STARTED: 10/1/21

DATE COMPLETED: 10/1/21

GROUND ELEVATION: NOT MEASURED

LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
					Bulk	CL	red-brown, dry LEAN CLAY W/SAND								
						CL	red-brown, sl. moist SANDY LEAN CLAY W/GRAVEL 2"-6" cobbles								
	5														
					Bulk	SP	lt. brown, moist SAND W/GRAVEL 10% 3"-8" cobbles		14.4		NP	46	50	4	Proctor
	10														
							BOTTOM OF PIT								

TP_LOGV1 SANTA_CLARA_WS_DA_TP.GPJ US EVAL.GDT 12/10/21

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA2-3

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY

CLIENT: ALPHA ENGINEERING COMPANY

PROJECT NUMBER: 202001-039

LOCATION: SEE SITE PLAN

DATE STARTED: 10/1/21

DIGGING METHOD: JOHN DEERE 160 EXCAVATOR

DATE COMPLETED: 10/1/21

OPERATOR: R. PIPER

GROUND ELEVATION: NOT MEASURED

DEPTH TO WATER - INITIAL: ∇ DRY'

AFTER 24 HOURS: ▼ N.M.

LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
						CL	red-brown, dry	LEAN CLAY								
						SM	lt. brown, sl. moist	SILTY SAND W/GRAVEL 10% cobbles & small boulders, dense - difficult to excavate								
	5				Bulk	SM	lt. red-brown, moist			9.5		NP	17	44	39	
								BOTTOM OF PIT								
	10															

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated Undrained Triaxial
- CU = Consolidated Undrained Triaxial
- HYD = Hydrometer
- DC = Dispersive Clay
- Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA2-101

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY

CLIENT: ALPHA ENGINEERING COMPANY

PROJECT NUMBER: 202001-039

LOCATION: SEE SITE PLAN

DATE STARTED: 10/4/21

DIGGING METHOD: JOHN DEERE 160 EXCAVATOR

DATE COMPLETED: 10/4/21

OPERATOR: R. PIPER

GROUND ELEVATION: NOT MEASURED

DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
					Bulk	CL	red-brown, dry — GRAVELLY LEAN CLAY W/SAND 30% <24" cobbles & small boulders								
						-	BASALT fractured								
							BOTTOM OF PIT								
	5														
	10														

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated Undrained Triaxial
- CU = Consolidated Undrained Triaxial
- HYD = Hydrometer
- DC = Dispersive Clay
- Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA2-102

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY

CLIENT: ALPHA ENGINEERING COMPANY

PROJECT NUMBER: 202001-039

LOCATION: SEE SITE PLAN

DATE STARTED: 10/4/21

DIGGING METHOD: JOHN DEERE 160 EXCAVATOR

DATE COMPLETED: 10/4/21

OPERATOR: R. PIPER

GROUND ELEVATION: NOT MEASURED

DEPTH TO WATER - INITIAL: ∇ DRY'   **AFTER 24 HOURS:** ▼ N.M.

LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
					Bulk	SC-SM	red-brown, dry SILTY CLAYEY SAND W/GRAVEL surface cobbles & small boulders								
							BASALT								
							BOTTOM OF PIT - REFUSAL								
	5														
	10														

TP_LOGV1 SANTA_CLARA_WS_DA_TP.GPJ US EVAL.GDT 12/10/21

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA2-103

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY

CLIENT: ALPHA ENGINEERING COMPANY

PROJECT NUMBER: 202001-039

LOCATION: SEE SITE PLAN

DATE STARTED: 10/4/21

DIGGING METHOD: JOHN DEERE 160 EXCAVATOR

DATE COMPLETED: 10/4/21

OPERATOR: R. PIPER

GROUND ELEVATION: NOT MEASURED

DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
					Bulk	GC	red-brown, dry — CLAYEY GRAVEL W/SAND surface boulders, 30% 2"-12" cobbles								
						-	- — BASALT fractured								
							BOTTOM OF PIT								
	5														
	10														

TP_LOGV1 SANTA_CLARA_WS_DA_TP.GPJ US EVAL.GDT 12/10/21

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA2-104

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY

CLIENT: ALPHA ENGINEERING COMPANY

LOCATION: SEE SITE PLAN

DIGGING METHOD: JOHN DEERE 160 EXCAVATOR

OPERATOR: R. PIPER

DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039

DATE STARTED: 10/4/21

DATE COMPLETED: 10/4/21

GROUND ELEVATION: NOT MEASURED

LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
					Bulk	CL	red-brown, dry	GRAVELLY LEAN CLAY W/SAND surface cobbles, 30% 2"-18" cobbles & small boulders								
					Bulk	GC	red-brown, sl. moist	CLAYEY GRAVEL W/SAND								
								BASALT								
								BOTTOM OF PIT - REFUSAL								
	5															
	10															

TP_LOGV1 SANTA_CLARA_WS_DA_TP.GPJ US EVAL.GDT 12/10/21

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated Undrained Triaxial
- CU = Consolidated Undrained Triaxial
- HYD = Hydrometer
- DC = Dispersive Clay
- Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA2-105

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY

CLIENT: ALPHA ENGINEERING COMPANY

LOCATION: SEE SITE PLAN

DIGGING METHOD: JOHN DEERE 160 EXCAVATOR

OPERATOR: D. BUNDY

DEPTH TO WATER - INITIAL: DRY' **AFTER 24 HOURS:** N.M.

PROJECT NUMBER: 202001-039

DATE STARTED: 10/4/21

DATE COMPLETED: 10/4/21

GROUND ELEVATION: NOT MEASURED

LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
						CL	red-brown, dry	LEAN CLAY W/GRAVEL 10% 2"-6" cobbles								
					Bulk	GC	red-brown, sl. moist	CLAYEY GRAVEL W/SAND 30% 2"-12" cobbles		6.1	33	13	41	31	28	Proctor DC
						-	-	BASALT fractured								
								BOTTOM OF PIT								

Depth scale: 5, 10

TP_LOGV1 SANTA_CLARA_WS_DA_TP.GPJ US EVAL.GDT 12/10/21

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA2-106

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY
CLIENT: ALPHA ENGINEERING COMPANY
LOCATION: SEE SITE PLAN
DIGGING METHOD: JOHN DEERE 160 EXCAVATOR
OPERATOR: R. PIPER
DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039
DATE STARTED: 10/4/21
DATE COMPLETED: 10/4/21
GROUND ELEVATION: NOT MEASURED
LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
					Bulk	CL	red-brown, dry SANDY LEAN CLAY W/GRAVEL 25% 2"-10" cobbles								
							BASALT								
							BOTTOM OF PIT - REFUSAL								
	5														
	10														

TP_LOGV1 SANTA_CLARA_WS_DA_TP.GPJ US EVAL.GDT 12/10/21

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LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. DA3-1

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY
CLIENT: ALPHA ENGINEERING COMPANY
LOCATION: SEE SITE PLAN
DRILLING METHOD: 20-CME-55 / HW CASING, HQ CASING ADVANCER
DRILLER: L.P.
DEPTH TO WATER - INITIAL: ∇ DRY'   **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039
DATE STARTED: 10/11/21
DATE COMPLETED: 10/11/21
GROUND ELEVATION:
LOGGED BY: W.R., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description		Permeability (ft/yr)	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
				11	2,7,9,(34)	SC	brown, sl. moist, dense	CLAYEY SAND W/GRAVEL trace organics	850 (15 oz/min)								
				13	16,24,29,(99+)	SC	brown, wet, very dense				23.3	24	9	29	43	28	
	5			13	16,26,25,(99+)	SM	brown, moist, very dense	SILTY SAND W/GRAVEL	36 (4 oz/min)								
	10			9	5,15,16,(52)	SM	lt. brown, moist, very dense	SILTY SAND			13.9		NP	4	61	35	
				9	7,10,10,(32)	SC-SM	brown, moist, dense	SILTY CLAYEY SAND	37 (9 oz/min)								
	15			12	16,20,27,(63)	SC-SM	brown, moist, very dense		10 (3 oz/min)		8.8	20	4	1	71	28	
	20			13	11,16,21,(43)	SC	brown, very moist, dense	CLAYEY SAND trace gravels	No Measuranle Loss								
	25			14	12,21,29,(52)	CH	brown, moist, hard	FAT CLAY	13 (6 oz/min)								
	30			16	12,21,29,(56)	CH	brown, moist, hard										
				6	Pushed T 2.25	CH	brown, moist, hard			104.0	20.2	57	34	1	2	97	CT
								BOTTOM OF HOLE									

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LEGEND:

- 2" OD Split Spoon (SPT)
- 2.5" OD Split Spoon
- 3" OD Split Spoon

Split Spoon Sample: 2,3,2,(6) — Blow Count per 6" — $(N_1)_{60}$ Value; *T 0.45* — Torvane (tsf); *PP 2.0* — Pocket Penetrometer (tsf); * With Liners; VST 2.30 — Vane Shear Test (tsf)

Thin-Walled Tube Sample: Pushed; *T 0.45* — Torvane (tsf); *PP 2.0* — Pocket Penetrometer (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
Chem. = pH, Resistivity, Sulfate, Chloride
Hyd. = Hydrometer
DC = Dispersive Clay
SS = Soluble Salts

TEST PIT LOG

TEST PIT NO. DA3-2

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY
CLIENT: ALPHA ENGINEERING COMPANY
LOCATION: SEE SITE PLAN
DIGGING METHOD: JOHN DEERE 160 EXCAVATOR
OPERATOR: R. PIPER
DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039
DATE STARTED: 10/1/21
DATE COMPLETED: 10/1/21
GROUND ELEVATION: NOT MEASURED
LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
					Bulk	CL	red-brown, dry LEAN CLAY W/SAND								
					Bulk	SC	CLAYEY SAND yellow-white, sl. moist		5.9	30	9	5	52	43	Proctor DC
						-	- BASALT								
							BOTTOM OF PIT								

Depth scale: 5, 10

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

RB&G ENGINEERING, INC.

TEST PIT LOG

TEST PIT NO. DA3-3

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY
CLIENT: ALPHA ENGINEERING COMPANY
PROJECT NUMBER: 202001-039
LOCATION: SEE SITE PLAN
DATE STARTED: 9/30/21
DIGGING METHOD: JOHN DEERE 160 EXCAVATOR
DATE COMPLETED: 10/1/21
OPERATOR: R. PIPER
GROUND ELEVATION: NOT MEASURED
DEPTH TO WATER - INITIAL: ∇ DRY'
AFTER 24 HOURS: ▼ N.M.
LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Rec. (in)	See Legend	USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
					Bulk	CL	brown, dry LEAN CLAY W/SAND pinholes								
					Bulk	GC	CLAYEY GRAVEL W/SAND cobbles brown, sl. moist								
						-	- BASALT								
							BOTTOM OF PIT								
	5														
	10														

TP_LOGV1 SANTA_CLARA_WS_DA_TP.GPJ US EVAL.GDT 12/10/21

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA3-4

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY

CLIENT: ALPHA ENGINEERING COMPANY

PROJECT NUMBER: 202001-039

LOCATION: SEE SITE PLAN

DATE STARTED: 9/30/21

DIGGING METHOD: JOHN DEERE 160 EXCAVATOR

DATE COMPLETED: 9/30/21

OPERATOR: R. PIPER

GROUND ELEVATION: NOT MEASURED

DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
					Bulk	CL	red-brown, dry	LEAN CLAY W/SAND								
					Bulk	CL	red-brown, sl. moist	SANDY LEAN CLAY W/GRAVEL								
	5					ML	lt. red-brown, sl. moist	GRAVELLY SILT W/SAND								
					Bulk	GP-GM	lt. red-brown, sl. moist	GRAVEL W/SILT & SAND cobbles								
	10				Bulk	SM	lt. brown, sl. moist	SILTY SAND W/GRAVEL cobbles & small boulders								
					Bulk	SP-SM	lt. red-brown, sl. moist	SAND W/SILT & GRAVEL								
						SM	yellow-white-brown, sl. moist	SILTY SAND								
	15				Bulk	GP-GM	yellow-white-brown, sl. moist	GRAVEL W/SILT & SAND		2.6		NP	51	44	5	Proctor Perm.*

BOTTOM OF PIT

*5.23 x 10-5 cm/sec

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated Undrained Triaxial
- CU = Consolidated Undrained Triaxial
- HYD = Hydrometer
- DC = Dispersive Clay
- Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA3-5

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY

CLIENT: ALPHA ENGINEERING COMPANY

PROJECT NUMBER: 202001-039

LOCATION: SEE SITE PLAN

DATE STARTED: 10/1/21

DIGGING METHOD: JOHN DEERE 160 EXCAVATOR

DATE COMPLETED: 10/1/21

OPERATOR: R. PIPER

GROUND ELEVATION: NOT MEASURED

DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Rec. (in)	See Legend	USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
					Bulk	CL	red-brown, dry GRAVELLY LEAN CLAY W/SAND some cobbles at 2'								
					Bulk	CL	LEAN CLAY W/SAND red-brown, sl. moist		8.5	40	22	2	24	74	Proctor DC
	5				Bulk	SM	SILTY SAND W/GRAVEL some cobbles at 7' lt. brown, sl. moist								
	10				Bulk	GM	lt. brown, sl. moist SILTY GRAVEL W/SAND 10" cobbles								
							BOTTOM OF PIT								

TP_LOGV1 SANTA_CLARA_WS_DA_TP.GPJ US EVAL.GDT 12/10/21

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA3-101

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY
CLIENT: ALPHA ENGINEERING COMPANY
PROJECT NUMBER: 202001-039
LOCATION: SEE SITE PLAN
DATE STARTED: 9/29/21
DIGGING METHOD: JOHN DEERE 160 EXCAVATOR
DATE COMPLETED: 9/29/21
OPERATOR: R. PIPER
GROUND ELEVATION: NOT MEASURED
DEPTH TO WATER - INITIAL: ∇ DRY'
AFTER 24 HOURS: ▼ N.M.
LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Sample Type	Rec. (in)	See Legend	USCS	Field Description	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
		Disturbed		Bulk	CL	red-brown, dry	LEAN CLAY W/SAND								
		Disturbed		Bulk	SC-SM	red w/white, sl. moist	SILTY CLAYEY SAND W/GRAVEL								
		Disturbed		Bulk	SM	red-brown, sl. moist	SILTY SAND W/GRAVEL cobbles								
	5														
		Disturbed		Bulk	GP-GM	red-brown, sl. moist	GRAVEL W/SILT & SAND								
		Disturbed		Bulk	SP-SM	lt. red-brown, sl. moist	SAND W/SILT & GRAVEL								
	10														
		Undisturbed		Bulk	SP-SM	lt. brown, moist									Soluble Salts
		Disturbed		Bulk	SP-SM	lt. brown, moist	SAND W/SILT & GRAVEL cemented layers, white striations		9.5		NP	27	61	12	Soluble Salts
	15														
		Disturbed		Bulk	SM	lt. brown, moist	SILTY SAND								
							BOTTOM OF PIT								

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

RB&G ENGINEERING, INC.

TEST PIT LOG

TEST PIT NO. DA3-102

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY

CLIENT: ALPHA ENGINEERING COMPANY

LOCATION: SEE SITE PLAN

DIGGING METHOD: JOHN DEERE 160 EXCAVATOR

OPERATOR: R. PIPER

DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039

DATE STARTED: 9/29/21

DATE COMPLETED: 9/29/21

GROUND ELEVATION: NOT MEASURED

LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
					Bulk	CL	red-brown, dry LEAN CLAY W/SAND								
	5				Bulk	SC	red-brown, sl. moist CLAYEY SAND W/GRAVEL		4.5	27	11	34	38	28	Proctor Perm.* DC DS
					Bulk	SP-SM	lt. red-brown, sl. moist SAND W/SILT & GRAVEL cemented layer								
	10				Bulk	SP-SM	lt. red-brown, moist SAND W/SILT & GRAVEL		6.4		NP	40	48	12	Proctor
					Bulk	SM	SILTY SAND W/GRAVEL lt. red-brown, sl. moist								
					Bulk	SC-SM	lt. red-brown, sl. moist SILTY CLAYEY SAND W/GRAVEL								
					Bulk	SC	lt. red-brown, sl. moist CLAYEY SAND BOTTOM OF PIT								
	15						*6.91 x 10-7 cm/sec								

TP_LOGV1 SANTA_CLARA_WS_DA_TP.GPJ US EVAL.GDT 12/10/21

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated Undrained Triaxial
- CU = Consolidated Undrained Triaxial
- HYD = Hydrometer
- DC = Dispersive Clay
- Chem. = pH, Resistivity, Sulfate, Chloride

RB&G ENGINEERING, INC.

TEST PIT LOG

TEST PIT NO. DA3-103

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY

CLIENT: ALPHA ENGINEERING COMPANY

LOCATION: SEE SITE PLAN

DIGGING METHOD: JOHN DEERE 160 EXCAVATOR

OPERATOR: R. PIPER

DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039

DATE STARTED: 9/29/21

DATE COMPLETED: 9/29/21

GROUND ELEVATION: NOT MEASURED

LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
					Bulk	CL	red-brown, dry SANDY LEAN CLAY								
					Bulk	CL	red-brown, sl. moist LEAN CLAY W/SAND								
					Bulk	CL	red-white, sl. moist SANDY LEAN CLAY		10.1	41	19	9	26	65	DC Soluble Salts
	5				Bulk	SM	lt. red-brown, sl. moist SILTY SAND W/GRAVEL								
					Bulk	GP-GM	lt. red-brown, moist GRAVEL W/SILT & SAND cobbles		5.1		NP	58	34	8	Proctor
	10				Bulk	SM	yellow-white, sl. moist SILTY SAND W/GRAVEL								
	15				Bulk	SP-SM	yellow-white, sl. moist SAND W/SILT & GRAVEL								
							BOTTOM OF PIT								

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS

UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA3-104

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY

CLIENT: ALPHA ENGINEERING COMPANY

LOCATION: SEE SITE PLAN

DIGGING METHOD: JOHN DEERE 160 EXCAVATOR

OPERATOR: R. PIPER

DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039

DATE STARTED: 9/29/21

DATE COMPLETED: 9/29/21

GROUND ELEVATION: NOT MEASURED

LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
					Bulk	CL	red-brown, dry	SANDY LEAN CLAY								
								CLAYEY SAND white striations								
					Bulk	SC	red-brown, sl. moist			8.0	35	19	3	51	46	Soluble Salts
	5							SILTY SAND W/GRAVEL								
					Bulk	SM	lt. red-brown, sl. moist									
						SM	red-brown, sl. moist	SILTY SAND								
	10															
					Bulk	SC	red-brown, sl. moist	CLAYEY SAND W/GRAVEL								
					Bulk	GC-GM	red-brown, sl. moist	SILTY CLAYEY GRAVEL W/SAND cobbles								
	15							CLAYEY SAND W/GRAVEL								
					Bulk	SC	red-brown, sl. moist									
								BOTTOM OF PIT								

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA3-105

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY
CLIENT: ALPHA ENGINEERING COMPANY
LOCATION: SEE SITE PLAN
DIGGING METHOD: JOHN DEERE 160 EXCAVATOR
OPERATOR: R. PIPER
DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039
DATE STARTED: 9/29/21
DATE COMPLETED: 9/30/21
GROUND ELEVATION: NOT MEASURED
LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
					Bulk	CL	brown-red, dry SANDY LEAN CLAY								
					Bulk	GP-GM	yellow-white, sl. moist GRAVEL W/SILT & SAND		2.9		NP	60	31	9	Soluble Salts
	5														
					Bulk	SP-SM	yellow-white, moist SAND W/SILT & GRAVEL		7.0		NP	34	56	10	Proctor
					Bulk	SC-SM	brown, moist SILTY CLAYEY SAND								
	10														
					Bulk	SC	CLAYEY SAND brown, sl. moist								
							BOTTOM OF PIT								

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LEGEND:
DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)
UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA3-106

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY
CLIENT: ALPHA ENGINEERING COMPANY
LOCATION: SEE SITE PLAN
DIGGING METHOD: JOHN DEERE 160 EXCAVATOR
OPERATOR: R. PIPER
DEPTH TO WATER - INITIAL: ▽ DRY'   **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039
DATE STARTED: 9/30/21
DATE COMPLETED: 9/30/21
GROUND ELEVATION: NOT MEASURED
LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
					Bulk	CL	red-brown, sl. moist	LEAN CLAY W/SAND								
					Bulk	CL	red-brown, sl. moist									
					Bulk	GC	red-brown, moist	CLAYEY GRAVEL W/SAND cobbles		9.5	37	17	40	35	25	Proctor DC DS
	5					-	-	CEMENTED LAYER								
					Bulk	SM	lt. red-brown, moist	SILTY SAND W/GRAVEL cobbles								
						GP	-	COBBLES								
	10				Bulk	GM	lt. red-brown, sl. moist	SILTY GRAVEL W/SAND cemented layers		4.4		NP	48	38	14	Soluble Salts
								BOTTOM OF PIT								

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; *0.45* ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

TEST PIT LOG

TEST PIT NO. DA3-107

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DAMMERON VALLEY
CLIENT: ALPHA ENGINEERING COMPANY
LOCATION: SEE SITE PLAN
DIGGING METHOD: JOHN DEERE 160 EXCAVATOR
OPERATOR: R. PIPER
DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039
DATE STARTED: 9/30/21
DATE COMPLETED: 9/30/21
GROUND ELEVATION: NOT MEASURED
LOGGED BY: C.S., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
					Bulk	CL	brown, dry SANDY LEAN CLAY								
					Bulk	SC-SM	brown, sl. moist SILTY CLAYEY SAND white striations		4.8	23	5	7	54	39	DC Soluble Salts
	5						SILTY SAND W/GRAVEL								
					Bulk	SM	yellow-white-brown, sl. moist								
							CLAYEY SAND W/GRAVEL								
	10				Bulk	SC	yellow-white-brown, sl. moist								
					Bulk	GC	yellow-white, sl. moist CLAYEY GRAVEL W/SAND								
	15						GRAVELLY LEAN CLAY W/SAND								
					Bulk	CL	yellow-white, sl. moist								
							BOTTOM OF PIT								

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bulk ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. DI1-1

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DIAMOND VALLEY

CLIENT: ALPHA ENGINEERING COMPANY

LOCATION: SEE SITE PLAN

DRILLING METHOD: 08-CME-55 / HW CASING TO 18'

DRILLER: D.K.

DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039

DATE STARTED: 8/27/21

DATE COMPLETED: 8/27/21

GROUND ELEVATION:

LOGGED BY: M.N.H., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Permeability (ft/yr)	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
				11	6,6,7,(28)	CL-ML	brown, dry, stiff	SANDY SILTY CLAY (fill)									
				14	4,4,5,(20)	SC-SM	brown, moist, med. dense	SILTY CLAYEY SAND silty sand lenses & seams (fill)	23 (2 oz/min)		13.2	23	5	0	51	49	DC SS
	5			8	Pushed	SM	brown, moist	SILTY SAND (fill)	45 (4 oz/min); 26 (5 oz/min)	101.7	12.1		NP	0	61	39	
				13	3,6,7,(26)	SM	brown, sl. moist, med. dense	SILTY SAND few organics, organic odor									
	10			13	5,7,8,(27)	CL	brown, sl. moist, stiff	SANDY LEAN CLAY trace organics, trace charcoal									
				10	5,9,9,(28) *PP >4.5*	CL	brown, sl. moist, very stiff	LEAN CLAY W/SAND	120 (41 oz/min)		13.8	26	9	0	17	83	
	15			7	Pushed *PP 4.0*	CL	brown, sl. moist, very stiff	SANDY LEAN CLAY		104.0	8.4	28	11	1	34	65	CT
				13	7,9,9,(23)	CL	brown, sl. moist, very stiff	SANDY LEAN CLAY trace gravels	5 (2 oz/min)								
	20			12	9,8,10,(22)	CL	brown, sl. moist, very stiff	SANDY LEAN CLAY silt lenses, trace charcoal, possible pinholes									
	25			12	8,12,12,(27)	CL	brown, sl. moist, very stiff	SANDY LEAN CLAY silt layers									
								BOTTOM OF HOLE									

202004-002 AV WATKINS SIPHON REPLACEMENT SANTA_CLARA_WS_DI.GPJ US EVAL.GDT 12/10/21

RB&G ENGINEERING, INC.

LEGEND:

- 2" OD Split Spoon (SPT)
- 2.5" OD Split Spoon
- 3" OD Split Spoon

Split Spoon Sample: 2,3,2,(6) — Blow Count per 6", $(N_1)_{60}$ Value; *T 0.45* — Torvane (tsf); *PP 2.0* — Pocket Penetrometer (tsf); * With Liners; VST 2.30 — Vane Shear Test (tsf)

Thin-Walled Tube Sample: Pushed; *T 0.45* — Torvane (tsf); *PP 2.0* — Pocket Penetrometer (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
Chem. = pH, Resistivity, Sulfate, Chloride
Hyd. = Hydrometer
DC = Dispersive Clay
SS = Soluble Salts

DRILL HOLE LOG

BORING NO. DI1-2

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DIAMOND VALLEY

CLIENT: ALPHA ENGINEERING COMPANY

PROJECT NUMBER: 202001-039

LOCATION: SEE SITE PLAN

DATE STARTED: 8/30/21

DRILLING METHOD: 08-CME-55 / HW CASING TO 18'

DATE COMPLETED: 8/31/21

DRILLER: T.K.

GROUND ELEVATION:

DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

LOGGED BY: M.N.H., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS *(AASHTO)*	Material Description		Permeability (ft/yr)	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
			2.5" OD Split Spoon	12	5,9,11,(43)	CL-ML	brown, dry, hard	SILTY CLAY W/SAND organics (fill)									
			2.5" OD Split Spoon	10	7,13,13,(55)	SC-SM	brown, moist, very dense	SILTY CLAYEY SAND (fill)	17 (2 oz/min)		9.6	20	5	1	64	35	DC SS
	5		2.5" OD Split Spoon	12	6,10,8,(36)	SC-SM	brown, sl. moist, dense	SILTY CLAYEY SAND silty sand lenses (fill?)	68 (6 oz/min); 780 (1 gal/min)								
	10		Thin-Walled Tube	17	Pushed *PP >4.5*	ML	brown, moist, very stiff	SANDY SILT	780 (1 gal/min)	117.2	11.0	17	3	0	47	53	CT
			2" OD Split Spoon (SPT)	12	6,9,10,(30) *PP >4.5*	CL	brown, sl. moist, very stiff		610 (1.5 gal/min)								
	15		2" OD Split Spoon (SPT)	12	6,10,11,(30)	CL	brown, sl. moist, very stiff	LEAN CLAY W/SAND	610 (1.5 gal/min)								
			Thin-Walled Tube	18	Pushed *PP >4.5*	CL	brown, sl. moist, hard		250 (0.8 gal/min)	124.3	10.4	27	12	0	19	81	
	20		2" OD Split Spoon (SPT)	12	8,13,15,(34)	CL	brown, sl. moist, very stiff	LEAN CLAY W/SAND silty sand lenses & seams, trace gravels	250 (0.8 gal/min)								
	25		2" OD Split Spoon (SPT)	13	6,10,13,(26)	CL	brown, moist, very stiff	LEAN CLAY silty sand lenses									
								BOTTOM OF HOLE									

RB&G ENGINEERING, INC.

LEGEND:

- 2" OD Split Spoon (SPT)
- 2.5" OD Split Spoon
- 3" OD Split Spoon

Split Spoon Sample: 2,3,2,(6) ← Blow Count per 6", (N_1)$_{60}$ Value; T 0.45 ← Torvane (tsf); PP 2.0 ← Pocket Penetrometer (tsf); * With Liners; VST 2.30 ← Vane Shear Test (tsf)

Thin-Walled Tube Sample: Pushed; T 0.45 ← Torvane (tsf); PP 2.0 ← Pocket Penetrometer (tsf)

OTHER TESTS

- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated, Undrained
- CU = Consolidated, Undrained
- Chem. = pH, Resistivity, Sulfate, Chloride
- Hyd. = Hydrometer
- DC = Dispersive Clay
- SS = Soluble Salts

DRILL HOLE LOG

BORING NO. DI2-1

PROJECT: SANTA CLARA WATERSHED EA - DIAMOND VALLEY

CLIENT: ALPHA ENGINEERING COMPANY
PROJECT NUMBER: 202001-039
LOCATION: SEE SITE PLAN
DATE STARTED: 8/26/21
DRILLING METHOD: 08-CME-55 / HW CASING ADVANCER
DATE COMPLETED: 8/27/21
DRILLER: T.K.
GROUND ELEVATION:
DEPTH TO WATER - INITIAL: ∇ DRY'
AFTER 24 HOURS: ▼ N.M.
LOGGED BY: M.N.H., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
			2.5" OD Split Spoon	9	5,8,9,(36)	CL	brown, dry, very stiff	LEAN CLAY W/SAND (fill)								
			2.5" OD Split Spoon	8	2,5,6,(23)	SC	brown, moist, med. dense	CLAYEY SAND trace gravels (fill)		10.5	24	9	10	44	46	SS
	5		2.5" OD Split Spoon	9	5,8,7,(30) *PP >4.5*	CL	brown, sl. moist, very stiff	SANDY LEAN CLAY (fill)		11.3	24	10	1	43	56	DC
	10		2.5" OD Split Spoon	12	2,10,10,(34)	SC	brown to dk. brown, moist, dense	CLAYEY SAND		13.8	24	9	8	45	47	
			2.5" OD Split Spoon	9	5,9,12,(31)	CL	brown to dk. brown, sl. moist, very stiff	SANDY LEAN CLAY								
	15		2.5" OD Split Spoon	9	7,10,14,(32)	CL	brown, sl. moist, very stiff									
								BOTTOM OF HOLE								

RB&G ENGINEERING, INC.

LEGEND:

2" OD Split Spoon (SPT)
2.5" OD Split Spoon
3" OD Split Spoon

Split Spoon Sample: 2,3,2,(6) — Blow Count per 6"; (N1)60 Value; T 0.45 — Torvane (tsf); PP 2.0 — Pocket Penetrometer (tsf); * With Liners; VST 2.30 — Vane Shear Test (tsf)

Thin-Walled Tube Sample: Pushed; T 0.45 — Torvane (tsf); PP 2.0 — Pocket Penetrometer (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
Chem. = pH, Resistivity, Sulfate, Chloride
Hyd. = Hydrometer
DC = Dispersive Clay
SS = Soluble Salts

DRILL HOLE LOG

BORING NO. DI2-101

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DIAMOND VALLEY
CLIENT: ALPHA ENGINEERING COMPANY
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / HQ CASING ADVANCER
DRILLER: T.K.
DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039
DATE STARTED: 8/26/21
DATE COMPLETED: 8/26/21
GROUND ELEVATION:
LOGGED BY: M.N.H., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
						CL	brown, dry	SANDY LEAN CLAY								
			2.5" OD Split Spoon	8	6,12,13,(53) *PP >4.5*	CL	brown w/white, dry, very stiff	SANDY LEAN CLAY mudstone sand clasts								
						GP	yellow, sl. moist	SANDSTONE GRAVEL cut & crushed								
			2.5" OD Split Spoon	9	39,27,17,(94)	GP-GM	brown & gray, moist, very dense	GRAVEL W/SILT & SAND		8.7		NP	65	24	10	SS
	5															
			2.5" OD Split Spoon	10	9,13,16,(58)	SC	gray-brown, moist, very dense	CLAYEY SAND		8.0	26	12	0	51	49	DC
	10		2.5" OD Split Spoon	10	11,17,18,(59) *PP >4.5*	CL	gray-brown, sl. moist, hard	SANDY LEAN CLAY trace gravels, charcoal flakes								
			2.5" OD Split Spoon	10	11,12,16,(41)	GC	brown, sl. moist, med. dense	CLAYEY GRAVEL W/SAND								
	15		2.5" OD Split Spoon	11	14,22,36,(77)	SC	brown, sl. moist, very dense	CLAYEY SAND W/GRAVEL								
								BOTTOM OF HOLE								

RB&G ENGINEERING, INC.

LEGEND:

2" OD Split Spoon (SPT)
2.5" OD Split Spoon
3" OD Split Spoon

Split Spoon Sample: 2,3,2,(6) — Blow Count per 6"; (6) — $(N_1)_{60}$ Value; *T 0.45* — Torvane (tsf); *PP 2.0* — Pocket Penetrometer (tsf); * — With Liners; VST 2.30 — Vane Shear Test (tsf)

Thin-Walled Tube Sample: Pushed; *T 0.45* — Torvane (tsf); *PP 2.0* — Pocket Penetrometer (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
Chem. = pH, Resistivity, Sulfate, Chloride
Hyd. = Hydrometer
DC = Dispersive Clay
SS = Soluble Salts

DRILL HOLE LOG

BORING NO. DI2-2

SHEET 1 OF 1

PROJECT: SANTA CLARA WATERSHED EA - DIAMOND VALLEY
CLIENT: ALPHA ENGINEERING COMPANY
LOCATION: SEE SITE PLAN
DRILLING METHOD: 20-CME-55 / NW CASING TO 25'
DRILLER: L.P.
DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 202001-039
DATE STARTED: 10/14/21
DATE COMPLETED: 10/14/21
GROUND ELEVATION:
LOGGED BY: W.R., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description		Permeability (ft/yr)	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
				15	3,7,4,(23) T 0.19	CL	brown, sl. moist, soft	SANDY LEAN CLAY trace organics	170 (3 oz/min)								
				11	Pushed	SC	brown, moist	CLAYEY SAND trace gravels	42 (6 oz/min)		14.2	26	12	10	42	48	
	5			2	5,4,2,(13)	SC	lt. brown, wet, med. dense	CLAYEY SAND W/GRAVEL									
	10			12	Pushed T 0.40	CL	dk. brown, wet, firm	SANDY LEAN CLAY	140 (32 oz/min)	100.7	26.6	30	15	5	43	52	SS
				11	1,2,2,(6) T 0.45	CL	brown, wet, firm	SANDY LEAN CLAY trace organics									
	15			12	1,2,2,(6) T 0.21	CL	dk. brown, moist, soft	SANDY LEAN CLAY silty sand seams	1,400 (3.2 gal/min)		18.9	27	11	1	44	55	
	20			9	5,5,6,(14) T 0.62	CL/CH	brown, moist, stiff	LEAN CLAY TO FAT CLAY	6,400 (19 gal/min)								
	25			7	3,6,5,(12)	GC	lt. brown, moist, very loose	CLAYEY GRAVEL W/SAND	1,200 (4.2 gal/min)								
	30					GC	lt. brown, moist										
				9	3,4,3,(8) T 0.30	CL	lt. brown, moist, firm	LEAN CLAY W/SAND									
								BOTTOM OF HOLE									

202004-002 AV WATKINS SIPHON REPLACEMENT SANTA_CLARA_WS_DI.GPJ US EVAL.GDT 12/10/21

RB&G ENGINEERING, INC.

LEGEND:

2" OD Split Spoon (SPT)
2.5" OD Split Spoon
3" OD Split Spoon

Split Spoon Sample: 2,3,2,(6) ← Blow Count per 6" / ← $(N_1)_{60}$ Value; T 0.45 ← Torvane (tsf); PP 2.0 ← Pocket Penetrometer (tsf); * ← With Liners; VST 2.30 ← Vane Shear Test (tsf)

Thin-Walled Tube Sample: Pushed; T 0.45 ← Torvane (tsf); PP 2.0 ← Pocket Penetrometer (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
Chem. = pH, Resistivity, Sulfate, Chloride
Hyd. = Hydrometer
DC = Dispersive Clay
SS = Soluble Salts

DRILL HOLE LOG

BORING NO. DI3-1

PROJECT: SANTA CLARA WATERSHED EA - DIAMOND VALLEY

SHEET 1 OF 1

CLIENT: ALPHA ENGINEERING COMPANY

PROJECT NUMBER: 202001-039

LOCATION: SEE SITE PLAN

DATE STARTED: 10/14/21

DRILLING METHOD: 20-CME-55 / NW CASING TO 25'

DATE COMPLETED: 10/14/21

DRILLER: L.P.

GROUND ELEVATION:

DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

LOGGED BY: W.R., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	Sample USCS (AASHTO)	Material Description		Permeability (ft/yr)	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
				14	3,8,8,(34)	CL	lt. brown, sl. moist, very stiff	LEAN CLAY W/SAND organics	2,500								
				4	2,1,2,(7) *T 0.65*	CL	lt. brown, moist to sl. moist, stiff		4,800								
	5																
				8	Pushed *T 0.24*	CL	brown, moist, soft	SANDY LEAN CLAY		98.8	24.0	34	18	0	35	65	CT
	10			10	3,3,6,(16)	CL	brown, sl. moist, stiff		3,700								
				4	Pushed	CL	brown, wet	LEAN CLAY W/GRAVEL									
	15			10	4,11,14,(33)	GC	brown, wet, med. dense	CLAYEY GRAVEL W/SAND	390		15.1	32	18	35	29	36	
	20			10	20,50/5"	CL	lt. brown, sl. moist, hard	LEAN CLAY W/SAND	5								
	25			10	33,50/3"	GC	lt. brown, wet, very dense	CLAYEY GRAVEL W/SAND	37								
	30			0	50/0"	-	no recovery	BOTTOM OF HOLE									

202004-002 AV WATKINS SIPHON REPLACEMENT SANTA_CLARA_WS_DI.GPJ US EVAL.GDT 12/10/21

RB&G ENGINEERING, INC.

LEGEND:

- 2" OD Split Spoon (SPT)
- 2.5" OD Split Spoon
- 3" OD Split Spoon

Split Spoon Sample: 2,3,2,(6) ← Blow Count per 6" ← $(N_1)_{60}$ Value; *T 0.45* ← Torvane (tsf); *PP 2.0* ← Pocket Penetrometer (tsf); * With Liners; VST 2.30 ← Vane Shear Test (tsf)

Thin-Walled Tube Sample: Pushed; *T 0.45* ← Torvane (tsf); *PP 2.0* ← Pocket Penetrometer (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
Chem. = pH, Resistivity, Sulfate, Chloride
Hyd. = Hydrometer
DC = Dispersive Clay
SS = Soluble Salts

APPENDIX E-7C

TECHNICAL DOCUMENTS, CONTINUED

Sample Photos

TEST PIT DA1-2 EXCAVATION

TEST PIT DA1-2 EXCAVATED MATERIAL

RB&G ENGINEERING, INC.

Figure PHOTO SHEETS - 1

Santa Clara Watershed EA

Washington County, Utah

TEST PIT DA1-3 EXCAVATION

TEST PIT DA1-3 EXCAVATED MATERIAL

TEST PIT DA1-3 EXCAVATED MATERIAL

TEST PIT DA1-3 EXCAVATED MATERIAL

RB&G ENGINEERING, INC.

Figure PHOTO SHEETS - 2

Santa Clara Watershed EA

Washington County, Utah


TEST PIT DA1-101 EXCAVATION


TEST PIT DA1-101 EXCAVATED MATERIAL


TEST PIT DA1-101 EXCAVATED MATERIAL


TEST PIT DA1-101 EXCAVATED MATERIAL

RB&G ENGINEERING, INC.

Figure PHOTO SHEETS - 3

Santa Clara Watershed EA

Washington County, Utah

TEST PIT DA1-102 EXCAVATION

TEST PIT DA1-102 EXCAVATED MATERIAL

TEST PIT DA1-102 EXCAVATED MATERIAL

RB&G ENGINEERING, INC.

Figure PHOTO SHEETS - 4

Santa Clara Watershed EA

Washington County, Utah

TEST PIT DA1-103 EXCAVATION

TEST PIT DA1-103 EXCAVATED MATERIAL

TEST PIT DA1-103 EXCAVATED MATERIAL

RB&G ENGINEERING, INC.

Figure PHOTO SHEETS - 5

Santa Clara Watershed EA

Washington County, Utah


TEST PIT DA2-2 EXCAVATION


TEST PIT DA2-2 EXCAVATED MATERIAL


TEST PIT DA2-2 EXCAVATED MATERIAL

RB&G ENGINEERING, INC.

Figure PHOTO SHEETS - 6

Santa Clara Watershed EA

Washington County, Utah

TEST PIT DA2-3 EXCAVATION

TEST PIT DA2-3 EXCAVATED MATERIAL

TEST PIT DA2-3 EXCAVATED MATERIAL

RB&G ENGINEERING, INC.

Figure PHOTO SHEETS - 7

Santa Clara Watershed EA

Washington County, Utah


TEST PIT DA2-101 EXCAVATION


TEST PIT DA2-102 EXCAVATION


TEST PIT DA2-101 EXCAVATED MATERIAL


TEST PIT DA2-102 EXCAVATED MATERIAL

RB&G ENGINEERING, INC.

Figure PHOTO SHEETS - 8

Santa Clara Watershed EA

Washington County, Utah

TEST PIT DA2-103 EXCAVATION

TEST PIT DA2-104 EXCAVATION

TEST PIT DA2-103 EXCAVATED MATERIAL

TEST PIT DA2-104 EXCAVATED MATERIAL

RB&G ENGINEERING, INC.

Figure PHOTO SHEETS - 9

Santa Clara Watershed EA

Washington County, Utah


TEST PIT DA2-105 EXCAVATION


TEST PIT DA2-105 EXCAVATION


TEST PIT DA2-105 EXCAVATED MATERIAL

TEST PIT DA2-106 EXCAVATION

TEST PIT DA1-106 EXCAVATED MATERIAL

TEST PIT DA2-106 EXCAVATED MATERIAL

RB&G ENGINEERING, INC.

Figure PHOTO SHEETS - 11

Santa Clara Watershed EA

Washington County, Utah


TEST PIT DA3-2 EXCAVATION


TEST PIT DA3-2 EXCAVATION


TEST PIT DA3-2 EXCAVATED MATERIAL


TEST PIT DA3-3 EXCAVATION


TEST PIT DA3-3 EXCAVATION & EXCAVATED MATERIAL

TEST PIT DA3-3 EXCAVATION

RB&G ENGINEERING, INC.

Figure PHOTO SHEETS - 13

Santa Clara Watershed EA

Washington County, Utah


TEST PIT DA3-4 EXCAVATION


TEST PIT DA3-4 EXCAVATED MATERIAL

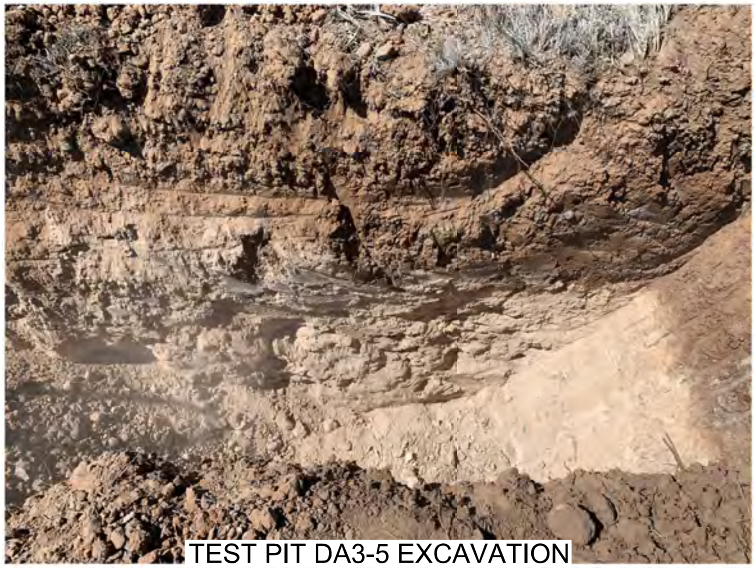

TEST PIT DA3-4 EXCAVATED MATERIAL

RB&G ENGINEERING, INC.

Figure PHOTO SHEETS - 14

Santa Clara Watershed EA

Washington County, Utah


TEST PIT DA3-5 EXCAVATION


TEST PIT DA3-5 EXCAVATED MATERIAL


TEST PIT DA3-5 EXCAVATION

RB&G ENGINEERING, INC.

Figure PHOTO SHEETS - 15

Santa Clara Watershed EA

Washington County, Utah

TEST PIT DA3-101 EXCAVATION

TEST PIT DA3-101 EXCAVATION

TEST PIT DA3-101 EXCAVATED MATERIAL


TEST PIT DA3-102 EXCAVATION


TEST PIT DA3-102 EXCAVATION

RB&G ENGINEERING, INC.

Figure PHOTO SHEETS - 17

Santa Clara Watershed EA

Washington County, Utah

TEST PIT DA3-103 EXCAVATION

TEST PIT DA3-103 EXCAVATION

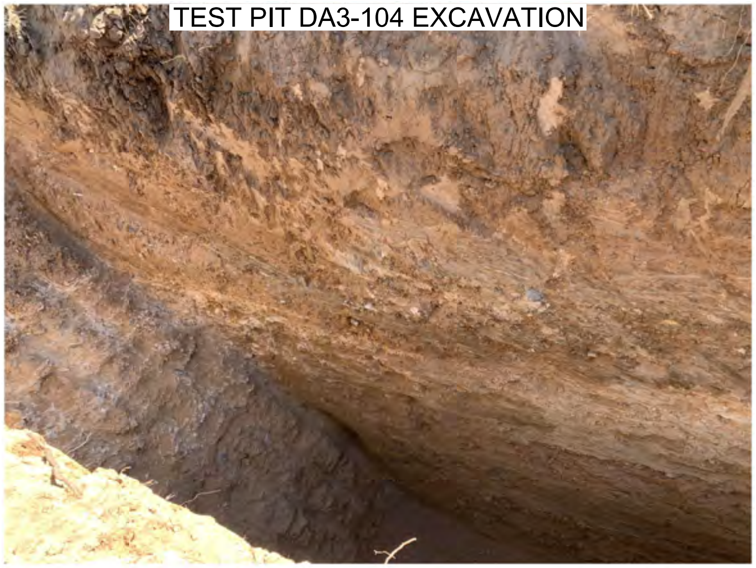
TEST PIT DA3-103 EXCAVATED MATERIAL

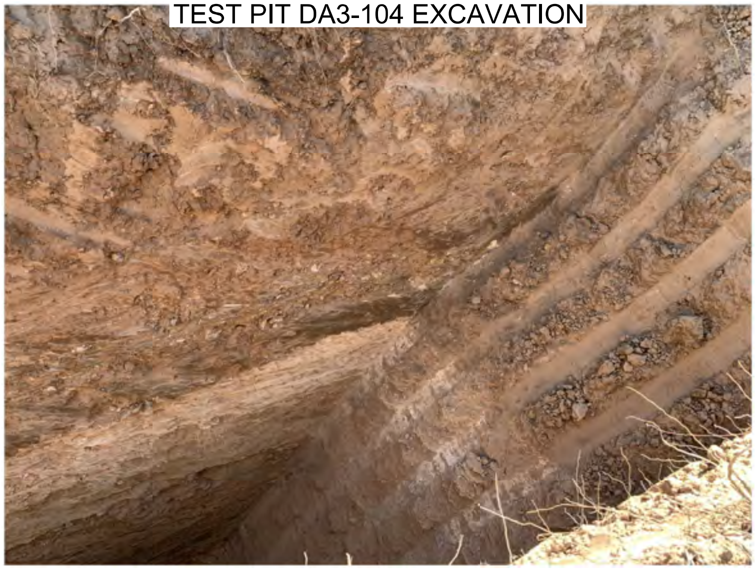
RB&G ENGINEERING, INC.

Figure PHOTO SHEETS - 18

Santa Clara Watershed EA

Washington County, Utah





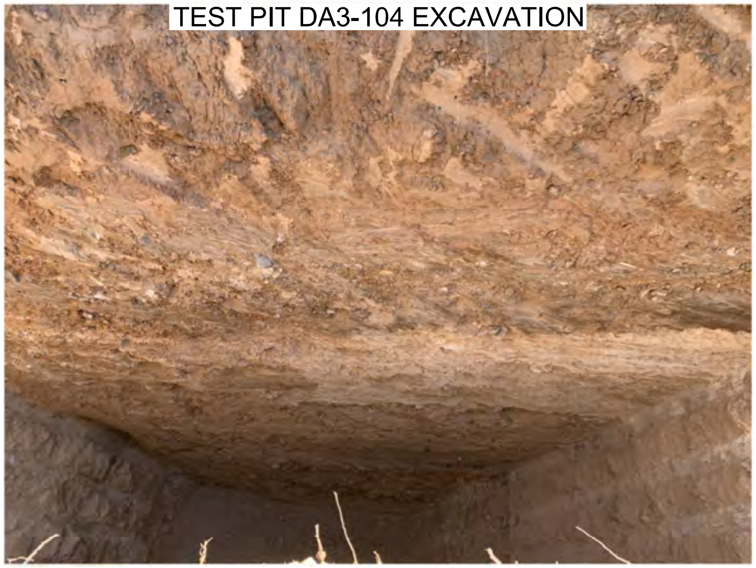


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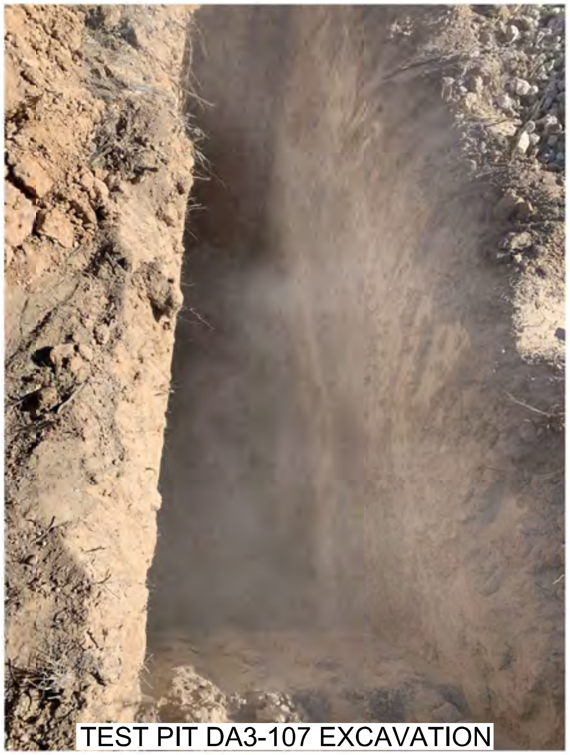
Figure PHOTO SHEETS - 19

Santa Clara Watershed EA

Washington County, Utah

TEST PIT DA3-105 EXCAVATION

TEST PIT DA3-105 EXCAVATED MATERIAL


TEST PIT DA3-107 EXCAVATION


TEST PIT DA3-107 EXCAVATED MATERIAL

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Figure PHOTO SHEETS - 21

Santa Clara Watershed EA

Washington County, Utah

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Figure PHOTO SHEETS - 22

Santa Clara Watershed EA

Washington County, Utah

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Figure PHOTO SHEETS - 23

Santa Clara Watershed EA

Washington County, Utah

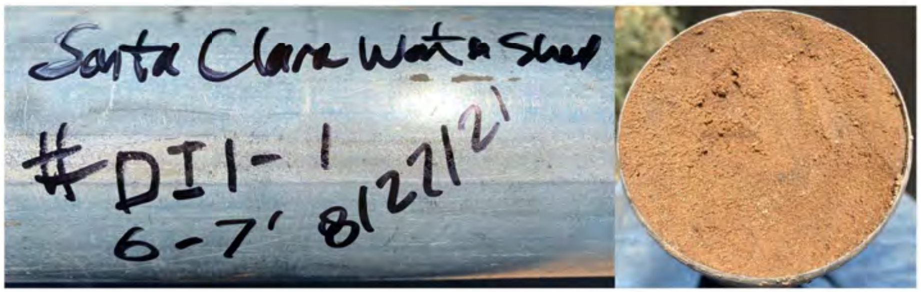

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Figure PHOTO SHEETS - 24

Santa Clara Watershed EA

Washington County, Utah

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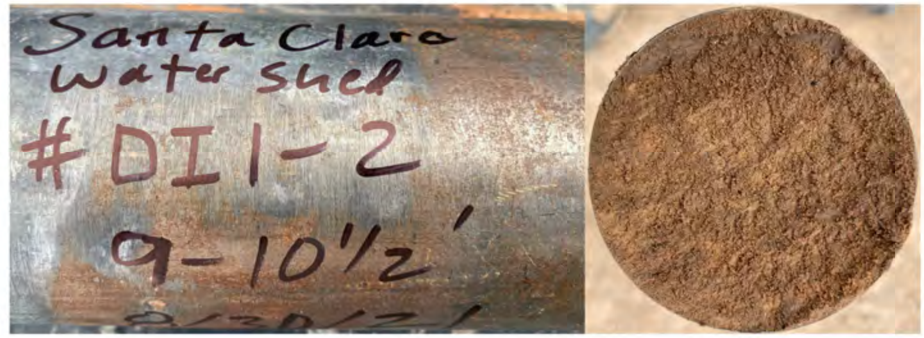
Figure PHOTO SHEETS - 25

Santa Clara Watershed EA

Washington County, Utah



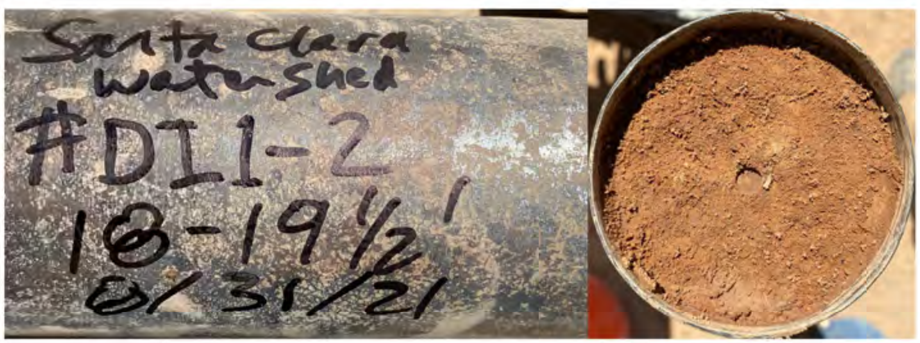


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Figure PHOTO SHEETS - 26

Santa Clara Watershed EA

Washington County, Utah

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Figure PHOTO SHEETS - 27

Santa Clara Watershed EA

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Figure PHOTO SHEETS - 28

Santa Clara Watershed EA

Washington County, Utah

APPENDIX C

Laboratory Testing

RB&G ENGINEERING, INC.

Table 1

SUMMARY OF TEST DATA

PROJECT: Santa Clara Watershed EA - Dammeron Valley
LOCATION: see site plan
PROJECT NO. 202101-039
FEATURE: Test pits and Borings

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	IN-PLACE		UNCONFINED OR UU TRIAXIAL COMPRESSIVE STRENGTH (psi)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			Dispersive Clay	Water Soluble Solids %	UNIFIED SOIL CLASSIFICATION SYSTEM
		DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY			
Dammeron Valley Investigations													
DA 1-1	3-4.5		13.0		31	24	7	6	54	40		0.27	SM
	6-7	139.1	0.5	UC 8,730									
	12-13	136.3	0.4	UC 4,840									
TP DA1 - 2	2-2.5		5.9		35	23	12	41	37	22	ND-1	0.28	GC
TP DA1 - 3	2-3		2.6		25	21	4	28	56	16	ND-1	1.15	SC-SM
TP DA1 - 101	4-5		5.2				NP	20	60	20			SM
	7.5-8.5		15.0		55	21	34	1	22	77	ND-1		CH
TP DA1 - 102	6-7		14.4		62	25	37	21	53	26			SC
	12-12.5		19.5		53	26	27	2	7	91	ND-2		CH
DA 2-1	6-7.5		15.5				NP	40	49	11		0.1	SP-SM
	15-16.5		16.4				NP	39	53	8			SP-SM
	25-26	170.2	0.7	UC 14,630									
TP DA2 - 2	6-7		14.4				NP	46	50	4			SP
TP DA2 - 3	5-6		9.5				NP	17	44	39			SM
TP DA2 - 105	1-2		6.1		33	20	13	41	31	28	ND-1		GC
DA 3-1	3-4.5		23.3		24	15	9	29	43	28			SC
	9-10.5		13.9				NP	4	61	35			SM
	15-16.5		8.8		20	16	4	1	71	28			SC-SM
	32-32.5	104.0	20.2		57	23	34	1	2	97			CH
TP DA3 - 2	3-3.5		5.9		30	21	9	5	52	43	ND-1		SC
TP DA3 - 4	15-15.3		2.6				NP	51	44	5			GP-GM
TP DA3 - 5	3-3.5		8.5		40	18	22	2	24	74	D-1		CL
TP DA3 - 101	11-12											0.25	
	12-13		9.5				NP	27	61	12		0.12	SP-SM
TP DA3 - 102	4-5		4.5		27	16	11	34	38	28	ND-1		SC
	9-10		6.4				NP	40	48	12			SP-SM
TP DA3 - 103	2.6-3		10.1		41	22	19	9	26	65	ND-1	2.96	CL
	9-10		5.1				NP	58	34	8			GP-GM
TP DA3 - 104	3-3.5		8.0		35	16	19	3	51	46		0.22	SC
TP DA3 - 105	3-3.5		2.9				NP	60	31	9		0.82	GP-GM
	6-7		7.0				NP	34	56	10			SP-SM
TP DA3 - 106	3-4		9.5		37	20	17	40	35	25	ND-1		GC
	9-10		4.4				NP	48	38	14		0.34	GM

NP=Non-Plastic

RB&G ENGINEERING, INC.

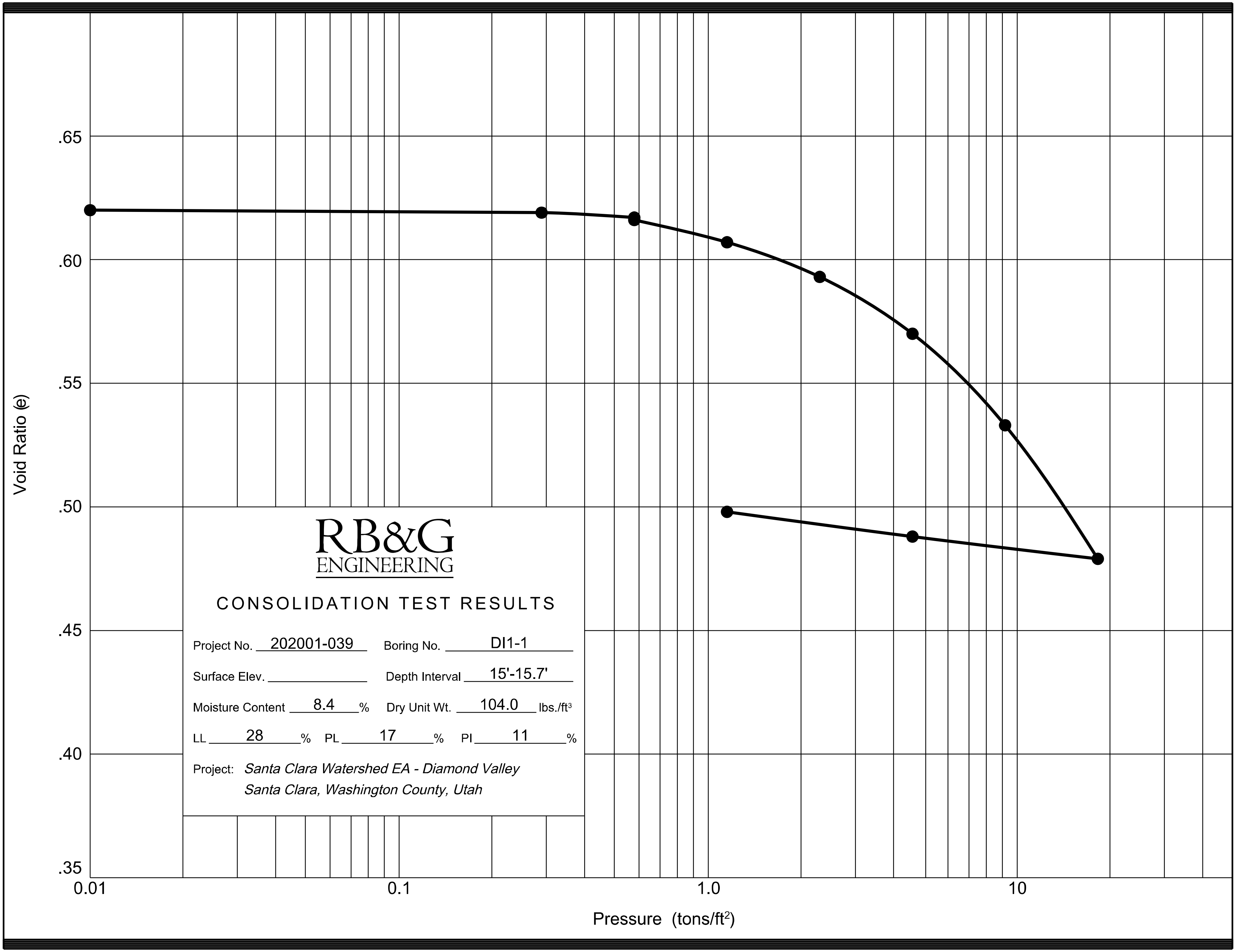
Table 1

SUMMARY OF TEST DATA

PROJECT: Santa Clara Watershed EA - Dammeron Valley
PROJECT NO. 202101-039
LOCATION: see site plan
FEATURE: Test pits and Borings

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	IN-PLACE		UNCONFINED OR UU TRIAXIAL COMPRESSIVE STRENGTH (psi)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			Dispersive Clay	Water Soluble Solids %	UNIFIED SOIL CLASSIFICATION SYSTEM
		DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY			
TP DA3 - 107	3-3.5		4.8		23	18	5	7	54	39	ND-1	0.44	SC-SM
Diamond Valley Investigations													
DI 1-1	3-4.5		13.2		23	18	5	0	51	49	ND-2	0.39	SC-SM
	6-7	101.7	12.1				NP	0	61	39			SM
	12-13.5		13.8		26	17	9	0	17	83			CL
	15-15.7	104.0	8.4		28	17	11	1	34	65			CL
DI 1-2	3-4.5		9.6		20	15	5	1	64	35	ND-2	0.36	SC-SM
	9-10.5	117.2	11.0		17	14	3	0	47	53			ML
	18-19.5	124.3	10.4		27	15	12	0	19	81			CL
DI 2-1	3-4.5		10.5		24	15	9	10	44	46		0.45	SC
	6-7.5		11.3		24	14	10	1	43	56	ND-1		CL
	9-10.5		13.8		24	15	9	8	45	47			SC
DI 2-2	3-4.5		14.2		26	14	12	10	42	48			SC
	9-10.5	100.7	26.6		30	15	15	5	43	52		0.35	CL
	15-16.5		18.9		27	16	11	1	44	55			CL
DI 2-101	3-4.5		8.7				NP	65	25	10		0.09	GP-GM
	6-7.5		8.0		26	14	12	0	51	49	ND-1		SC
DI 3-1	6-7.5	98.8	24.0		34	16	18	0	35	65			CL
	15-16.5		15.1		32	14	18	35	29	36			GC

NP=Non-Plastic



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CONSOLIDATION TEST RESULTS

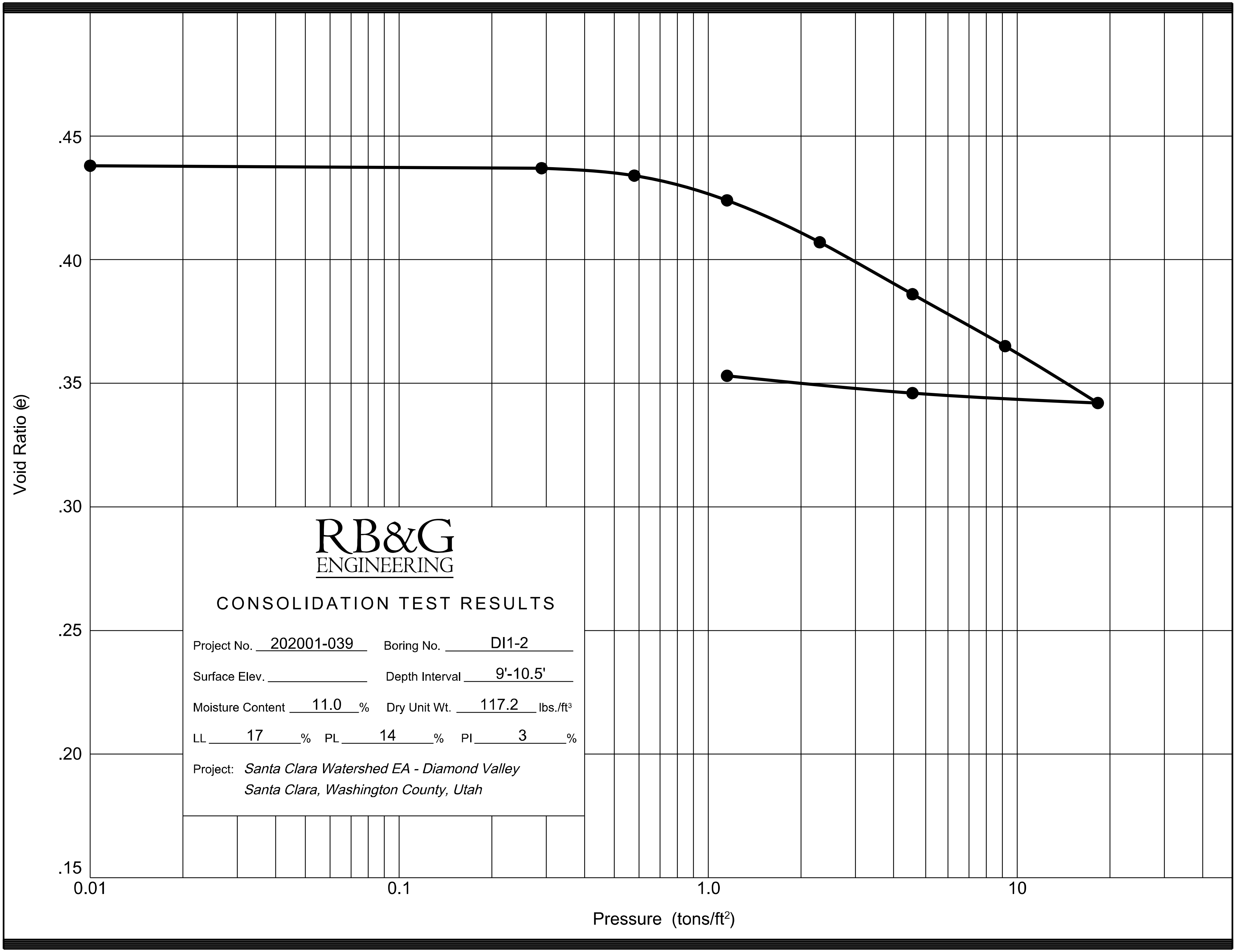
Project No. 202001-039 Boring No. DI1-1

Surface Elev. ______ Depth Interval 15'-15.7'

Moisture Content 8.4 % Dry Unit Wt. 104.0 lbs./ft³

LL 28 % PL 17 % PI 11 %

Project: *Santa Clara Watershed EA - Diamond Valley*
Santa Clara, Washington County, Utah



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CONSOLIDATION TEST RESULTS

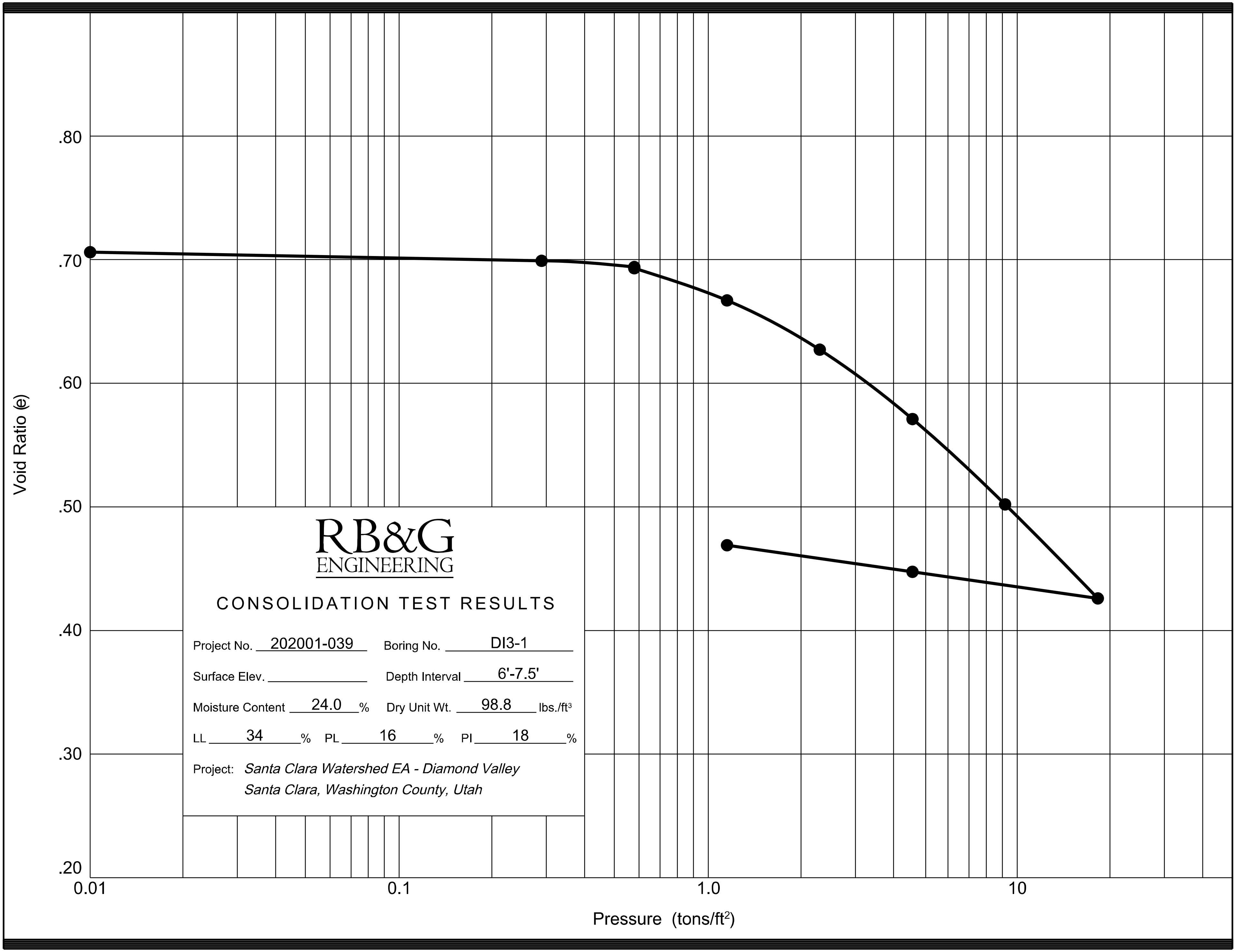
Project No. 202001-039 Boring No. DI1-2

Surface Elev. ________ Depth Interval 9'-10.5'

Moisture Content 11.0 % Dry Unit Wt. 117.2 lbs./ft³

LL 17 % PL 14 % PI 3 %

Project: *Santa Clara Watershed EA - Diamond Valley*
Santa Clara, Washington County, Utah



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CONSOLIDATION TEST RESULTS

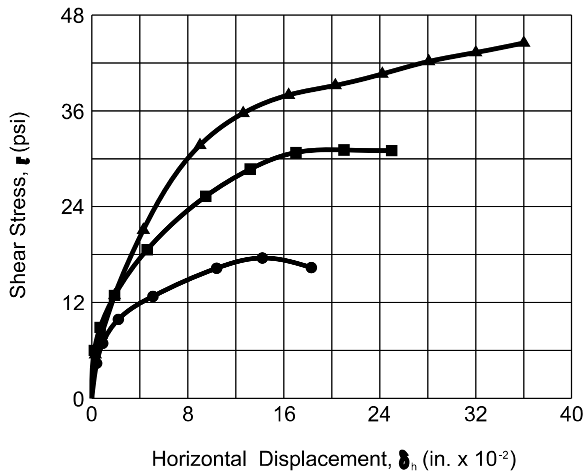
Project No. 202001-039 Boring No. DI3-1

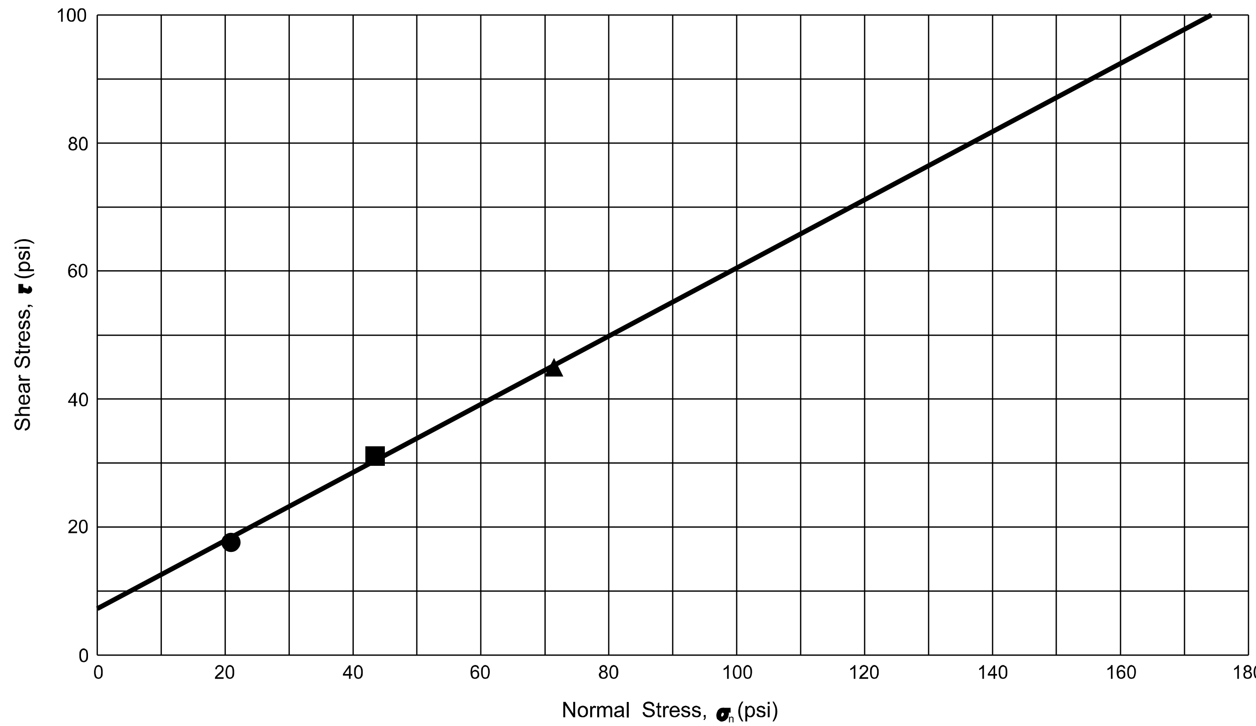
Surface Elev. ______ Depth Interval 6'-7.5'

Moisture Content 24.0 % Dry Unit Wt. 98.8 lbs./ft³

LL 34 % PL 16 % PI 18 %

Project: *Santa Clara Watershed EA - Diamond Valley*
Santa Clara, Washington County, Utah





Test No. or Symbol	Sample Size (inches)	Sample Data		Degree of Saturation (%)	Normal Stress σ_n (psi)	Maximum Shear Stress τ (psi)	Strain Rate (inches/minute)	Shear Strength Parameters	
		Dry Density (pcf)	Moisture Content (%)					Friction Angle (degrees)	Cohesion (psi)
●	2.41	98.5	19.0	~100	20.9	17.6	0.0006	28.0	7.2
■	2.41	97.6	20.6	~100	43.4	31.1	0.0006		
▲	2.41	97.8	19.8	~100	71.4	44.5	0.0006		

MATERIAL: SILTY CLAYEY SAND W/GRAVEL, SC-SM (TEST PERFORMED ON -3/8" MATERIAL)

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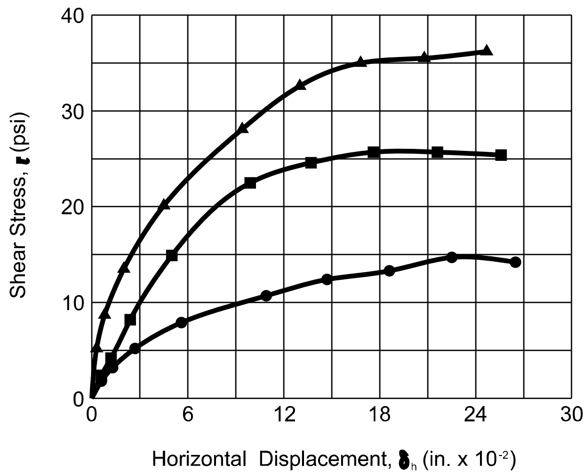
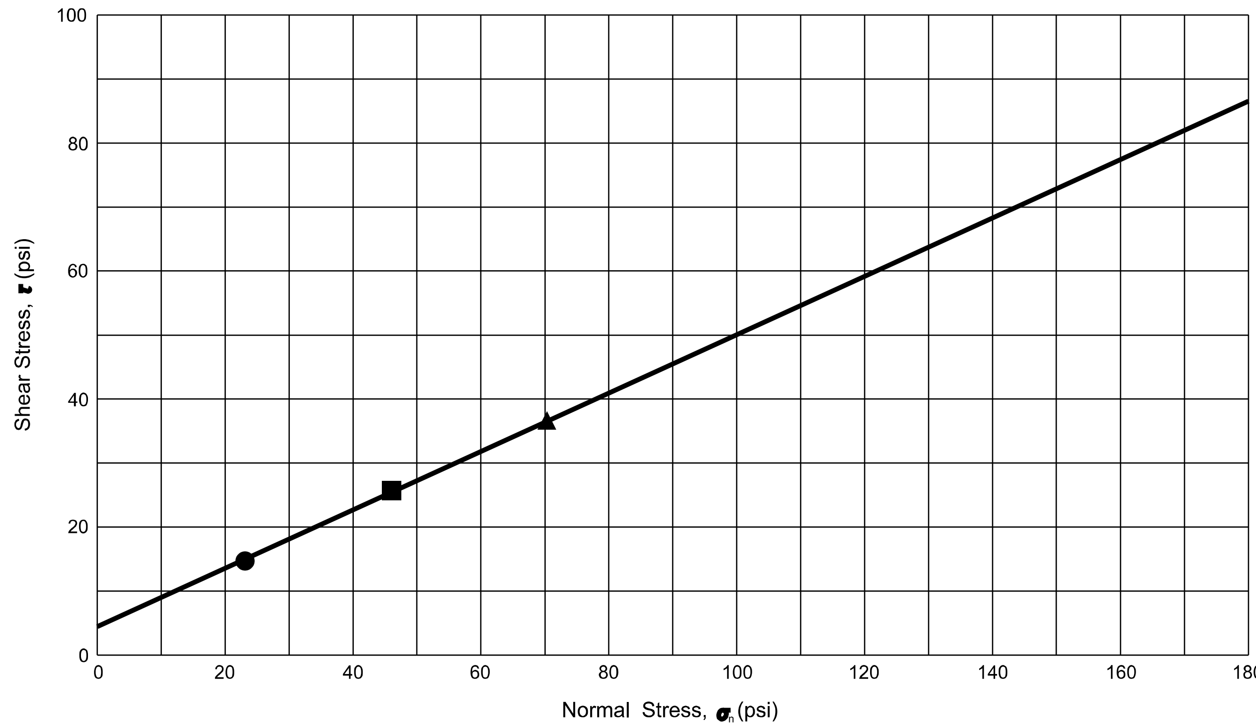
DIRECT SHEAR TEST

Project: *Santa Clara Watershed EA - Dammeron Valley*
Washington County, Utah

HOLE NO.: TP DA1-003

DEPTH: 2'-3'





Test No. or Symbol	Sample Size (inches)	Sample Data		Degree of Saturation (%)	Normal Stress σ_n (psi)	Maximum Shear Stress τ (psi)	Strain Rate (inches/ minute)	Shear Strength Parameters	
		Dry Density (pcf)	Moisture Content (%)					Friction Angle (degrees)	Cohesion (psi)
●	2.35	98.3	19.4	~100	23.1	14.7	0.0006		
■	2.35	99.7	19.5	~100	46.0	25.7	0.0006	24.5	4.5
▲	2.35	98.3	19.3	~100	70.3	36.2	0.0006		

MATERIAL: CLAYEY SAND W/GRAVEL, SC (TEST PERFORMED ON -3/8" MATERIAL)

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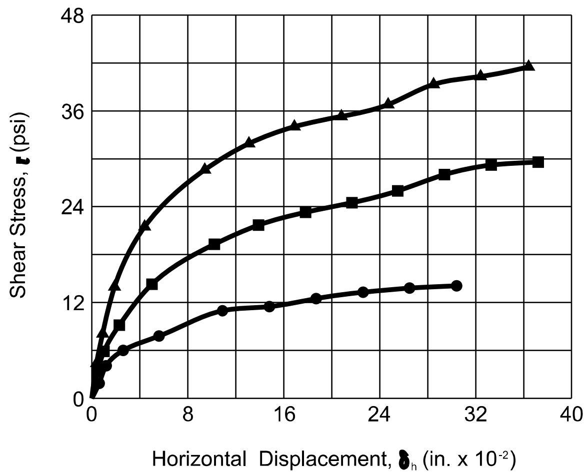
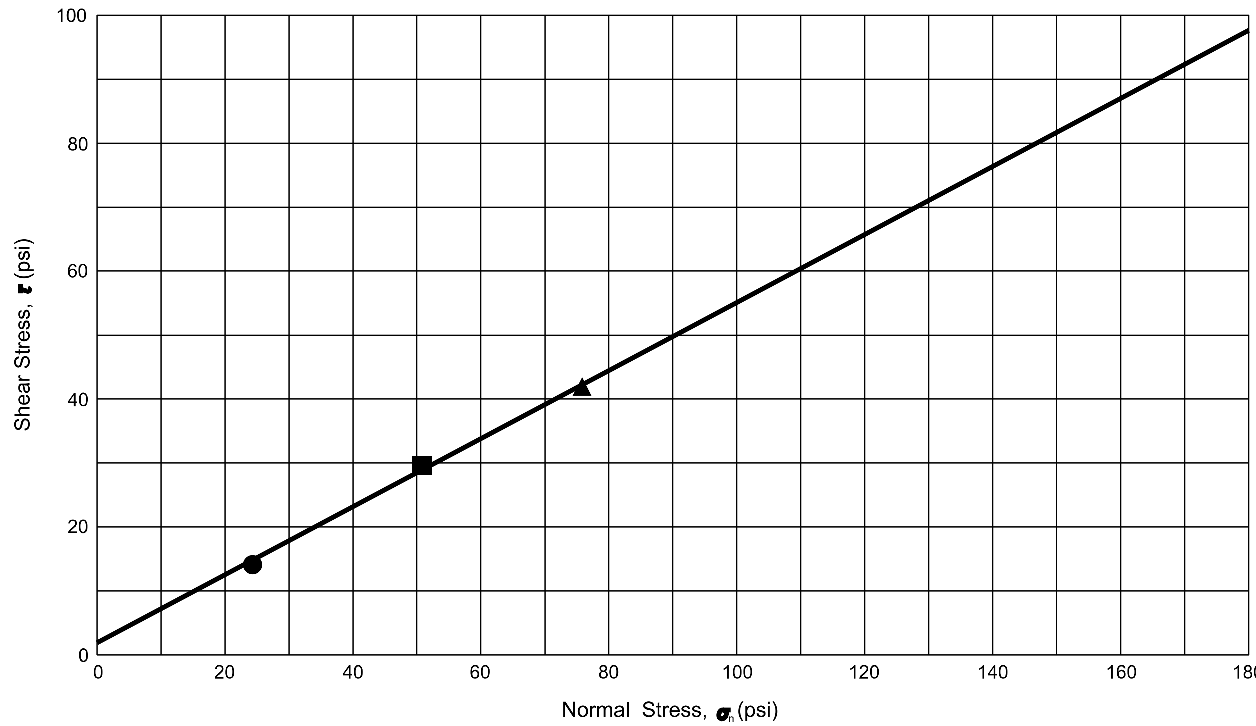
DIRECT SHEAR TEST

Project: *Santa Clara Watershed EA - Dammeron Valley*
Washington County, Utah

HOLE NO.: TP DA1-102

DEPTH: 6'-7'





Test No. or Symbol	Sample Size (inches)	Sample Data		Degree of Saturation (%)	Normal Stress σ_n (psi)	Maximum Shear Stress τ (psi)	Strain Rate (inches/ minute)	Shear Strength Parameters	
		Dry Density (pcf)	Moisture Content (%)					Friction Angle (degrees)	Cohesion (psi)
●	2.35	99.4	15.3	~100	24.3	14.1	0.0006	28.0	1.9
■	2.35	100.6	13.5	~100	50.8	29.6	0.0006		
▲	2.35	102.7	14.4	~100	75.8	41.5	0.0006		

MATERIAL: CLAYEY SAND W/GRAVEL, SC (TEST PERFORMED ON -3/8" MATERIAL)

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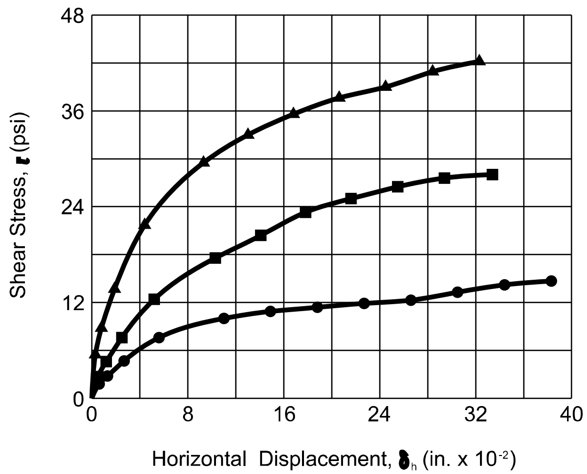
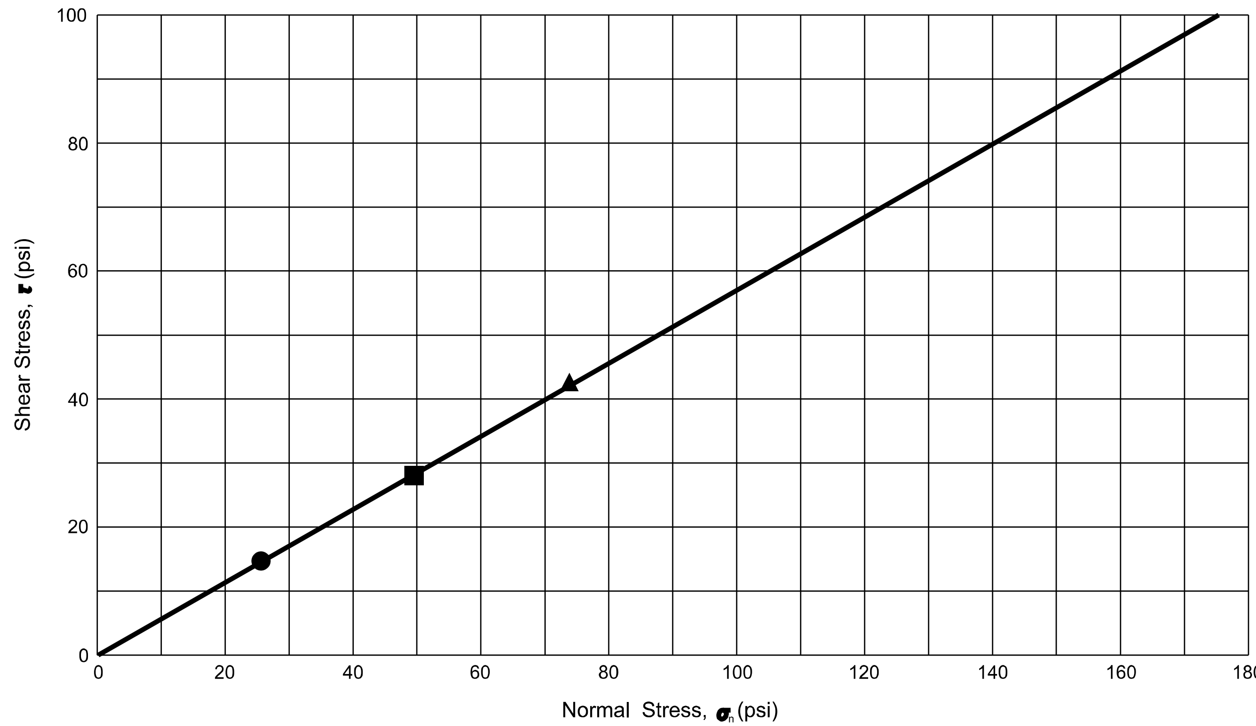
DIRECT SHEAR TEST

Project: *Santa Clara Watershed EA - Dammeron Valley*
Washington County, Utah

HOLE NO.: TP DA3-102

DEPTH: 4'-5'





Test No. or Symbol	Sample Size (inches)	Sample Data		Degree of Saturation (%)	Normal Stress σ_n (psi)	Maximum Shear Stress τ (psi)	Strain Rate (inches/ minute)	Shear Strength Parameters	
		Dry Density (pcf)	Moisture Content (%)					Friction Angle (degrees)	Cohesion (psi)
●	2.35	96.4	18.3	~100	25.6	14.7	0.0006	29.7	0.0
■	2.35	94.8	19.4	~100	49.5	28.0	0.0006		
▲	2.35	94.1	18.9	~100	73.8	42.2	0.0006		

MATERIAL: CLAYEY GRAVEL W/SAND, GC (TEST PERFORMED ON -3/8" MATERIAL)

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DIRECT SHEAR TEST

Project: *Santa Clara Watershed EA - Dammeron Valley*
Washington County, Utah

HOLE NO.: TP DA3-106

DEPTH: 3'-4'

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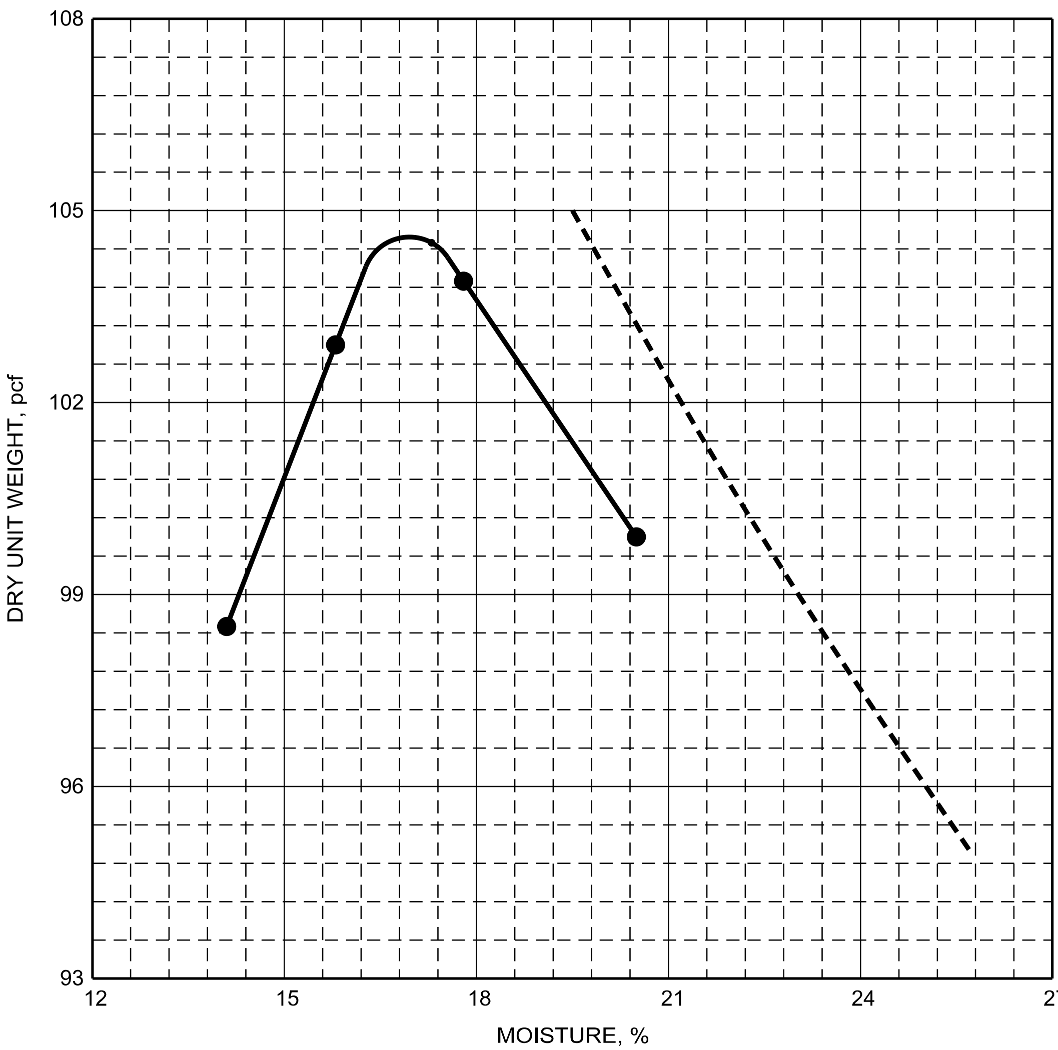
SANTA CLARA WATERSHED EA - DAMMERON VALLEY

Washington County, Utah

MOISTURE-DENSITY RELATION (PROCTOR) ASTM D698

Location	TEST PIT DA1-003 AT 2'-3'	Test Date	10/12/2021
Sample ID	NA	Technician	T. HENDRICKS
Material	SILTY CLAYEY SAND W/GRAVEL	Classification	SC-SM (Test)



-- 100% Saturation Curve NA Not applicable / available	*UNCORRECTED RESULTS*		*OVERSIZE CORRECTION*	
	Max. Dry Density (pcf)	104.5	Max. Dry Density (pcf)	106.6
Specific gravity type is bulk unless otherwise indicated. Results are as per the test method listed above and relate only to the items tested. Rock correction for >3/4-inch material is per ASTM D4718 or AASHTO T224.	Optimum Moisture (%)	17.3	Optimum Moisture (%)	16.3
	Specific Gravity	2.50	Specific Gravity	2.50
	Moisture, As-Received (%)	3	Percent Oversize (%)	6

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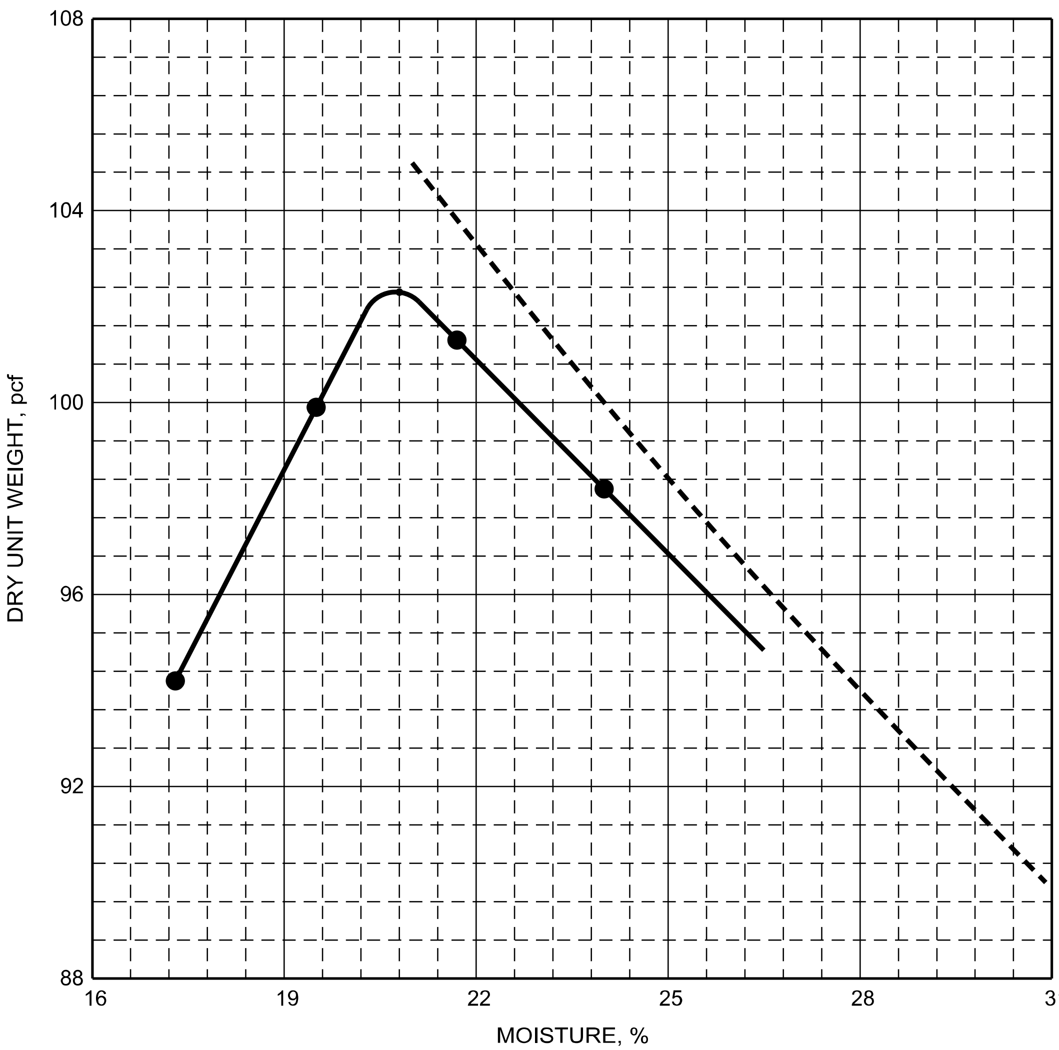
SANTA CLARA WATERSHED EA - DAMMERON VALLEY

Washington County, Utah

MOISTURE-DENSITY RELATION (PROCTOR) ASTM D698

Location	TEST PIT DA1-102 AT 6'-7'	Test Date	10/12/2021
Sample ID	NA	Technician	T. HENDRICKS
Material	CLAYEY SAND W/GRAVEL	Classification	SC (Test)



	UNCORRECTED RESULTS		OVERSIZE CORRECTION	
- - 100% Saturation Curve NA Not applicable / available	Max. Dry Density (pcf)	102.3	Max. Dry Density (pcf)	NA
Specific gravity type is bulk unless otherwise indicated. Results are as per the test method listed above and relate only to the items tested. Rock correction for >3/4-inch material is per ASTM D4718 or AASHTO T224.	Optimum Moisture (%)	20.8	Optimum Moisture (%)	NA
	Specific Gravity	2.60	Specific Gravity	NA
	Moisture, As-Received (%)	15	Percent Oversize (%)	0

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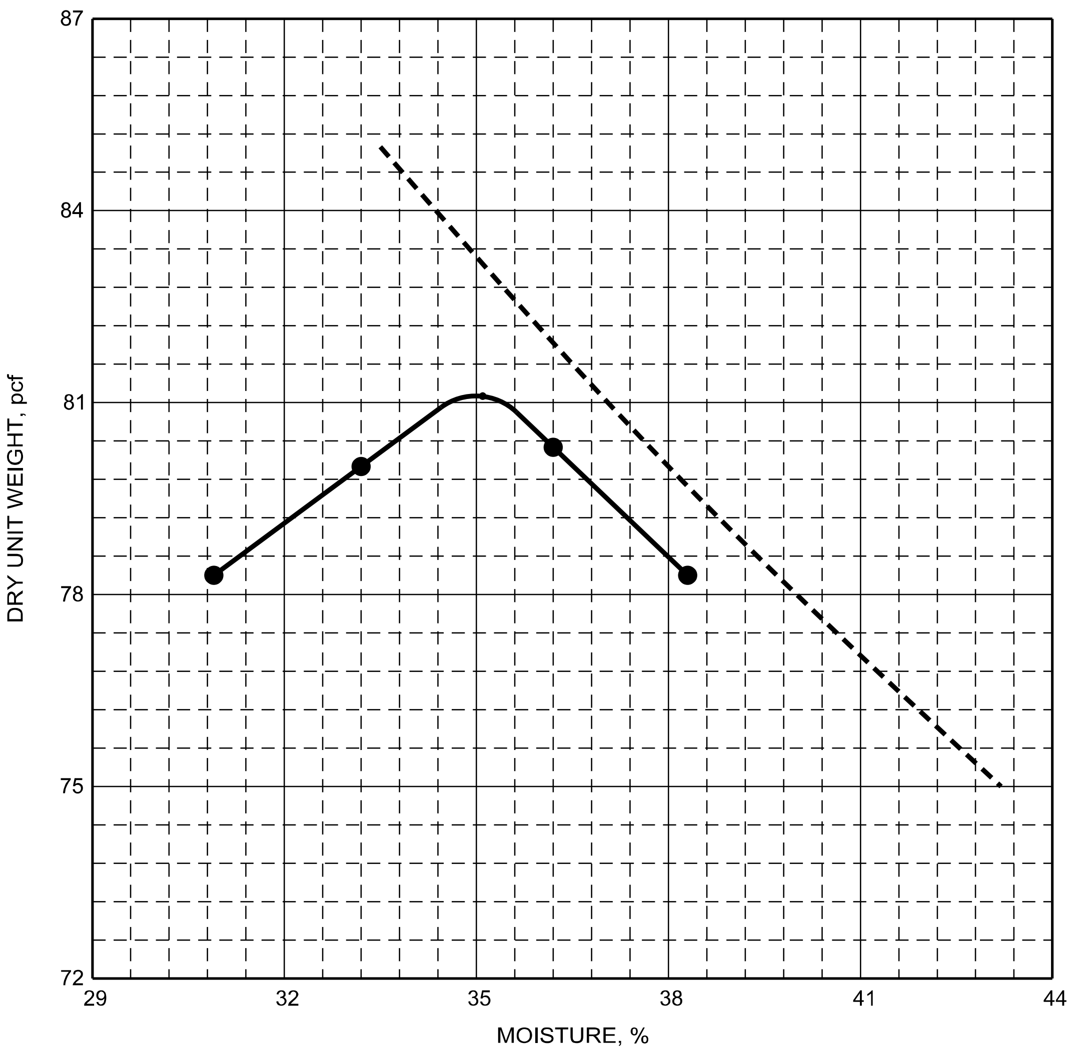
SANTA CLARA WATERSHED EA - DAMMERON VALLEY

Washington County, Utah

MOISTURE-DENSITY RELATION (PROCTOR) ASTM D698

Location	TEST PIT DA2-002 AT 6'-7'	Test Date	10/19/2021
Sample ID	NA	Technician	T. HENDRICKS
Material	SAND W/GRAVEL	Classification	SP (Test)



-- 100% Saturation Curve NA Not applicable / available	*UNCORRECTED RESULTS*		*OVERSIZE CORRECTION*	
	Max. Dry Density (pcf)	81.1	Max. Dry Density (pcf)	84.3
Specific gravity type is bulk unless otherwise indicated. Results are as per the test method listed above and relate only to the items tested. Rock correction for >3/4-inch material is per ASTM D4718 or AASHTO T224.	Optimum Moisture (%)	35.1	Optimum Moisture (%)	32.5
	Specific Gravity	2.50	Specific Gravity	2.50
	Moisture, As-Received (%)	15	Percent Oversize (%)	8

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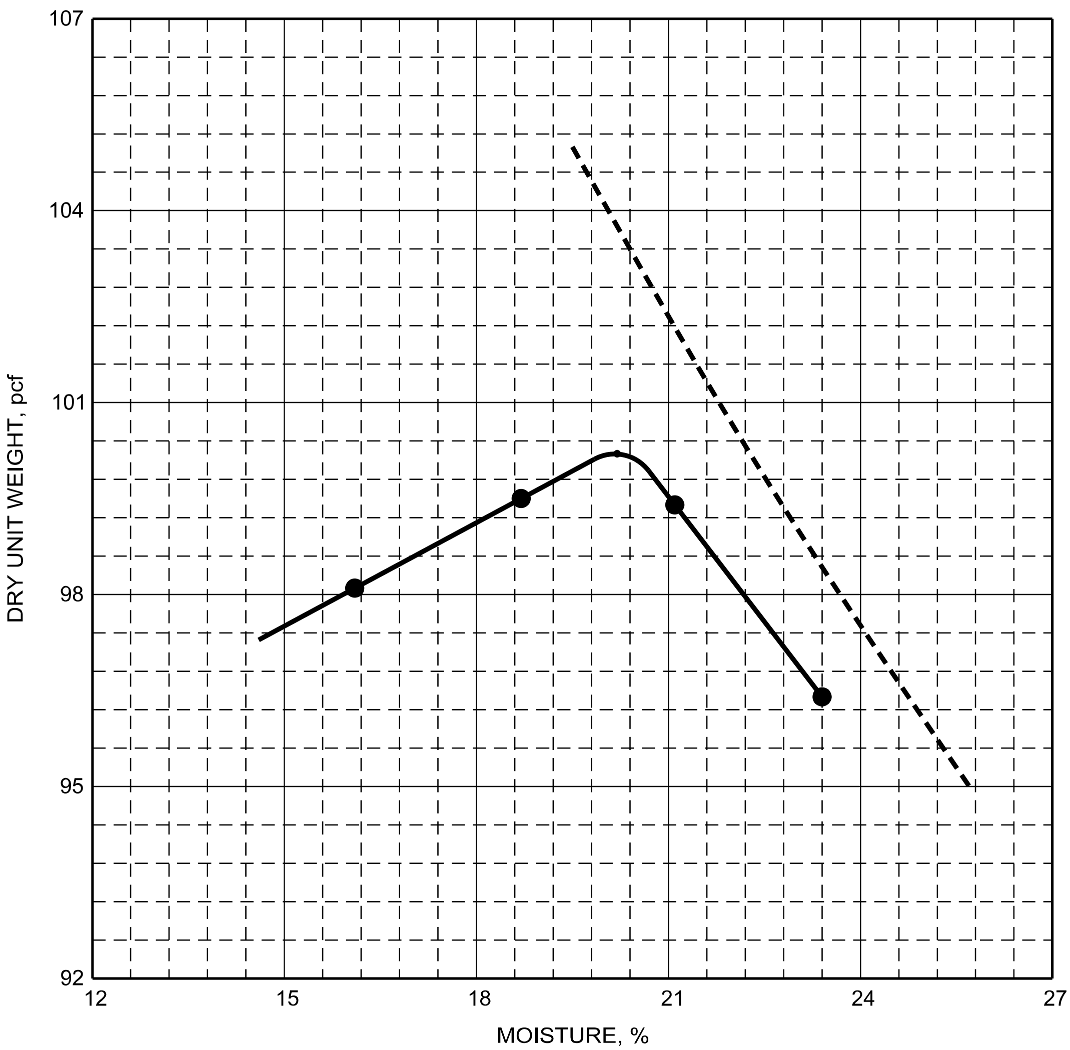
SANTA CLARA WATERSHED EA - DAMMERON VALLEY

Washington County, Utah

MOISTURE-DENSITY RELATION (PROCTOR) ASTM D698

Location	TEST PIT DA2-105 AT 1'-2'	Test Date	10/19/2021
Sample ID	NA	Technician	T. HENDRICKS
Material	CLAYEY GRAVEL W/SAND	Classification	GC (Test)



- - 100% Saturation Curve NA Not applicable / available	*UNCORRECTED RESULTS*		*OVERSIZE CORRECTION*	
	Max. Dry Density (pcf)	100.2	Max. Dry Density (pcf)	NA
Specific gravity type is bulk unless otherwise indicated. Results are as per the test method listed above and relate only to the items tested. Rock correction for >3/4-inch material is per ASTM D4718 or AASHTO T224.	Optimum Moisture (%)	20.2	Optimum Moisture (%)	NA
	Specific Gravity	2.50	Specific Gravity	NA
	Moisture, As-Received (%)	8	Percent Oversize (%)	0

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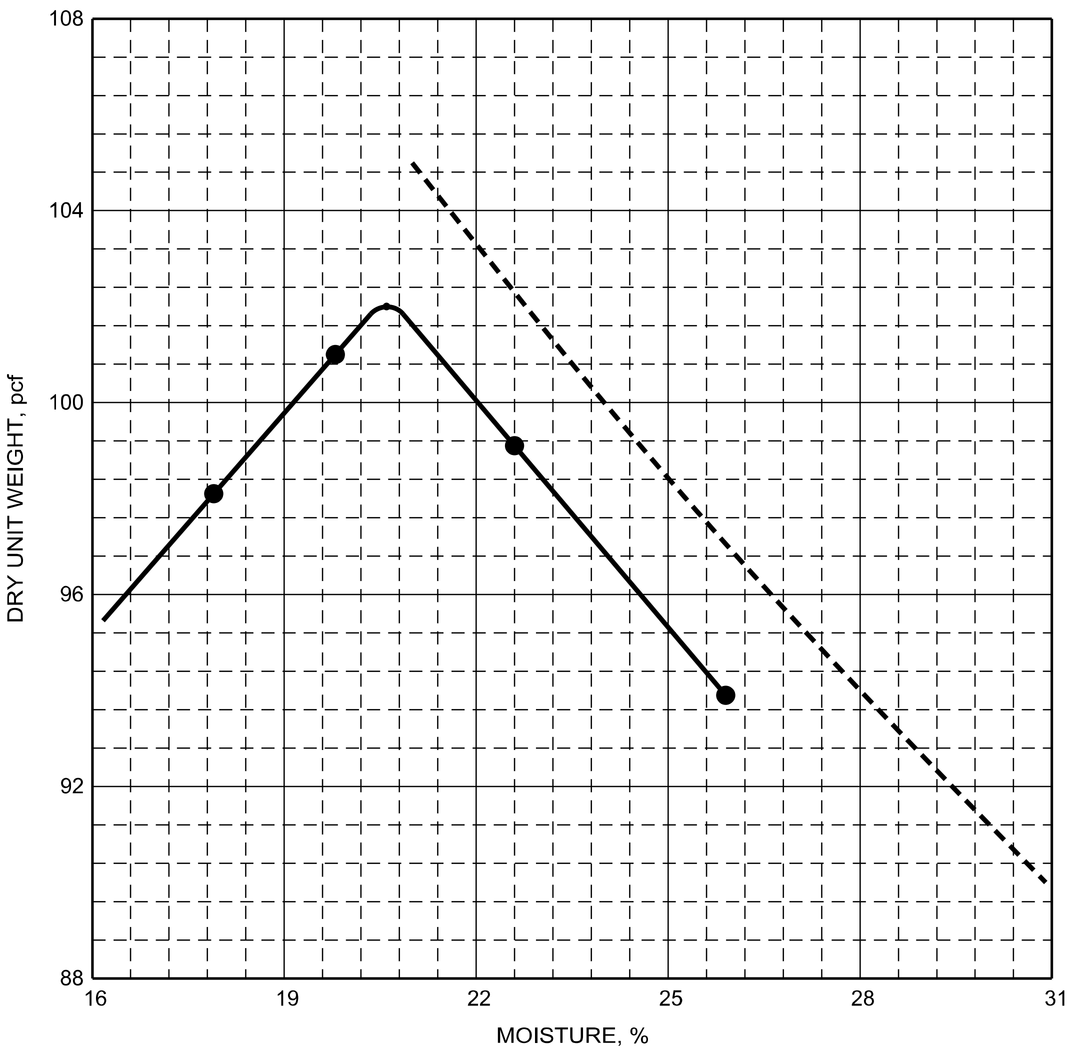
SANTA CLARA WATERSHED EA - DAMMERON VALLEY

Washington County, Utah

MOISTURE-DENSITY RELATION (PROCTOR) — ASTM D698

Location	TEST PIT DA3-002 AT 3'-3.5'	Test Date	10/22/2021
Sample ID	NA	Technician	T. HENDERSON
Material	CLAYEY SAND	Classification	SC (Test)



-- 100% Saturation Curve NA Not applicable / available	*UNCORRECTED RESULTS*		*OVERSIZE CORRECTION*	
	Max. Dry Density (pcf)	102.0	Max. Dry Density (pcf)	NA
Specific gravity type is bulk unless otherwise indicated. Results are as per the test method listed above and relate only to the items tested. Rock correction for >3/4-inch material is per ASTM D4718 or AASHTO T224.	Optimum Moisture (%)	20.6	Optimum Moisture (%)	NA
	Specific Gravity	2.60	Specific Gravity	NA
	Moisture, As-Received (%)	6	Percent Oversize (%)	0

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RBG No.	202001-039
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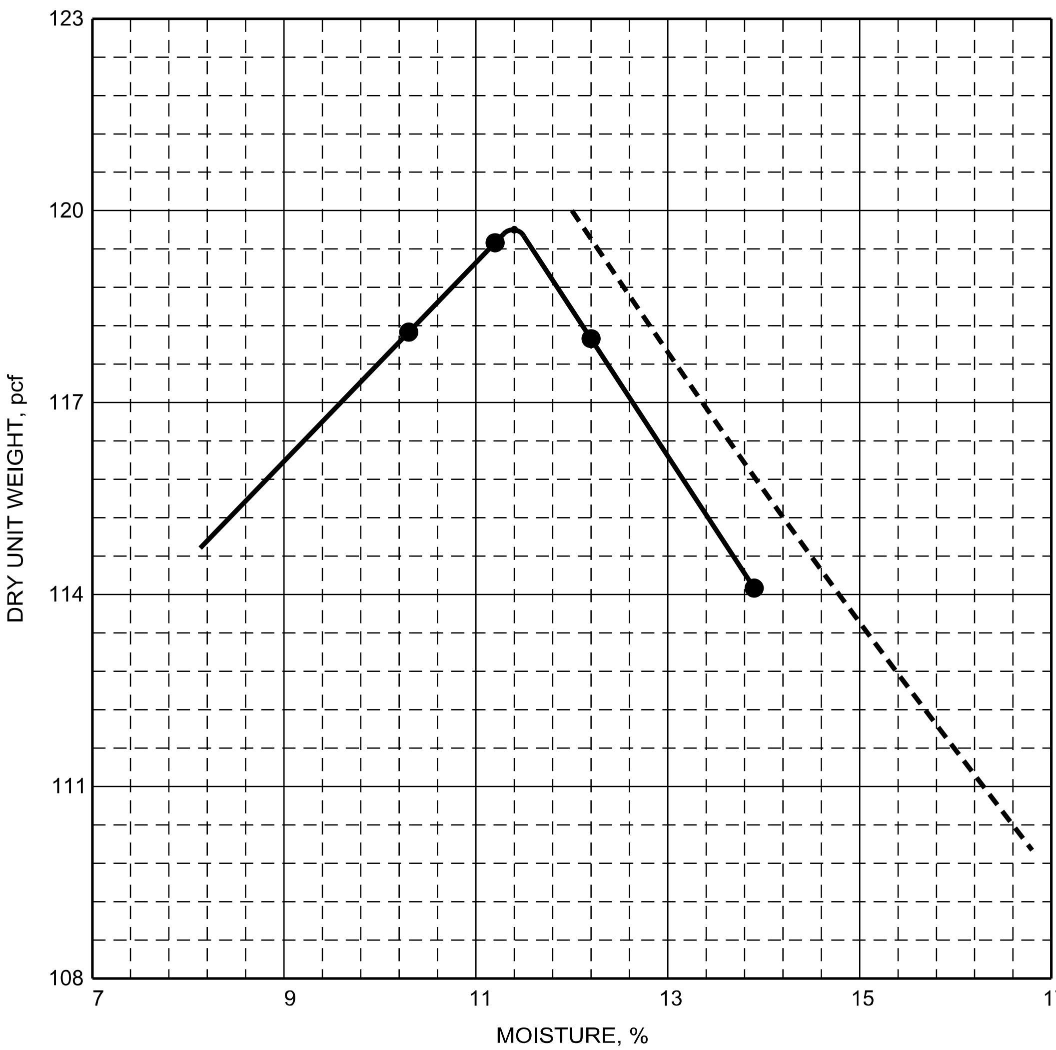
SANTA CLARA WATERSHED EA - DAMMERON VALLEY

Washington County, Utah

MOISTURE-DENSITY RELATION (PROCTOR) — ASTM D698

Location	TEST PIT DA3-004 AT 15'-15.3'	Test Date	10/25/2021
Sample ID	NA	Technician	T. HENDERSON
Material	GRAVEL W/SILT & SAND	Classification	GP-GM (Test)



– – 100% Saturation Curve NA Not applicable / available	*UNCORRECTED RESULTS*		*OVERSIZE CORRECTION*	
	Max. Dry Density (pcf)	119.7	Max. Dry Density (pcf)	128.7
Specific gravity type is bulk unless otherwise indicated. Results are as per the test method listed above and relate only to the items tested. Rock correction for >3/4-inch material is per ASTM D4718 or AASHTO T224.	Optimum Moisture (%)	11.4	Optimum Moisture (%)	8.7
	Specific Gravity	2.50	Specific Gravity	2.50
	Moisture, As-Received (%)	3	Percent Oversize (%)	30+

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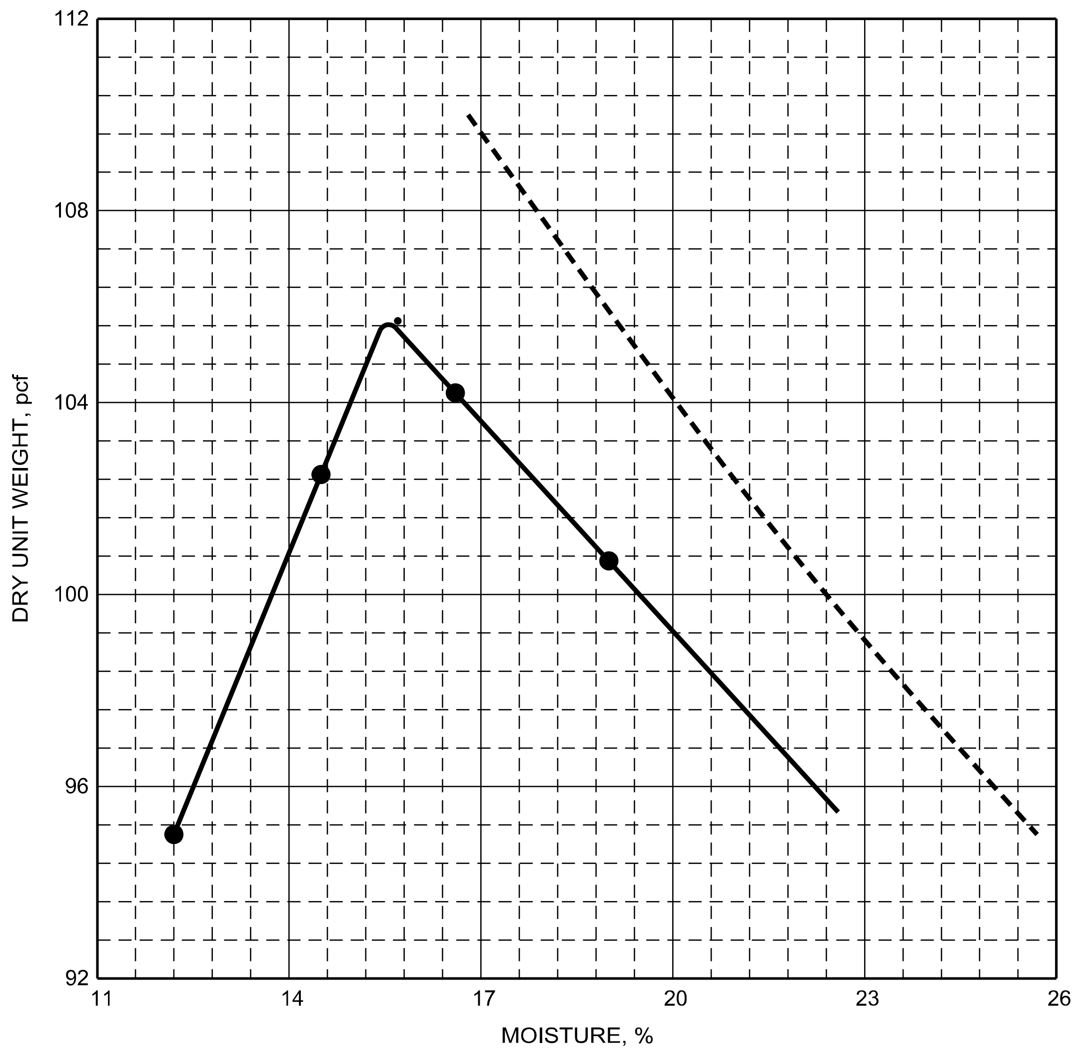
Washington County, Utah

MOISTURE-DENSITY RELATION (PROCTOR) ASTM D698

Location	TEST PIT DA3-005 AT 3'-3.5'	Test Date	10/12/2021
Sample ID	NA	Technician	T. DAY, T. HENDERSON, T. HENDRICKS
Material	LEAN CLAY W/SAND	Classification	CL (Test)



- - 100% Saturation Curve NA Not applicable / available	*UNCORRECTED RESULTS*		*OVERSIZE CORRECTION*	
	Max. Dry Density (pcf)	105.7	Max. Dry Density (pcf)	NA
Specific gravity type is bulk unless otherwise indicated. Results are as per the test method listed above and relate only to the items tested. Rock correction for >3/4-inch material is per ASTM D4718 or AASHTO T224.	Optimum Moisture (%)	15.7	Optimum Moisture (%)	NA
	Specific Gravity	2.50	Specific Gravity	NA
	Moisture, As-Received (%)	9	Percent Oversize (%)	0

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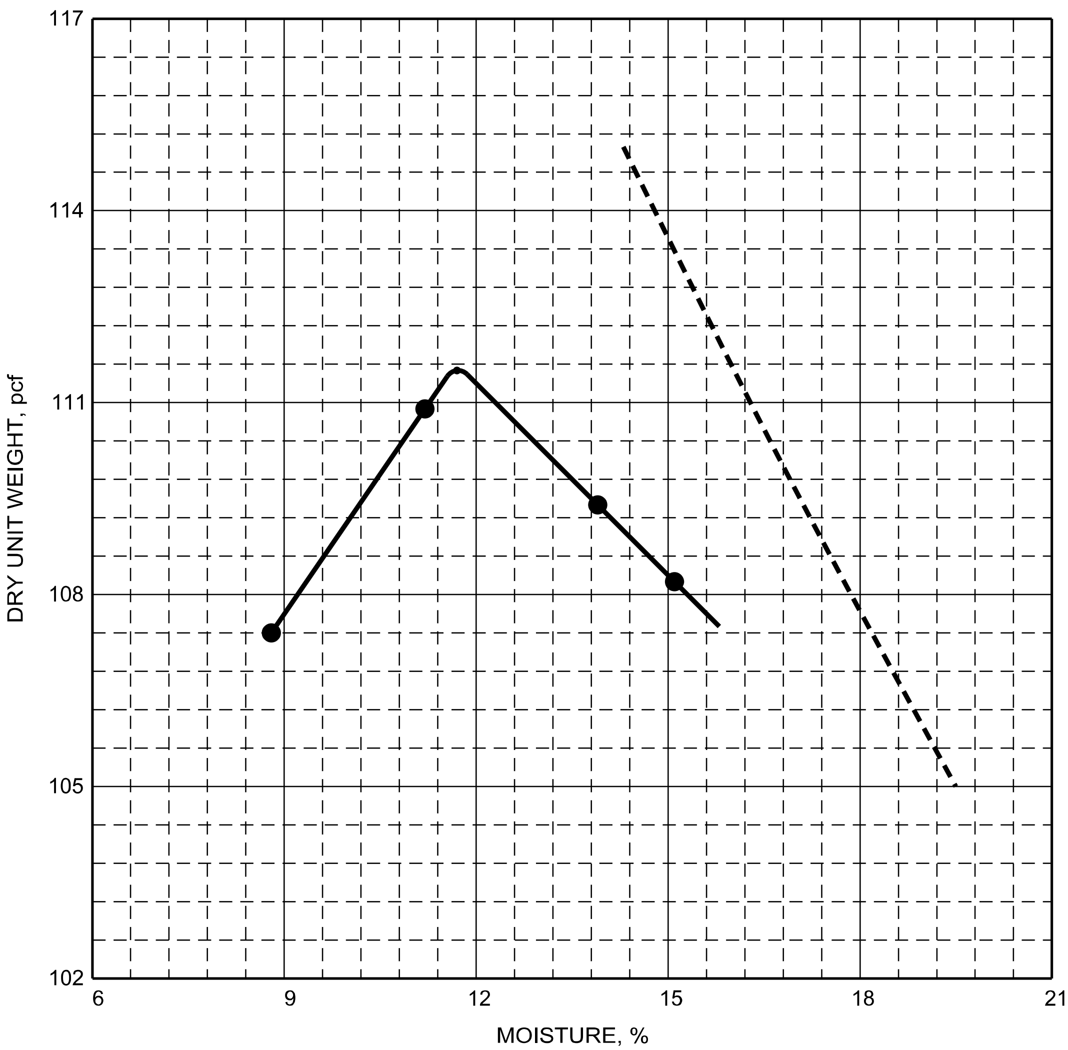
SANTA CLARA WATERSHED EA - DAMMERON VALLEY

Washington County, Utah

MOISTURE-DENSITY RELATION (PROCTOR) ASTM D698

Location	TEST PIT DA3-102 AT 4'-5'	Test Date	10/13/2021
Sample ID	NA	Technician	C. PRICE, T. HENDRICKS
Material	CLAYEY SAND W/GRAVEL	Classification	SC (Test)



-- 100% Saturation Curve NA Not applicable / available	*UNCORRECTED RESULTS*		*OVERSIZE CORRECTION*	
	Max. Dry Density (pcf)	111.5	Max. Dry Density (pcf)	115.5
Specific gravity type is bulk unless otherwise indicated. Results are as per the test method listed above and relate only to the items tested. Rock correction for >3/4-inch material is per ASTM D4718 or AASHTO T224.	Optimum Moisture (%)	11.7	Optimum Moisture (%)	10.4
	Specific Gravity	2.50	Specific Gravity	2.50
	Moisture, As-Received (%)	5	Percent Oversize (%)	12

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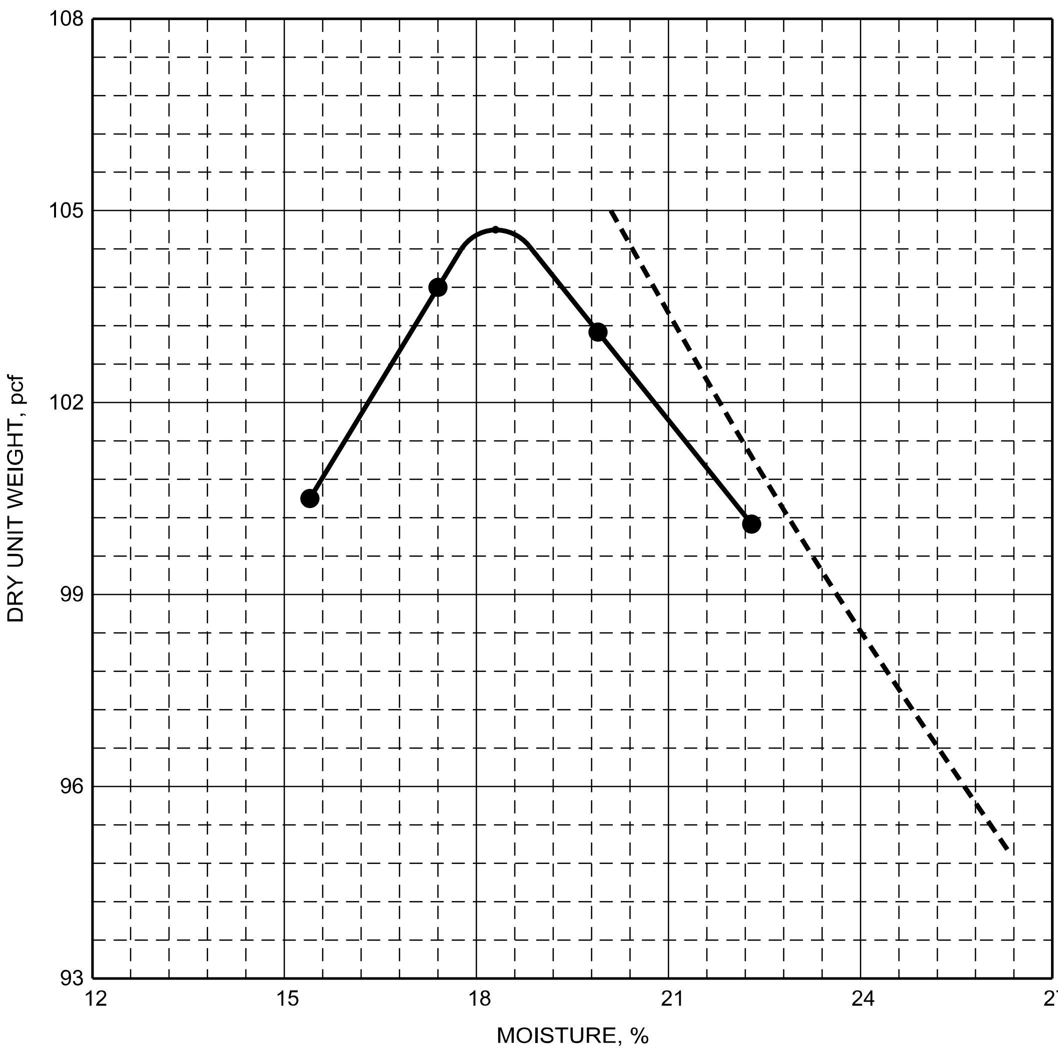
SANTA CLARA WATERSHED EA - DAMMERON VALLEY

Washington County, Utah

MOISTURE-DENSITY RELATION (PROCTOR) ASTM D698

Location	TEST PIT DA3-102 AT 9'-10'	Test Date	10/19/2021
Sample ID	NA	Technician	J. REITZ
Material	SAND W/SILT & GRAVEL	Classification	SP-SM (Test)



- - 100% Saturation Curve NA Not applicable / available	*UNCORRECTED RESULTS*		*OVERSIZE CORRECTION*	
	Max. Dry Density (pcf)	104.7	Max. Dry Density (pcf)	109.0
Specific gravity type is bulk unless otherwise indicated. Results are as per the test method listed above and relate only to the items tested. Rock correction for >3/4-inch material is per ASTM D4718 or AASHTO T224.	Optimum Moisture (%)	18.3	Optimum Moisture (%)	16.7
	Specific Gravity	2.50	Specific Gravity	2.50
	Moisture, As-Received (%)	7	Percent Oversize (%)	12

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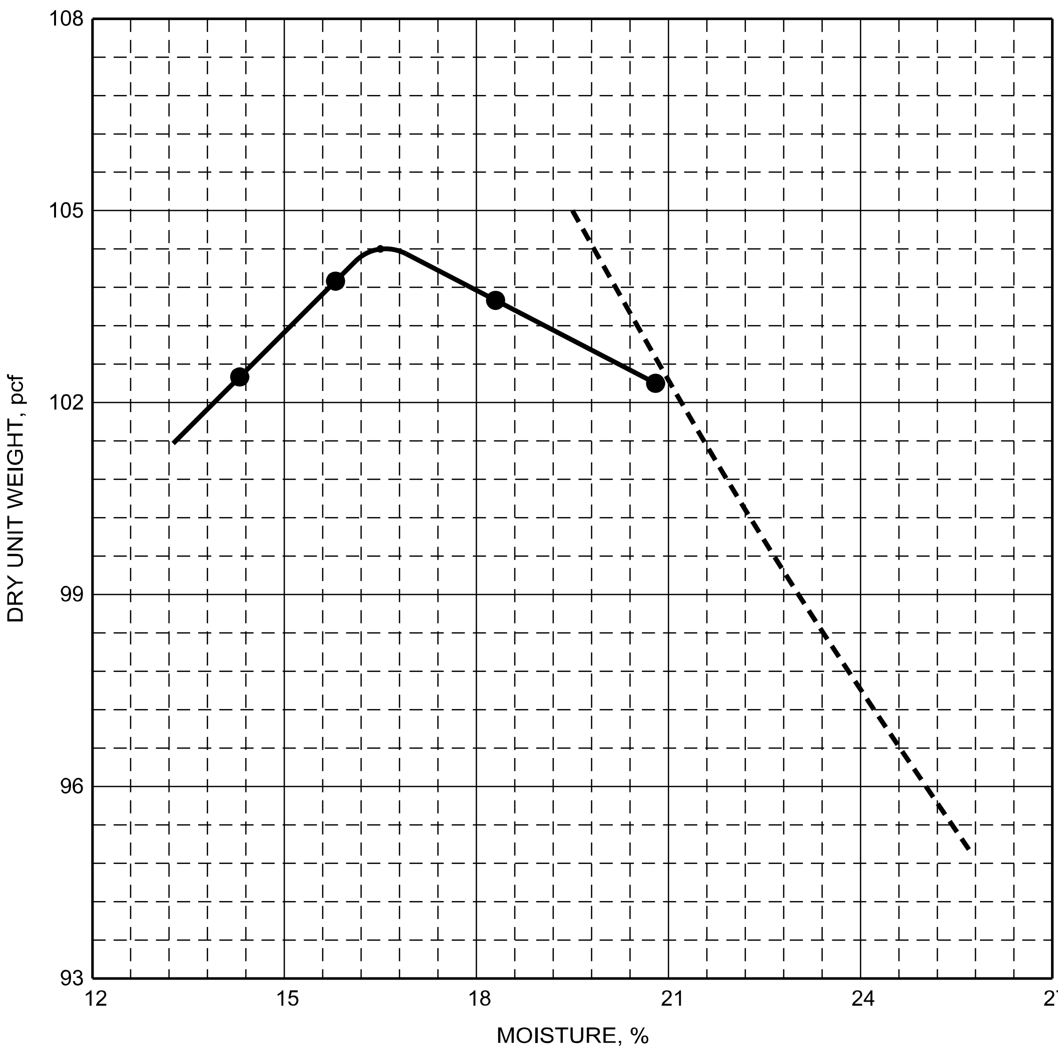
SANTA CLARA WATERSHED EA - DAMMERON VALLEY

Washington County, Utah

MOISTURE-DENSITY RELATION (PROCTOR) ASTM D698

Location	TEST PIT DA3-103 AT 9'-10'	Test Date	10/20/2021
Sample ID	NA	Technician	C. PRICE
Material	GRAVEL W/SILT & SAND	Classification	GP-GM (Test)



	UNCORRECTED RESULTS		OVERSIZE CORRECTION	
100% Saturation Curve NA Not applicable / available	Max. Dry Density (pcf)	104.4	Max. Dry Density (pcf)	115.9
Specific gravity type is bulk unless otherwise indicated. Results are as per the test method listed above and relate only to the items tested. Rock correction for >3/4-inch material is per ASTM D4718 or AASHTO T224.	Optimum Moisture (%)	16.5	Optimum Moisture (%)	12.1
	Specific Gravity	2.50	Specific Gravity	2.50
	Moisture, As-Received (%)	7	Percent Oversize (%)	30+

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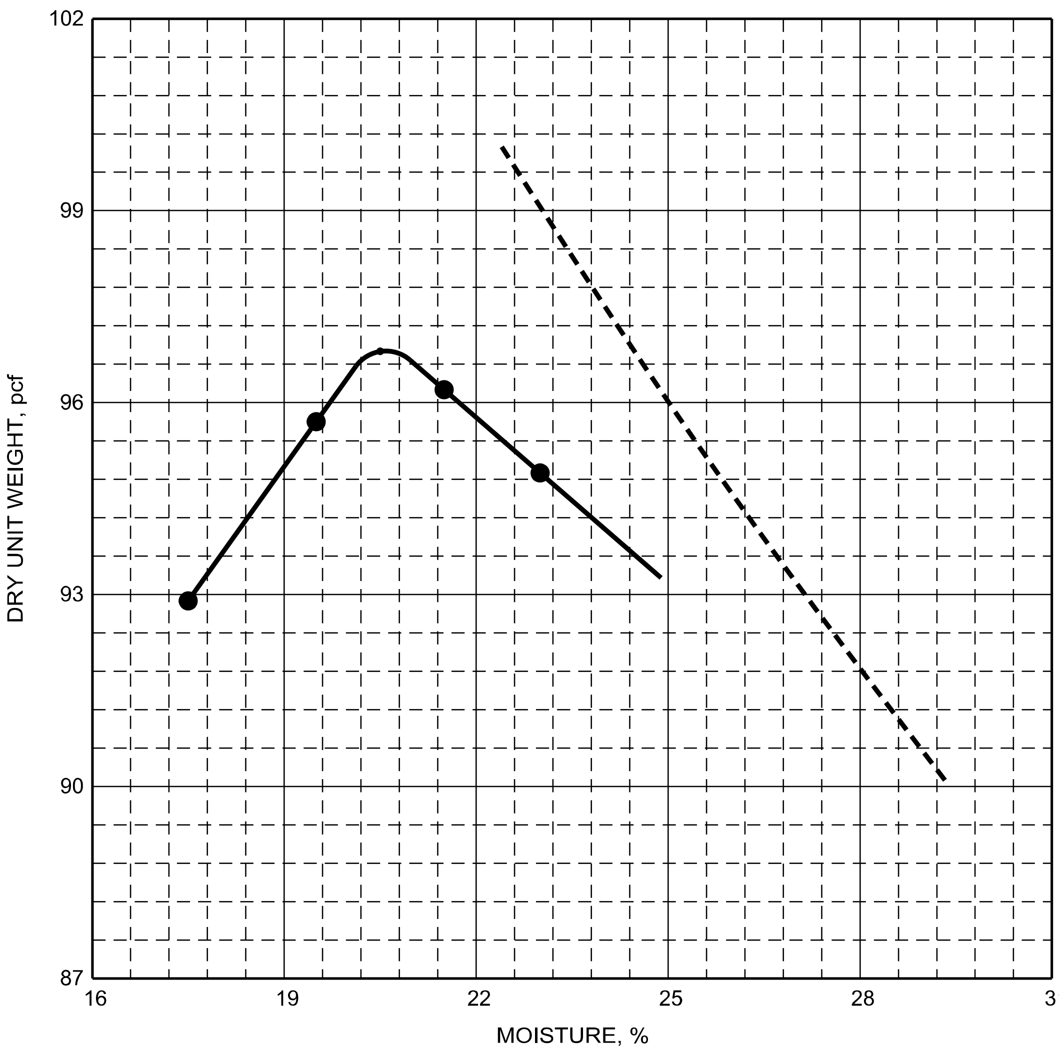
SANTA CLARA WATERSHED EA - DAMMERON VALLEY

Washington County, Utah

MOISTURE-DENSITY RELATION (PROCTOR) ASTM D698

Location	TEST PIT DA3-105 AT 6'-7'	Test Date	10/22/2021
Sample ID	NA	Technician	T. HENDERSON
Material	SAND W/SILT & GRAVEL	Classification	SP-SM (Test)



-- 100% Saturation Curve NA Not applicable / available	*UNCORRECTED RESULTS*		*OVERSIZE CORRECTION*	
	Max. Dry Density (pcf)	96.8	Max. Dry Density (pcf)	NA
Specific gravity type is bulk unless otherwise indicated. Results are as per the test method listed above and relate only to the items tested. Rock correction for >3/4-inch material is per ASTM D4718 or AASHTO T224.	Optimum Moisture (%)	20.5	Optimum Moisture (%)	NA
	Specific Gravity	2.50	Specific Gravity	NA
	Moisture, As-Received (%)	7	Percent Oversize (%)	0

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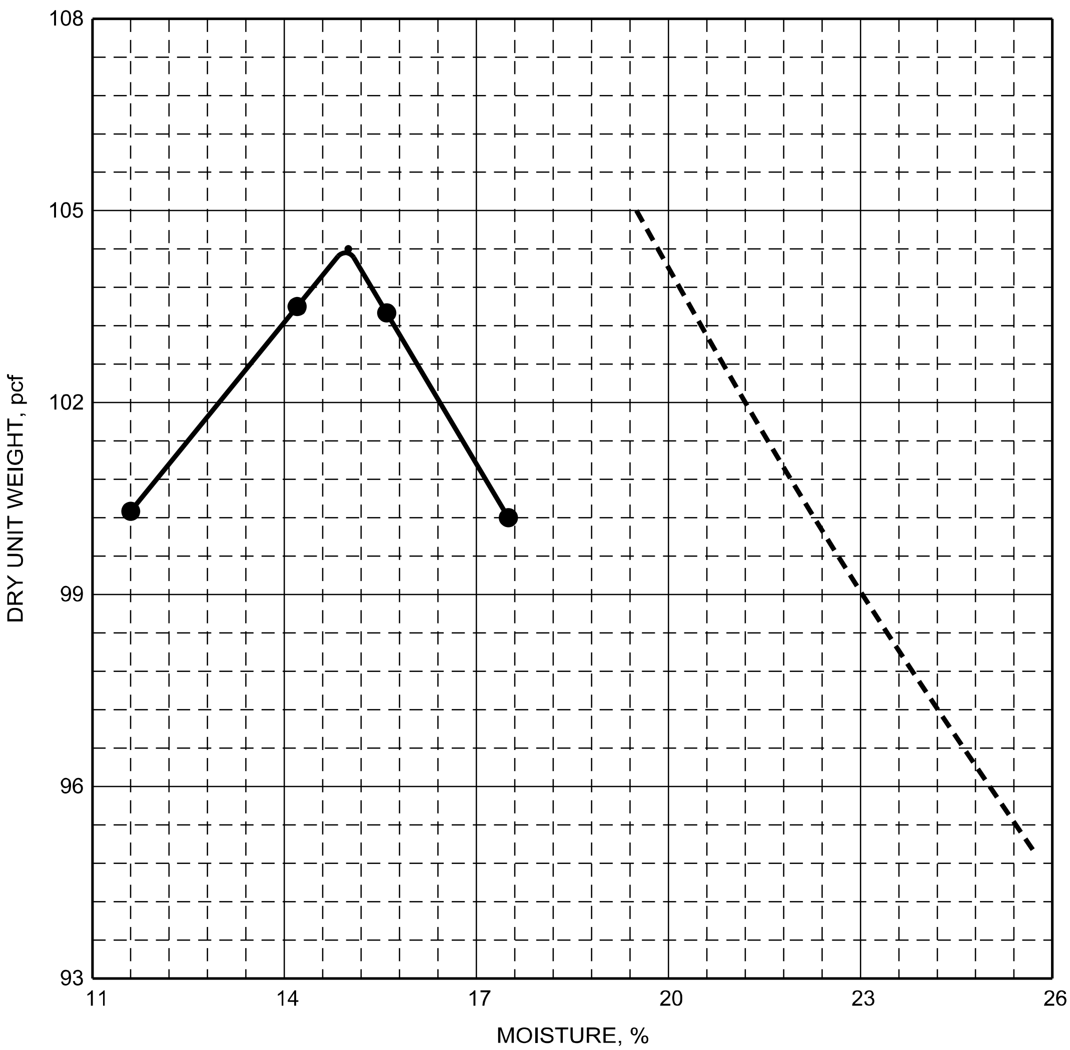
SANTA CLARA WATERSHED EA - DAMMERON VALLEY

Washington County, Utah

MOISTURE-DENSITY RELATION (PROCTOR) ASTM D698

Location	TEST PIT DA3-106 AT 3'-4'	Test Date	10/19/2021
Sample ID	NA	Technician	T. DAY, T. HENDERSON
Material	CLAYEY GRAVEL W/SAND	Classification	GC (Test)



- - 100% Saturation Curve NA Not applicable / available	*UNCORRECTED RESULTS*		*OVERSIZE CORRECTION*	
	Max. Dry Density (pcf)	104.4	Max. Dry Density (pcf)	110.6
Specific gravity type is bulk unless otherwise indicated. Results are as per the test method listed above and relate only to the items tested. Rock correction for >3/4-inch material is per ASTM D4718 or AASHTO T224.	Optimum Moisture (%)	15.0	Optimum Moisture (%)	13.1
	Specific Gravity	2.50	Specific Gravity	2.50
	Moisture, As-Received (%)	11	Percent Oversize (%)	17

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APPENDIX D

Sedimentation Calculations

Santa Clara EA

Sedimentation Calculations - Sediment Yield Classification Procedure

May 2021

Basin	Drainage Basin (mi^2)	Total Rating	Annual Sediment Yield (ac-ft/mi^2)			50-yr Sediment Yield (ac-ft)			Surface Geology		Soils		Climate		Runoff		Topography		Ground Cover		Land Use		Upland Erosion		Channel Erosion
Dammeron 1	0.28	38	0.2	-	0.5	**2.8**	-	**7.1**	3	Hard basalt and limestone, moderatly weathered and fractured	5	Sand and silt with frequent rock fragments	5	Infrequent convective storms, moderate intensity	5	Moderate flows or runoff per unit area	10	Moderate slopes, moderate flood plain development	0	Ground cover less than 40%, noticeable rock fragments	-10	No cultivation, logging, or grazing	10	Rill, gully, or landslide erosion over about 25% of area	10	Occasional channel erosion in bed and banks
Dammeron 2	3.57	38	0.2	-	0.5	**35.7**	-	**89.3**	3	Hard basalt and limestone, moderatly weathered and fractured	5	Sand and silt with frequent rock fragments	5	Infrequent convective storms, moderate intensity	5	Moderate flows or runoff per unit area	10	Moderate slopes, moderate flood plain development	0	Ground cover less than 40%, noticeable rock fragments	-10	No cultivation, logging, or grazing	10	Rill, gully, or landslide erosion over about 25% of area	10	Occasional channel erosion in bed and banks
Dammeron 3	0.73	38	0.2	-	0.5	**7.3**	-	**18.4**	3	Hard basalt and limestone, moderatly weathered and fractured	5	Sand and silt with frequent rock fragments	5	Infrequent convective storms, moderate intensity	5	Moderate flows or runoff per unit area	10	Moderate slopes, moderate flood plain development	0	Ground cover less than 40%, noticeable rock fragments	-10	No cultivation, logging, or grazing	10	Rill, gully, or landslide erosion over about 25% of area	10	Occasional channel erosion in bed and banks
Diamond 1	0.90	38	0.2	-	0.5	**9.0**	-	**22.5**	3	Hard basalt and limestone, moderatly weathered and fractured	5	Sand and silt with frequent rock fragments	5	Infrequent convective storms, moderate intensity	5	Moderate flows or runoff per unit area	10	Moderate slopes, moderate flood plain development	0	Ground cover less than 40%, noticeable rock fragments	-10	No cultivation, logging, or grazing	10	Rill, gully, or landslide erosion over about 25% of area	10	Occasional channel erosion in bed and banks
Diamond 2	0.93	38	0.2	-	0.5	**9.3**	-	**23.3**	3	Hard basalt and limestone, moderatly weathered and fractured	5	Sand and silt with frequent rock fragments	5	Infrequent convective storms, moderate intensity	5	Moderate flows or runoff per unit area	10	Moderate slopes, moderate flood plain development	0	Ground cover less than 40%, noticeable rock fragments	-10	No cultivation, logging, or grazing	10	Rill, gully, or landslide erosion over about 25% of area	10	Occasional channel erosion in bed and banks
Diamond 3	0.60	38	0.2	-	0.5	**6.0**	-	**15.0**	3	Hard basalt and limestone, moderatly weathered and fractured	5	Sand and silt with frequent rock fragments	5	Infrequent convective storms, moderate intensity	5	Moderate flows or runoff per unit area	10	Moderate slopes, moderate flood plain development	0	Ground cover less than 40%, noticeable rock fragments	-10	No cultivation, logging, or grazing	10	Rill, gully, or landslide erosion over about 25% of area	10	Occasional channel erosion in bed and banks

Table 2.9. List of drainage basin characteristics and possible range of numerical ratings (modified from Pacific Southwest Interagency Committee, Water Management Subcommittee, 1968)

Drainage basin characteristics	Sediment yield levels		
	High rating	Moderate rating	Low rating
Surface geology	10: marine shales and related mudstones and siltstones	5: rocks of medium hardness moderately weathered and fractured	0: massive hard formations
Soils	10: fine textured and easily dispersed or single grain salts and fine sands	5: medium textured, occasional rock fragments, or caliche crusted layers	0: frequent rock fragments, aggregated clays, or high organic content
Climate	10: frequent intense convective storms	5: infrequent convective storms, moderate intensity	0: humid climate with low intensity rainfall, arid climate with low intensity rainfall, or arid climate with rare convective storms
Runoff	10: high flows or volume per unit area	5: moderate flows or runoff volume per unit area	0: low flows or volume per unit area or rare runoff events
Topography	20: steep slopes (in excess of 30%), high relief, little or no flood plain development	10: moderate slopes (about 20%), moderate flood plain development	0: gentle slopes (less than 5%), extensive flood plain development
Ground cover	10: ground cover less than 20%, no rock or organic litter in surface soil	0: ground cover less than 40%, noticeable organic litter in surface soil	-10: area completely covered by vegetation, rock fragments, organic litter with little opportunity for rainfall to erode soil
Land use	10: more than 50% cultivated, sparse vegetation, and no rock in surface soil	0: less than 25% cultivated, less than 50% intensively grazed	-10: no cultivation, no recent logging, and only low intensity grazing, if any
Upland erosion	25: rill, gully, or landslide erosion over more than 50% of the area	10: rill, gully, or landslide erosion over about 25% of area	0: no apparent signs of erosion
Channel erosion	25: continuous or frequent bank erosion, or active headcuts and degradation in tributary channels	10: occasional channel erosion of bed or banks	0: wide shallow channels with mild gradients, channels in massive rock, large boulders, or dense vegetation or artificially protected channels

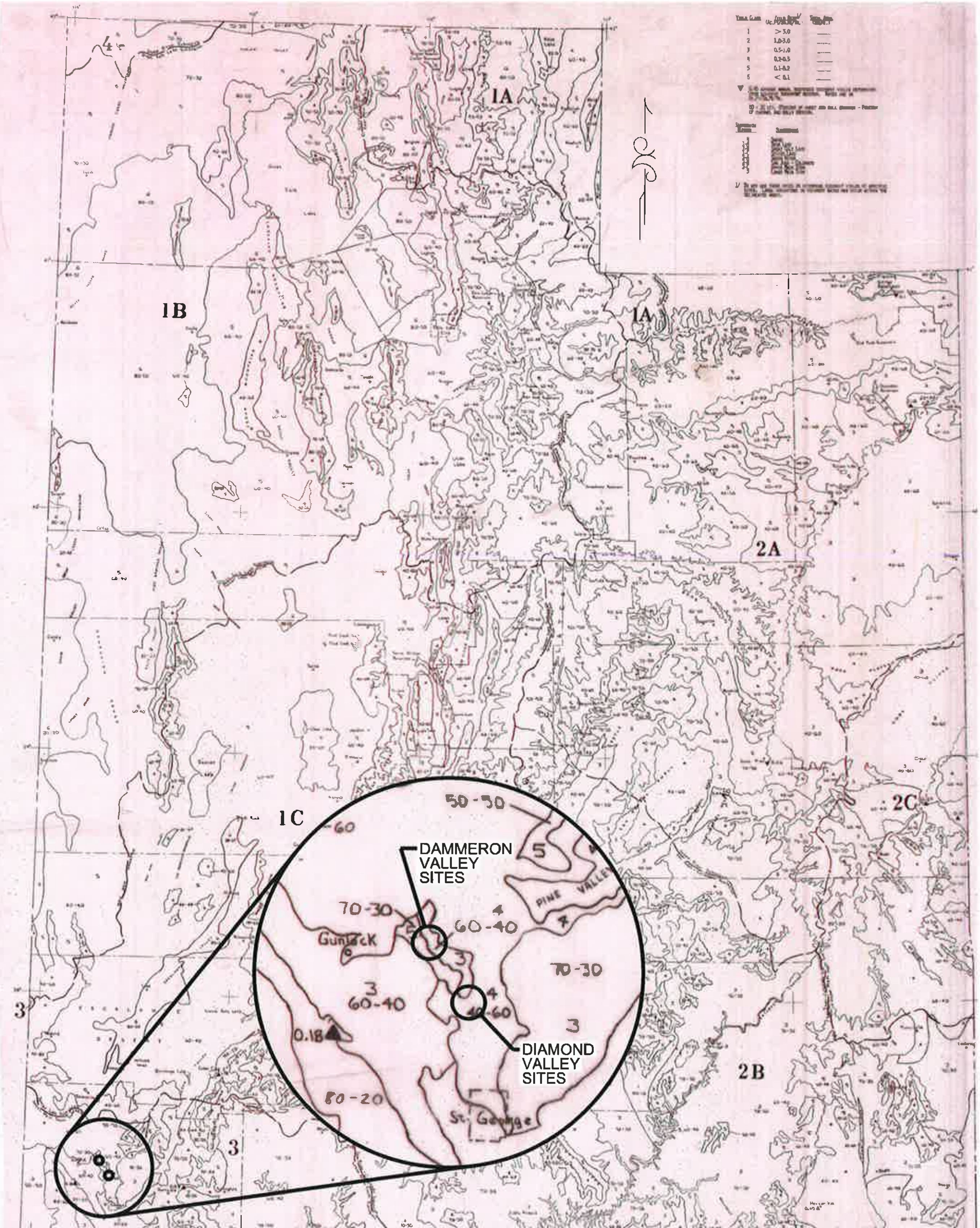
Table 2.10. Drainage basin sediment yield classification (Randle, 1996)

Drainage basin classification number	Total rating	Annual sediment yield (ac-ft/mi^2)
1	> 100	> 3
2	75 to 100	1.0 to 3.0
3	50 to 75	0.5 to 1.0
4	25 to 50	0.2 to 0.5
5	0 to 25	<0.2

Empirical sediment yield as a function of drainage area using Strand and Pemberton (1982) equation for the semiarid climate of the Southwestern United States.

Equation for the southwestern United States Qs=1.84A^-.24

Drainage Basin	Area (mi^2)	Average Annual Sediment	50 Year Sediment Yield (acre-	100 Year Sediment Yield
Dammeron 1	0.28	2.5	35.4	70.8
Dammeron 2	3.57	1.4	242.1	484.2
Dammeron 3	0.73	2.0	72.8	145.5
Diamond 1	0.90	1.9	84.8	169.6
Diamond 2	0.93	1.9	87.3	174.5
Diamond 3	0.60	2.1	62.4	124.8



ESTIMATED SEDIMENT YIELD RATES
FOR THE
STATE OF UTAH

EROSION & SEDIMENTATION -70
WESTERN U.S. WATER PLAN
AUGUST 1973
(SUBJECT TO REVISION)
prepared by
U.S.D.A., Soil Conservation Service

10 5 0 5 10 15
scale in miles

SOURCES OF INFORMATION

1. Great Basin, Upper Colorado and Lower Colorado Regions, Comprehensive Framework Study, Appendices VIII, Watershed Management, June 1971, Pacific Southwest Inter-Agency Committee/Water Resources Council.
2. Utah State Soils Map and soils descriptions.
3. Reservoir surveys by SCS & USGS
4. Suspended load measurements by USGS, USBR & SCS.
5. Watershed studies by SCS.
6. General knowledge of the state from regular SCS program work.

APPENDIX E-8

CULTURAL RESOURCE DOCUMENTS

(November 2015) **BUREAU OF LAND MANAGEMENT**

Summary Report of Cultural Resources Inspection

PROJECT NUMBER: U21TN0316

Report Title: *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase I: Borehole and Test Pit Locations, Washington County, Utah*

1. Report Date: June 2021
2. Date(s) of Survey: May 17–21 and 24–28, 2021
3. Development Company: USDA NRCS
4. Responsible Institution: Transcon Environmental, Inc.
5. Principal Investigator: Lindsey M. Evenson
6. BLM Field Office: St. George Field Office
7. County(ies): Washington County, Utah
8. NEPA Number: *TBD*
9. Fieldwork Location:
   USGS Map: Veyo, Saddle Mountain, and Washington, Utah

Township 40 South	Range 16 West	Sections 8, 9, 16, 17, 21, and 25
Township 41 South	Range 16 West	Sections 1 and 2

10. Description of the Undertaking (including the Area of Potential Effects):
The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiutes Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report encompasses Phase I of the project, which consists of geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Phase II consists of the entire project area, including Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The entirely of the project encompasses approximately 587.82 acres: 296.38 acres in Phase I and 291.44 acres in Phase II. The overall project area of 587.82 is broken down as follows: Dammeron Valley (337.23 acres), Diamond Valley (187.42 acres), and Shivwits (63.17 acres). As previously noted, this report only documents Phase I: Borehole and Test Pit Locations; Phase II: Entire Project is not discussed further in this report.

Phase I of the project crosses lands managed by the Bureau of Land Management (BLM) St. George Field Office, and the State of Utah School and Institutional Trust Lands Administration (SITLA) as well as private lands (see **Table 1**, *Phase 1 Total Survey Area*, for acreage per area and landowner); portions of the project cross within the Utah Department of Transportation (UDOT) highway rights-of-way (ROWs) along State Route (SR)-18 and Old Highway 91. Phase I includes preliminary testing sites (8-inch borehole drilling and 20-foot-square test pits) to determine placement of project components.

The Phase I project area consists of blocks in Dammeron and Diamond valleys in Washington County, Utah. The project areas are located within portions of Dammeron Valley—Township 40 South; Range 16 West; Sections 8, 9, 16, 17, and 21—and Diamond Valley—Township 40 South, Range 16 West, Section 35 and Township 41 South, Range 16 West, Sections 1 and 2 of the Salt Lake Baseline and Meridian. The project crosses the Veyo, Saddle Mountain, and Washington, Utah 7.5-minute U.S. Geological Survey (USGS) topographic quadrangle maps (**Appendix A**, *Project Results Maps*).

The project area of potential effect (APE) for Phase I totals 296.38 acres. Boreholes and test pit areas will be accessed along existing roads that have been cleared of vegetation, where possible, using wheeled and tracked equipment. Borings will be up to 8 inches in diameter, and the disturbed area for test pits will measure approximately 20 square feet. Borings will be backfilled without grout or bentonite and test pits will be backfilled with excavated materials. Construction equipment will likely consist of rotary drill equipment for the boreholes, and test pits may be dug by hand or machine using power excavating equipment such as bulldozers, trenching machines, large-diameter bucket augers, clamshells, and backhoes. The portion(s) of the APE utilized for the Project during construction would be further defined during final project engineering. A total of 296.38 acres were evaluated for cultural resources.

Alpha Engineering Company retained Transcon Environmental, Inc. (Transcon) to support the NRCS project by conducting a cultural resources analysis. The cultural resources survey and this resulting report have been completed as part of that analysis and were conducted in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended. The NRCS served as the lead agency on the project. The survey was conducted under a BLM St. George Field Office fieldwork authorization (FWA) dated May 13, 2021, a SITLA FWA dated May 11, 2021, and a UDOT FWA dated May 11, 2021. A desktop literature review was conducted for the proposed project area on May 3, 2021, and a Class III (intensive pedestrian) cultural resources inventory was conducted in two field sessions from May 17–21, 2021, and May 24–28, 2021, for a total of 20 person-days of fieldwork. Lindsey M. Evenson served as Principal Investigator and report author, Jennifer L. Bannick served as report co-author and co-Field Director, and Brent Larsen served as co-Field Director.

11. Location(s) and Date(s) of Literature Review:

1. Field Office: N/A
2. Utah Division of State History/Sego: May 3, 2021
3. Historic Records and Maps: May 3, 2021
4. Satellite imagery: May 3, 2021

12. Results of Literature Review (½ mile buffer):

On May 3, 2021, prior to the commencement of fieldwork, records on file with the Utah Division of State History were reviewed to determine whether previously identified cultural resources were present or if any previously reported archaeological investigations had been conducted within 0.5 mile of the proposed project alignment (UDSH 2021a). The results of this background research are presented in **Appendix B**, *Results of Literature Review*. The results of this literature review indicate there are a total of 32 previously conducted cultural resource surveys (**Table B-1**) and 43 previously recorded cultural resource sites (**Table B-2**) within 0.5 mile of the project area. Of these, nine previously conducted surveys and four previously identified sites were mapped as overlapping, being immediately adjacent to, or being crossed by some portion of the current project APE.

Previously Conducted Cultural Resource Surveys

Background research identified 33 previously conducted cultural resource surveys within 0.5 mile of the project area (**Appendix B**, *Results of Literature Review*). Of these, ten previously conducted cultural surveys cross into or overlap some portion of the project APE, and only one was conducted within the past 10 years (U20TN0970 - *Cultural Resources Inventory Report, Dominion Energy Utah's Utah Feeder Line 135 Replacement Project, Washington County, Utah* [in progress]). These surveys mapped within or adjacent to the project area are detailed in **Table B-1**, *Previous Cultural Surveys within 0.5 Mile of the Project Area*. No portion of the current project APE was left unsurveyed due to prior survey efforts.

Previously Recorded Cultural Resource Sites

Background research identified 44 previously recorded cultural resources within 0.5 mile of the project area; these previously recorded sites are detailed in **Table B-2**, *Previously Recorded Cultural Resource Sites within 0.5 Mile of the Project Area*. Of these, four were mapped within or adjacent to the Phase I project APE during the literature review. These cultural resources consist of one historic road segment (*Road from St. George to Pine Valley*), two prehistoric lithic scatters, and one prehistoric artifact scatter (sites 42WS2428, 42WS5150, 42WS5151, and 42WS5152, respectively).

Historic Document Review

In addition to the Sego literature review (described above), Transcon consulted a number of historic documents and records, including BLM land records (e.g., historic General Land Office [GLO] records, land patents, mining records, grazing records, Master Title Plat records, etc.), the Utah State Historic Preservation Office's historic contexts, individual BLM field office predictive models (if available) and Class I documents (if available), water rights, Sanborn maps, and Utah Division of Water Rights (UDWR) records (BLM 2021a, 2021b, 2021c, 2021d, 2021e; LOC 2021; UDSH 2021b, 2021c; UDWR 2021). As a result of this historic document review, it was determined that the GLO records, land patents, grazing records, and water rights records yielded historic resources in or very near to the project area (see General Land Office Maps, Land Patent Records, Grazing Allotment Records, and Water Rights Records sections below).

General Land Office Maps

Historic GLO maps and plats of the project area were reviewed and accessed through the BLM website on December 2, 2020 (BLM 2020b). Original cadastral surveys for Township 40 South; Range 15 West; Sections 8, 9, 16, 17, 21, and 35 (1887) and Township 41 South, Range 16 West, Sections 1 and 2 (1887) were perused (BLM 2021a). These historic resources indicate a few historic improvements near the project area, including historic roads (To Pine Valley, Old Road, Wood Road, St. George and Pine Valley Road, Wood Roads, and unnamed), a ditch, a fence, cultivated fields, a reservoir, a transmission line (Telegraph Line), and structures (John Alger, Geo. Edwards, Old Cabin, and unnamed); these historic GLO developments are detailed in **Table B-3**, *Historic GLO Maps*.

Additional historic maps were accessed from both the USGS TopoView topographic map viewer created by the National Geologic Map Database Project and the Utah Geological Survey Aerial Imagery Collection (DNR 2021; USGS 2021a, 2021b, 2021c). Historic aerial imagery in the vicinity of the project (1939, 1950, 1953, 1958) indicates a few visible historic developments, including established roads/highways, cultivated fields, and ranches. Portions of the historic road system are likely the same as (or adjacent to) the present alignments of SR-18 and other roads around Dammeron and Diamond valleys (DNR 2021).

Land Patent Records

Historic land patent records within the project area were also reviewed and accessed through the BLM website on May 3, 2021. These historic resources indicate 14 land patents near the project area with dates ranging from 1892 to 1983. Twelve of these land patents are for parcels located within the project APE: Willard E. Alger (11/12/1913), Samuel L. Carter (6/12/1922), William Carter (7/10/1918 and 6/02/1924), David Chidester (6/22/1899), James F. Cottam (2/14/1922), Esaias Edwards (6/21/1892), Myrza A. Miles (1/24/1921), Utah State (7/16/1894, 7/24/1902, 6/15/1965, 1/10/1966, and 9/30/1983), and George W. Higgins (5/16/1896) (BLM 2021b).

Grazing Allotment Records

Historic grazing allotment records within the project area were also reviewed and accessed through the BLM National Data website on May 3, 2021. This resource indicated two active grazing allotments in or near the project area. One of these allotments, the Veyo Allotment (#14055), encompasses the eastern half and southern portion of the project APE within Dammeron Valley; the Sand Wash Allotment (#04136) borders the southern portion of the project APE within Dammeron Valley, and the Diamond Vall Allotment (#04075) crosses the southeastern portion of the project APE in Diamond Valley. There are no dates associated with this data to indicate if these are historic allotments (BLM 2021e).

Water Rights Records

Historic water rights records within the project area were reviewed and accessed through the UDWR records website on May 3, 2021. These historic resources indicate that there are 20 historic water rights within 0.5 mile of the project APE, including surface and underground water sources originating from Whitaker Well, Alger Canyon Springs, Leo Canyon Springs, Wide Canyon Stream, and various unnamed springs and underground wells. None of these are directly within the project APE (UDWR 2021).

Summary and Expectations

Based on the results of the record search, it was anticipated that four previous sites may be located within or immediately adjacent to the project APE; however, it was understood that some of those sites' previous recordings are within a growing rural community and, as a result, may not be relocated in the project APE.

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13. Description of Field Methods:

The survey was conducted in 15-meter-wide transects (blocks in Dammeron and Diamond valleys) throughout the entire project APE. This resulted in a total of approximately 296.38 acres evaluated for cultural resources (**Table 1**, *Total Survey Area*). No portion of the project APE was left unsurveyed due to prior survey efforts.

Isolated occurrence (IO) locations were documented during the survey. Previously identified cultural resource sites identified during the survey had locations noted, revisited, and recorded/updated after the survey was conducted for a more thorough review and to update site documentation, as necessary. These sites and IOs are discussed below in **Table 2**, *Total Sites Recorded*, and **Table 3**, *Newly Identified Isolated Occurrences within the Project APE*. The *Cultural Resource Fieldwork Guidelines and Standards BLM Supplement H-8110—Utah—May 2020* and the *Utah State Historic Preservation Office & Antiquities Section Archaeological Compliance Guidance—June 2020* were adhered to at all times during fieldwork (BLM 2021f; UDSH 2021a).

14. Area Surveyed:
Table 1, below, indicates the total acreage per landowner surveyed to Class III standards within the Phase I project area.

TABLE 1 PHASE I TOTAL SURVEY AREA				
Acreage	**BLM**	**SITLA**	**Private**	**TOTAL**
Dammeron Valley Phase I Acreage	144.47	24.08	45.39	213.94
Diamond Valley Phase I Acreage	12.72	7.88	61.84	82.44
TOTAL Phase I Acreage	**157.19**	**31.96**	**107.23**	**296.38**

15. Sites Recorded:
Of the four previously recorded sites mapped within the project APE, four sites were relocated and evaluated during the Class III inventory (**Table 2**). Updated Utah Archaeology Site Forms have been prepared for all four sites.

<table>
<tr><th colspan="9">TABLE 2
TOTAL SITES RECORDED*</th></tr>
<tr><th colspan="2"></th><th colspan="2">BLM</th><th colspan="2">STATE</th><th colspan="2">PRIVATE</th><th>TOTAL</th></tr>
<tr><th colspan="2"></th><th>#</th><th>Site No.</th><th>#</th><th>Site No.</th><th>#</th><th>Site No.</th><th></th></tr>
<tr><td rowspan="2">Revisits
Updated</td><td>Eligible</td><td>1</td><td>42WS2428*</td><td>0</td><td></td><td>0</td><td></td><td>1</td></tr>
<tr><td>Not Eligible</td><td>0</td><td></td><td>1</td><td>42WS5150</td><td>1</td><td>42WS5151,
42WS5152</td><td>3</td></tr>
<tr><td rowspan="2">Revisits
Not Updated</td><td>Eligible</td><td>0</td><td></td><td>0</td><td></td><td>0</td><td></td><td>0</td></tr>
<tr><td>Not Eligible</td><td>0</td><td></td><td>0</td><td></td><td>0</td><td></td><td>0</td></tr>
<tr><td rowspan="2">Newly
Recorded</td><td>Eligible</td><td>0</td><td></td><td>0</td><td></td><td>0</td><td></td><td>0</td></tr>
<tr><td>Not Eligible</td><td>0</td><td></td><td>0</td><td></td><td>0</td><td></td><td>0</td></tr>
<tr><td>TOTAL</td><td></td><td>1</td><td></td><td>1</td><td></td><td>2</td><td></td><td>4</td></tr>
<tr><td colspan="9">*Note: site 42WS2428 is located within the jurisdiction indicated as well as on SITLA-managed land and private property.</td></tr>
</table>

16. Individual Site Descriptions and Determinations of Eligibility and Effect:
Transcon assessed four previously recorded sites during the Class III inventory (**Appendix C**, *Cultural Resource Sites Within the Project APE*). One of these sites (42WS2428) is recommended to be Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant regional events. The remaining three sites (42WS5150, 42WS5151, 42WS5152) are recommended Not Eligible for NRHP listing under any Criteria. Additionally, Transcon recommends that site 42WS5152 is no longer an archaeological site as it has been destroyed by the construction of Homestead Drive. Transcon has prepared updated site forms for all four sites reflecting the 2021 revisit.

17. Isolated Occurrences:
A total of three IOs were identified and recorded within the project APE during the Class III inventory (**Appendix A**, *Project Results Maps*). These IOs are detailed in **Table 3**, *Newly Identified Isolated Occurrences Within the Project APE*, and shown in **Figures 1–3**, below. None of these IOs are recommended Eligible for listing on the NRHP under any Criteria.

<table>
<tr><th colspan="7">TABLE 3
NEWLY IDENTIFIED ISOLATED OCCURRENCES WITHIN THE PROJECT APE*</th></tr>
<tr><th>IO No.</th><th>Temporal Affiliation</th><th>Description</th><th>UTM—E</th><th>UTM—N</th><th>Figure</th><th>Map Panel</th></tr>
<tr><td>IO-01</td><td>Prehistoric</td><td>Four quartzite flakes</td><td></td><td></td><td>1</td><td>1</td></tr>
<tr><td>IO-02</td><td>Historic</td><td>Water diversion valve</td><td></td><td></td><td>2</td><td>2</td></tr>
<tr><td>IO-03</td><td>Historic</td><td>Culvert</td><td></td><td></td><td>3</td><td>2</td></tr>
<tr><td colspan="7">*Note: UTM coordinates are provided in NAD'83 Zone 12; "UTM—E" represents the Easting and "UTM—N" represents the Northing.</td></tr>
</table>

18. Summary of Findings:
As a result of the Class III inventory, it was determined that a total of four previously identified cultural resource sites are located within or crossed by the project APE (42WS2428, 42WS5150, 42WS5151, and 42WS5152). Updated Utah Archaeology Site Forms have been prepared for all four sites mapped within the project APE; however, Transcon recommends that 42WS5152 is no longer an archaeological site. No new cultural resource sites were identified as a result of this survey; however, a total of three IOs were identified and recorded within the APE. Modern debris was also noted but not recorded at various places within the project area, as it appears to have originated from modern recreational visitation.

Survey conditions were good, consisting of sunny to clouded or partially clouded skies and hot temperatures. For most of the survey, ground visibility was good to excellent, ranging between 60 and 80 percent or greater (**Figures 4** and **5**). Of the four cultural resource sites identified within the Project APE, one site is recommended Eligible for listing on the NRHP under Criterion A (42WS2428); the remaining three sites (42WS5150, 42WS5151, and 42WS5152 [recommended to no longer be considered an archaeological site]) and all three IOs are recommended Not Eligible for NRHP listing under any Criteria.

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19. Collection Yes___ No _X_

(If Yes) Curation Facility: N/A Accession Number(s): N/A

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20. Conclusion/Recommendation of Effect:
Transcon archaeologists conducted a Class III cultural resources inventory of 296.38 acres of BLM St. George Field Office-managed, SITLA-managed, and privately owned lands in Dammeron and Diamond valleys in Washington County, Utah. This investigation was requested by Alpha Engineering Company in support of an NRCS project to determine if any significant cultural resources which could be affected by the proposed undertaking were present within the project area.

As a result of the survey, it was determined that a total of four cultural resource sites are located within the project APE (see **Appendix C**, *Cultural Resource Sites Within the Project APE*, for details). Of these four sites, one (42WS2428) is recommended Eligible for listing on the NRHP under Criterion A for its association with significant historic events, and the remaining three sites (42WS5150, 42WS5151, and 42WS5152) and all three IOs are recommended Not Eligible for the NRHP under any Criteria. Additionally, 42WS5151 is recommended to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property.

Transcon recommends that the project will result in *No Adverse Effects to Historic Properties.* At the only Eligible site location within the project APE (42WS2428), the alignment of the historic road has been heavily disturbed/destroyed and almost entirely reclaimed by vegetation in one crossing; it has lost all historic format in another crossing, and all elements of the segment are non-contributing to the overall eligibility of the site within the Project APE (**Table 4**, *Project Summary and Conclusions*).

TABLE 4
PROJECT SUMMARY AND CONCLUSIONS

Site No.	Temporal Affiliation	Site Description	Eligibility	Effects	Site Protective or Avoidance Measures
42WS2428	Historic	Historic road (*Road from St. George to Pine Valley*)	Eligible—A, *non-contributing*	*No Adverse Effect*	None; non-contributing segment
42WS5150	Prehistoric	Prehistoric lithic scatter	Not Eligible	No effect	N/A
42WS5151	Prehistoric	Prehistoric lithic scatter	Not Eligible	No effect	N/A
42WS5152	Prehistoric	Prehistoric artifact scatter	Not Eligible	No effect	N/A

If any previously undetected or unreported cultural features or deposits are encountered during future project-related activities, these activities must be discontinued in the immediate area of the feature(s), and a BLM archaeologist (or SITLA archaeologist, where appropriate) must be consulted to evaluate their nature and significance.

References:

Bureau of Land Management (BLM)

2021a “Cadastral Surveys and Plats” Land Records, Bureau of Land Management, Utah. Accessed May 3, 2021, at https://www.ut.blm.gov/LandRecords/search_plats.cfm.

2021b “Land Patent Records” Land Records, Bureau of Land Management, Utah. Accessed May 3, 2021, at https://glorecords.blm.gov/search/default.aspx.

2021c “Mineral Survey Records” Land Records, Bureau of Land Management, Utah. Accessed May 3, 2021, at https://www.ut.blm.gov/LandRecords/special_surveys.cfm#special_results.

2021d “Master Title Plat Maps” Land Records, Bureau of Land Management, Utah. Accessed May 3, 2021, at https://glorecords.blm.gov/search/default.aspx.

2021e “Grazing Allotments” National Data, Bureau of Land Management, Utah. Accessed May 3, 2021, at https://blm-egis.maps.arcgis.com/apps/webappviewer/index.html?id=6f0da4c7931440a8a80bfe20eddd7550.

2021f Cultural Resource Fieldwork Guidelines and Standards BLM Supplement H-8110—Utah. Accessed May 3, 2021, at https://www.blm.gov/sites/blm.gov/files/Cultural%20Resource%20Fieldwork%20Guidelines%20and%20Standards.pdf.

Library of Congress

2021 “Sanborn Fire Insurance Maps” Sanborn Maps Collection, Library of Congress. Accessed May 3, 2021, at https://www.loc.gov/collections/sanborn-maps/index/location/?q=Utah.

United States Geological Survey (USGS)

2021a Veyo 7.5-Minute topographic map. Accessed May 3, 2021, at https://ngmdb.usgs.gov/topoview/viewer/#13/37.2971/-113.6607.

2021b Saddle Mountain 7.5-Minute topographic map. Accessed May 3, 2021, at https://ngmdb.usgs.gov/topoview/viewer/#13/37.2642/-113.6794.

2021c Washington 7.5-Minute topographic map. Accessed May 3, 2021, at https://ngmdb.usgs.gov/topoview/viewer/#13/37.2143/-113.6133.

Utah Division of Natural Resources (DNR)

2021 UGS Aerial Imagery Collection. Accessed on May 3, 2021, at https://geodata.geology.utah.gov/imagery/.

Utah Division of State History (UDSH)

2021a Archaeological Compliance Guidance. Utah State Historic Preservation Office & Antiquities Section. Accessed May 3, 2021, at https://drive.google.com/file/d/1_e2QLxR2pLUBns2l2GyDbomzJeWTH_Wu/view.

2021b Historic Contexts. Utah Department of Heritage and Arts, Utah Division of State History. Accessed May 3, 2021, at https://drive.google.com/drive/u/0/folders/1f29mMHZF5NZuuz8ar8WkHEMu0oKDiW6R.

2021c Sego. Utah Department of Heritage and Arts, Utah Division of State History. Accessed May 3, 2021, at https://shpo.utah.gov/portal/apps/webappviewer/index.html?id=8d1c8337d050431080f7dce538f7677c.

Utah Division of Water Resources (UDWR)

2021 “Water Right Areas” Utah Division of Water Rights Database. Accessed May 3, 2021, at https://maps.waterrights.utah.gov/EsriMap/map.asp.

*Include the appropriate amount of 1:24,000 scale topographic maps, which clearly identify the APE, area of Class II or III survey area, sites, and isolated finds.
**Include at least one landscape photograph of the area surveyed.
8100-3 Form

Figure 4. Overview of the block survey area in Dammeron Valley. View to the north.

Figure 5. Project overview showing the eastern block survey area over the borehole locations in Diamond Valley. View to the northwest.

APPENDIX A

PROJECT RESULTS MAPS

APPENDIX B

RESULTS OF LITERATURE REVIEW

TABLE B-1 PREVIOUS CULTURAL SURVEYS WITHIN 0.5 MILE OF THE PROJECT AREA						
Survey No.	**Survey Name**	**Organization**	**Date**	**In/Out***	**Project Area****	**Phase*****
U82BL0146	Pipeline ROW	BLM	1982	Out	Study Area	N/A
U82BL0151	Buhler Power and Pipeline	BLM	1982	Out	Study Area	N/A
U86BC0383	An Archaeological Inventory of the Proposed Red Butte to Middleton 138 kV Power Line in Washington County, Utah	Brigham Young University	1986	Out	Study Area	N/A
U86BL0560	Road ROW Vicinity of Dammeron Valley	BLM	1986	Out	Study Area	N/A
U86NP0409	A Cultural Resource Inventory of the Dammeron Valley Powerline Extension, Washington County, Utah	A.K. Nielson Associates	1986	In	Dammeron Valley	Phase I, Phase II
U89PD0087	Cultural Resource Inventory of SR-18, Snow Canyon to Veyo, From Milepost 12.67 to Milepost 19.8, Washington County, Utah	P-III Associates, Inc. (P-III)	1989	In	Dammeron Valley	Phase I, Phase II
U91NP0299	An Archaeological Inventory of the Proposed UAMPS Central Substation to St. George Substation Access, Equipment Stations and Wire Set-up Locations, Washington County, Utah	A.K. Nielson Associates	1991	Out	Study Area	N/A
U92NP0658	UP&L Dammeron Valley Distribution	A.K. Nielson Associates	1992	In	Dammeron Valley	Phase I, Phase II
U93NP0713	UP&L Dammeron Valley Distribution	A.K. Nielson Associates	1993	Out	Study Area	N/A
U94BL0491	Diamond Valley Fence	BLM	1994	In	Dammeron Valley	Phase I, Phase II
U95BL0756	Chuck Buhler Road	BLM	1995	Out	Study Area	N/A
U95IG0312	An Archaeological Survey of the Diamond Valley Gravel Pit, Washington County, Utah	Intersearch, Inc.	1995	Out	Study Area	N/A
U96JB0202	A Cultural Resource Inventory of the Dammeron Valley—Sand Cove Utah Power Replacement Powerline near Veyo, Utah	JBR Environmental Consultants, Inc.	1996	Out	Study Area	N/A
U01EP0270	A Cultural Resource Inventory of 4 Segments of 69kV Power Lines from Dammeron to Ivins, Washington County, Utah	EarthTouch LLC	2001	Out	Study Area	N/A
U02BL0312	Diamond Valley Exchange	BLM	2002	Out	Study Area	N/A
U03BL0609	Diamond Valley—Red Cliffs Reserve Trailhead Parking	BLM	2003	Out	Study Area	N/A

TABLE B-1 PREVIOUS CULTURAL SURVEYS WITHIN 0.5 MILE OF THE PROJECT AREA						
Survey No.	**Survey Name**	**Organization**	**Date**	**In/Out***	**Project Area****	**Phase*****
U04BS0282	A Cultural Resources Inventory of the Proposed Red Butte to St. George Transmission Line Upgrade in Washington County, Utah	Baseline Data, Inc.	2004	Out	Study Area	N/A
U06HQ0775	An Archaeological Survey of Three Fire Break Lines in Dammeron Valley, Washington County, Utah	HRA, Inc.	2006	In	Dammeron Valley	Phase I, Phase II
U06MX0031	An Archaeological Inventory of the Canyon Trails Easement, Dammeron Valley, Phase 2	McFadden Archaeological Consulting	2006	Out	Study Area	N/A
U08ES0816	Cultural Resources Inventory of the Dammeron and Central Fuels Project Areas North of St. George, Washington County, Utah	EnviroSystems Management, Inc.	2008	In	Dammeron Valley	Phase I, Phase II
U08HO0786	Results of Testing & Data Recovery for the Red Butte to St. George Transmission Line Upgrade, Washington County, Utah	Bighorn Archaeological Consultants, LLC (Bighorn)	2008	Out	Study Area	N/A
U08HQ1022	An Archaeological Survey of Approximately 560 Acres in Three Parcels within the Dammeron Valley, Washington County, Utah	HRA, Inc.	2008	In	Dammeron Valley	Phase I, Phase II
U09HO0364	A Cultural Resource Inventory of the Red Butte to St. George Transmission Line Upgrade Access Roads, Washington County, Utah	Bighorn	2009	Out	Study Area	N/A
U10IG0862	Tower Engineering—Dammeron Valley Tower Site Survey	Intersearch, Inc.	2010	Out	Study Area	N/A
U10LI0939	St. George Travel Management Plan	Logan Simpson	2010	In	Dammeron Valley	Phase I, Phase II
U10ST0248	Utah Education Network Btop Surveys	SWCA Environmental Consultants	2010	In	Diamond Valley	Phase I, Phase II
U11BL0843	Diamond Valley ESR CRI	BLM	2011	Out	Study Area	N/A
U16HQ0389	Data Recovery at Four Prehistoric Sites in the Dammeron Valley Residential Development, Washington County, Utah	HRA, Inc.	2016	Out	Study Area	N/A
U17BL0939	Lava Ridge Trailhead Improvement	BLM	2017	Out	Study Area	N/A

TABLE B-1 PREVIOUS CULTURAL SURVEYS WITHIN 0.5 MILE OF THE PROJECT AREA						
Survey No.	**Survey Name**	**Organization**	**Date**	**In/Out***	**Project Area****	**Phase*****
U17SH0627	Cultural Resources Inventory in Support of an Environmental Quality Incentives Program Brush Management Project on Shivwits Band of Paiutes Land, Washington County, Utah	NRCS	2017	Out	Study Area	N/A
U17UT0379	SR-18; Diamond Valley Intersection Improvements Cultural Resources Survey	UDOT	2017	Out	Study Area	N/A
U19TN0509	Cultural Resources Inventory Report, Lloyd Graff LTD's Graff Road Project, Washington County, Utah	Transcon	2019	Out	Study Area	N/A
U20TN0970	Cultural Resources Inventory Report, Dominion Energy Utah's Utah Feeder Line 135 Replacement Project, Washington County, Utah (in progress)	Transcon	2021	In	Dammeron Valley	Phase I, Phase II

*Note: "In" is a project crossing or overlapping some portion of the APE (also blue text); "Out" is a project mapped outside the APE.
**Note: There are three project areas: Dammeron Valley, Diamond Valley, and Shivwits; anything within the 0.5-mile study area but outside the three APE project areas is referenced as "Study Area."
***Note: There are two project phases: Phase I: Borehole and Test Pit Locations and Phase II: Entire Project.

TABLE B-2 PREVIOUSLY IDENTIFIED CULTURAL RESOURCE SITES WITHIN 0.5 MILE OF THE PROJECT AREA					
Site No.	**Description**	**Eligibility**	**In/Out***	**Project Area ****	**Phase *****
42WS0531	Prehistoric lithic scatter	*Unevaluated*	Out	Study Area	N/A
42WS0532	Prehistoric lithic scatter	*Unevaluated*	Out	Study Area	N/A
42WS0533	Prehistoric lithic scatter	*Unevaluated*	Out	Study Area	N/A
42WS0534	Prehistoric lithic scatter	*Unevaluated*	Out	Study Area	N/A
42WS0535	Prehistoric campsite	*Unevaluated*	Out	Study Area	N/A
42WS0536	Prehistoric lithic scatter	*Unevaluated*	Out	Study Area	N/A
42WS0537	Prehistoric lithic scatter	*Unevaluated*	Out	Study Area	N/A
42WS0538	Prehistoric lithic scatter	*Unevaluated*	Out	Study Area	N/A
42WS0539	Prehistoric campsite	*Unevaluated*	Out	Study Area	N/A
42WS0540	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A

TABLE B-2
PREVIOUSLY IDENTIFIED CULTURAL RESOURCE SITES
WITHIN 0.5 MILE OF THE PROJECT AREA

Site No.	Description	Eligibility	In/Out*	Project Area **	Phase ***
42WS0541	Prehistoric campsite	Determined Eligible	Out	Study Area	N/A
42WS0544	Prehistoric lithic scatter	*Unevaluated*	Out	Study Area	N/A
42WS1553	Prehistoric lithic scatter and rock alignment	Determined Not Eligible	Out	Study Area	N/A
42WS1554	Prehistoric lithic scatter with fossil exposure	Determined Eligible	Out	Study Area	N/A
42WS1555	Prehistoric lithic scatter and rock alignment	Determined Not Eligible	Out	Study Area	N/A
42WS1556	Historic isolated structures	Determined Not Eligible	Out	Study Area	N/A
42WS2203	Prehistoric campsite	Determined Eligible	Out	Study Area	N/A
42WS2206	Prehistoric campsite	Recommended Eligible	Out	Study Area	N/A
42WS2425	Prehistoric lithic scatter	Recommended Not Eligible	Out	Study Area	N/A
42WS2428	Historic road *(Road from St. George to Pine Valley)*	Recommended Eligible	In	Diamond Valley	Phase I, Phase II
42WS2761	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS2762	Prehistoric lithic scatter and rock alignment	Determined Eligible	Out	Study Area	N/A
42WS3124	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS4174	Prehistoric campsite	Recommended Eligible	Out	Study Area	N/A
42WS4175	Prehistoric campsite	Recommended Eligible	Out	Study Area	N/A
42WS4311	Prehistoric Paiute campsite	Determined Eligible	Out	Study Area	N/A
42WS4824	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS5126	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS5127	Prehistoric lithic scatter	Recommended Eligible	Out	Study Area	N/A
42WS5128	Prehistoric lithic scatter	Determined Eligible	Out	Study Area	N/A
42WS5145	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS5146	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS5147	Prehistoric artifact scatter	Determined Not Eligible	Out	Study Area	N/A
42WS5149	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS5150	Prehistoric lithic scatter	Determined Not Eligible	In	Dammeron Valley	Phase I, Phase II
42WS5151	Prehistoric lithic scatter	Determined Not Eligible	In	Dammeron Valley	Phase I
42WS5152	Prehistoric artifact scatter	Determined Not Eligible	In	Dammeron Valley	Phase I
42WS5153	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS5155	Historic artifact scatter	Determined Not Eligible	Out	Study Area	N/A
42WS5269	Prehistoric campsite	Recommended Eligible	Out	Study Area	N/A

TABLE B-2 PREVIOUSLY IDENTIFIED CULTURAL RESOURCE SITES WITHIN 0.5 MILE OF THE PROJECT AREA					
Site No.	**Description**	**Eligibility**	**In/Out***	**Project Area ****	**Phase *****
42WS5525	Multicomponent: Prehistoric and historic artifact scatter with features	Determined Not Eligible	Out	Study Area	N/A
42WS5526	Multicomponent: Prehistoric and historic artifact scatter with features	Determined Eligible	Out	Study Area	N/A
42WS5715	Prehistoric campsite	Recommended Eligible	Out	Study Area	N/A
42WS6498	Historic artifact scatter (in progress)	Recommended Not Eligible	Out	Study Area	N/A
*Note: "In" is a site mapped within or crossed by some portion of the APE (also blue text); "Out" is a site mapped outside the APE. **Note: There are three project areas: Dammeron Valley, Diamond Valley, and Shivwits; anything within the 0.5-mile study area but outside the three APE project areas is referenced as "Study Area." ***Note: There are two project phases: Phase I: Borehole and Test Pit Locations and Phase II: Entire Project.					

TABLE B-3 HISTORIC GENERAL LAND OFFICE MAPS				
Date	**Township**	**Range**	**Historic Features near the Project Area**	**Project Area***
1877	40 South	16 West	Roads (*To Pine Valley, Old Road*, and unnamed)	Dammeron Valley
1877	40 South	16 West	Roads (unnamed), reservoir, cultivated fields, and structures (*John Alger, Geo. Edwards,* and *Old Cabin*)	Diamond Valley
1877	41 South	16 West	Roads (*Wood Road, St. George and Pine Valley Road, Wood Roads,* and unnamed), transmission line (*Telegraph Line*), cultivated field, fence, and ditch	Diamond Valley
*Note: There are three project areas: Dammeron Valley, Diamond Valley, and Shivwits.				

APPENDIX C

CULTURAL RESOURCE SITES WITHIN THE PROJECT APE

TABLE C-1 CULTURAL RESOURCE SITES WITHIN THE PROJECT APE						
Site Number	**Site Name**	**Land Owner**	**Site Description**	**Eligibility Recommendation**	**Effects**	**Protective or Avoidance Measures**
42WS2428	*Road from St. George to Pine Valley*	BLM, Private, SITLA	Site 42WS2428 is the historic *Road from St. George to Pine Valley*. The site was originally recorded in 1989 by P-III and later revisited and re-evaluated on various occasions in 1994, 1996, 2004, 2006, 2008, and twice in 2021; various segments of the site have been recommended or determined to be Not Eligible, and others have been recommended or determined to be Eligible under Criterion A. Transcon archaeologists revisited two crossings of Segment M of the historic road within the current project APE in 2021 and noted that the northern portion (**Surveyed Area 1**) of the road segment within the APE appears to be in use as a frontage road and looks like a modern two track; it is non-contributing to the overall eligibility of the site as it has lost all historic format. The southern crossing of Segment M (**Surveyed Area 2**) is in very poor condition, has been reclaimed by vegetation for the most part, and is presumed to be in the previously plotted location by evidence of some incised areas and a change in vegetation along the alignment. Transcon concurs with the previous site eligibility determination and recommends site 42WS2428 is Eligible for listing on the NRHP under Criterion A because the site is associated with historically important events of transportation and settlement between Pine Valley and St. George; however, Transcon recommends the portion of Segment M revisited in 2021 is non-contributing to the overall integrity and eligibility of the site.	Eligible—A; non-contributing	*No Adverse Effects*	None; non-contributing segment.
42WS5150		SITLA	Site 41WS5150 is a prehistoric lithic scatter. The site was originally recorded by HRA, Inc. in 2008 and was determined Not Eligible for the NRHP under any Criteria. When revisited in 2021, Transcon archaeologists observed the site to be in similar condition to the 2008 recording with a diffuse scatter of lithic debris (approximately 50 flakes) within the site area consisting primarily of gray quartzite tertiary flakes with some white chert tertiary flakes. Transcon archaeologists relocated and documented previously recorded AC-01; however, previously recorded AC-02 and the previously recorded lithic tools were not relocated. There is some displacement of artifacts by erosion and obscurement of the site area by selective bullhogging, and the site has been impacted by a dirt road that bisects the site. Formerly documented diagnostic artifacts have likely been collected, as the site is close to a developing residential neighborhood and sees frequent visitation. Transcon concurs with the previous site eligibility determination and recommends site 42WS5150 is Not Eligible for listing on the NRHP under any Criteria.	Not Eligible	No Effects	N/A

TABLE C-1
CULTURAL RESOURCE SITES WITHIN THE PROJECT APE

Site Number	Site Name	Land Owner	Site Description	Eligibility Recommendation	Effects	Protective or Avoidance Measures
42WS5151		Private	Site 41WS5151 is a prehistoric lithic scatter. The site was originally recorded by HRA, Inc. in 2008 and was determined Not Eligible for the NRHP under any Criteria. When revisited in 2021, Transcon archaeologists observed a very small amount of lithic debitage, 5 total pieces (4 light gray quartzite flakes and 1 white chert tertiary flake), which is far less than the previously recorded 20 flakes. Additionally, the previously noted lithic tools were not relocated. There appears to be displacement of artifacts by erosion, and some areas of the site have been selectively bullhogged. The site is adjacent to a residential property, and the diagnostic artifacts have likely been collected. Transcon concurs with the previous site eligibility determination and recommends site 42WS5151 is Not Eligible for listing on the NRHP under any Criteria.	Not Eligible	No Effects	N/A
42WS5152		Private	Site 41WS5152 was a prehistoric artifact scatter. The site was originally recorded by HRA, Inc. in 2008 and was determined Not Eligible for the NRHP under any Criteria. When revisited in 2021, Transcon archaeologists observed that a road (Homestead Drive) has been constructed through the site and that selective bullhogging has been conducted within the site area. Transcon archaeologists were unable to relocate the previously documented lithic flake assemblage, any ceramics, or any of the documented diagnostic tools. Only a single quartzite tertiary flake was relocated within the site area. Transcon concurs with the previous site eligibility determination and recommends site 42WS5152 is Not Eligible for listing on the NRHP under any Criteria. Additionally, Transcon recommends 42WS5152 no longer be considered an archaeological site as it has been destroyed by the construction of Homestead Drive.	Not Eligible	No Effects	N/A; recommended destroyed (no longer an archaeological site).

(November 2015) **BUREAU OF LAND MANAGEMENT**

Summary Report of Cultural Resources Inspection

PROJECT NUMBER: U21TN0317

Report Title: Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase II: Entire Project, Washington County, Utah

1. Report Date: August 2022
2. Date(s) of Survey: May 17–21 and 24–28, 2021
3. Development Company: USDA NRCS
4. Responsible Institution: Transcon Environmental, Inc.
5. Principal Investigator: Lindsey M. Evenson
6. BLM Field Office: St. George Field Office
7. County(ies): Washington County, Utah
8. NEPA Number: *TBD*
9. Fieldwork Location:
USGS Map: Veyo, Saddle Mountain, Washington, and Shivwits Utah

Township 40 South	Range 16 West	Sections 8, 9, 16, 17, 21, and 35
Township 41 South	Range 16 West	Sections 1 and 2
Township 41 South	Range 17 West	Sections 28 and 33

10. Description of the Undertaking (including the Area of Potential Effects):
The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) is proposing to develop and authorize the Santa Clara Watershed Plan-EA. The proposed watershed area totals approximately 243,000 acres and encompasses the rural, unincorporated communities of Dammeron Valley and Diamond Valley; the Plan would also involve stream restoration, irrigation, and riparian restoration to benefit the endangered southwestern willow flycatcher within the Shivwits Band of Paiute Indians (Shivwits) Reservation. Specific proposed flood control measures within Dammeron and Diamond valleys include channel routing and small flood and sediment control basins of less than 12,500 acre-feet individual structure capacity and 25,000 acre-feet total capacity. This report presents Phase II of the project (Entire Project), which includes the completed Phase I geotechnical and borehole test pit locations within Dammeron and Diamond Valleys (Utah Antiquities Project No. U21TN0316). Phase II consists of the entire project area, including Diamond and Dammeron Valleys, the Shivwits portion, and the Phase I geotechnical testing (Utah Antiquities Project No. U21TN0317). The entirety of the project encompasses approximately 587.82 acres, including 296.38 acres that was previously surveyed in Phase I, and 291.44 acres of new survey in Phase II. The entire project area (Phase I and Phase II) encompasses 587.82 acres includes the following areas: Dammeron Valley (337.23 acres), Diamond Valley (187.42 acres), and Shivwits (63.17 acres).

The previously completed survey for Phase I of the project included preliminary testing sites (8-inch borehole drilling and 20-square-foot test pits) to determine placement of project components, and both Phases cross lands managed by the Bureau of Land Management (BLM) St. George Field Office, and the State of Utah School and Institutional Trust Lands Administration (SITLA) as well as private lands; additionally, Phase II crosses Shivwits Reservation tribal lands (see **Table 1**, *Total Survey Area*, for acreage per project phase, area, and landowner). Portions of the project also cross within the Utah Department of Transportation (UDOT) highway rights-of-way (ROWs) along State Route (SR)-18 and Old Highway 91.

The Phase II project area encompasses the previously completed survey area for Phase I and consists of survey area in Dammeron and Diamond valleys, as well as Shivwits Reservation tribal land in Washington County, Utah. The project areas are located within portions of Dammeron Valley—Township 40 South; Range 16 West; Sections 8, 9, 16, 17, 21, and 21; Diamond Valley—Township 40 South, Range 16 West, Section 35 and Township 41 South, Range 16 West, Sections 1 and 2; and Shivwits—Township 41 South, Range 17 West, Sections 28 and 33 and of the Salt Lake Baseline and Meridian. The project crosses the Veyo, Saddle Mountain, Washington, and Shivwits, Utah 7.5-minute U.S. Geological Survey (USGS) topographic quadrangle maps (**Appendix A**, *Project Results Maps*).

The project area of potential effect (APE) for Phase II totals 587.82 acres (296.38 previously surveyed acres and 291.44 acres of new survey). Boreholes and test pit areas will be accessed along existing roads that have been cleared of vegetation, where possible, using wheeled and tracked equipment. Borings will be up to 8 inches in diameter, and the disturbed area for test pits will measure approximately 20 square feet. Borings will be backfilled without grout or bentonite and test pits will be backfilled with excavated materials. Construction equipment will likely consist of rotary drill equipment for the boreholes, and test pits may be dug by hand or machine using power excavating equipment such as bulldozers, trenching machines, large-diameter bucket augers, clamshells, and backhoes. A total of 587.82 acres were evaluated for cultural resources.

Alpha Engineering Company retained Transcon Environmental, Inc. (Transcon) to support the NRCS project by conducting a cultural resources analysis. The cultural resources survey and this resulting report have been completed as part of that analysis and were conducted in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended. The NRCS served as the lead agency on the project. The survey was conducted under a BLM St. George Field Office fieldwork authorization (FWA) dated May 13, 2021, a SITLA FWA dated May 11, 2021, and a UDOT FWA dated May 11, 2021. A desktop literature review was conducted for the proposed project area on May 3, 2021, and a Class III (intensive pedestrian) cultural resources inventory was conducted in two field sessions from May 17–21, 2021, and May 24–28, 2021, for a total of 20 person-days of fieldwork. Lindsey M. Evenson served as Principal Investigator and report author, Jennifer L. Bannick served as report co-author and co-Field Director, and Brent Larsen served as co-Field Director.

11. Location(s) and Date(s) of Literature Review:

1. Field Office: N/A
2. Utah Division of State History/Sego: May 3, 2021
3. Historic Records and Maps: May 3, 2021
4. Satellite imagery: May 3, 2021

12. Results of Literature Review (one half- mile buffer):

On May 3, 2021, prior to the commencement of fieldwork, records on file with the Utah Division of State History (UDSH) were reviewed to determine whether previously identified cultural resources were present or if any previously reported archaeological investigations had been conducted within 0.5 mile of the proposed project alignment (UDSH 2021a). The results of this background research are presented in **Appendix B**, *Results of Literature Review*. The results of this literature review indicate there are a total of 39 previously conducted cultural resource surveys (**Table B-1**) and 65 previously recorded cultural resource sites (**Table B-2**) within 0.5 mile of the project area. Of these, 13 previously conducted surveys and 7 previously identified sites were mapped as overlapping, being immediately adjacent to, or being crossed by some portion of the current project APE.

Previously Conducted Cultural Resource Surveys

Background research identified 39 previously conducted cultural resource surveys within 0.5 mile of the project area (**Appendix B**, *Results of Literature Review*). Of these, 13 previously conducted cultural surveys cross into or overlap some portion of the project APE, and only two were conducted within the past 10 years (U20TN0970 - *Cultural Resources Inventory Report, Dominion Energy Utah's Utah Feeder Line 135 Replacement Project, Washington County, Utah* [in progress]; and U16HO0417 - *A Cultural Resource Inventory of the Old Highway 91 Milepost 0.00 to 16.50 Safety Improvements Project, Washington County, Utah*). These surveys mapped within or adjacent to the project area are detailed in **Table B-1**, *Previous Cultural Surveys within 0.5 Mile of the Project Area*. No portion of the current project APE was left unsurveyed due to prior survey efforts.

Previously Recorded Cultural Resource Sites

Background research identified 65 previously recorded cultural resources within 0.5 mile of the project area; these previously recorded sites are detailed in **Table B-2**, *Previously Recorded Cultural Resource Sites within 0.5 Mile of the Project Area*. Of these, seven were mapped within or adjacent to the Phase II (Entire Project) APE during the literature review; however, sites 42WS2428, 42WS5150, 42WS5151, and 42WS5152 were recently updated during Phase I of the project and were not revisited during Phase II. The remaining previously recorded cultural resources consist of one historic pipeline and suspension bridge, and two prehistoric lithic scatters (sites 42WS4692, 42WS4823, 42WS5154, respectively).

Historic Document Review

In addition to the Sego literature review (described above), Transcon consulted a number of historic documents and records, including BLM land records (e.g., historic General Land Office [GLO] records, land patents, mining records, grazing records, Master Title Plat records, etc.), the Utah State Historic Preservation Office's historic contexts, individual BLM field office predictive models (if available) and Class I documents (if available), water rights, Sanborn maps, and Utah Division of Water Rights (UDWR) records (BLM 2021a, 2021b, 2021c, 2021d, 2021e; LOC 2021; UDSH 2021a, 2021b; UDWR 2021). As a result of this historic document review, it was determined that the GLO records, land patents, grazing records, and water rights records yielded historic resources in or very near to the project area (see General Land Office Maps, Land Patent Records, Grazing Allotment Records, and Water Rights Records sections below).

General Land Office Maps

Historic GLO maps and plats of the project area were reviewed and accessed through the BLM website on May 3, 2021 (BLM 2021a). Original cadastral surveys for Township 40 South; Range 15 West; Sections 8, 9, 16, 17, 21, and 35 (1887); Township 41 South, Range 16 West, Sections 1 and 2 (1887); and Township 41 South, Range 17 West, Sections 28 and 33 (1912) were perused (BLM 2021a). These historic resources indicate a few historic improvements near the project area, including historic roads (To Pine Valley, Old Road, Wood Road, St. George and Pine Valley Road, Wood Roads, Road from Shem to St. George, Road from Apex Mine to Shem, and unnamed), a ditch, fences, cultivated fields, a stable, a reservoir, transmission lines (Telegraph Line, Telephone Line Acoma/St. George), and structures (John Alger, Geo. Edwards, Old Cabin, Shem [abandoned], Office, Smelter Stack, House, Mission, Church, House No. 1, House No. 2, Indian Jail, Indian Agent's House, Indian School, and unnamed); these historic GLO developments are detailed in **Table B-3**, *Historic GLO Maps*.

Additional historic maps were accessed from both the USGS TopoView topographic map viewer created by the National Geologic Map Database Project and the Utah Geological Survey Aerial Imagery Collection (DNR 2021; USGS 2021a, 2021b, 2021c, 2021d). Historic aerial imagery in the vicinity of the project (1939, 1950, 1953, 1958) indicates a few visible historic developments, including established roads/highways, cultivated fields, and ranches. Portions of the historic road system are likely the same as (or adjacent to) the present alignments of SR-18 and other roads around Dammeron and Diamond valleys, and Old Highway 91 near the Shivwits Reservation (DNR 2021).

Land Patent Records

Historic land patent records within the project area were also reviewed and accessed through the BLM website on May 3, 2021 (BLM 2021b). These historic resources indicate 14 land patents near the project area with dates ranging from 1892 to 1983. Twelve of these land patents are for parcels located within the project APE: Willard E. Alger (11/12/1913), Samuel L. Carter (6/12/1922), William Carter (7/10/1918 and 6/02/1924), David Chidester (6/22/1899), James F. Cottam (2/14/1922), Esaias Edwards (6/21/1892), Myrza A. Miles (1/24/1921), Utah State (7/16/1894, 7/24/1902, 6/15/1965, 1/10/1966, and 9/30/1983), George W. Higgins (5/16/1896), and Walker Bank and Trust Co. (10/23/1956) (BLM 2021b).

Grazing Allotment Records

Historic grazing allotment records within the project area were also reviewed and accessed through the BLM National Data website on May 3, 2021. This resource indicated two active grazing allotments in or near the project area. One of these allotments, the Veyo Allotment (#14055), encompasses the eastern half and southern portion of the project APE within Dammeron Valley; the Sand Wash Allotment (#04136) borders the southern portion of the project APE within Dammeron Valley, and the Diamond Vall Allotment (#04075) crosses the southeastern portion of the project APE in Diamond Valley.

There are no grazing allotments on the Shivwits tribal lands; however, the reservation is bordered to the north by the Gunlock Allotment (#14025), the northwest by the Jackson Wash Allotment (#14030), the southwest by the Beaver Dam Slope Allotment (#14004), to the south by the Castle Cliffs Allotment (#14076) and the Curly Hollow Allotment (#14015), and to the southeast and east by the Santa Clara Creek Allotment (#14047) and the Santa Clara Creek Custodial Allotment (#04071). There are no dates associated with this data to indicate if these are historic allotments (BLM 2021e).

Water Rights Records

Historic water rights records within the project area were reviewed and accessed through the UDWR records website on May 3, 2021. These historic resources indicate that there are 24 historic water rights within 0.5 mile of the project APE, including surface and underground water sources originating from Whitaker Well, Alger Canyon Springs, Leo Canyon Springs, Wide Canyon Stream, the Santa Clara River, and various unnamed springs and underground wells. None of these are directly within the project APE (UDWR 2021).

Summary and Expectations

Based on the results of the record search, it was anticipated that three previous sites may be located within or immediately adjacent to the project APE in the new survey area; however, it was understood that one of the previously recorded sites (42WS4823) is located near a growing rural community and, as a result, may not be relocated in the project APE.

13. Description of Field Methods:

The survey was conducted in 15-meter-wide transects (blocks in Dammeron, Diamond, and Shem valleys) throughout the entire project APE. This resulted in a total of approximately 587.82 acres evaluated for cultural resources. No portion of the project APE was left unsurveyed due to prior survey efforts; however, some portions of the new survey area in the project APE were surveyed to Class II (reconnaissance) only as they are located on private property in disturbed residential neighborhoods (**Table 1**, *Total Survey Area*).

Isolated occurrence (IO) locations were documented during the survey. Previously identified cultural resource sites identified during the survey had locations noted, revisited, and recorded/updated after the survey was conducted for a more thorough review and to update site documentation, as necessary. These sites and IOs are discussed below in **Table 2**, *Total Sites Recorded*, and **Table 3**, *Newly Identified Isolated Occurrences within the Project APE*. The *Cultural Resource Fieldwork Guidelines and Standards BLM Supplement H-8110—Utah—February 2021* and the *Utah State Historic Preservation Office & Antiquities Section Archaeological Compliance Guidance—June 2020* were adhered to at all times during fieldwork (BLM 2021f; UDSH 2021c).

14. Area Surveyed:
Table 1, below, indicates the total acreage per landowner surveyed to Class II and III standards within the entire project area.

TABLE 1
TOTAL SURVEY ACREAGE

Project Area	Phase	Survey Type	BLM	SITLA	Private	Tribal	TOTAL
Dammeron Valley	Phase I	Class III	144.47	24.08	45.39	0.00	213.94
	Phase II	Class II	0.00	0.00	23.98	0.00	23.98
		Class III	69.61	15.24	14.45	0.00	99.30
Diamond Valley	Phase I	Class III	12.72	7.88	61.84	0.00	82.44
	Phase II	Class II	0.00	0.00	57.89	0.00	57.89
		Class III	19.17	10.53	17.39	0.00	47.10
Shivwits	Phase I	Class II	0.00	0.00	0.00	0.00	0.00
	Phase II	Class III	0.00	0.00	0.00	63.17	63.17
Combined Project Area	Phase I	Class III	157.19	31.96	107.23	0.00	296.38
	Phase II	Class II	0.00	0.00	81.87	0.00	81.87
		Class III	88.78	25.78	31.84	63.17	209.57
TOTAL PROJECT SURVEY ACREAGE			**245.97**	**57.74**	**220.94**	**63.17**	**587.82**

15. Sites Recorded:
Four previously recorded sites mapped within the project APE were relocated and evaluated during the Class III inventory during Phase I of the Project (42WS2428, 42WS5150, 42WS5151, and 42WS5152); 9 sites (including sites that were previously redocumented for Phase I, sites 42WS2428 and 42WS5150, previously recorded sites 42WS4692, 42WS4823 and 42WS5154, and 4 newly recorded sites, 42WS6520, 42WS6521, 42WS6522, and 42WS6523) are located in the new Phase II survey area (**Table 2**). Updated and new Utah Archaeology Site Forms have been prepared for sites 42WS4692, 42WS4823, 42WS5154, 42WS6520, 42WS6521, 42WS6522, and 42WS6523.

TABLE 2
TOTAL SITES RECORDED*

		BLM		STATE		PRIVATE		TRIBAL		TOTAL
		#	Site No.	#	Site No.	#	Site No.	#	Site No.	
	Eligible	1	42WS2428*	0		0		0		1

TABLE 2 TOTAL SITES RECORDED*										
		BLM		STATE		PRIVATE		TRIBAL		TOTAL
		#	Site No.	#	Site No.	#	Site No.	#	Site No.	
Revisits *Updated*	Not Eligible	0		3	42WS5150* 42WS4823 42WS5154	2	42WS5151* 42WS5152*	1	42WS4692	6
Revisits *Not Updated*	Eligible	0		0		0		0		0
	Not Eligible	0		0		0		0		0
Newly Recorded	Eligible	0		0		0		4	42WS6520, 42WS6521, 42WS6522, 42WS6523	4
	Not Eligible	0		0		0		0		
TOTAL		**1**		**3**		**2**		**5**		**11**
*Note: site 42WS2428 is located within the jurisdiction indicated as well as on SITLA-managed land and private property; also, sites 42WS2428, 42WS5150, 42WS5151 and 42WS5152 are located in Phase I and were reported separately (see U21TN0316).										

16. Individual Site Descriptions and Determinations of Eligibility and Effect:
Transcon reported separately on four previously recorded sites during the Class III inventory during Phase I (sites 42WS2428, 42WS5150, 42WS5151, and 42WS5152). One of these sites (42WS2428) is recommended to be Eligible for listing on the National Register of Historic Places (NRHP) under Criterion A for its association with significant regional events. Three sites (42WS5150, 42WS5151, 42WS5152) are recommended Not Eligible for NRHP listing under any Criteria. Additionally, Transcon recommends that site 42WS5152 is no longer an archaeological site as it has been destroyed by the construction of Homestead Drive. Transcon has prepared updated site forms for all four sites reflecting the 2021 revisit (see U21TN0316 - *Cultural Resources Inventory Report, NRCS's Santa Clara Watershed Plan-EA Project—Phase I: Borehole and Test Pit Locations, Washington County, Utah*).

Additionally, three previously recorded sites (42WS4692, 42WS4823, and 42WS5154) were relocated and redocumented during new Class III survey, and four new sites were recorded on Shivwits tribal lands (42WS6520, 42WS6521, 42WS6522, and 45WS6523). Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all recommended to be Eligible for listing on the NRHP under Criterion A for their association with significant regional events and Criterion D for information potential; additionally, sites 42WS6520, 42WS6521, and 42WS6523 are also recommended to be Eligible for listing on the NRHP under Criterion C as they embody the distinctive characteristics of a type, period, and method of construction in the region. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154) are recommended Not Eligible for NRHP listing under any Criteria (**Appendix C**, *Cultural Resource Sites Within the Project APE*).

17. Isolated Occurrences:
Three IOs were identified and recorded within the project APE during the Class III inventory in Phase I (**Appendix A**, *Project Results Maps*). These IOs were reported separately in Phase I of the Project (U21TN0316). Two additional IOs (IO-04 and IO-05) were identified and recorded during the new survey (**Table 3**, *Newly Identified Isolated Occurrences Within the Project APE*, and shown in **Figures 1–2**, below). IO-05 consists of a single petroglyph panel and was not considered a site as it has been moved from its original context by road construction/maintenance. None of these IOs are recommended Eligible for listing on the NRHP under any Criteria.

Table 3 NEWLY IDENTIFIED ISOLATED OCCURRENCES WITHIN THE PROJECT APE*						
IO No.	**Temporal Affiliation**	**Description**	**UTM—E**	**UTM—N**	**Figure**	**Map Panel**
IO-01	Prehistoric	Four quartzite flakes			N/A	1

Table 3 NEWLY IDENTIFIED ISOLATED OCCURRENCES WITHIN THE PROJECT APE*						
IO No.	**Temporal Affiliation**	**Description**	**UTM—E**	**UTM—N**	**Figure**	**Map Panel**
IO-02	Historic	Water diversion valve			N/A	2
IO-03	Historic	Culvert			N/A	2
IO-04	Historic	Irrigation pipe			1	3
IO-05	Prehistoric	Petroglyph panel			2	3
*Note: UTM coordinates are provided in NAD'83 Zone 12; "UTM—E" represents the Easting and "UTM—N" represents the Northing. IO-01 – IO-03 were previously reported in U21TN0316, Phase I of the Project.						

18. Summary of Findings:
As a result of the Class II and Class III inventory, it was determined that a total of seven previously identified cultural resource sites are located within or crossed by the project APE (42WS2428, 42WS4692, 42WS4823, 42WS5150, 42WS5151, 42WS5152, 42WS5154). Four of these sites were recently reported separately under Phase I of the project and were not updated as part of this report (see U21TN0316). Updated Utah Archaeology Site Forms have been prepared for three previously recorded sites identified within the project APE during new survey (42WS4692, 42WS4823, and 42WS5154); additionally, Transcon identified four new cultural resource sites as a result of this survey (42WS6520, 42WS6521, 42WS6522, and 42WS6523). Also, a total of three IOs were identified and recorded within the APE during Phase I of the Project (IO-01, IO-02, and IO-03); these IOs were reported separately, and two additional IOs (IO-04 and IO-05) were identified as a result of new survey. Modern debris was also noted but not recorded at various places within the project area, as it appears to have originated from modern recreational visitation.

Survey conditions were good, consisting of sunny to clouded or partially clouded skies and hot temperatures. For most of the survey, ground visibility was good to excellent, ranging between 60 and 80 percent or greater (**Figures 3** and **4**). Of the seven cultural resource sites identified within the Project APE during new survey (four sites were reported separately in Phase I of the project; 42WS2428, 42WS5150, 42WS5151, and 42WS5152) four newly recorded sites are recommended Eligible for listing on the NRHP under Criteria A and D (42WS6520, 42WS6521, 42WS6522, and 42WS6523), and three sites are also recommended Eligible under Criterion C (42WS6520, 42WS6521, and42WS6523); the remaining previously recorded three sites (42WS4692, 42WS4823, and 42WS5154 and all five IOs (three previously reported and two newly identified) are recommended Not Eligible for the NRHP under any Criteria.

19. Collection Yes___ No _X_

(If Yes) Curation Facility: N/A Accession Number(s): N/A

20. Conclusion/Recommendation of Effect:
Transcon archaeologists conducted a Class II and III cultural resources inventory of 587.82 acres of BLM St. George Field Office-managed, SITLA-managed, privately owned, and Tribal lands in Dammeron, Diamond, and Shem valleys in Washington County, Utah. This investigation was requested by Alpha Engineering Company in support of an NRCS project to determine if any significant cultural resources which could be affected by the proposed undertaking were present within the project area.

As a result of the survey, it was determined that a total of 11 cultural resource sites are located within the project APE (see **Appendix C**, *Cultural Resource Sites Within the Project APE*, for details). Of these 11 sites, four sites were recently reported separately under Phase I of the Project and were not updated as part of this report (42WS2428, 42WS5150, 42WS5151, 42WS5154 [see U21TN0316]). Site (42WS2428) is recommended Eligible for listing on the NRHP under Criterion A for its association with significant historic events, and three sites (42WS5150, 42WS5151, and 42WS5152) are recommended Not Eligible for the NRHP under any Criteria. Additionally, 42WS5151 is recommended to no longer be considered an archaeological site, as is has been destroyed by the construction of Homestead Drive and a residential property.

Also, three previously recorded sites were identified within the project APE during new survey (42WS4692, 42WS4823, and 42WS5154), and four new cultural resource sites as a result of this survey (42WS6520, 42WS6521, 42WS6522, and 42WS6523). Sites 42WS6520, 42WS6521, 42WS6522, and 45WS6523 are all recommended to be Eligible for listing on the NRHP under Criterion A for their association with significant regional events and Criterion D for information potential;

additionally, sites 42WS6520, 42WS6521, and 42WS6523 are also recommended to be Eligible for listing on the NRHP under Criterion C as they embody the distinctive characteristics of a type, period, and method of construction in the region. The three previously recorded sites (42WS4692, 42WS4823, and 42WS5154), and all five IOs (three previously reported [IO-01 – IO-03] and two newly identified [IO-04 and IO-05]) are recommended Not Eligible for NRHP listing under any Criteria (**Appendix C**, *Cultural Resource Sites Within the Project APE*).

Transcon recommends that the project will result in *No Adverse Effects to Historic Properties.* At one Eligible site location within the project APE (42WS2428), the alignment of the historic road has been heavily disturbed/destroyed and almost entirely reclaimed by vegetation in one crossing; it has lost all historic format in another crossing, and all elements of the segment are non-contributing to the overall eligibility of the site within the Project APE.

For all Eligible sites in the Shivwits area of the project, a pre-construction meeting should be held, an inadvertent discovery plan should be prepared, and an archaeological and Tribal monitor should be present for all ground disturbance within 15 meters of each site boundary. Additionally, at the two Eligible historic ditch sites on the Shivwits Reservation (42WS6520 and 42WS6523) the ditch should be flagged during construction (**Table 4**, *Project Summary and Conclusions*). Extensive ground disturbance is anticipated to occur within the Shivwits area of the project. **Table 5**, *Santa Clara Watershed Plan-EA Project Preliminary Cultural Effects Recommendations (Shivwits)* details these anticipated disturbances in relation to the documented cultural sites in that area.

TABLE 4
PROJECT SUMMARY AND CONCLUSIONS

Site No.	Temporal Affiliation	Site Description	Eligibility	Effects	Proposed Construction Elements Within the Site Boundary
42WS2428	Historic	Historic road (*Road from St. George to Pine Valley*)	Eligible—A, *non-contributing*	*No Adverse Effect*	None; non-contributing segment
42WS4692	Historic	Historic pipeline and suspension bridge	Not Eligible	No effect	N/A
42WS4823	Prehistoric	Prehistoric lithic scatter	Not Eligible	No effect	N/A
42WS5150	Prehistoric	Prehistoric lithic scatter	Not Eligible	No effect	N/A
42WS5151	Prehistoric	Prehistoric lithic scatter	Not Eligible	No effect	N/A
42WS5152	Prehistoric	Prehistoric artifact scatter	Not Eligible	No effect	N/A
42WS5154	Prehistoric	Prehistoric lithic scatter	Not Eligible	No effect	N/A
42WS6520	Historic	Historic irrigation ditch	Eligible—A, C, D	*No Adverse Effect*	All ground disturbance activities should take place at least 15 meters away from the site boundary; the ditch should be flagged, and an archaeological and Tribal monitor should be present during all ground disturbance activities.
42WS6521	Multi-component	Multi-component prehistoric artifact scatter and historic schoolhouse/habitation complex	Eligible—A, C, D	*No Adverse Effect*	All ground disturbance activities should take place at least 15 meters away from the site boundary; an archaeological and Tribal monitor should be present during all ground disturbance activities.
42WS6522	Multi-component	Multi-component prehistoric and historic artifact scatter	Eligible—A, D	*No Adverse Effect*	All ground disturbance activities should take place at least 15 meters away from the site boundary; an archaeological and Tribal monitor should be present

TABLE 4 PROJECT SUMMARY AND CONCLUSIONS					
Site No.	**Temporal Affiliation**	**Site Description**	**Eligibility**	**Effects**	**Proposed Construction Elements Within the Site Boundary**
					during all ground disturbance activities.
42WS6523	Historic	Historic flood control ditch	Eligible—A, C, D	*No Adverse Effect*	All ground disturbance activities should take place at least 15 meters away from the site boundary; the ditch should be flagged, and an archaeological and Tribal monitor should be present during all ground disturbance activities.

If any previously undetected or unreported cultural features or deposits are encountered during future project-related activities, these activities must be discontinued in the immediate area of the feature(s), and an NRCS archaeologist (or BLM, SITLA, or UDOT archaeologist, where appropriate) must be consulted to evaluate their nature and significance. Procedures for post-review discoveries, as outlined in the NRCS 2015 Prototype Programmatic Agreement with the Utah SHPO, shall be followed.

TABLE 5 SANTA CLARA WATERSHED PLAN-EA PROJECT CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)							
Site No.	**Site Type**	**Eligibility**	**Design**	**Impacts**	**Status**	**Effects**	**Mitigation***
42WS6520	Historic canal	Eligible - A, C, D	Pipeline	Crosses NW edge of site, within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
				Enters site boundary at one other location	Contributing	No Adverse Effect	
42WS6521	Multi-component habitation complex	Eligible A, C, D	Pipeline	Crosses W edge of site, with nearby features	Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Ditch Rip Rap	Within N edge of site in area of prior disturbance (erosion); will repair eroded channel without impacting intact masonry	Non-Contributing	No Adverse Effect	
42WS6522	Multi-component artifact scatter	Eligible - A, D	Pipeline	Crosses S edge of site within area of existing disturbance	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent
			Bank Rip Rap	Crosses N edge of site, within area of no	Contributing	No Adverse Effect	

TABLE 5 SANTA CLARA WATERSHED PLAN-EA PROJECT CULTURAL EFFECTS RECOMMENDATIONS (SHIVWITS AREA)							
Site No.	**Site Type**	**Eligibility**	**Design**	**Impacts**	**Status**	**Effects**	**Mitigation***
				surface observations			discovery plan prior to construction.
42WS6523	Historic flood control ditch	Eligible - A, C, D	Pipeline	Crosses at S end of site, within area of prior disturbance (erosion and existing pipeline crossing); new pipe will be placed within existing pipeline	Non-Contributing	No Adverse Effect	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
			Ditch Rip Rap	Within center of site, within area of prior disturbance (erosion); will repair eroded channel without impacting intact masonry	Non-Contributing	No Adverse Effect	
N/A	N/A	N/A	Land Leveling	No sites within the proposed land leveling area (previously disturbed area)	N/A	N/A	N/A
*Note: both a cultural and Tribal monitor are recommended to be present for all ground disturbing activities within the Shivwits area of the project.							

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Utah Division of Natural Resources (DNR) 2021 UGS Aerial Imagery Collection. Accessed on May 3, 2021, at https://geodata.geology.utah.gov/imagery/ .

Utah Division of State History (UDSH) 2021a Sego. Utah Department of Heritage and Arts, Utah Division of State History. Accessed May 3, 2021, at https://shpo.utah.gov/portal/apps/webappviewer/index.html?id=8d1c8337d050431080f7dce538f7677c.

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____________. 2021c Archaeological Compliance Guidance. Utah State Historic Preservation Office & Antiquities Section. Accessed May 3, 2021, at https://drive.google.com/file/d/1_e2QLxR2pLUBns2l2GyDbomzJeWTH_Wu/view.

Utah Division of Water Resources (UDWR) 2021“Water Right Areas” Utah Division of Water Rights Database. Accessed May 3, 2021, at https://maps.waterrights.utah.gov/EsriMap/map.asp.

*Include the appropriate amount of 1:24,000 scale topographic maps, which clearly identify the APE, area of Class II or III survey area, sites, and isolated finds.
**Include at least one landscape photograph of the area surveyed.
8100-3 Form

Figure 3. Overview showing site 42WS6521 multi-component historic schoolhouse, habitation complex, and prehistoric artifact scatter in Shem Valley on Paiute (Shivwits) land. View to the west.

Figure 4. Overview showing a portion of site 42WS6523 historic flood control ditch in Shem Valley on Paiute (Shivwits) land. View to the northeast.

APPENDIX A

PROJECT RESULTS MAPS

APPENDIX B

RESULTS OF LITERATURE REVIEW

TABLE B—1 PREVIOUS CULTURAL SURVEYS WITHIN 0.5 MILE OF THE PROJECT AREA						
Survey No.	**Survey Name**	**Organization**	**Date**	**In/Out***	**Project Area****	**Phase*****
U82BL0146	Pipeline Right-of-Way (ROW)	Bureau of Land Management (BLM)	1982	Out	Study Area	N/A
U82BL0151	Buhler Power and Pipeline	BLM	1982	Out	Study Area	N/A
U86BC0383	An Archaeological Inventory of the Proposed Red Butte to Middleton 138 kV Power Line in Washington County, Utah	Brigham Young University	1986	Out	Study Area	N/A
U86BL0560	Road ROW Vicinity of Dammeron Valley	BLM	1986	Out	Study Area	N/A
U86NP0409	A Cultural Resource Inventory of the Dammeron Valley Powerline Extension, Washington County, Utah	A.K. Nielson Associates	1986	In	Dammeron Valley	Phase I, Phase II
U89PD0087	Cultural Resource Inventory of SR-18, Snow Canyon to Veyo, From Milepost 12.67 to Milepost 19.8, Washington County, Utah	P-III Associates, Inc. (P-III)	1989	In	Dammeron Valley	Phase I, Phase II
U91NP0299	An Archaeological Inventory of the Proposed UAMPS Central Substation to St. George Substation Access, Equipment Stations and Wire Set-up Locations, Washington County, Utah	A.K. Nielson Associates	1991	Out	Study Area	N/A
U92NP0658	UP&L Dammeron Valley Distribution	A.K. Nielson Associates	1992	In	Dammeron Valley	Phase I, Phase II
U93NP0713	UP&L Dammeron Valley Distribution	A.K. Nielson Associates	1993	Out	Study Area	N/A
U94BL0491	Diamond Valley Fence	BLM	1994	In	Dammeron Valley	Phase I, Phase II
U95BL0756	Chuck Buhler Road	BLM	1995	Out	Study Area	N/A
U95IG0312	An Archaeological Survey of the Diamond Valley Gravel Pit, Washington County, Utah	Intersearch, Inc.	1995	Out	Study Area	N/A
U96JB0202	A Cultural Resource Inventory of the Dammeron Valley - Sand Cove Utah Power Replacement Powerline near Veyo, Utah	JBR Environmental Consultants, Inc.	1996	Out	Study Area	N/A
U97BL0553	Gunlock to Ivins Pipeline	BLM	1997	In	Shivwits	Phase II
U01EP0270	A Cultural Resource Inventory of 4 Segments of 69kV Power Lines from Dammeron to Ivins, Washington County, Utah	EarthTouch LLC	2001	Out	Study Area	N/A
U02BL0312	Diamond Valley Exchange	BLM	2002	Out	Study Area	N/A

TABLE B—1 PREVIOUS CULTURAL SURVEYS WITHIN 0.5 MILE OF THE PROJECT AREA						
Survey No.	**Survey Name**	**Organization**	**Date**	**In/Out***	**Project Area****	**Phase*****
U03BL0609	Diamond Valley - Red Cliffs Reserve Trailhead Parking	BLM	2003	Out	Study Area	N/A
U04BS0282	A Cultural Resources Inventory of the Proposed Red Butte to St. George Transmission Line Upgrade in Washington County, Utah	Baseline Data, Inc.	2004	Out	Study Area	N/A
U05IG0648	An Archaeological Survey of the Proposed Shivwits Band of Paiute Indians Tamarisk Removal Project Area, in Washington County, Utah	Intersearch, Inc.	2005	In	Shivwits	Phase II
U05MQ0506	Cultural Resource Inventory for the Santa Clara River Bridge (Structure 053006D) on Shivwits Tribal Land, Washington County, Utah	Montgomery Archaeological Consultants	2005	In	Shivwits	Phase II
U06HQ0775	An Archaeological Survey of Three Fire Break Lines in Dammeron Valley, Washington County, Utah	HRA, Inc.	2006	In	Dammeron Valley	Phase I, Phase II
U06MX0031	An Archaeological Inventory of the Canyon Trails Easement, Dammeron Valley, Phase 2	McFadden Archaeological Consulting	2006	Out	Study Area	N/A
U08ES0816	Cultural Resources Inventory of the Dammeron and Central Fuels Project Areas North of St. George, Washington County, Utah	EnviroSystems Management, Inc.	2008	In	Dammeron Valley	Phase I, Phase II
U08HO0786	Results of Testing & Data Recovery for the Red Butte to St. George Transmission Line Upgrade, Washington County, Utah	Bighorn Archaeological Consultants, LLC (Bighorn)	2008	Out	Study Area	N/A
U08HQ1022	An Archaeological Survey of Approximately 560 Acres in Three Parcels within the Dammeron Valley, Washington County, Utah	HRA, Inc.	2008	In	Dammeron Valley	Phase I, Phase II
U09HO0364	A Cultural Resource Inventory of the Red Butte to St. George Transmission Line Upgrade Access Roads, Washington County, Utah	Bighorn	2009	Out	Study Area	N/A
U10IG0862	Tower Engineering - Dammeron Valley Tower Site Survey	Intersearch, Inc.	2010	Out	Study Area	N/A
U10LI0939	St. George Travel Management Plan	Logan Simpson	2010	In	Dammeron Valley	Phase I, Phase II
U10ST0248	Utah Education Network Btop Surveys	SWCA	2010	In	Diamond Valley	Phase I, Phase II

TABLE B—1 PREVIOUS CULTURAL SURVEYS WITHIN 0.5 MILE OF THE PROJECT AREA						
Survey No.	**Survey Name**	**Organization**	**Date**	**In/Out***	**Project Area****	**Phase*****
U11BL0843	Diamond Valley ESR CRI	BLM	2011	Out	Study Area	N/A
U13SH0355	Cultural Resources Inventory of the Shem Dam Rehabilitation Emergency Watershed Protection (EWP) Project, Washington County, Utah	USDA NRCS	2013	Out	Study Area	N/A
U13SH0832	Cultural Resources Inventory of the Motoqua Cutoff Road Emergency Watershed Protection (EWP) Project, Washington County, Utah	NRCS	2013	Out	Study Area	N/A
U16HQ0389	Data Recovery at Four Prehistoric Sites in the Dammeron Valley Residential Development, Washington County, Utah	HRA, Inc.	2016	Out	Study Area	N/A
U16HO0417	A Cultural Resource Inventory of the Old Highway 91 Milepost 0.00 to 16.50 Safety Improvements Project, Washington County, Utah	Bighorn	2016	In	Shivwits	Phase II
U17BL0939	Lava Ridge Trailhead Improvement	BLM	2017	Out	Study Area	N/A
U17SH0627	Cultural Resources Inventory in Support of an Environmental Quality Incentives Program (EQIP) Brush Management Project on Shivwits Band of Paiutes Land, Washington County, Utah	NRCS	2017	Out	Study Area	N/A
U17UT0379	SR-18; Diamond Valley Intersection Improvements Cultural Resources Survey	UDOT	2017	Out	Study Area	N/A
U19TN0509	Cultural Resources Inventory Report, Lloyd Graff LTD's Graff Road Project, Washington County, Utah	Transcon Environmental, Inc. (Transcon)	2019	Out	Study Area	N/A
U20TN0970	Cultural Resources Inventory Report, Dominion Energy Utah's Utah Feeder Line 135 Replacement Project, Washington County, Utah (in progress)	Transcon	2021	In	Dammeron Valley	N/A

*Note: "In" is a project crossing or overlapping some portion of the APE (also blue text); "Out" is a project mapped outside the APE.
**Note: There are three project areas: Dammeron Valley, Diamond Valley, and Shivwits; anything within the 0.5-mile study area but outside the three APE project areas is referenced as "Study Area."
***Note: There are two project phases: Phase I: Borehole and Test Pit Locations and Phase II: Entire Project.

TABLE B—2 PREVIOUSLY IDENTIFIED CULTURAL RESOURCE SITES WITHIN 0.5 MILE OF THE PROJECT AREA					
Site No.	**Description**	**Eligibility**	**In/Out***	**Project Area ****	**Phase *****
42WS0531	Prehistoric lithic scatter	*Unevaluated*	Out	Study Area	N/A
42WS0532	Prehistoric lithic scatter	*Unevaluated*	Out	Study Area	N/A
42WS0533	Prehistoric lithic scatter	*Unevaluated*	Out	Study Area	N/A
42WS0534	Prehistoric lithic scatter	*Unevaluated*	Out	Study Area	N/A
42WS0535	Prehistoric campsite	*Unevaluated*	Out	Study Area	N/A
42WS0536	Prehistoric lithic scatter	*Unevaluated*	Out	Study Area	N/A
42WS0537	Prehistoric lithic scatter	*Unevaluated*	Out	Study Area	N/A
42WS0538	Prehistoric lithic scatter	*Unevaluated*	Out	Study Area	N/A
42WS0539	Prehistoric campsite	*Unevaluated*	Out	Study Area	N/A
42WS0540	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS0541	Prehistoric campsite	Determined Eligible	Out	Study Area	N/A
42WS0544	Prehistoric lithic scatter	*Unevaluated*	Out	Study Area	N/A
42WS1553	Prehistoric lithic scatter and rock alignment	Determined Not Eligible	Out	Study Area	N/A
42WS1554	Prehistoric lithic scatter with fossil exposure	Determined Eligible	Out	Study Area	N/A
42WS1555	Prehistoric lithic scatter and rock alignment	Determined Not Eligible	Out	Study Area	N/A
42WS1556	Historic isolated structures	Determined Not Eligible	Out	Study Area	N/A
42WS2203	Prehistoric campsite	Determined Eligible	Out	Study Area	N/A
42WS2204	Prehistoric artifact scatter	Determined Eligible	Out	Study Area	N/A
42WS2205	Prehistoric campsite	Recommended Eligible	Out	Study Area	N/A
42WS2206	Prehistoric campsite	Recommended Eligible	Out	Study Area	N/A
42WS2425	Prehistoric lithic scatter	Recommended Not Eligible	Out	Study Area	N/A
42WS2428	Historic road	Recommended Eligible	In	Diamond Valley	Phase I, Phase II
42WS2761	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A

TABLE B—2 PREVIOUSLY IDENTIFIED CULTURAL RESOURCE SITES WITHIN 0.5 MILE OF THE PROJECT AREA					
Site No.	**Description**	**Eligibility**	**In/Out***	**Project Area ****	**Phase *****
42WS2762	Prehistoric lithic scatter and rock alignment	Determined Eligible	Out	Study Area	N/A
42WS2763	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS3124	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS3125	Prehistoric campsite	Determined Eligible	Out	Study Area	N/A
42WS3534	Multi-component: Prehistoric rock art; historic signatures	Determined Eligible	Out	Study Area	N/A
42WS3535	Prehistoric petroglyph	Determined Eligible	Out	Study Area	N/A
42WS3536	Prehistoric petroglyph	Determined Eligible	Out	Study Area	N/A
42WS3540	Prehistoric roomblocks and artifact scatter	Determined Eligible	Out	Study Area	N/A
42WS3709	Historic road (*Old US-91, Arrowhead Trail/Highway*)	Determined Eligible	Out	Study Area	N/A
42WS4143	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS4174	Prehistoric campsite	Recommended Eligible	Out	Study Area	N/A
42WS4175	Prehistoric campsite	Recommended Eligible	Out	Study Area	N/A
42WS4311	Prehistoric Paiute campsite	Determined Eligible	Out	Study Area	N/A
42WS4409	Historic wagon road (*Old Spanish Trail, Road to California, Mormon Road*)	Determined Eligible	Out	Study Area	N/A
42WS4692	Historic pipeline and suspension bridge	Recommended Not Eligible	In	Shivwits	Phase II
42WS4693	Historic rock piers	Determined Eligible	Out	Study Area	N/A
42WS4694	Prehistoric rock art	Recommended Eligible	Out	Study Area	N/A
42WS4695	Multi-component: Prehistoric rock art and historic walls	Recommended Eligible	Out	Study Area	N/A
42WS4715	Prehistoric habitation	Determined Eligible	Out	Study Area	N/A
42WS4716	Historic road	Recommended Eligible	Out	Study Area	N/A
42WS4717	Historic cistern	Recommended Eligible	Out	Study Area	N/A

TABLE B—2 PREVIOUSLY IDENTIFIED CULTURAL RESOURCE SITES WITHIN 0.5 MILE OF THE PROJECT AREA					
Site No.	**Description**	**Eligibility**	**In/Out***	**Project Area ****	**Phase *****
42WS4822	Prehistoric lithic scatter	Determined Eligible	Out	Study Area	N/A
42WS4823	Prehistoric lithic scatter	Determined Not Eligible	In	Shivwits	Phase II
42WS4824	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS5126	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS5127	Prehistoric lithic scatter	Recommended Eligible	Out	Study Area	N/A
42WS5128	Prehistoric lithic scatter	Determined Eligible	Out	Study Area	N/A
42WS5145	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS5146	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS5147	Prehistoric artifact scatter	Determined Not Eligible	Out	Study Area	N/A
42WS5149	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS5150	Prehistoric lithic scatter	Determined Not Eligible	In	Dammeron Valley	Phase I, Phase II
42WS5151	Prehistoric lithic scatter	Determined Not Eligible	In	Dammeron Valley	Phase I
42WS5152	Prehistoric artifact scatter	Determined Not Eligible	In	Dammeron Valley	Phase I
42WS5153	Prehistoric lithic scatter	Determined Not Eligible	Out	Study Area	N/A
42WS5154	Prehistoric lithic scatter	Determined Not Eligible	In	Dammeron Valley	Phase II
42WS5155	Historic artifact scatter	Determined Not Eligible	Out	Study Area	N/A
42WS5269	Prehistoric campsite	Recommended Eligible	Out	Study Area	N/A
42WS5525	Multi-component: Prehistoric and historic artifact scatter with features	Determined Not Eligible	Out	Study Area	N/A
42WS5526	Multi-component: Prehistoric and historic artifact scatter with features	Determined Eligible	Out	Study Area	N/A
42WS5715	Prehistoric campsite	Recommended Eligible	Out	Study Area	N/A
42WS5931	Historic dam (*Shem or Winsor Dam*)	Determined Eligible	Out	Study Area	N/A
*Note: "In" is a site mapped within or crossed by some portion of the APE (also blue text); "Out" is a site mapped outside the APE.					

TABLE B—2 PREVIOUSLY IDENTIFIED CULTURAL RESOURCE SITES WITHIN 0.5 MILE OF THE PROJECT AREA					
Site No.	**Description**	**Eligibility**	**In/Out***	**Project Area ****	**Phase *****
**Note: There are three project areas: Dammeron Valley, Diamond Valley, and Shivwits; anything within the 0.5-mile study area but outside the three APE project areas is referenced as "Study Area." ***Note: There are two project phases: Phase I: Borehole and Test Pit Locations and Phase II: Entire Project.					

TABLE B—3 HISTORIC GENERAL LAND OFFICE MAPS				
Date	**Township**	**Range**	**Historic Features near the Project Area**	**Project Area***
1877	40 South	16 West	Roads (*To Pine Valley, Old Road*, and unnamed)	Dammeron Valley
1877	40 South	16 West	Roads (unnamed), reservoir, cultivated fields, and structures (*John Alger, Geo. Edwards,* and *Old Cabin*)	Diamond Valley
1877	41 South	16 West	Roads (*Wood Road, St. George and Pine Valley Road, Wood Roads,* and unnamed), transmission line (*Telegraph Line*), cultivated field, fence, and ditch	Diamond Valley
1912	41 South	17 West	Roads (*Road from Shem to St. George, Road from Apex Mine to Shem, unnamed)* structures *(Shem [abandoned], Office, Smelter Stack, House, Mission, Church, House No. 1, House No. 2, Indian Jail, Indian Agent's House, Indian School*, unnamed), graveyard (*Indian Graveyard*), transmission line (*Telephone Line Acoma/St. George*), fences, cultivated fields, stable	Shivwits
*Note: There are three project areas: Dammeron Valley, Diamond Valley, and Shivwits.				

APPENDIX C

CULTURAL RESOURCE SITES WITHIN THE PROJECT APE

TABLE C-1 CULTURAL RESOURCE SITES WITHIN THE PROJECT APE						
Site Number	**Site Name**	**Land Owner**	**Site Description**	**Eligibility Recommendation**	**Effects**	**Protective or Avoidance Measures**
42WS2428	*Road from St. George to Pine Valley*	BLM, Private, SITLA	Site 42WS2428 is the historic *Road from St. George to Pine Valley*. The site was originally recorded in 1989 by P-III and later revisited and re-evaluated on various occasions in 1994, 1996, 2004, 2006, 2008, and twice in 2021; various segments of the site have been recommended or determined to be Not Eligible, and others have been recommended or determined to be Eligible under Criterion A. Transcon archaeologists revisited two crossings of Segment M of the historic road within the current project APE in 2021 and noted that the northern portion (**Surveyed Area 1**) of the road segment within the APE appears to be in use as a frontage road and looks like a modern two track; it is non-contributing to the overall eligibility of the site as it has lost all historic format. The southern crossing of Segment M (**Surveyed Area 2**) is in very poor condition, has been reclaimed by vegetation for the most part, and is presumed to be in the previously plotted location by evidence of some incised areas and a change in vegetation along the alignment. Transcon concurs with the previous site eligibility determination and recommends site 42WS2428 is Eligible for listing on the NRHP under Criterion A because the site is associated with historically important events of transportation and settlement between Pine Valley and St. George; however, Transcon recommends the portion of Segment M revisited in 2021 is non-contributing to the overall integrity and eligibility of the site.	Eligible—A; non-contributing	*No Adverse Effects*	None; non-contributing segment.
42WS4692		Tribal	Site 42WS4692 is a historic pipeline and suspension bridge complex. The site was originally recorded by Montgomery Archaeological Consultants in 2005 and was determined Not Eligible for the NRHP under any Criteria. When revisited in 2021, Transcon archaeologists observed that the site has been severely altered since the 2005 recording. Transcon rerecorded Features A (suspension cable bridge with bases), B (headgate and pit), and C (two rock and mortar piers); however, Feature A now consists of rock, mortar and concrete supports only; the pipe and support bridge that previously spanned the Santa Clara River is now gone, and one of the previously reported components of Feature C (the southwestern rock pier) is also missing - this has either been removed or is somewhere beneath the large amount of basalt riprap on the southwestern side of the river. A modern pipe culvert has been placed on the northeastern side of the river to the west of Feature A through which water now drains. Transcon concurs with the previous site eligibility determination and recommends site 42WS4692 is Not Eligible for listing on the NRHP under any Criteria.	Not Eligible	No Effects	N/A

TABLE C-1 CULTURAL RESOURCE SITES WITHIN THE PROJECT APE						
Site Number	**Site Name**	**Land Owner**	**Site Description**	**Eligibility Recommendation**	**Effects**	**Protective or Avoidance Measures**
42WS4823		SITLA	Site 42WS4823 is a prehistoric lithic scatter. The site was originally recorded by HRA, Inc. in 2006 and was determined Not Eligible for the NRHP under any Criteria. When revisited in 2021, Transcon archaeologists noted a diffuse scatter of lithic debris within the site area consisting primarily of quartzite with some chert tertiary flakes observed. There appears to be displacement of artifacts by erosion and the site is located in close proximity to a residential neighborhood. Transcon archaeologists noted that the site is similar in condition to the 2006 recording with approximately 150 tan quartzite and white chert tertiary flakes total. The previously recorded artifacts were not relocated; however, Transcon recorded A-01 biface, A-02 biface and AC-01 lithic debris concentration which has approximately 60 flakes. There is a drainage area circling around the southern site area, and the two newly identified bifaces are located within AC-01. Transcon concurs with the previous site eligibility determination and recommends site 42WS4823 is Not Eligible for listing on the NRHP under any Criteria.	Not Eligible	No Effects	N/A
42WS5150		SITLA	Site 42WS5150 is a prehistoric lithic scatter. The site was originally recorded by HRA, Inc. in 2008 and was determined Not Eligible for the NRHP under any Criteria. When revisited in 2021, Transcon archaeologists observed the site to be in similar condition to the 2008 recording with a diffuse scatter of lithic debris (approximately 50 flakes) within the site area consisting primarily of gray quartzite tertiary flakes with some white chert tertiary flakes. Transcon archaeologists relocated and documented previously recorded AC-01; however, previously recorded AC-02 and the previously recorded lithic tools were not relocated. There is some displacement of artifacts by erosion and obscurement of the site area by selective bullhogging, and the site has been impacted by a dirt road that bisects the site. Formerly documented diagnostic artifacts have likely been collected, as the site is close to a developing residential neighborhood and sees frequent visitation. Transcon concurs with the previous site eligibility determination and recommends site 42WS5150 is Not Eligible for listing on the NRHP under any Criteria.	Not Eligible	No Effects	N/A
42WS5151		Private	Site 42WS5151 is a prehistoric lithic scatter. The site was originally recorded by HRA, Inc. in 2008 and was determined Not Eligible for the NRHP under any Criteria. When revisited in 2021, Transcon archaeologists observed a very small amount of lithic debitage, 5 total pieces (4 light gray quartzite flakes and 1 white chert tertiary flake), which is far less than the previously recorded 20 flakes. Additionally, the previously noted lithic tools were not relocated. There appears to be displacement of artifacts by erosion, and some areas of the site have been selectively bullhogged. The site is adjacent to a residential property, and the diagnostic artifacts have likely been collected. Transcon concurs with the previous site eligibility determination and recommends site 42WS5151 is Not Eligible for listing on the NRHP under any Criteria.	Not Eligible	No Effects	N/A

TABLE C-1 CULTURAL RESOURCE SITES WITHIN THE PROJECT APE						
Site Number	**Site Name**	**Land Owner**	**Site Description**	**Eligibility Recommendation**	**Effects**	**Protective or Avoidance Measures**
42WS5152		Private	Site 42WS5152 was a prehistoric artifact scatter. The site was originally recorded by HRA, Inc. in 2008 and was determined Not Eligible for the NRHP under any Criteria. When revisited in 2021, Transcon archaeologists observed that a road (Homestead Drive) has been constructed through the site and that selective bullhogging has been conducted within the site area. Transcon archaeologists were unable to relocate the previously documented lithic flake assemblage, any ceramics, or any of the documented diagnostic tools. Only a single quartzite tertiary flake was relocated within the site area. Transcon concurs with the previous site eligibility determination and recommends site 42WS5152 is Not Eligible for listing on the NRHP under any Criteria. Additionally, Transcon recommends 42WS5152 no longer be considered an archaeological site as it has been destroyed by the construction of Homestead Drive.	Not Eligible	No Effects	N/A; recommended destroyed (no longer an archaeological site).
42WS5154		SITLA	Site 42WS5154 is a prehistoric lithic scatter. The site was originally recorded by HRA, Inc. in 2008 and was determined Eligible for the NRHP under Criterion D. In 2015, HRA Inc. collected surface artifacts at the site, excavated 7 backhoe trenches spaced 10 meters apart throughout the site, and excavated two test units, with artifact types and testing indicated a Formative to Late Prehistoric and Early to Middle Archaic presence at the site. When revisited in 2021, Transcon archaeologists relocated all 7 backhoe trenches. No diagnostic artifacts were relocated as the site has been previously collected, and only 5 chert tertiary flakes were observed in the disturbed soil near the backhoe trenches. As the site has been collected and excavations have exhausted the research potential of the site, Transcon recommends site 42WS5154 is Not Eligible for listing on the NRHP under any Criteria.	Not Eligible	No Effects	N/A; was Eligible (D) in 2008, but excavations exhausted data potential in 2015.
42WS6520		Tribal	Site 42WS6520 is a historic irrigation ditch recorded for the first time in 2021 by Transcon and recommended Eligible for the NRHP under Criteria A, C, and D. The site consists of a series of sandstone slab and cement lined irrigation ditch segments recorded (from north to south) as F-01 irrigation ditch segment; F-02 irrigation ditch segment; and F-03 irrigation ditch segment. These segments run parallel to Gunlock Drive, on the northeastern side of the highway. The ditch has disappeared in many locations along the alignment, and in some places, it is represented only by a shallow linear depression or a graded shelf. As the site is located in close proximity to Gunlock Drive, modern trash is ubiquitous along the site alignment. Transcon recommends site 42WS6520 is Eligible for listing on the NRHP under any Criteria A, C, and D for important events in this region as it was essential for irrigation/subsistence for the Shivwits; it retains structural integrity, and the design and workmanship of the site is relatively unique and intact; and for information potential regarding past irrigation practices in the region.	Eligible—A, C, D	*No Adverse Effects*	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.

TABLE C-1 CULTURAL RESOURCE SITES WITHIN THE PROJECT APE						
Site Number	**Site Name**	**Land Owner**	**Site Description**	**Eligibility Recommendation**	**Effects**	**Protective or Avoidance Measures**
42WS6521		Tribal	Site 42WS6521 is multi-component historic schoolhouse, habitation complex, and prehistoric artifact scatter in a 370 by 250-meter area recorded for the first time in 2021 by Transcon and recommended Eligible for the NRHP under Criteria A, C, and D. Transcon archaeologists recorded a variety of historic features (21) intermingled with prehistoric artifacts throughout the site, as well as two projectile points (A-01 and A-02), and one historic artifact concentration (AC-01). Features include F-01 schoolhouse, F-02 superintendent's foundation, F-03 rock wall, F-04 small foundation, F-05 water cistern/storage tank, F-06 windmill pipe, F-07 generator room, F-08 basketball court, F-09 foundation with collapsed boulders, F-10 rock alignment, F-11 rock retaining wall, F-12 Collapsed structure, foundation, and rock alignment, F-13 foundation, F-14 mortar and flagstone foundation, F-15 foundation, F-16 road, F-17 flood control ditch, F-18 canal catchment, F-19 block and mortar structure, F-20 cement pad, and F-21 stacked rock wall. Additionally, there are 700 plus pieces of lithic debris and 600 plus prehistoric ceramic fragments within the site area. Transcon recommends site 42WS6521 is Eligible for listing on the NRHP under Criteria A, C, and D for important events in this region as it was a schoolhouse and agricultural center for the Shivwits; some features retain structural integrity, and the design and workmanship of some features in the site are relatively unique and intact; and for information potential regarding past irrigation practices and land use patterns.	Eligible—A, C, D	*No Adverse Effects*	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.
42WS6522		Tribal	Site 42WS6522 is a multi-component historic artifact scatter and prehistoric artifact scatter recorded for the first time in 2021 by Transcon and recommended Eligible for the NRHP under Criteria A and D. Transcon archaeologists observed prehistoric and historic artifacts in a 104 by 73-meter area that are mixed together in an area that has been bulldozed and consists of several push piles. Historic artifacts within the site appear to date from the early 1900s to the 1960s. There are thousands (5000+) of historic glass fragments (clear, brown, amber, cobalt, green, green and white milk glass, medicine bottles, bases) in AC-01 multi-component historic/prehistoric artifact concentration, and diffusely spread throughout the site area with increased density near AC-01. Additional historic artifacts include 400+ historic ceramic fragments, various indeterminate metal artifacts, 30+ cinder blocks, and a gas can spout. Prehistoric artifacts are scattered throughout the site area and mixed with historic artifacts. The prehistoric artifact assemblage includes 1000+ flakes throughout the site area; most flakes are chert tertiary flakes in various colors but primarily a mottled translucent, gray mottled, and white and blue/purple chert type, with some obsidian flakes noted; there are very few primary or secondary flakes. There are 2000+ ceramic fragments within the site area, predominantly grayware with less common black-on-gray and black-on-white and corrugated grayware. Transcon recommends site 42WS6522 is Eligible for listing on the NRHP under Criteria A and D as it was part of an agricultural center for the Shivwits and for information	Eligible—A, D	*No Adverse Effects*	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.

TABLE C-1 CULTURAL RESOURCE SITES WITHIN THE PROJECT APE						
Site Number	**Site Name**	**Land Owner**	**Site Description**	**Eligibility Recommendation**	**Effects**	**Protective or Avoidance Measures**
			potential regarding past irrigation and farming techniques on the reservation, as well as land use patterns.			
42WS6523		Tribal	Site 42WS6523 is a historic flood control ditch recorded for the first time in 2021 by Transcon and recommended Eligible for the NRHP under Criteria A, C, and D. The site consists of a historic flood control ditch constructed with stacked sandstone slabs and is approximately 490 feet long on the northern side of US-91 and varies in dimension along the alignment but is generally 5 feet wide on the bottom and about 5 feet wide at the top of the ditch. There is approximately 300 feet of stacked sandstone that is intact within the ditch after which there is a 30-foot-long blowout and then 100 feet of buried but visible wall within an earthen section after which the stacked rock is re-exposed for about 60 feet. The ditch ranges in depth from 4 to 6 feet deep and extends to the northwest from US-91. The average size of the sandstone slabs ranges from 12 to 24 inches long and 1 foot wide and 7 inches thick. Some of the sandstone slabs are stacked with no mortar on the top 3 feet. There is an inscribed culvert connecting to US-91 and an inscription in the mortar near a spillway within the ditch. Transcon recommends site 42WS6523 is Eligible for listing on the NRHP under Criteria A, C, and D for important events in this region as it was essential for flood control for the Shivwits; it retains structural integrity, and the design and workmanship of the site is relatively unique and intact; and for information regarding past flood control practices in the region.	Eligible—A, C, D	*No Adverse Effects*	Archaeological and Tribal monitor present during construction, a pre-construction meeting, and an inadvertent discovery plan prior to construction.

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February 21, 2024

Tara S. Hoffman
State Watershed Cultural Resources Specialist/Tribal Liaison
Natural Resources Conservation Service
Wallace F. Bennett Federal Building, 125 State Street # 4010
Salt Lake City, Utah 84138

RE: USDA NRCS's Santa Clara Watershed Plan-EA Project—Supplemental Cultural Resources Desktop Review Memo

Dear Ms. Hoffman:

Pursuant to your request, Transcon Environmental, Inc. (Transcon) is pleased to submit this Supplemental Cultural Resources Desktop Review Memo as part of the desktop environmental compliance review activities associated with the ***USDA NRCS's Santa Clara Watershed Plan-EA Project*** (Project) being conducted to develop and authorize the Santa Clara Watershed Plan-EA.

The proposed project is broken into two phases: **Phase I: Borehole and Test Pit Locations** (Utah Antiquities Project No. U21TN0316) and **Phase II: Entire Project** (Utah Antiquities Project No. U21TN0317). The original literature review for both phases of the Project was conducted on May 3, 2021, prior to the commencement of fieldwork, and included a Sego (the Utah State Historic Preservation Office's [USHPO] online database) literature review, as well as a comprehensive historic document review which consulted a number of historic documents and records, including Bureau of Land Management land records (e.g., historic General Land Office [GLO] records, land patents, mining records, grazing records, Master Title Plat records, etc.), the USHPO's historic contexts, water rights, Sanborn maps, and Utah Division of Water Rights (UDWR) records.

At the time the original literature review was conducted, a review of historic structures/buildings in the proposed Project area was not required and was not completed. The purpose of this Supplemental Cultural Resources Desktop Review Memo is to provide supplemental historic research for the Project as a whole, including both phases of the Project, and to identify any historic structures/buildings within the Project Area of Potential Effect (APE) prior to construction design finalization that may be impacted by the proposed development/construction activities.

If you have any questions regarding this information, please contact me directly at 801-649-5141 ext. 310 or levenson@transcon.com.

Sincerely,

Lindsey M. Evenson
Regional Manager | Senior Archaeologist
Transcon Environmental, Inc.

HISTORIC STRUCTURES/BUILDINGS

The USHPO Historic Utah Buildings online database (HUB) was reviewed for the entire proposed Project area (including both phases) and accessed through the HUB website on February 20, 2024. Records indicate there are no previously recorded historic buildings within the Project APE (for both Phase I and Phase II), and there are also no historic buildings located within 0.5 mile of the Project area (HUB 2024).

Based on these findings, Transcon recommends that there are no historic structures/buildings within the Project APE, and that there will be no impacts to any historic structures/buildings as the result of the proposed Project implementation or other Project-related construction activities.

REFERENCES:

Historic Utah Buildings (HUB).
2024 Utah State Historic Preservation Office. Accessed February 20, 2024, at: https://shpo.utah.gov/portal/apps/webappviewer/index.html?id=8e218e18c2b74477b5f520e5617bebaf.

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February 16, 2021

Emily Fife, State Conservationist
NRCS
Wallace F. Bennett Federal Building
125 S. State St., Room 4010
Salt Lake City, UT 8418-1100

Re: Shivwits Band of Paiutes' Response to NRCS' formal request to be a Cooperating Agency in the development of the Santa Clara Watershed Plan-Environmental Assessment (Plan-EA)

Dear Emily:

The Shivwits Band of Paiutes (Shivwits Band) is in receipt of the Natural Resources Conservation Service's (NRCS) formal request for the Band to be a Cooperating Agency in the development of the Santa Clara Watershed Plan.

The Shivwits Band appreciates and accepts NRCS's invitation to be a cooperating agency and would like to discuss potential terms of a memorandum of agreement regarding the Band's participation as a Cooperating Agency. Could we set up a time to talk in the next week or two? I am available at mark@echohawk.com or directly by phone at 435.922.8920.

The Shivwits Band looks forward to working with NRCS on this important project.

Sincerely,

Mark Echo Hawk

Mark A. Echo Hawk
Counsel for Shivwits Band of Paiutes

Cc: Shivwits Band Council
Kyle Wheeler, Water Resources Coordinator
Norm Evenstad, Asst. State Conservationist – Water Resources

APPENDIX E-9A

AQUATIC RESOURCES

PRELIMINARY AQUATIC RESOURCE DELINEATION REPORT

Santa Clara Watershed Plan Project
Washington County, Utah
SPK 2021-00134

Prepared for:

Washington County Utah
10 North 100 East
St. George, Utah 84770

and

United States Department of Agriculture
Natural Resources Conservation Service
Wallace F. Bennett Federal Building
125 South State Street, Room 4010
Salt Lake City, Utah 84138-1100

For submittal to:

United States Army Corps of Engineers
Intermountain Regulatory Branch
Sacramento District—Bountiful Field Office
533 West 2600 South, Suite 150
Bountiful, Utah 84010

Prepared by:

Transcon Environmental, Inc.
444 South Main Street, Suite A6
Cedar City, Utah 84720

Transcon environmental | Planners & Scientists

October 2021

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INTRODUCTION

The U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), with assistance from Washington County as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. Currently, the proposed improvements include the installation and reestablishment of a series of detention basins in the communities of Dammeron Valley and Diamond Valley and irrigation supply improvement and armoring along the Santa Clara River on Shivwits Band of Paiutes tribal land near Ivins, Utah. The detention basins and armoring will provide flood protection to the local communities and Shivwits tribal farming area. The engineering design is being performed by Alpha Engineering Company out of St. George, Utah.

PROJECT LOCATION AND DESCRIPTION

Project Location

The overall review area for the proposed project is in Washington County, Utah. The review area is separated into three general sections: Shivwits, Dammeron Valley, and Diamond Valley. Below is a brief description and general location of each review area:

- The Shivwits Review Area encompasses approximately 63.6 acres and is located along the Santa Clara River along Old Highway 91 at Gunlock Road within the Shivwits Band of Paiutes Indian Reservation (37.184170, -113.762145)
- The northern section of the Dammeron Valley Review Area encompasses approximately 165.5 acres and is located within and to the east of the town of Dammeron Valley, north of the City of St. George, Utah, along Utah State Route 18 (SR-18) (37.310682, -113.661842)
- The southern section of the Dammeron Valley Review Area encompasses approximately 48.3 acres and is located 0.7 mile south of the town Dammeron Valley, crossing SR-18 (37.293470, -113.655903)
- The northern section of the Diamond Valley Review Area encompasses approximately 13.0 acres and is located at the northwestern limits of the town of Diamond Valley (37.258245, -113.616462)
- The southern section of the Diamond Valley Review Area encompasses approximately 69.4 acres and is located within and to the east of the town of Diamond Valley (37.251757, -113.607277)

The total area reviewed for this study encompasses approximately 360 acres of land and is located within Township 40 South, Range 16 West, Sections 8, 9, 16, 17, 21, and 35; Township 41 South, Range 16 West, Sections 1 and 2; and Township 41 South, Range 17 West, Sections 28 and 33 of the Salt Lake Baseline and Meridian. The review area is depicted in **Appendix A**, *Aquatic Resources Maps*.

Access to the Shivwits Review Area can be made by traveling northwest from St. George on Old Highway 91 approximately 10 miles or by traveling from the town of Veyo south on Gunlock Road approximately 14 miles. The Shivwits Review Area is located directly adjacent to the north side of Old Highway 91. Access to the Dammeron Valley Review Area can be made by traveling northwest from St. George on SR-18 approximately 17.5 miles or by traveling from the town of Enterprise south on SR-18 for approximately 19 miles. The boundaries of the Dammeron Valley Review Area are located directly adjacent to the east side of SR-18. The Diamond Valley Review Area is located approximately 3 miles to the south of the Diamond Valley Review Area on SR-18 and can be accessed by taking Diamond Valley Drive east off of SR-18 for approximately 0.6 mile. The boundaries of the Diamond Valley Review Area are located primarily within private residential developments.

Project Description

At this time, the proposed project is anticipated to include the construction of up to three detention basins on dry washes east of Dammeron Valley, the re-routing of existing flows to an adjacent routed channel on the south end of Dammeron Valley, the potential construction of an alternative detention basin and the re-establishment of up to three existing detention basins in Diamond Valley, armoring and protection along an existing channel in Diamond Valley, and armoring portions of the south bank of the Santa Clara River just west of the Shivwits tribal community near the Shem Dam. Two man-made ditches will also be armored in the Shivwits Review Area, and a water pipeline will be hung on the Gunlock Road bridge, replacing the existing pipeline. Additional project measures may be identified as the planning process for the proposed project moves forward.

Defined areas of permanent and temporary disturbance are currently under development and have not been finalized; however, final project measures would be designed to avoid permanent impacts to Waters of the U.S. (WOTUS), where possible, and significant impacts to WOTUS are not expected as a result of this project. For the Shivwits Review Area specifically, no rip rap or other project measures would be installed below the ordinary high watermark (OHWM) of the Santa Clara River, and no permanent impacts to the river would occur. Impacts to Washes 4 and 5 will be unavoidable due to the rerouting of Wash 4 into Wash 5.

STUDY METHODS

A focused evaluation of WOTUS located within the review area was performed from May 24– 26 and September 7–10, 2021. The methods used to identify potentially jurisdictional WOTUS and any other potential aquatic features (including wetlands) within the review area were based upon the U.S. Army Corps of Engineers' (USACE's) *Jurisdictional Determination Form Instructional Guidebook* (USACE 2007), *A Field Guide to the Identification of the Ordinary High Water Mark in the Arid West Region of the Western United States* (Lichvar and McColley 2008), the *USACE Wetland Delineation Manual* (USACE 1987), and the *Regional Supplement to the USACE Wetland Delineation Manual: Arid West Region* (USACE 2008).

Existing data was reviewed before conducting a field assessment to identify potentially jurisdictional WOTUS. Information reviewed included the following:

- Recent and historic aerial photography
- U.S. Fish and Wildlife Service National Wetlands Inventory Mapper (USFWS 2021)
- Natural Resources Conservation Service soil maps (NRCS 2021)

A Transcon Environmental, Inc. aquatic resource specialist used two methods to identify WOTUS in the field:

1. Locations with previously mapped wetlands and potentially jurisdictional water features were identified in the field and investigated
2. The review area was traversed and inspected for signs of wetlands and water features (e.g., changes in vegetation, depressions holding water, or channels), which were then investigated

OHWM data was collected for the Santa Clara River and all ditches and washes with a distinct OHWM within the review area. Excepting where the proposed pipeline would be hung on the Gunlock Road bridge, the OHWM of the Santa Clara River was only delineated along its southern banks, as all remaining proposed project activities will occur to the south and outside of the OHWM for the river. Additionally, a formal wetland delineation was conducted adjacent to the Santa Clara River in order to determine the extent of a suspected wetland.

Photographs taken during field review can be found in **Appendix B**. OHWM and photo locations are indicated on the *Aquatic Resources Detail Map* in **Appendix A**. The datasheets used to collect OHWM and wetland data can be found in **Appendix C**.

EXISTING CONDITIONS

Existing Field Conditions

Land Use

Much of the Dammeron Valley and Diamond Valley review areas are disturbed and currently occupied by residential and agricultural development. The areas not occupied by residential or agricultural land is undeveloped, native lands with signs of recreational use such as hiking, hunting, and off-road vehicle use.

The lands within the Shivwits Review Area include fallow agricultural fields (now used for grazing) and the Santa Clara River riparian corridor. Surrounding lands mostly consist of undeveloped native land used for grazing.

Vegetation

Vegetation found in the Dammeron Valley and Diamond Valley review areas are similar and consist almost entirely of upland shrub-steppe and woodland species. Vegetation found in the Shivwits Review Area consists of riparian-dominant trees and shrubs associated with the Santa Clara River surrounded by mixed desert scrub species.

Dominant ecological systems in the review areas include Introduced Upland Vegetation—Shrub; Inter-Mountain Basins Big Sagebrush Shrubland; Mojave Mid-Elevation Mixed Desert Scrub; Sonara-Mojave Mixed Salt Desert Scrub; Inter-Mountain Basins Semi-Desert Shrub Steppe; Introduced Upland Vegetation—Annual Grassland; Pasture/Hay; North American Warm Desert Lower Montane Riparian Woodland and Shrubland; Great Basin Pinyon-Juniper Woodland; and Developed, Open Space (USGS 2021). Dominant native vegetation observed within the review area includes narrow-leaf cottonwood (*Populus angustifolia*), coyote willow (*Salix exigua*), tamarisk (*Tamarix ramosissima*), narrow-leaf cattail (*Typha angustifolia*), Utah juniper (*Juniperus osteosperma*), sagebrush (*Artemesia tridentata*), and salt bush (*Atriplex confertifolia*).

Soils

NRCS soils surveys indicate nine native soil types in the review area (NRCS 2021). **Table 1** lists the soil types and whether they meet the NRCS hydric soils criteria. Of the nine soil types identified within the review area, only one, *Fluvaquents and torrifluvents, sandy*, is indicated to be hydric. The NRCS custom resource report, including a description and map for all soils contained within the review area, is located in **Appendix D**.

TABLE 1
NATIVE SOIL TYPES IN THE REVIEW AREA

Map Unit Name	Acres in Review Area	Percent of Review Area	NRCS Hydric Soil
Badland, very steep	6.5	1.8	No
Eroded land-Shalet complex, warm	3.6	1.0	No
Fluvaquents and torrifluvents, sandy	9.8	2.7	Yes
Leeds silty clay loam, 1 to 2 percent slopes	43.7	12.2	No

TABLE 1 NATIVE SOIL TYPES IN THE REVIEW AREA			
Map Unit Name	**Acres in Review Area**	**Percent of Review Area**	**NRCS Hydric Soil**
Mogatsu-Pastura complex, 2 to 20 percent slopes	138.3	38.4	No
Naplene silt loam, 2 to 6 percent slopes	100.2	27.8	No
Redbank fine sandy loam, 1 to 5 percent slopes	24.8	6.9	No
Water	0.9	0.3	No
Yaki very cobbly loam, 3 to 35 percent slopes	32	8.9	No

OBSERVATIONS

Overview

One river, two ditches, nine washes, and one potential wetland were identified during desktop and field reviews. Descriptions of each feature are detailed below.

Santa Clara River (Photos 1–3 and 11–13; Sheets 1–2, Aquatic Resources Detail Map)

The OHWM of the Santa Clara River meandered in and out of the northern limits of the Shivwits Review Area and was delineated for approximately 1.39 miles. With the exception of an approximately 140-foot area beginning at the Gunlock Road bridge, where the delineation was conducted from bank to bank, the OHWM data was taken from the outermost channel; however, the river contained multiple channels in some places as it traveled along the northern limits of the review area. Along the entirety of the banks of the Santa Clara River reviewed as part of this survey was thick, riparian vegetation including but not limited to narrow-leaf cottonwood, coyote willow, tamarisk, and narrow-leaf cattail. The substrate within the river consisted of cobbles towards the northern section under the Gunlock Road bridge and transitioned to sand and mud further downstream. The banks of the river within the review area were steep walled and exhibited signs of significant erosion during periods of high flow.

Flows within this section of the Santa Clara River appeared to be permanent in nature and were observed during the survey to vary from swift to low. Multiple active beaver dams have affected the flow of the river in this area. Flows carried by the Santa Clara River traveled southeast from the review area and continued south for approximately 14 miles before converging with the Virgin River.

Potential Wetland 1 (Photos 4–8; Sheet 1, Aquatic Resources Detail Map)

Potential Wetland 1 was located adjacent to the south side of the Santa Clara River at the northern limits of the Shivwits Review Area. Although the soil depths did not meet the technical definition of hydric soils, the soil components observed during field delineation did indicate the presence of hydric soils. These indicators included hydrogen sulfide, sandy mucky material, and stratified layers. The water table was high in this area, and there were portions that were inundated with up to 2 inches of water at the time of survey. In addition to the presence of hydric soil indicators, vegetation within this area consisted of riparian and hydrophytic species including *Phragmites* spp., narrow-leaf cattail, tamarisk, coyote willow, and narrow-leaf cottonwood. The entirety of Potential Wetland 1 was within the OHWM of the Santa Clara River. The southern edge of the potential wetland was bordered by a sandy bank with large boulders and a mix of riparian and upland vegetation. The northern edge of the potential wetland was defined by the southernmost, swift-flowing channel of the Santa Clara River.

Ditch 1 (Photos 9 and 10; Sheet 2, Aquatic Resources Detail Map)

Ditch 1 entered the south side of the Shivwits Review Area via a culvert south of Gunlock Road. Flows traveled northwest for approximately 250 feet before turning northeast towards the Santa Clara River. The initial 250 feet of the ditch was improved with stone walls and a concrete bottom and was approximately 5 feet wide. The ditch blows out and no longer contained any improvements after approximately 250 feet, when it began to follow the natural contours of the land. After the blowout and for approximately 282 feet, the OHWM was clearly visible within the steep-walled drainage. The OHWM was barely visible in the final approximately 54 feet before draining into the Santa Clara River and was primarily covered in upland vegetation mixed with some riparian vegetation.

Within the review area, Ditch 1 encompassed approximately 0.07 acre and was 585 feet in length. Ditch 1 appeared to be ephemeral in nature, as it likely only conveys seasonal stormwaters from the basin located 0.5 mile southwest as well as runoff from Old Highway 91.

Ditch 2 (Photos 14–16; Sheet 2, Aquatic Resources Detail Map)

Ditch 2 entered the Shivwits Review Area via a culvert south of Old Highway 91. Flows traveled northeast towards the Santa Clara River. The initial approximately 327 feet of the ditch was improved with stone walls and a concrete bottom and was approximately 5 feet wide. After approximately 327 feet, the ditch dropped off of a heavily eroded bank where the OHWM was barely visible beneath vegetation and debris. Approximately 51 feet after the drop, the ditch drained into the Santa Clara River.

Within the review area, Ditch 2 encompassed approximately 0.03 acre and was 378 feet in length. Ditch 2 appeared to be ephemeral in nature, as it conveyed seasonal stormwaters from the basin located 0.3 mile south as well as runoff from Old Highway 91.

Wash 1 (Photos 17–24; Sheets 3–6, Aquatic Resources Detail Map)

Wash 1 entered the northern section of the Dammeron Valley Review Area near its northeastern limits. Flows traveled southwest for the initial approximately 0.45 mile. This portion of the wash began with a sandy substrate which progressively transitioned to more cobble and pebble. Vegetation adjacent to the wash consisted of upland vegetation. The width varied and began to taper further downstream with an average width of approximately 3.5 feet.

At approximately 0.45 mile, the wash entered the developed area of Dammeron Valley and flowed east. It crossed beneath Homestead Drive East via a culvert; entered lands that were within an active vineyard; and continued east crossing North Dammeron Valley Drive, North Canyon Trails Drive, SR-18, and North Carters Pond Road via culverts before exiting the review area approximately 165 feet after crossing North Carters Pond Road. This portion of the wash was approximately 0.81 mile and was heavily disturbed by the surrounding residential and agricultural areas. Significant disturbances included berming, redirected flows, and other unnatural topographical changes. After crossing North Dammeron Valley Road, the wash followed the alignment of a series of what appear to be man-made ditches where the OHWM was hardly discernable. The substrate of this portion of the wash consisted of sandy and rocky soil overgrown with vegetation (mostly native and invasive upland grasses). The width of Wash 1 in this portion was approximately 2 feet. Upon exiting the review area, the wash continued flowing west before dissipating just east of Upper Sand Cove Reservoir.

Within the review area, Wash 1 encompassed approximately 0.37 acre and was 1.24 miles in length. Wash 1 appeared to be ephemeral in nature, as it likely conveys seasonal stormwaters from the surrounding basins as well as runoff from the town roads and properties within the town of Dammeron Valley.

Wash 2 (Photos 25–27; Sheet 6, Aquatic Resources Detail Map)

Wash 2 entered the northern section of the Dammeron Valley Review Area near its southeastern limits. Flows traveled southeast within the review area. The OHWM was barely visible throughout much of the wash, as it conveyed sheet flow from the surrounding uplands, only becoming obvious in areas of high flow volume. Just as the wash entered the residential area in the town of Dammeron Valley, flows dissipated to the extent that the OHWM was no longer visible. The substrate of this wash consisted of sandy and rocky soil, and the width was between 1.5 to 2 feet throughout.

Within the review area, Wash 2 encompassed approximately 0.07 acre and was 0.32 mile long. Wash 2 appeared to be ephemeral in nature, as it conveyed seasonal stormwaters from the surrounding basins. Before leaving the review area, flows dissipated into the adjacent residential area.

Wash 3 (Photos 28 and 29; Sheet 6, Aquatic Resources Detail Map)

Wash 3 entered the northern section of the Dammeron Valley Review Area at its southeastern corner. Flows traveled northwest within the review area, ultimately converging with Wash 2. The OHWM was barely visible throughout much of the wash, as it conveyed sheet flow from the surrounding uplands, only becoming obvious in areas of high flow volume. The substrate of this wash consisted of sandy and rocky soil, and the width was approximately 1.5 feet throughout.

Within the review area, Wash 3 encompassed approximately 0.03 acre and was 893 feet in length. Wash 3 appeared to be ephemeral in nature, as it conveyed stormwater from the surrounding basins and a small hill to the southeast.

Wash 4 (Photos 30–31 and 34–35; Sheets 7–8, Aquatic Resources Detail Map)

Wash 4 entered the southern section of the Dammeron Valley Review Area at the northeastern limits of the review area. Flows traveled west within the review area and generally followed the alignment of the adjacent unpaved roadway, Horseman Park Drive. This wash was defined by steep walls and a narrow width (2 feet wide on average) with a sandy to rocky substrate surrounded by upland vegetation. Minor anthropogenic influences on this wash included a dirt road crossing.

Within the review area, Wash 4 encompassed approximately 0.09 acre and was 0.37 mile in length. Wash 4 appeared to be ephemeral in nature, as it conveyed stormwater from the surrounding basins and nearby hills and mountains. The flows conveyed by this wash exit the review area, travel under SR-18, and continue north in a ditch along SR-18 before dissipating into the surrounding residential areas of Dammeron Valley.

Wash 5 (Photos 32 and 33; Sheet 7, Aquatic Resources Detail Map)

Wash 5 entered the southern section of the Dammeron Valley Review Area at the southwestern limits of the review area. Flows traveled west-southwest within the review area. As the wash entered the review area, it appeared to have few anthropogenic influences on its shape or flow; the wash was defined by a distinct OHWM with an average width of approximately 11 feet. The substrate was cobble and rocky, and the wash was surrounded by upland vegetation. After approximately 343 feet, the wash crossed an unpaved and overgrown road, where it lost much of its definition. The OHWM was significantly thinner, averaging approximately 5 feet for the next approximately 530 feet, although the substrate and surrounding vegetation remained the same. Debris accumulated within the wash just before it entered a culvert beneath SR-18. Upon exiting the culvert, the wash continued for approximately 671 feet before exiting the review area. Within this portion of the wash, the OHWM had an average width of about 10 feet, with a maximum width of 16 feet as it exited the culvert.

Within the review area, Wash 5 encompassed approximately 0.09 acre and was 527 feet in length. Wash 5 appeared to be ephemeral in nature, as it conveyed stormwater from the surrounding basins and runoff from

SR-18. After exiting the review area, Wash 5 continued west for approximately 0.65 mile before draining into a larger wash where flows continued west for another 2.8 miles before converging with Sand Cone Wash. Flows continued east for 4.7 miles before draining into Gunlock Reservoir.

Wash 6 (Photos 36–41; Sheets 9 and 10, Aquatic Resources Detail Map)

Wash 6 entered the northern section of the Diamond Valley Review Area at its northern limits and continued into the southern section of the Diamond Valley Review area where it exited at the southwestern corner. Flows traveled south within the review area. Where the wash entered the review area and up until it crossed a frequently used unpaved road, it appeared to have few anthropogenic influences on its shape or flow and was defined by steep banks and a distinct OHWM with an average width of approximately 7 feet. The substrate consisted of large rocks to small cobbles, and the wash was surrounded by upland vegetation. After crossing the unpaved road, the wash continued for approximately 0.28 mile before exiting the review area for the first time. The OHWM in this section was still distinct, with an average width of approximately 8 feet and the substrate remaining unchanged; however, there were significantly more anthropogenic influences on flows, specifically from dirt and rock fill that have created berms.

Wash 6 entered the Diamond Valley Review Area for the second time in the southern section at its western limits, where it crossed West Jade Drive before exiting the review area again after approximately 309 feet. Flows in this portion have been heavily affected by anthropogenic influences including concrete and rip rap bank stabilization. The OHWM was clearly defined and averages approximately 5 feet. The substrate was sandy with some rocks and cobble, and the banks abutted residential properties and roads. The vegetation consisted of a mix of native and exotic upland and landscape species.

Wash 6 entered the Diamond Valley Review Area for the final time in the southwestern corner of the southern section, where it crossed West Diamond Valley Drive before exiting the review area after approximately 376 feet. This portion of Wash 6 was similar to the previous section in its anthropogenic influences, OHWM, substrate, and vegetation.

Within the review area, Wash 6 encompassed approximately 0.55 acre and was 0.37 mile in length. Wash 6 appeared to be ephemeral in nature. Wash 6 appeared to either be a tributary of or the southernmost portion of Rock Hollow Wash, which conveyed stormwater and snowmelt runoff from the Pine Valley Mountains located 7 miles northeast. After exiting the review area, Wash 6 continued 1.2 miles to the southwest before losing definition along the southern base of the Cinder Cone volcano.

Wash 7 (Photos 43–45 and 47; Sheets 11 and 12, Aquatic Resources Detail Map)

Wash 7 began in the southern section of the Diamond Valley Review Area near the northeastern corner. This wash has been heavily affected by anthropogenic influences including berms, unpaved roads, grading on residential lots, and a detention basin 150 feet east of the headwaters (**Photo 46**); however, it did appear to generally follow the alignment of a natural wash that flowed east. The OHWM throughout the review area was poorly defined and at points dissipated altogether, causing Wash 7 to be separated into three sections within the review area. The OHWM again became defined after dissipating once enough sheet flow from the hill to the north drained into it. This in turn increased flows within the alignment of the original wash. The substrate for this wash ranged from fine to cobbles and pebbles and was surrounded by upland vegetation that in places grew within the OHWM. The wash crossed beneath two small culverts beneath residential roads and continued before crossing West Diamond Valley Road via a larger culvert and draining into a detention basin (**Photo 42**).

Within the review area, Wash 7 encompassed approximately 0.10 acre and was a discontinuous 0.33 mile. Wash 7 appeared to be ephemeral in nature, as it conveyed stormwater that overflows from the detention basin to the east and sheetflow from the hillside to the north. Wash 7 ultimately drained into a detention basin within the Diamond Valley Review Area.

Wash 8 and 8a (Photos 47–52; Sheet 12, Aquatic Resources Detail Map)

Washes 8 and 8a entered the southern section of the Diamond Valley Review Area at the southeastern corner. Wash 8a was a small (only 36 feet within the review area) wash that conveyed runoff north from the unpaved road approximately 94 feet south of the review area before converging with Wash 8. The substrate of Wash 8a was rocky, and the average width of the OHWM was 1 foot. Wash 8 flowed west for approximately 704 feet. This portion of the wash appeared natural, with a clearly defined OHWM with an average width of approximately 4 feet. The substrate within the wash was fine to rocky. Vegetation adjacent to the wash consisted of upland vegetation. After approximately 704 feet, the wash flowed north and was heavily affected by anthropogenic influences including a large berm and unpaved road. The wash followed an unpaved road where the OHWM was poorly defined for approximately 0.21 mile before draining into a detention basin (**Photo 48**). In this portion, the surrounding vegetation consisted of upland grasses, while the substrate was fine mixed occasionally with small rocks.

Within the review area, Washes 8 and 8a encompassed approximately 0.10 acre and were a combined 0.35 mile. Both washes appeared to be ephemeral in nature. Before converging with Wash 8, Wash 8a conveyed runoff from the nearby dirt road. In addition to conveying seasonal stormwaters from the basin 0.55 mile east, Wash 8 conveyed runoff from the same dirt road as well as sheetflow from the hill to the north and east. Wash 8 ultimately drained into a detention basin within the Diamond Valley Review Area.

CONCLUSION

Within the 360-acre review area, one river, two ditches, nine washes, and one potential wetland were identified. Of these features, both ditches and seven washes show some level of anthropogenic influences ranging from minor to significant. **Table 2** below lists the features and their attributes as well as in which review area they are located.

TABLE 2
AQUATIC FEATURES OBSERVED IN THE REVIEW AREA

Feature Name	Linear Feet	Acres	Review Area
Santa Clara River	7,339	N/A	Shivwits
Potential Wetland 1	N/A	0.27	Shivwits
Ditch 1	585	0.07	Shivwits
Ditch 2	378	0.03	Shivwits
Wash 1	6,568	0.37	Dammeron Valley
Wash 2	1,666	0.65	Dammeron Valley
Wash 3	939	0.30	Dammeron Valley
Wash 4	1,942	0.09	Dammeron Valley
Wash 5	527	0.09	Diamond Valley
Wash 6	2,929	0.51	Diamond Valley
Wash 7	1,761	0.11	Diamond Valley
Wash 8	1,820	0.10	Diamond Valley
Wash 8a	36	0.00	Diamond Valley

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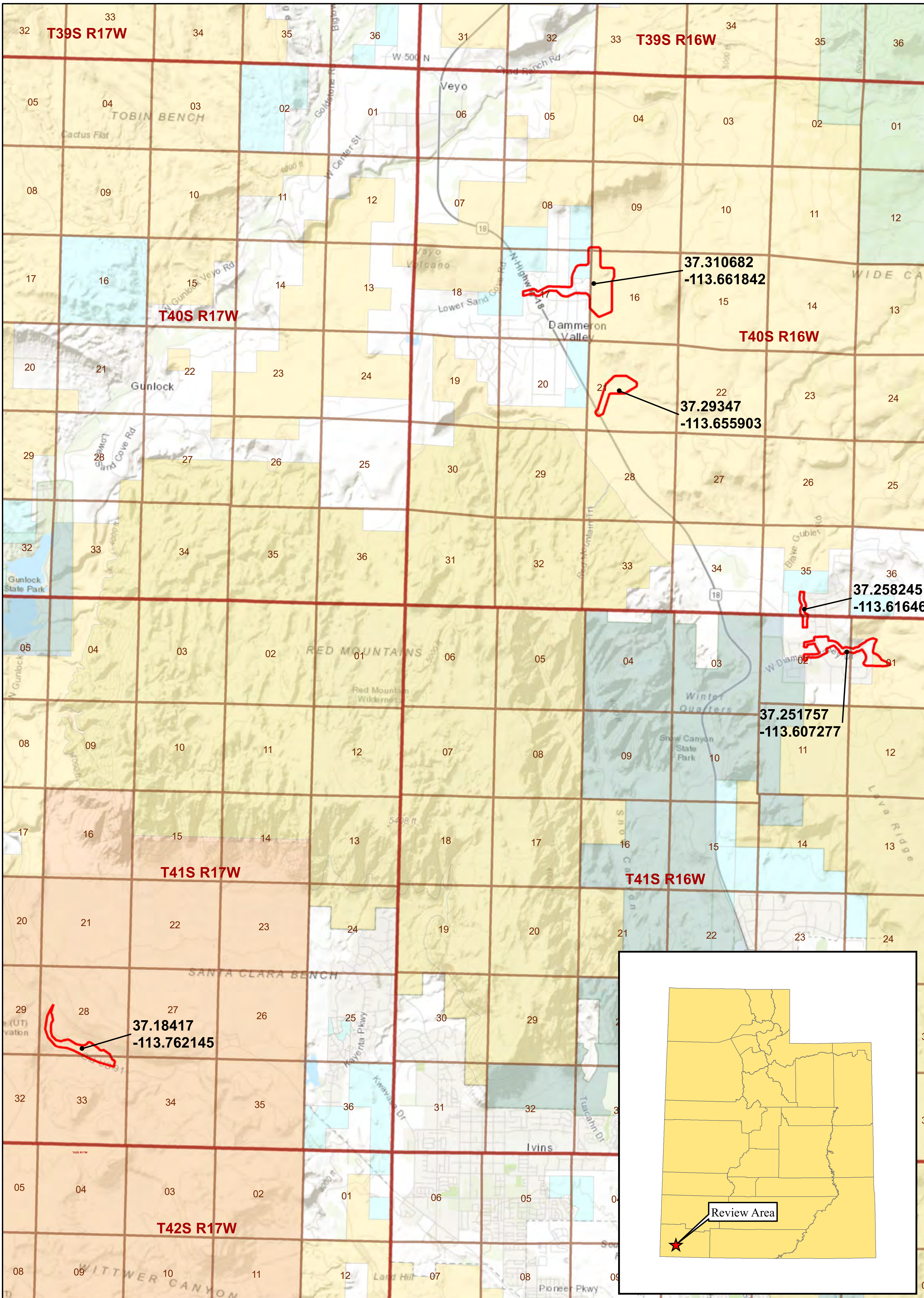
APPENDIX A

AQUATIC RESOURCES MAPS



Santa Clara Watershed EA SPK 2021-00134	Drawn By: C Melisi Date: 10/11/2021	**Project Location**

No.	Revision	Date	By	Appr.

0 0.5 1 2 3
Miles

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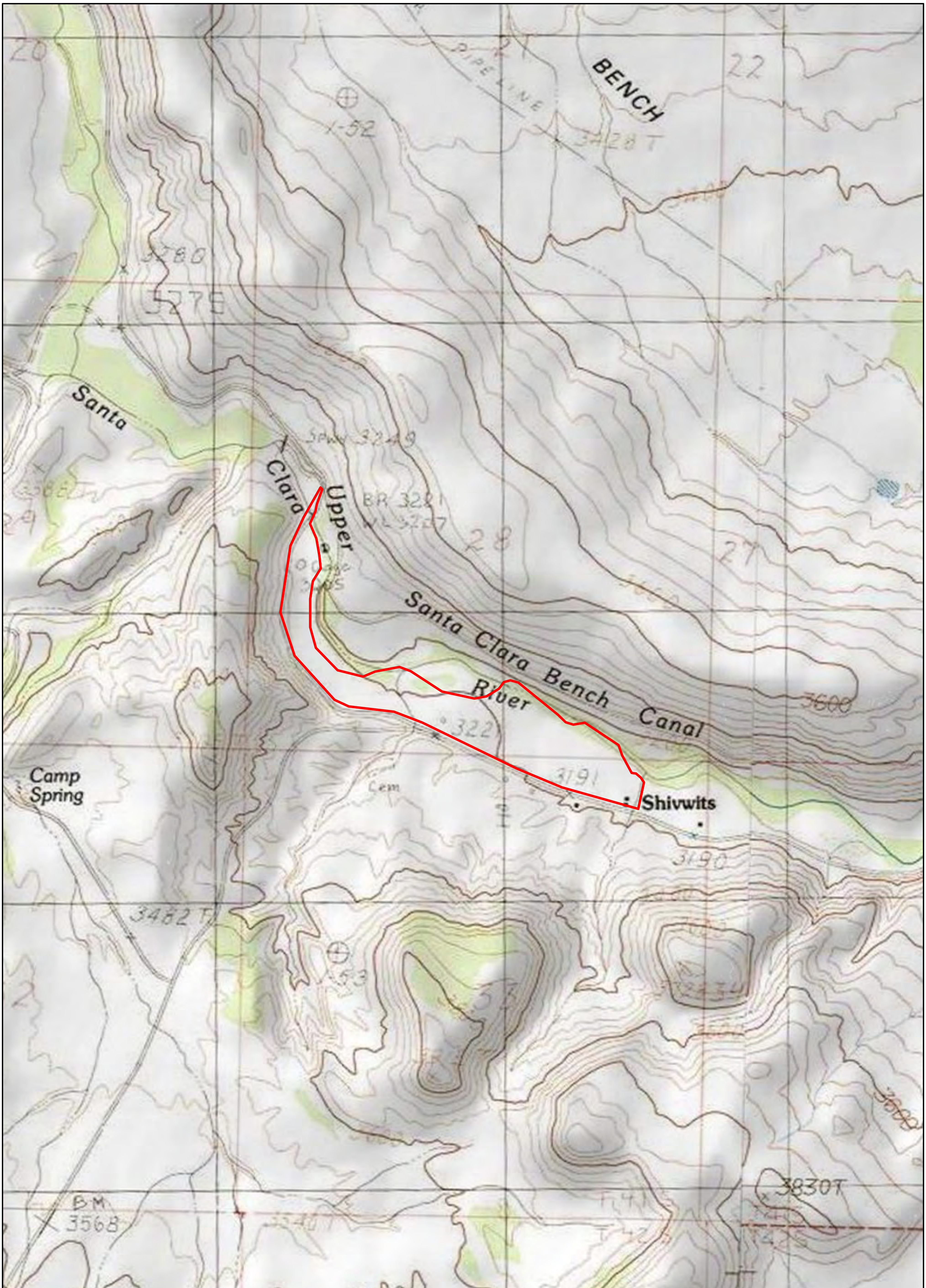
Legend

Review Area

Land Jurisdiction

- Bureau of Land Management
- Indian Reservation
- US Forest Service
- School and Institutional Trust Lands Administration
- Utah State Parks
- Private



Santa Clara Watershed EA SPK 2021-00134	Drawn By: C Melisi Date: 10/8/2021	**USGS 7.5' Quad Map (*Shivwits*, Utah)** **(Shivwits Review Area)**

No.	Revision	Date	By	Appr.

N

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Feet

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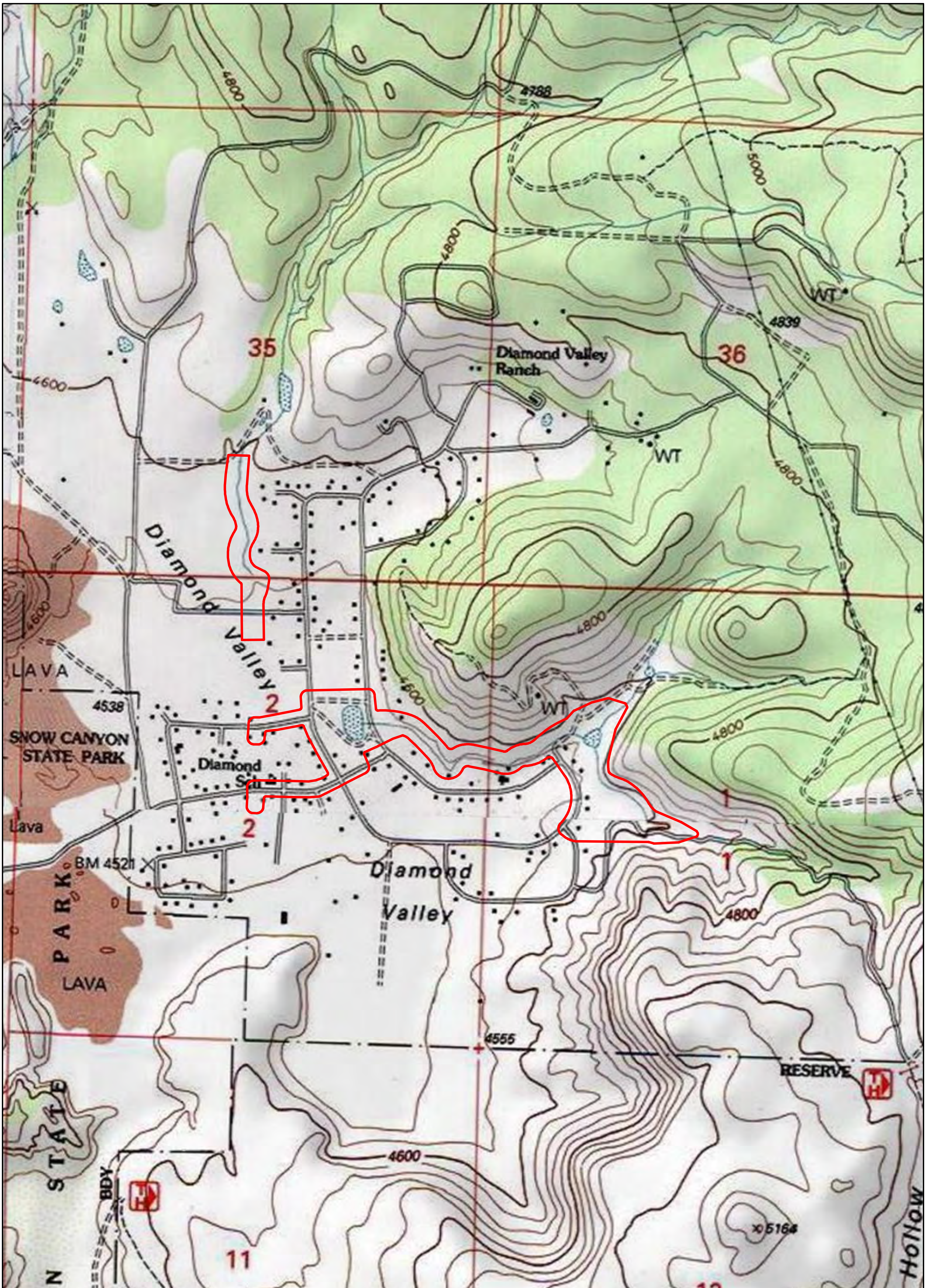
Legend

Review Area



Santa Clara Watershed EA SPK 2021-00134	Drawn By: C Melisi Date: 10/8/2021	USGS 7.5' Quad Map (*Saddle Mountain* and *Washington*, Utah) (Diamond Valley Review Area)	**Legend** Review Area

No.	Revision	Date	By	Appr.

N

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Feet

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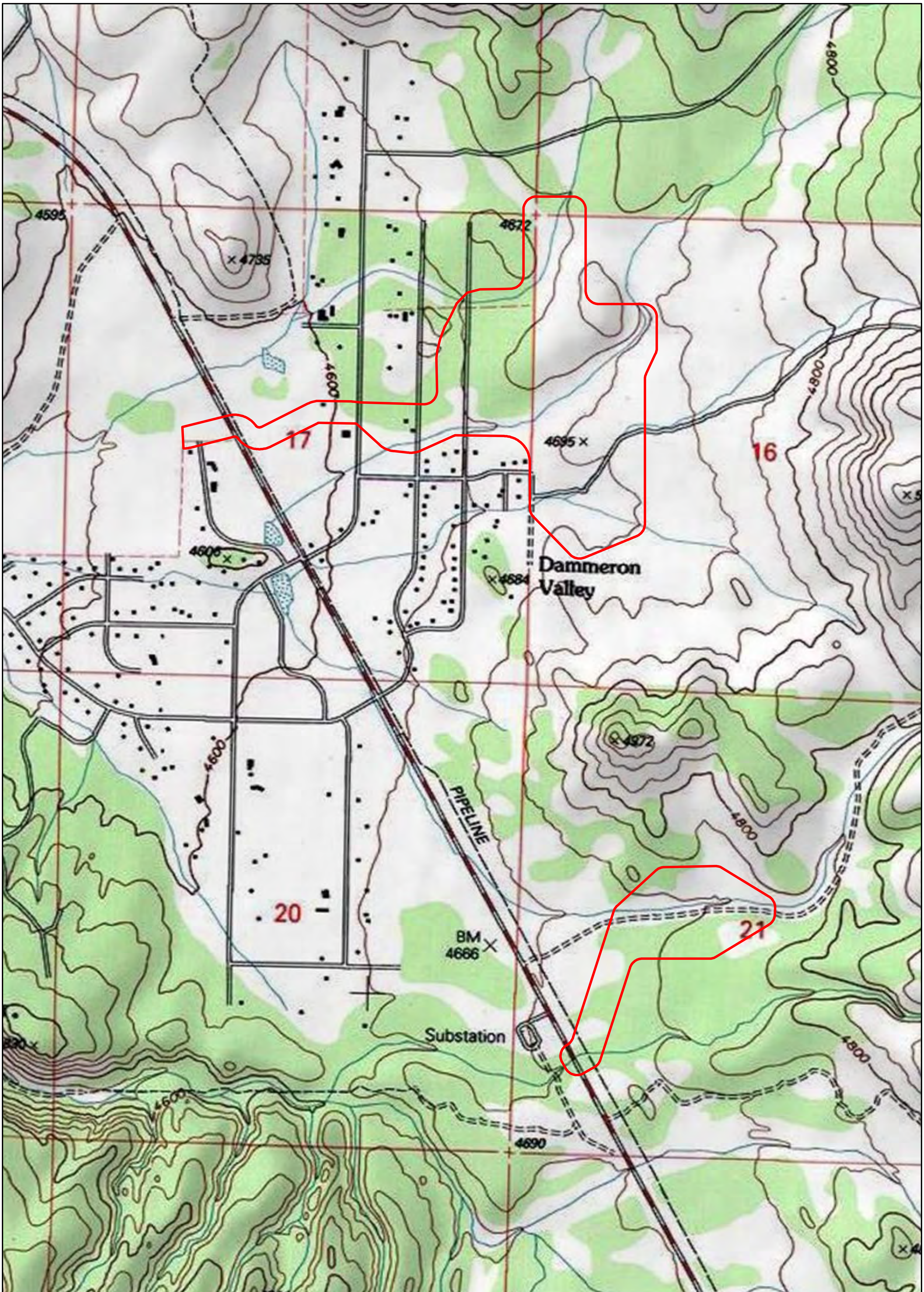

Santa Clara Watershed EA SPK 2021-00134	Drawn By: C Melisi Date: 10/8/2021	**USGS 7.5' Quad Map (*Veyo,* Utah)** **(Dammeron Valley Review Area)**	**Legend** Review Area

No.	Revision	Date	By	Appr.

N

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Feet

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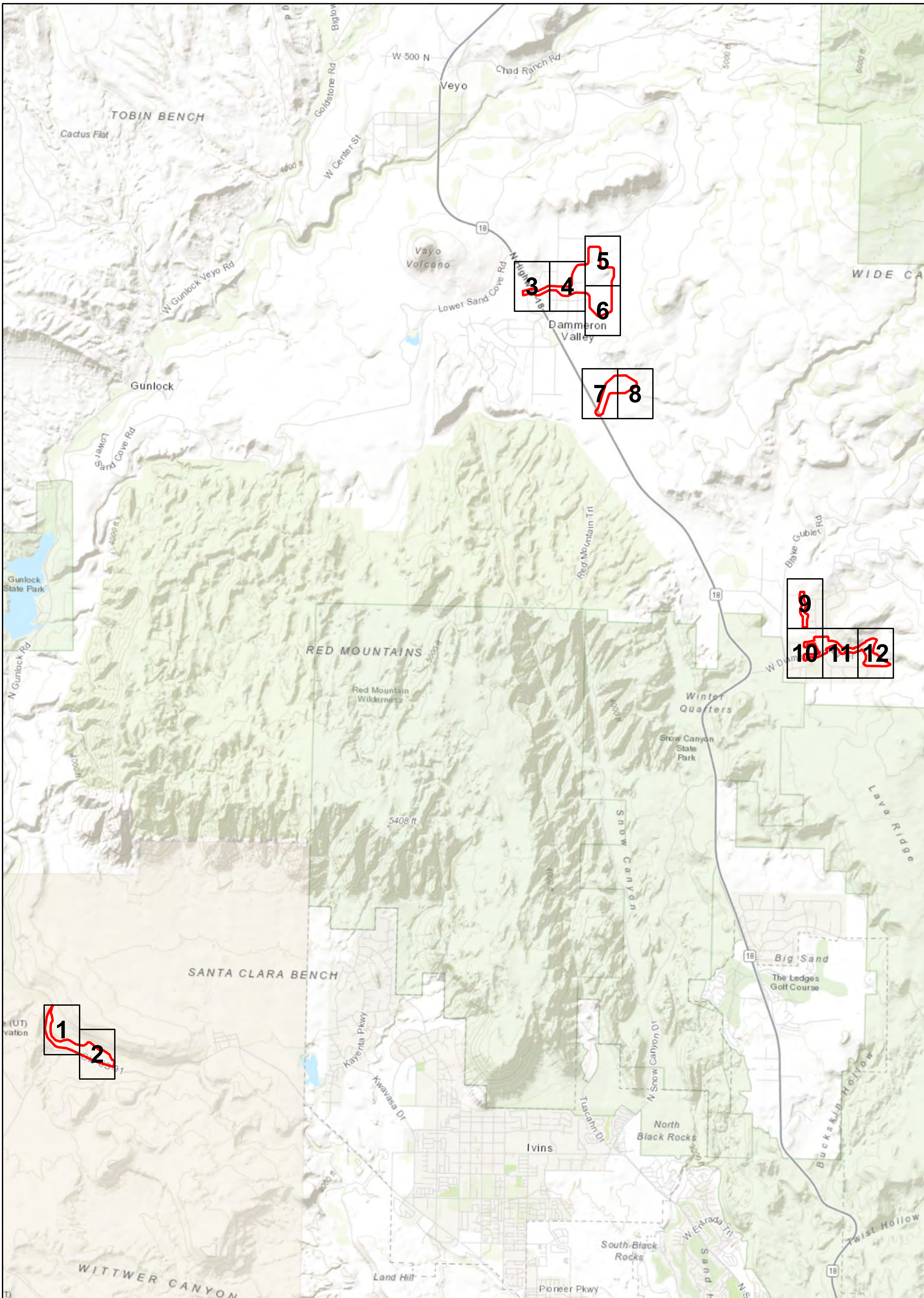

Santa Clara Watershed EA
SPK 2021-00134

Drawn By: C Melisi
Date: 10/8/2021

Aquatic Resources Detail Map (Index)

No.	Revision	Date	By	Appr.

N

0 0.5 1 2
Miles

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Legend

Review Area

Sheet

ID	Lat	Long	Feet	Ac
Santa Clara River	37.189801	-113.768182	7339	N/A
Potential Wetland 1	37.289830	-113.658971	N/A	0.27
Ditch 1	37.184544	-113.764285	585	0.07
Ditch 2	37.181528	-113.755406	378	0.03
Wash 1	37.256417	-113.616200	6568	0.37
Wash 2	37.252145	-113.604987	1666	0.65
Wash 3	37.307989	-113.659420	939	0.3
Wash 4	37.306843	-113.658447	1942	0.09
Wash 5	37.310149	-113.664785	527	0.09
Wash 6	37.250350	-113.600470	2929	0.51
Wash 7	37.249609	-113.598584	1761	0.11
Wash 8	37.294549	-113.654708	1820	0.1
Wash 8a	37.252492	-113.609656	36	0

Santa Clara Watershed EA
SPK 2021-00134

Drawn By: C Melisi
Date: 6/7/2022

Aquatic Resources Detail Map (Sheet 1 of 12)

No.	Revision	Date	By	Appr.
1	Added pit locations to sheet 1. Correct lat/long of wetland 1.	6/7/2022	J. Pfadt	

N

0 200 400
Feet

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Legend

- Review Area
- Photo Location
- OHWM Data Plot
- Pit Location
- Santa Clara River Ordinary High Water Mark
- Ordinary High Water Mark
- Potential Wetland Limits

ID	Lat	Long	Feet	Ac
Santa Clara River	37.189801	-113.768182	7339	N/A
Potential Wetland 1	37.185060	-113.764722	N/A	0.27
Ditch 1	37.184544	-113.764285	585	0.07
Ditch 2	37.181528	-113.755406	378	0.03
Wash 1	37.256417	-113.616200	6568	0.37
Wash 2	37.252145	-113.604987	1666	0.65
Wash 3	37.307989	-113.659420	939	0.3
Wash 4	37.306843	-113.658447	1942	0.09
Wash 5	37.310149	-113.664785	527	0.09
Wash 6	37.250350	-113.600470	2929	0.51
Wash 7	37.249609	-113.598584	1761	0.11
Wash 8	37.294549	-113.654708	1820	0.1
Wash 8a	37.252492	-113.609656	36	0

Santa Clara Watershed EA
SPK 2021-00134

Drawn By: C Melisi
Date: 6/7/2022

Aquatic Resources Detail Map (Sheet 2 of 12)

No.	Revision	Date	By	Appr.
1	Added pit locations to sheet 1. Correct lat/long of wetland 1.	6/7/2022	J. Pfadt	

N

0 200 400
Feet

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Legend

- Review Area
- Photo Location
- OHWM Data Plot
- Santa Clara River Ordinary High Water Mark
- Ordinary High Water Mark

ID	Lat	Long	Feet	Ac
Santa Clara River	37.189801	-113.768182	7339	N/A
Potential Wetland 1	37.185060	-113.764722	N/A	0.27
Ditch 1	37.184544	-113.764285	585	0.07
Ditch 2	37.181528	-113.755406	378	0.03
Wash 1	37.256417	-113.616200	6568	0.37
Wash 2	37.252145	-113.604987	1666	0.65
Wash 3	37.307989	-113.659420	939	0.3
Wash 4	37.306843	-113.658447	1942	0.09
Wash 5	37.310149	-113.664785	527	0.09
Wash 6	37.250350	-113.600470	2929	0.51
Wash 7	37.249609	-113.598584	1761	0.11
Wash 8	37.294549	-113.654708	1820	0.1
Wash 8a	37.252492	-113.609656	36	0

Santa Clara Watershed EA
SPK 2021-00134

Drawn By: C Melisi
Date: 6/7/2022

No.	Revision	Date	By	Appr.
1	Added pit locations to sheet 1. Correct lat/long of wetland 1.	6/7/2022	J. Pfadt	

Aquatic Resources Detail Map
(Sheet 3 of 12)

N

0 200 400
Feet

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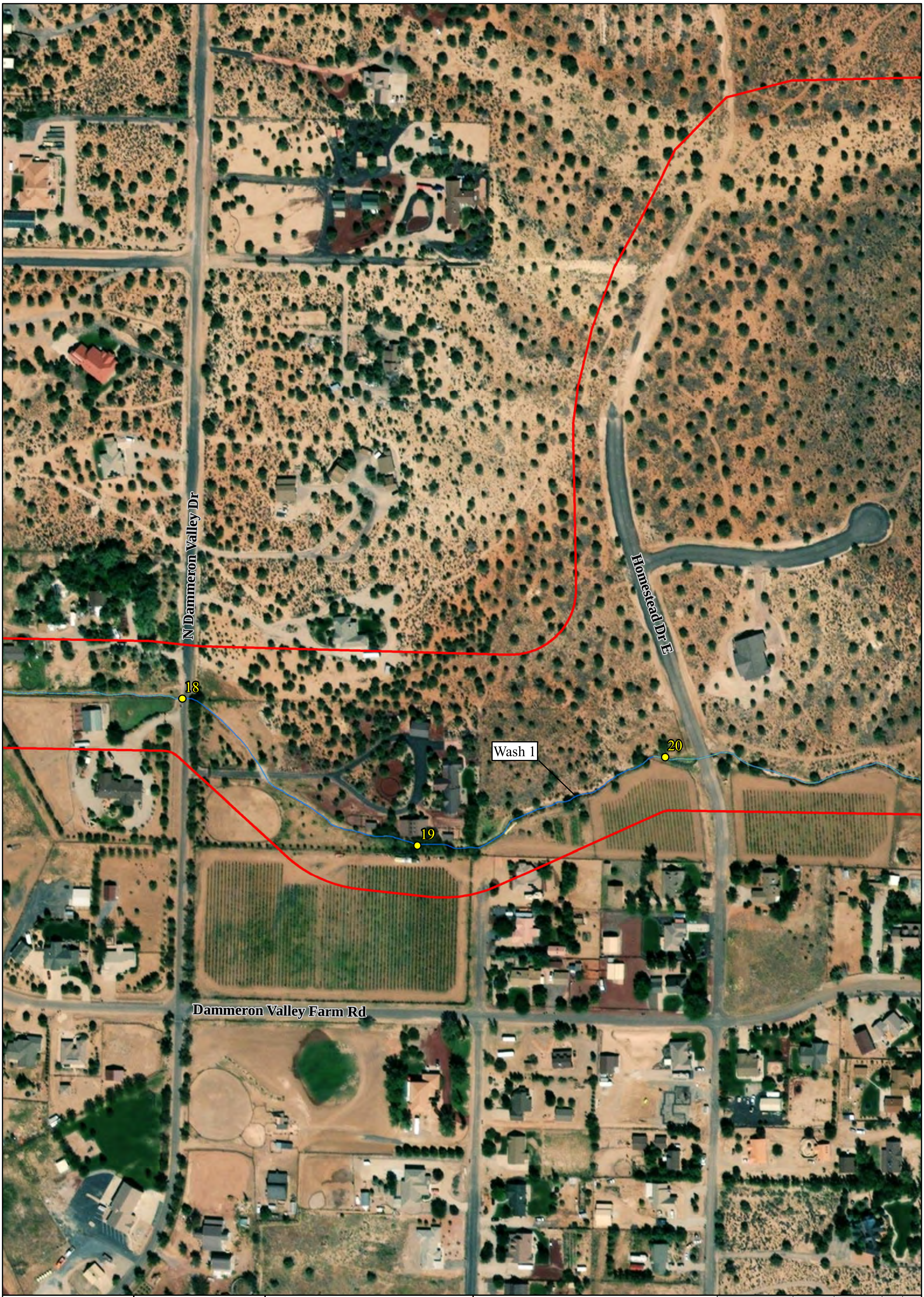
Legend

- Review Area
- Photo Location
- OHWM Data Plot
- Ordinary High Water Mark

ID	Lat	Long	Feet	Ac
Santa Clara River	37.189801	-113.768182	7339	N/A
Potential Wetland 1	37.185060	-113.764722	N/A	0.27
Ditch 1	37.184544	-113.764285	585	0.07
Ditch 2	37.181528	-113.755406	378	0.03
Wash 1	37.256417	-113.616200	6568	0.37
Wash 2	37.252145	-113.604987	1666	0.65
Wash 3	37.307989	-113.659420	939	0.3
Wash 4	37.306843	-113.658447	1942	0.09
Wash 5	37.310149	-113.664785	527	0.09
Wash 6	37.250350	-113.600470	2929	0.51
Wash 7	37.249609	-113.598584	1761	0.11
Wash 8	37.294549	-113.654708	1820	0.1
Wash 8a	37.252492	-113.609656	36	0



Santa Clara Watershed EA
SPK 2021-00134

Drawn By: C Melisi
Date: 6/7/2022

No.	Revision	Date	By	Appr.
1	Added pit locations to sheet 1. Correct lat/long of wetland 1.	6/7/2022	J. Pfadt	

Aquatic Resources Detail Map (Sheet 4 of 12)

N

0 200 400
Feet

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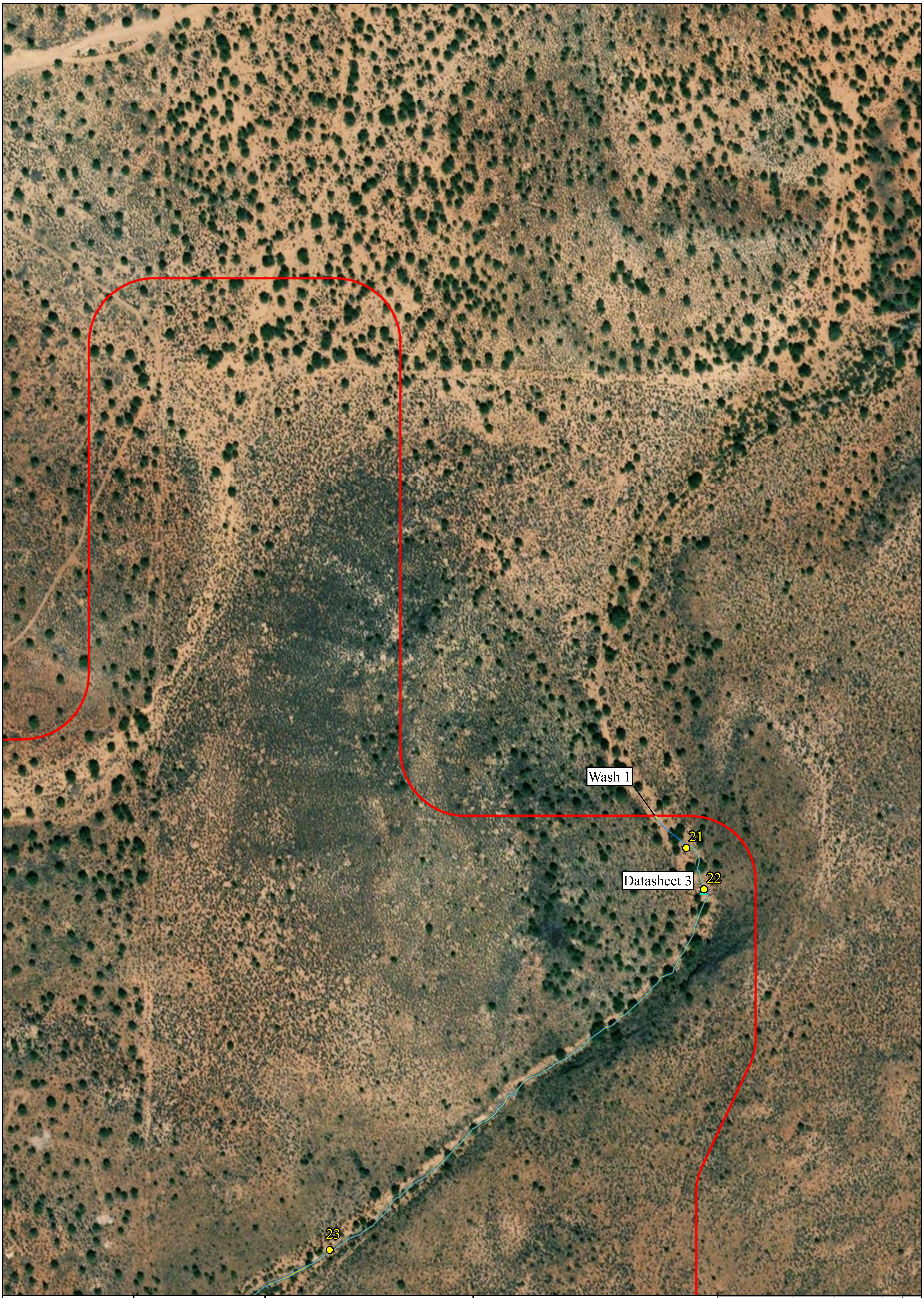
Legend

- Review Area
- Photo Location
- OHWM Data Plot
- Ordinary High Water Mark

ID	Lat	Long	Feet	Ac
Santa Clara River	37.189801	-113.768182	7339	N/A
Potential Wetland 1	37.185060	-113.764722	N/A	0.27
Ditch 1	37.184544	-113.764285	585	0.07
Ditch 2	37.181528	-113.755406	378	0.03
Wash 1	37.256417	-113.616200	6568	0.37
Wash 2	37.252145	-113.604987	1666	0.65
Wash 3	37.307989	-113.659420	939	0.3
Wash 4	37.306843	-113.658447	1942	0.09
Wash 5	37.310149	-113.664785	527	0.09
Wash 6	37.250350	-113.600470	2929	0.51
Wash 7	37.249609	-113.598584	1761	0.11
Wash 8	37.294549	-113.654708	1820	0.1
Wash 8a	37.252492	-113.609656	36	0



Santa Clara Watershed EA
SPK 2021-00134

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No.	Revision	Date	By	Appr.
1	Added pit locations to sheet 1. Correct lat/long of wetland 1.	6/7/2022	J. Pfadt	

Aquatic Resources Detail Map
(Sheet 5 of 12)

N

0 200 400
Feet

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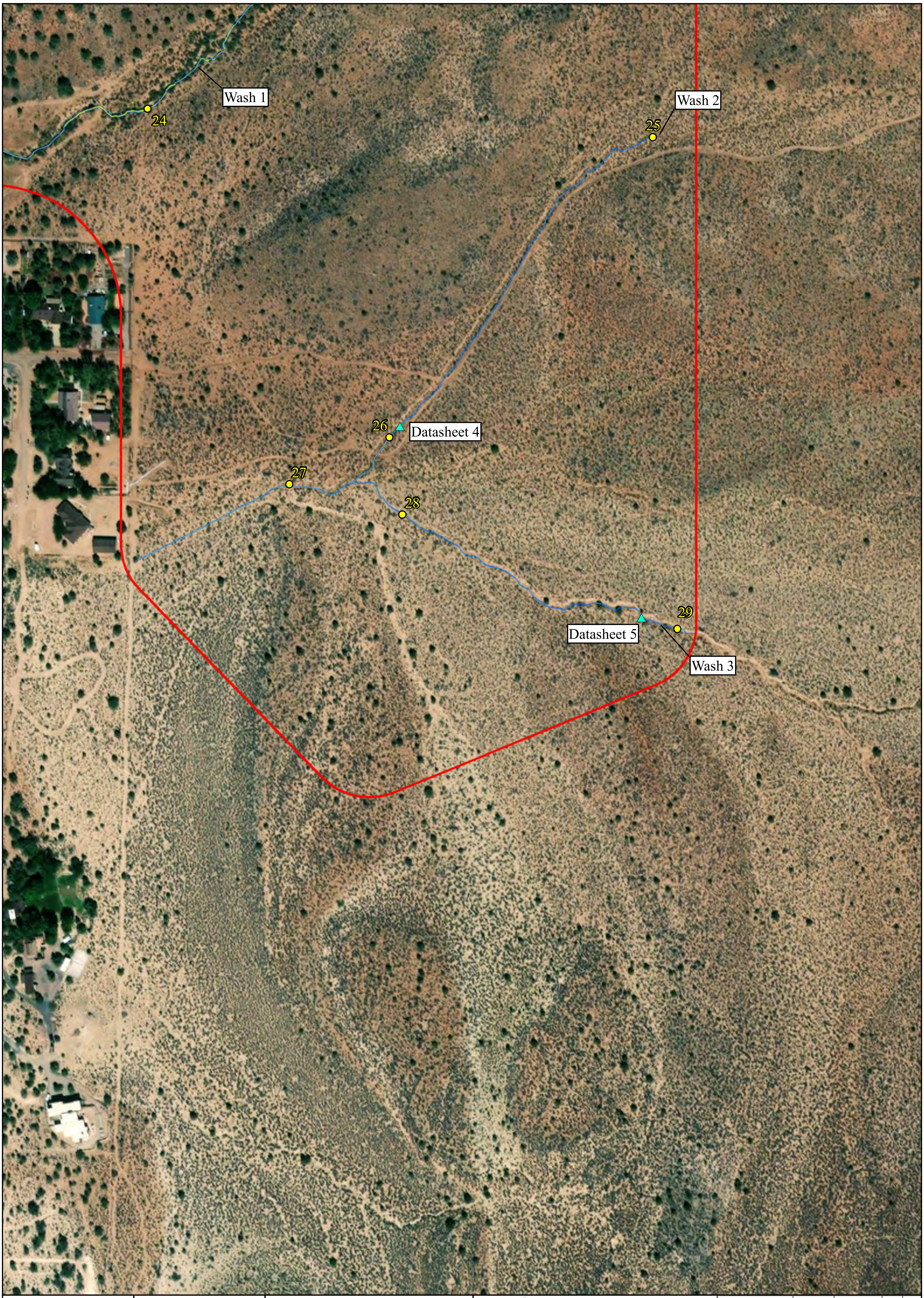
Legend

- Review Area
- Photo Location
- OHWM Data Plot
- Ordinary High Water Mark

ID	Lat	Long	Feet	Ac
Santa Clara River	37.189801	-113.768182	7339	N/A
Potential Wetland 1	37.185060	-113.764722	N/A	0.27
Ditch 1	37.184544	-113.764285	585	0.07
Ditch 2	37.181528	-113.755406	378	0.03
Wash 1	37.256417	-113.616200	6568	0.37
Wash 2	37.252145	-113.604987	1666	0.65
Wash 3	37.307989	-113.659420	939	0.3
Wash 4	37.306843	-113.658447	1942	0.09
Wash 5	37.310149	-113.664785	527	0.09
Wash 6	37.250350	-113.600470	2929	0.51
Wash 7	37.249609	-113.598584	1761	0.11
Wash 8	37.294549	-113.654708	1820	0.1
Wash 8a	37.252492	-113.609656	36	0



Santa Clara Watershed EA
SPK 2021-00134

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Date: 6/7/2022

Aquatic Resources Detail Map (Sheet 6 of 12)

No.	Revision	Date	By	Appr.
1	Added pit locations to sheet 1. Correct lat/long of wetland 1.	6/7/2022	J. Pfadt	

N

0 200 400
Feet

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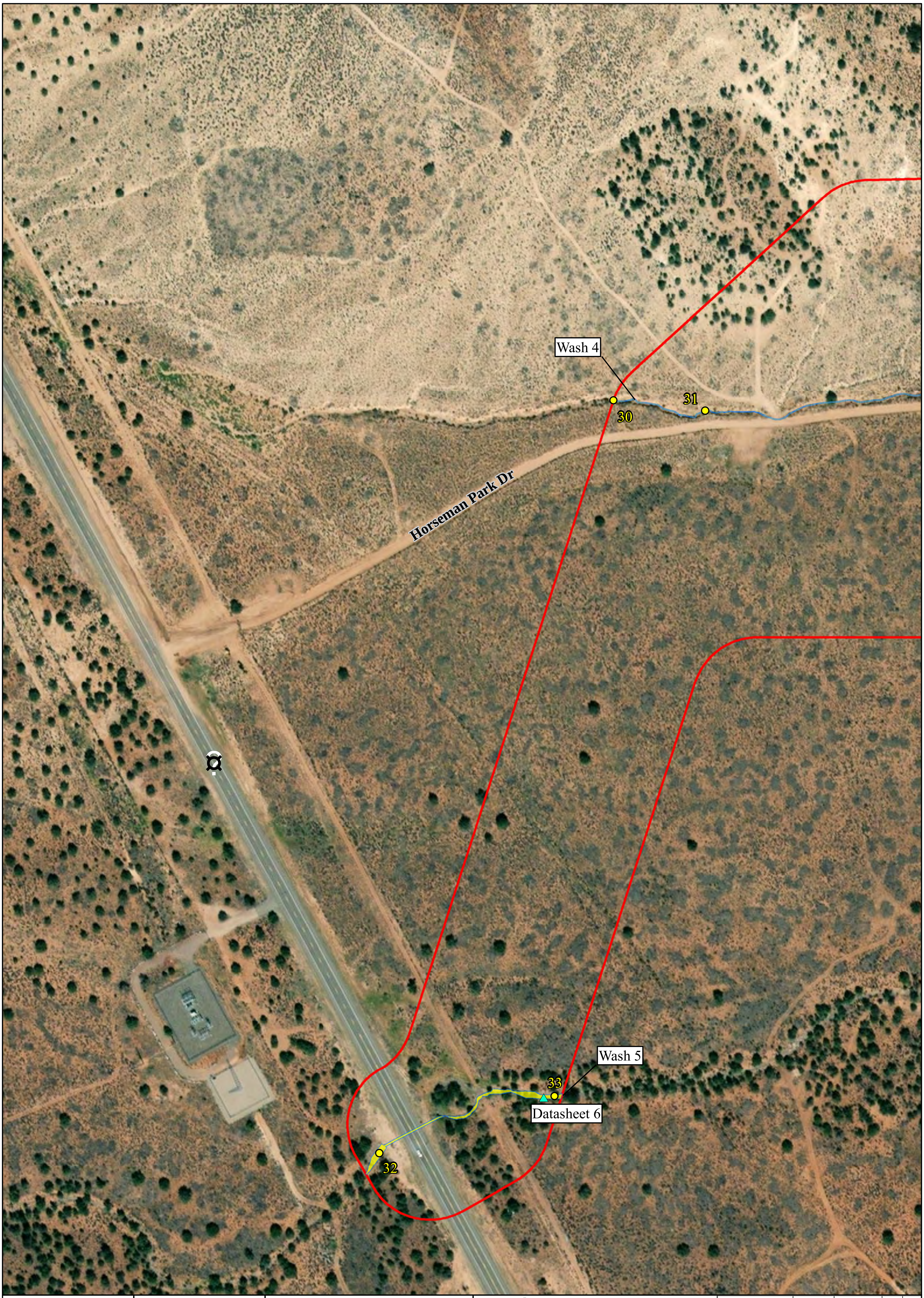
Legend

- Review Area
- Photo Location
- OHWM Data Plot
- Ordinary High Water Mark

ID	Lat	Long	Feet	Ac
Santa Clara River	37.189801	-113.768182	7339	N/A
Potential Wetland 1	37.185060	-113.764722	N/A	0.27
Ditch 1	37.184544	-113.764285	585	0.07
Ditch 2	37.181528	-113.755406	378	0.03
Wash 1	37.256417	-113.616200	6568	0.37
Wash 2	37.252145	-113.604987	1666	0.65
Wash 3	37.307989	-113.659420	939	0.3
Wash 4	37.306843	-113.658447	1942	0.09
Wash 5	37.310149	-113.664785	527	0.09
Wash 6	37.250350	-113.600470	2929	0.51
Wash 7	37.249609	-113.598584	1761	0.11
Wash 8	37.294549	-113.654708	1820	0.1
Wash 8a	37.252492	-113.609656	36	0



Santa Clara Watershed EA
SPK 2021-00134

Drawn By: C Melisi
Date: 6/7/2022

No.	Revision	Date	By	Appr.
1	Added pit locations to sheet 1. Correct lat/long of wetland 1.	6/7/2022	J. Pfadt	

Aquatic Resources Detail Map (Sheet 7 of 12)

N

0 200 400
Feet

Transcon environmental | Planners & Scientists

Legend

- Review Area
- Photo Location
- OHWM Data Plot
- Ordinary High Water Mark

ID	Lat	Long	Feet	Ac
Santa Clara River	37.189801	-113.768182	7339	N/A
Potential Wetland 1	37.185060	-113.764722	N/A	0.27
Ditch 1	37.184544	-113.764285	585	0.07
Ditch 2	37.181528	-113.755406	378	0.03
Wash 1	37.256417	-113.616200	6568	0.37
Wash 2	37.252145	-113.604987	1666	0.65
Wash 3	37.307989	-113.659420	939	0.3
Wash 4	37.306843	-113.658447	1942	0.09
Wash 5	37.310149	-113.664785	527	0.09
Wash 6	37.250350	-113.600470	2929	0.51
Wash 7	37.249609	-113.598584	1761	0.11
Wash 8	37.294549	-113.654708	1820	0.1
Wash 8a	37.252492	-113.609656	36	0

Santa Clara Watershed EA
SPK 2021-00134

Drawn By: C Melisi
Date: 6/7/2022

Aquatic Resources Detail Map
(Sheet 8 of 12)

No.	Revision	Date	By	Appr.
1	Added pit locations to sheet 1. Correct lat/long of wetland 1.	6/7/2022	J. Pfadt	

N

0 200 400
Feet

Transcon environmental Planners & Scientists

Legend
- Review Area
- Photo Location
- OHWM Data Plot
- Ordinary High Water Mark

ID	Lat	Long	Feet	Ac
Santa Clara River	37.189801	-113.768182	7339	N/A
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Wash 3	37.307989	-113.659420	939	0.3
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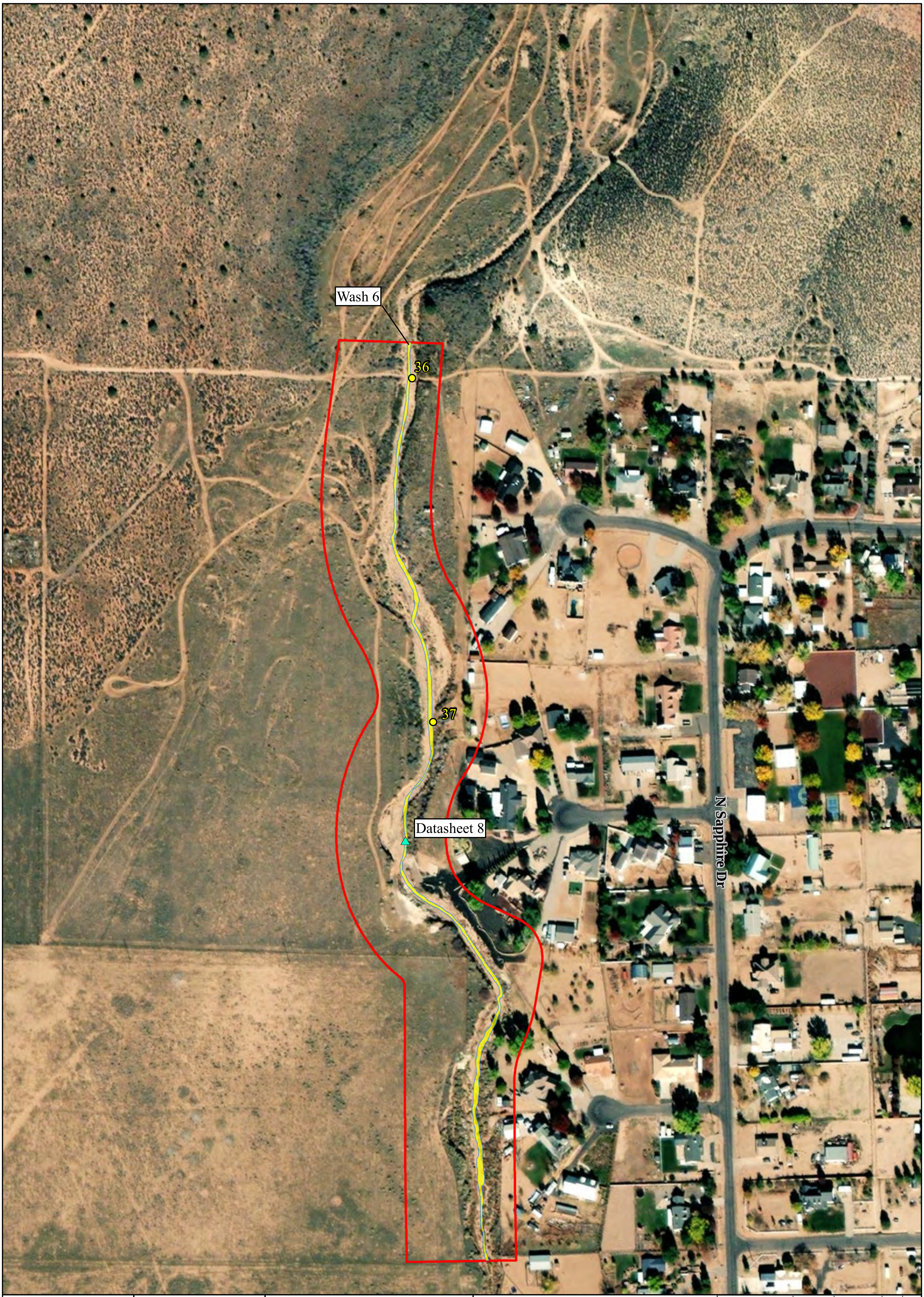
Wash 8	37.294549	-113.654708	1820	0.1
Wash 8a	37.252492	-113.609656	36	0

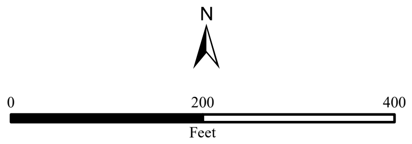


Santa Clara Watershed EA
SPK 2021-00134

Drawn By: C Melisi
Date: 6/7/2022

Aquatic Resources Detail Map
(Sheet 9 of 12)

No.	Revision	Date	By	Appr.
1	Added pit locations to sheet 1. Correct lat/long of wetland 1.	6/7/2022	J. Pfadt	



Transcon environmental | Planners & Scientists

Legend

- Review Area
- Photo Location
- OHWM Data Plot
- Ordinary High Water Mark

ID	Lat	Long	Feet	Ac
Santa Clara River	37.189801	-113.768182	7339	N/A
Potential Wetland 1	37.185060	-113.764722	N/A	0.27
Ditch 1	37.184544	-113.764285	585	0.07
Ditch 2	37.181528	-113.755406	378	0.03
Wash 1	37.256417	-113.616200	6568	0.37
Wash 2	37.252145	-113.604987	1666	0.65
Wash 3	37.307989	-113.659420	939	0.3
Wash 4	37.306843	-113.658447	1942	0.09
Wash 5	37.310149	-113.664785	527	0.09
Wash 6	37.250350	-113.600470	2929	0.51
Wash 7	37.249609	-113.598584	1761	0.11
Wash 8	37.294549	-113.654708	1820	0.1
Wash 8a	37.252492	-113.609656	36	0

Santa Clara Watershed EA
SPK 2021-00134

Drawn By: C Melisi
Date: 6/7/2022

Aquatic Resources Detail Map (Sheet 10 of 12)

No.	Revision	Date	By	Appr.
1	Added pit locations to sheet 1. Correct lat/long of wetland 1.	6/7/2022	J. Pfadt	

N

0 200 400
Feet

Transcon environmental | Planners & Scientists

Legend

- Review Area
- Photo Location
- OHWM Data Plot
- Ordinary High Water Mark

ID	Lat	Long	Feet	Ac
Santa Clara River	37.189801	-113.768182	7339	N/A
Potential Wetland 1	37.185060	-113.764722	N/A	0.27
Ditch 1	37.184544	-113.764285	585	0.07
Ditch 2	37.181528	-113.755406	378	0.03
Wash 1	37.256417	-113.616200	6568	0.37
Wash 2	37.252145	-113.604987	1666	0.65
Wash 3	37.307989	-113.659420	939	0.3
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Wash 5	37.310149	-113.664785	527	0.09
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Wash 7	37.249609	-113.598584	1761	0.11
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Wash 8a	37.252492	-113.609656	36	0

Santa Clara Watershed EA
SPK 2021-00134

Drawn By: C Melisi
Date: 6/7/2022

Aquatic Resources Detail Map
(Sheet 11 of 12)

No.	Revision	Date	By	Appr.
1	Added pit locations to sheet 1. Correct lat/long of wetland 1.	6/7/2022	J. Pfadt	

N

0 200 400
Feet

Transcon environmental Planners & Scientists

Legend

- Review Area
- Photo Location
- OHWM Data Plot
- Ordinary High Water Mark

ID	Lat	Long	Feet	Ac
Santa Clara River	37.189801	-113.768182	7339	N/A
Potential Wetland 1	37.185060	-113.764722	N/A	0.27
Ditch 1	37.184544	-113.764285	585	0.07
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Wash 4	37.306843	-113.658447	1942	0.09
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Wash 8a	37.252492	-113.609656	36	0

Santa Clara Watershed EA
SPK 2021-00134

Drawn By: C Melisi
Date: 6/7/2022

No.	Revision	Date	By	Appr.
1	Added pit locations to sheet 1. Correct lat/long of wetland 1.	6/7/2022	J. Pfadt	

Aquatic Resources Detail Map
(Sheet 12 of 12)

N

0 200 400
Feet

Transcon environmental | Planners & Scientists

Legend

- Review Area
- Photo Location
- OHWM Data Plot
- Ordinary High Water Mark

ID	Lat	Long	Feet	Ac
Santa Clara River	37.189801	-113.768182	7339	N/A
Potential Wetland 1	37.185060	-113.764722	N/A	0.27
Ditch 1	37.184544	-113.764285	585	0.07
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Wash 6	37.250350	-113.600470	2929	0.51
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Wash 8a	37.252492	-113.609656	36	0

APPENDIX E-9B

AQUATIC RESOURCES

APPENDIX B

FIELD PHOTOGRAPHS

Photo No. 1

View of the Santa Clara River from under the Gunlock Rd bridge looking downstream (facing southeast)

Photo No. 2

View of the Santa Clara River looking upstream towards the Gunlock Rd bridge where the replacement pipe will be hung from (facing northwest)

Photo No. 3

View of the Santa Clara River at the northern section of the Shivwits Review Area looking upstream. Note the OHWM and thick riparian vegetation (facing south)

Photo No. 4

View of the location of wetland dig 1

Photo No. 5

View of wetland dig 1

Photo No. 6

View of the location of wetland dig 2

Photo No. 7

View of wetland dig 2

Photo No. 8

Typical view of Potential Wetland 1

Photo No. 9

View of the improved section of Ditch 1 looking downstream (facing northwest)

Photo No. 10

View from the improved section of Ditch 1 looking downstream at the blowout (facing north)

Photo No. 11

Typical view of the upland area adjacent to Santa Clara River (facing east)

Photo No. 12

View of the Santa Clara River near the eastern section of the Shivwits Review Area looking downstream. Note the OHWM and thick riparian vegetation (facing southeast)

Photo No. 13

View of heavily eroding upland area adjacent to the Santa Clara River (facing east)

Photo No. 14

View of the improved section of Ditch 2 looking upstream (facing southwest)

Photo No. 15

View of the improved section of Ditch 2 looking downstream where flows drop off the heavily eroded bank (facing northeast)

Photo No. 16

View of Ditch 2 looking upstream towards the heavily eroded bank. Note copious amounts of debris within the OHWM (facing southwest)

Photo No. 17

View of Wash 1 looking downstream from N Canyon Trails Dr. Note the barely distinguishable OHWM due to vegetation growth (facing southwest)

Photo No. 18

View of Wash 1 looking downstream from N Dammeron Valley Dr (facing west)

Photo No. 19

View of Wash 1 within the Vineyard looking downstream (facing west)

Photo No. 20

View of Wash 1 looking upstream towards the culvert crossing beneath Homestead Dr E (facing east)

Photo No. 21

View of Wash 1 looking downstream where it enters the review area (facing southwest)

Photo No. 22

View of Wash 1 looking downstream (facing south)

Photo No. 23

View of Wash 1 looking upstream (facing northeast)

Photo No. 24

View of Wash 1 looking upstream

Photo No. 25

View of Wash 2 headwaters looking downstream (facing southwest))

Photo No. 26

View of Wash 2 looking downstream (facing southwest)

Photo No. 27

View of Wash 2 looking downstream where it begins to lose definition (facing west)

Photo No. 28

View of Wash 3 looking upstream. Note poorly defined OHWM (facing southeast)

Photo No. 29

View of Wash 3 looking downstream where it enters the review area (facing northwest)

Photo No. 30

View of Wash 4 looking upstream where it exits the review area (facing east)

Photo No. 31

View of Wash 4 looking upstream (facing east)

Photo No. 32

View of Wash 5 looking downstream where it exits the review area (facing west)

Photo No. 33

View of Wash 5 looking downstream where it enters the review area (facing west)

Photo No. 34

View of Wash 4 looking upstream (facing east)

Photo No. 35

View of Wash 4 looking downstream where it enters the review area (facing west)

Photo No. 36

View of Wash 6 from the unpaved road crossing looking downstream near where it enters the review area (facing south)

Photo No. 37

View of Wash 6 looking downstream (facing south)

Photo No. 38

View of Wash 6 looking upstream from W Jade Dr (facing north)

Photo No. 39

View of Wash 6 looking downstream from W Jade Dr (facing south)

Photo No. 40

View of Wash 6 looking upstream from W Diamond Valley Rd (facing north)

Photo No. 41

View of Wash 6 looking downstream from W Diamond Valley Rd (facing south)

Photo No. 42

View of the detention basin west of W Diamond Valley Rd (facing west)

Photo No. 43

View of Wash 7 from the culvert under Diamond Valley Rd looking upstream towards its headwaters (facing east)

Photo No. 44

View of Wash 7 looking downstream. Note no OHWM and berm on left (facing west)

Photo No. 45

View of Wash 7 looking downstream (facing west)

Photo No. 46

View of detention basin in northwestern corner of the southern section of the Dammeron Valley Review Area (facing southwest)

Photo No. 47

View of Wash 7 looking downstream from its headwaters. Note poorly defined OHWM (facing southwest)

Photo No. 48

View of where Wash 8 drains into the detention basin at the northeast corner of the Diamond Valley Review Area (facing northwest)

Photo No. 49

View of Wash 8 looking downstream (facing north)

Photo No. 50

View of Wash 8 looking downstream. Note the OHWM is a road (facing northwest)

Photo No. 51

View of Wash 8 where it converges with the unpaved road and flows north following the road alignment (facing east)

Photo No. 52

View of Wash 8 looking downstream from where it enters the Diamond Valley Review Area (facing west)

APPENDIX C

OHWM AND WETLAND DELINEATION DATASHEETS

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Santa Clara Watershed EA	**Date:** 9/7/21	**Time:**
Project Number:	**Town:** Shivwits	**State:** UT
Stream: Ditch 1 (reinforced area)	**Photo begin file#:** 9	**Photo end file#:**
Investigator(s): Cornelis'		

Y ☒ / N ☐ Do normal circumstances exist on the site?	**Location Details:**
Y ☒ / N ☐ Is the site significantly disturbed?	**Projection:** **Datum:** **Coordinates:** 37.184225, -113.764451

Potential anthropogenic influences on the channel system:

It is a manmade channel lined w/ concrete and rocks

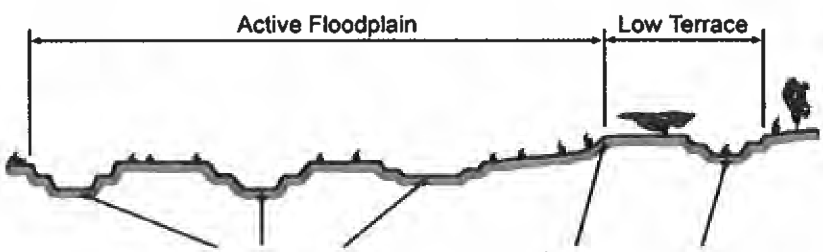
Brief site description:

Former ag field

Checklist of resources (if available):

- ☒ Aerial photography
  - Dates:
- ☐ Topographic maps
- ☐ Geologic maps
- ☐ Vegetation maps
- ☐ Soils maps
- ☐ Rainfall/precipitation maps
- ☐ Existing delineation(s) for site
- ☒ Global positioning system (GPS)
- ☐ Other studies
- ☐ Stream gage data
  - Gage number:
  - Period of record:
    - ☐ History of recent effective discharges
    - ☐ Results of flood frequency analysis
    - ☐ Most recent shift-adjusted rating
    - ☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units



Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:
   - ☐ Mapping on aerial photograph
   - ☐ Digitized on computer
   - ☒ GPS
   - ☐ Other:

Project ID: Santa Clara **Cross section ID:** Ditch 1 (reinforced area) **Date:** 9/7 **Time:**

Cross section drawing:

OHWM

GPS point: 37.184225, -113.764451

Indicators:

- ☐ Change in average sediment texture
- ☐ Change in vegetation species
- ☐ Change in vegetation cover
- ☐ Break in bank slope
- ☒ Other: man made channel
- ☐ Other: ____________

Comments:

Concrete bottom and stone sides contain flows

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: ____________

Characteristics of the floodplain unit:

Average sediment texture: ____________

Total veg cover: ____% Tree: ____% Shrub: ____% Herb: ____%

Community successional stage:

- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☐ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ____________
- ☐ Other: ____________
- ☐ Other: ____________

Comments:

Project ID: Santa Clara **Cross section ID:** Ditch 1 reinforced area **Date:** 9/7 **Time:**

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: ____________________

Characteristics of the floodplain unit:
Average sediment texture: ________________
Total veg cover: _____ % Tree: _____ % Shrub: _____ % Herb: _____ %
Community successional stage:
☐ NA
☐ Early (herbaceous & seedlings)
☐ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:
☐ Mudcracks
☐ Ripples
☐ Drift and/or debris
☐ Presence of bed and bank
☐ Benches
☐ Soil development
☐ Surface relief
☐ Other: ________________
☐ Other: ________________
☐ Other: ________________

Comments:

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: ____________________

Characteristics of the floodplain unit:
Average sediment texture: ________________
Total veg cover: _____ % Tree: _____ % Shrub: _____ % Herb: _____ %
Community successional stage:
☐ NA
☐ Early (herbaceous & seedlings)
☐ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:
☐ Mudcracks
☐ Ripples
☐ Drift and/or debris
☐ Presence of bed and bank
☐ Benches
☐ Soil development
☐ Surface relief
☐ Other: ________________
☐ Other: ________________
☐ Other: ________________

Comments:

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Santa Clara Watershed EA	**Date:** 9/7/2021	**Time:**
Project Number:	**Town:** Shivwits	**State:** UT
Stream: Ditch 1 (after blowout)	**Photo begin file#:** 10	**Photo end file#:**
Investigator(s): CMcl's		

Y ☒ / N ☐ Do normal circumstances exist on the site?	**Location Details:**
Y ☒ / N ☐ Is the site significantly disturbed?	**Projection:** **Datum:** **Coordinates:** 37.184493, -113.764555

Potential anthropogenic influences on the channel system:

Concrete bottom + rock lined channel upstream

Brief site description:

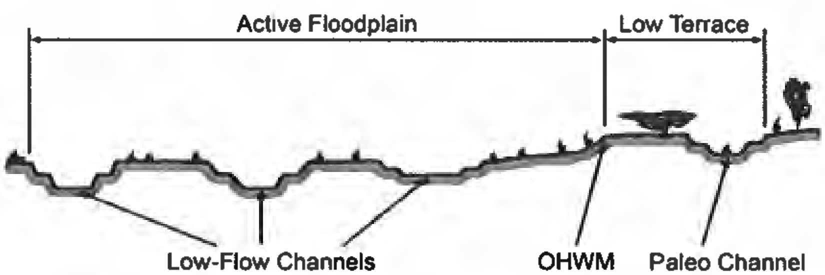
this portion appears to be a blowout of where a manmade ditch was located historically

Checklist of resources (if available):

- ☒ Aerial photography
  Dates:
- ☐ Topographic maps
- ☐ Geologic maps
- ☐ Vegetation maps
- ☐ Soils maps
- ☐ Rainfall/precipitation maps
- ☐ Existing delineation(s) for site
- ☒ Global positioning system (GPS)
- ☐ Other studies

- ☐ Stream gage data
  Gage number:
  Period of record:
  - ☐ History of recent effective discharges
  - ☐ Results of flood frequency analysis
  - ☐ Most recent shift-adjusted rating
  - ☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units

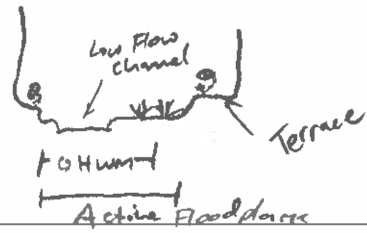


Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:
   - ☐ Mapping on aerial photograph
   - ☐ Digitized on computer
   - ☒ GPS
   - ☐ Other:

Project ID: Santa Clara **Cross section ID:** Ditch 1 (BO) **Date:** 9/7 **Time:**

Cross section drawing:



OHWM

GPS point: 37.187493, -113.764555

Indicators:

- [x] Change in average sediment texture
- [ ] Change in vegetation species
- [x] Change in vegetation cover
- [x] Break in bank slope
- [ ] Other: ____________
- [ ] Other: ____________

Comments:

Floodplain unit:

- [x] Low-Flow Channel
- [ ] Active Floodplain
- [ ] Low Terrace

GPS point: 37.184493, -113.764558

Characteristics of the floodplain unit:

Average sediment texture: Sandy, small pebbles

Total veg cover: 0 % Tree: ____ % Shrub: ____ % Herb: ____ %

Community successional stage:

- [x] NA
- [ ] Early (herbaceous & seedlings)
- [ ] Mid (herbaceous, shrubs, saplings)
- [ ] Late (herbaceous, shrubs, mature trees)

Indicators:

- [ ] Mudcracks
- [ ] Ripples
- [ ] Drift and/or debris
- [x] Presence of bed and bank
- [ ] Benches
- [ ] Soil development
- [ ] Surface relief
- [ ] Other: ____________
- [ ] Other: ____________
- [ ] Other: ____________

Comments:

Project ID: Santa Clara **Cross section ID:** Ditch 1 (BO) **Date:** 9/7 **Time:**

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 37.184493, -113.764555

Characteristics of the floodplain unit:

Average sediment texture: Sandy

Total veg cover: 5 % Tree: 0 % Shrub: 0 % Herb: 5 %

Community successional stage:

- ☒ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☒ Mudcracks
- ☐ Ripples
- ☒ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☒ Soil development
- ☐ Surface relief
- ☐ Other: ____
- ☐ Other: ____
- ☐ Other: ____

Comments:

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: 37.184493, -113.764555

Characteristics of the floodplain unit:

Average sediment texture: Sandy

Total veg cover: 5 % Tree: 0 % Shrub: 0 % Herb: 5 %

Community successional stage:

- ☒ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☒ Mudcracks
- ☐ Ripples
- ☒ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☒ Soil development
- ☐ Surface relief
- ☐ Other: ____
- ☐ Other: ____
- ☐ Other: ____

Comments:

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Santa Clara Watershed EA
Project Number:
Stream: Ditch 2 (reinforced area)
Investigator(s): Cmelis

Date: 9/7/21 **Time:**
Town: Shivwits **State:** UT
Photo begin file#: 14-15 **Photo end file#:**

Y [x] / N [ ] Do normal circumstances exist on the site?

Y [x] / N [ ] Is the site significantly disturbed?

Location Details:

Projection: **Datum:**
Coordinates: 37.181398, -113.755454

Potential anthropogenic influences on the channel system:

It is a manmade channel with a concrete bottom and rock walls

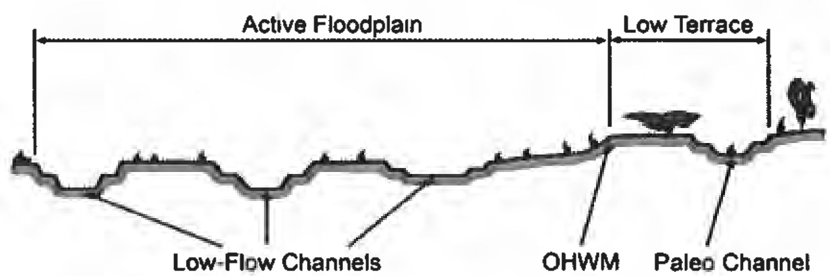
Brief site description:

Former ag field

Checklist of resources (if available):

- [x] Aerial photography
  Dates:
- [ ] Topographic maps
- [ ] Geologic maps
- [ ] Vegetation maps
- [ ] Soils maps
- [ ] Rainfall/precipitation maps
- [ ] Existing delineation(s) for site
- [x] Global positioning system (GPS)
- [ ] Other studies
- [ ] Stream gage data
  Gage number:
  Period of record:
  - [ ] History of recent effective discharges
  - [ ] Results of flood frequency analysis
  - [ ] Most recent shift-adjusted rating
  - [ ] Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units



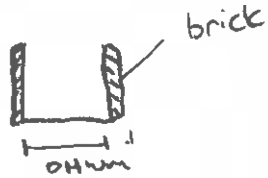
Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:
   - [ ] Mapping on aerial photograph
   - [ ] Digitized on computer
   - [x] GPS
   - [ ] Other:

Kentford)

Project ID: Santa Clara **Cross section ID:** Ditch 2 **Date:** 9/7 **Time:**

Cross section drawing:



OHWM

GPS point: 37.181398, -113.755454

Indicators:

- ☐ Change in average sediment texture
- ☐ Change in vegetation species
- ☐ Change in vegetation cover
- ☐ Break in bank slope
- ☒ Other: man made channel
- ☐ Other: ______

Comments:

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: ______

Characteristics of the floodplain unit:

Average sediment texture: ______

Total veg cover: ____ % Tree: ____ % Shrub: ____ % Herb: ____ %

Community successional stage:

- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☒ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☐ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ______
- ☐ Other: ______
- ☐ Other: ______

Comments:

(reinforced)

Project ID: Santa Clara **Cross section ID:** Ditch 2 **Date:** 9/7 **Time:**

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: ____________________

Characteristics of the floodplain unit:
Average sediment texture: ______________
Total veg cover: _____ % Tree: _____ % Shrub: _____ % Herb: _____ %
Community successional stage:
☐ NA ☐ Mid (herbaceous, shrubs, saplings)
☐ Early (herbaceous & seedlings) ☐ Late (herbaceous, shrubs, mature trees)

Indicators:
☐ Mudcracks ☐ Soil development
☐ Ripples ☐ Surface relief
☐ Drift and/or debris ☐ Other: ____________
☐ Presence of bed and bank ☐ Other: ____________
☐ Benches ☐ Other: ____________

Comments:

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: ____________________

Characteristics of the floodplain unit:
Average sediment texture: ______________
Total veg cover: _____ % Tree: _____ % Shrub: _____ % Herb: _____ %
Community successional stage:
☐ NA ☑ Mid (herbaceous, shrubs, saplings)
☐ Early (herbaceous & seedlings) ☐ Late (herbaceous, shrubs, mature trees)

Indicators:
☐ Mudcracks ☐ Soil development
☐ Ripples ☐ Surface relief
☐ Drift and/or debris ☐ Other: ____________
☐ Presence of bed and bank ☐ Other: ____________
☐ Benches ☐ Other: ____________

Comments:

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Santa Clara Watershed EA
Date: 7/7/21
Time:
Project Number:
Town: Shivwits
State: UT
Stream: Ditch 2 (after blowout)
Photo begin file#: 15-16
Photo end file#:
Investigator(s): Melissa

Y ☒ / N ☐ Do normal circumstances exist on the site?

Y ☒ / N ☐ Is the site significantly disturbed?

Location Details:

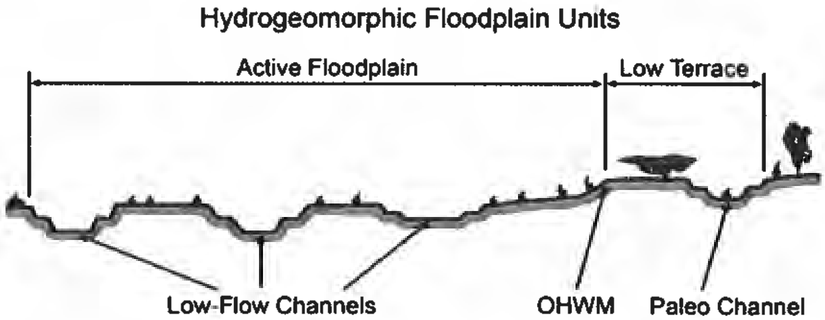
Projection:
Datum:
Coordinates: 37.182008, -113.755232

Potential anthropogenic influences on the channel system:
This area is a blowout/erosion area downstream from a manmade ditch

Brief site description:
adjacent to and w/in riparian corridor

Checklist of resources (if available):

- ☒ Aerial photography
  Dates:
- ☐ Topographic maps
- ☐ Geologic maps
- ☐ Vegetation maps
- ☐ Soils maps
- ☐ Rainfall/precipitation maps
- ☐ Existing delineation(s) for site
- ☒ Global positioning system (GPS)
- ☐ Other studies
- ☐ Stream gage data
  Gage number:
  Period of record:
  - ☐ History of recent effective discharges
  - ☐ Results of flood frequency analysis
  - ☐ Most recent shift-adjusted rating
  - ☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event



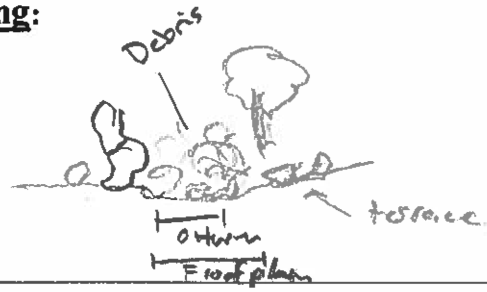
Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:
   - ☐ Mapping on aerial photograph
   - ☒ GPS
   - ☐ Digitized on computer
   - ☐ Other:

(150)

Project ID: Santa Clara **Cross section ID:** Ditch 2 **Date:** 9/7 **Time:**

Cross section drawing:



OHWM

GPS point: 37.182008, -113.755232

Indicators:

- ☐ Change in average sediment texture
- ☐ Change in vegetation species
- ☐ Change in vegetation cover
- ☐ Break in bank slope
- ☒ Other: slightly lower elevation
- ☐ Other: ______

Comments:

Very poorly defined OHWM. Entire area below the ditch is filled w/ debris. Ground is not visible

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 37.182008, -113.755232

Characteristics of the floodplain unit:

Average sediment texture: sandy

Total veg cover: 75 % Tree: 5 % Shrub: 10 % Herb: 60 %

Community successional stage:

- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☒ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☐ Mudcracks
- ☐ Ripples
- ☒ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ______
- ☐ Other: ______
- ☐ Other: ______

Comments:

Project ID: Santa Clara **Cross section ID:** Ditch 2 (130) **Date:** 9/7 **Time:**

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: 37.182008, -113.755232

Characteristics of the floodplain unit:

Average sediment texture: sandy

Total veg cover: 75 % Tree: 10 % Shrub: 5 % Herb: 60 %

Community successional stage:

- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☒ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☐ Mudcracks
- ☐ Ripples
- ☒ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ________
- ☐ Other: ________
- ☐ Other: ________

Comments:

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: ________

Characteristics of the floodplain unit:

Average sediment texture: ________

Total veg cover: ___ % Tree: ___ % Shrub: ___ % Herb: ___ %

Community successional stage:

- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☐ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ________
- ☐ Other: ________
- ☐ Other: ________

Comments:

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Santa Clara Watershed EA **Project Number:** **Stream:** Wash 1 **Investigator(s):** Chelsi	**Date:** 9/7/21 **Time:** **Town:** Dameron Valley **State:** UT **Photo begin file#:** 17-24 **Photo end file#:**
Y [x] / N [ ] Do normal circumstances exist on the site? Y [x] / N [ ] Is the site significantly disturbed?	**Location Details:** **Projection:** **Datum:** **Coordinates:** 37.312967, -113.657158

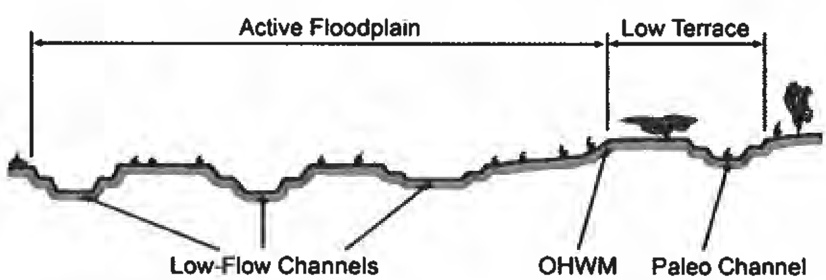
Potential anthropogenic influences on the channel system:
No anthropogenic influences until it exits the upland area and enters Dameron Valley

Brief site description:
Sandy and rocky wash

Checklist of resources (if available):

- [x] Aerial photography
  Dates:
- [ ] Topographic maps
- [ ] Geologic maps
- [ ] Vegetation maps
- [ ] Soils maps
- [ ] Rainfall/precipitation maps
- [ ] Existing delineation(s) for site
- [x] Global positioning system (GPS)
- [ ] Other studies
- [ ] Stream gage data
  Gage number:
  Period of record:
  - [ ] History of recent effective discharges
  - [ ] Results of flood frequency analysis
  - [ ] Most recent shift-adjusted rating
  - [ ] Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units

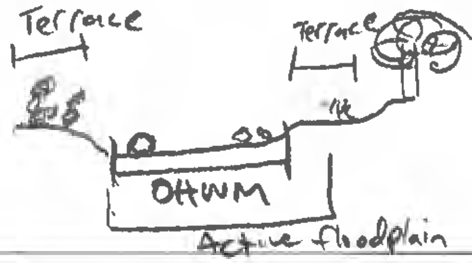


Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:
   - [ ] Mapping on aerial photograph
   - [x] GPS
   - [ ] Digitized on computer
   - [ ] Other:

Project ID: Santa Clara **Cross section ID:** Wash 1 **Date:** 9/7 **Time:**

Cross section drawing:



OHWM

GPS point: 37.312967, -113.657158

Indicators:

- [x] Change in average sediment texture
- [x] Change in vegetation species
- [x] Change in vegetation cover
- [ ] Break in bank slope
- [ ] Other: ____________
- [ ] Other: ____________

Comments:

Floodplain unit: [ ] Low-Flow Channel [x] Active Floodplain [ ] Low Terrace

GPS point: 37.312967, -113.657158

Characteristics of the floodplain unit:

Average sediment texture: sandy, pebbles

Total veg cover: 10 % Tree: 0 % Shrub: 5 % Herb: 5 %

Community successional stage:

- [ ] NA
- [ ] Early (herbaceous & seedlings)
- [x] Mid (herbaceous, shrubs, saplings)
- [ ] Late (herbaceous, shrubs, mature trees)

Indicators:

- [ ] Mudcracks
- [ ] Ripples
- [x] Drift and/or debris
- [x] Presence of bed and bank
- [ ] Benches
- [ ] Soil development
- [ ] Surface relief
- [ ] Other: ____________
- [ ] Other: ____________
- [ ] Other: ____________

Comments:

Project ID: Santa Clara **Cross section ID:** Wash 1 **Date:** 9/7 **Time:**

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: 31.312967, -113.657158

Characteristics of the floodplain unit:
Average sediment texture: ____________
Total veg cover: 15 % Tree: 1 % Shrub: 10 % Herb: 4 %
Community successional stage:
- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☒ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:
- ☐ Mudcracks
- ☐ Ripples
- ☒ Drift and/or debris
- ☒ Presence of bed and bank
- ☐ Benches
- ☒ Soil development
- ☐ Surface relief
- ☐ Other: ____________
- ☐ Other: ____________
- ☐ Other: ____________

Comments:

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: ____________

Characteristics of the floodplain unit:
Average sediment texture: ____________
Total veg cover: ____ % Tree: ____ % Shrub: ____ % Herb: ____ %
Community successional stage:
- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:
- ☐ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ____________
- ☐ Other: ____________
- ☐ Other: ____________

Comments:

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Santa Clara Watershed EA
Project Number:
Stream: Wash 2
Investigator(s): C Melis
Date: 9/10/21
Town: Dammeron
Photo begin file#: 25-27
Time:
State: UT
Photo end file#:

Y ☒ / N ☐ Do normal circumstances exist on the site?

Y ☐ / N ☒ Is the site significantly disturbed?

Location Details:

Projection:
Datum:
Coordinates: 37.307723, -113.659403

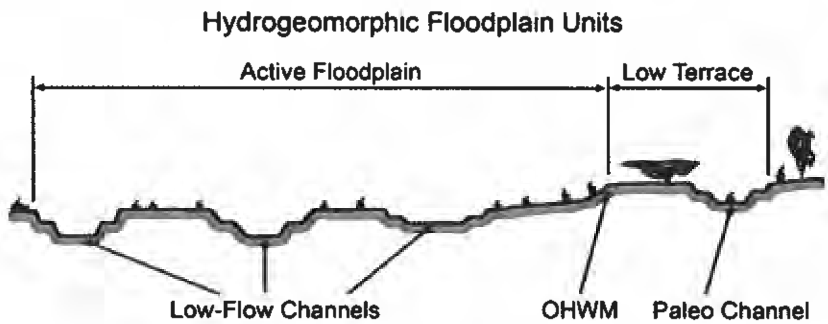
Potential anthropogenic influences on the channel system:
small areas that have been bermed closer to Dammeron valley

Brief site description:
upland sage brush

Checklist of resources (if available):

☒ Aerial photography
Dates:
☐ Topographic maps
☐ Geologic maps
☐ Vegetation maps
☐ Soils maps
☐ Rainfall/precipitation maps
☐ Existing delineation(s) for site
☒ Global positioning system (GPS)
☐ Other studies

☐ Stream gage data
Gage number:
Period of record:
☐ History of recent effective discharges
☐ Results of flood frequency analysis
☐ Most recent shift-adjusted rating
☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

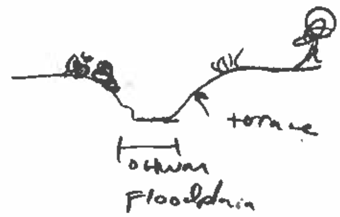


Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:
   ☐ Mapping on aerial photograph ☒ GPS
   ☐ Digitized on computer ☐ Other:

Project ID: Santa Clara **Cross section ID:** Wash 2 **Date:** 9/10 **Time:**

Cross section drawing:



OHWM

GPS point: 37.307723, -113.659403

Indicators:

- ☒ Change in average sediment texture
- ☐ Change in vegetation species
- ☒ Change in vegetation cover
- ☒ Break in bank slope
- ☐ Other: ______
- ☐ Other: ______

Comments:

very narrow OHWM

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 37.307723, -113.659403

Characteristics of the floodplain unit:

Average sediment texture: ______

Total veg cover: 2 % Tree: ____ % Shrub: .5 % Herb: 1.5 %

Community successional stage:

- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☒ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☐ Mudcracks
- ☐ Ripples
- ☒ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ______
- ☐ Other: ______
- ☐ Other: ______

Comments:

Project ID: Santa Clara **Cross section ID:** Wash 2 **Date:** 9/10 **Time:**

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: 37.307723 -113.659403

Characteristics of the floodplain unit:

Average sediment texture: ____________

Total veg cover: 50 % Tree: 5 % Shrub: 25 % Herb: 20 %

Community successional stage:

- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☒ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☐ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☒ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ____________
- ☐ Other: ____________
- ☐ Other: ____________

Comments:

~~**Floodplain unit:** ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace~~

~~**GPS point:** ____________~~

~~**Characteristics of the floodplain unit:**~~

~~Average sediment texture: ____________~~

~~Total veg cover: ___ % Tree: ___ % Shrub: ___ % Herb: ___ %~~

~~Community successional stage:~~

- ~~☐ NA~~
- ~~☐ Early (herbaceous & seedlings)~~
- ~~☐ Mid (herbaceous, shrubs, saplings)~~
- ~~☐ Late (herbaceous, shrubs, mature trees)~~

~~**Indicators:**~~

- ~~☐ Mudcracks~~
- ~~☐ Ripples~~
- ~~☐ Drift and/or debris~~
- ~~☐ Presence of bed and bank~~
- ~~☐ Benches~~
- ~~☐ Soil development~~
- ~~☐ Surface relief~~
- ~~☐ Other: ____________~~
- ~~☐ Other: ____________~~
- ~~☐ Other: ____________~~

~~**Comments:**~~

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Santa Clara Watershed EA	**Date:** 9/10/21	**Time:**
Project Number:	**Town:** Dammeron	**State:** UT
Stream: Wash 3	**Photo begin file#:** 28-29	**Photo end file#:**
Investigator(s): cmelis		

Y ☒ / N ☐ Do normal circumstances exist on the site?

Y ☐ / N ☒ Is the site significantly disturbed?

Location Details:

Projection: **Datum:**

Coordinates: 37.306561, -113.657466

Potential anthropogenic influences on the channel system:

none

Brief site description:

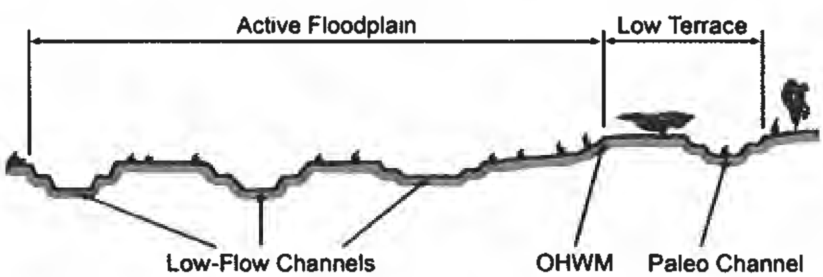
sagebrush upland

Checklist of resources (if available):

- ☐ Aerial photography
  Dates:
- ☐ Topographic maps
- ☐ Geologic maps
- ☐ Vegetation maps
- ☐ Soils maps
- ☐ Rainfall/precipitation maps
- ☐ Existing delineation(s) for site
- ☐ Global positioning system (GPS)
- ☐ Other studies

- ☐ Stream gage data
  Gage number:
  Period of record:
  - ☐ History of recent effective discharges
  - ☐ Results of flood frequency analysis
  - ☐ Most recent shift-adjusted rating
  - ☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units



Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:
   - ☐ Mapping on aerial photograph
   - ☐ Digitized on computer
   - ☐ GPS
   - ☐ Other:

Project ID: Santa Clara **Cross section ID:** Wash 3 **Date:** 9/10 **Time:**

Cross section drawing:

OHWM

GPS point: 37.306561, -113.657466

Indicators:

- [x] Change in average sediment texture
- [ ] Change in vegetation species
- [x] Change in vegetation cover
- [ ] Break in bank slope
- [ ] Other: ________
- [ ] Other: ________

Comments:

Very narrow OHWM

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 37.306561, -113.657466

Characteristics of the floodplain unit:

Average sediment texture: sandy

Total veg cover: 1 % Tree: ____ % Shrub: 1 % Herb: ____ %

Community successional stage:

- [ ] NA
- [ ] Early (herbaceous & seedlings)
- [x] Mid (herbaceous, shrubs, saplings)
- [ ] Late (herbaceous, shrubs, mature trees)

Indicators:

- [ ] Mudcracks
- [ ] Ripples
- [x] Drift and/or debris
- [ ] Presence of bed and bank
- [ ] Benches
- [ ] Soil development
- [ ] Surface relief
- [ ] Other: ________
- [ ] Other: ________
- [ ] Other: ________

Comments:

Project ID: Sula Clw **Cross section ID:** Wash 3 **Date:** 9/10 **Time:**

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: 37.306561, -113.657466

Characteristics of the floodplain unit:

Average sediment texture: fine

Total veg cover: 75 % Tree: 5 % Shrub: 35 % Herb: 35 %

Community successional stage:

- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☒ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☐ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☒ Soil development
- ☐ Surface relief
- ☐ Other: ______
- ☐ Other: ______
- ☐ Other: ______

Comments:

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: ______

Characteristics of the floodplain unit:

Average sediment texture: ______

Total veg cover: ____ % Tree: ____ % Shrub: ____ % Herb: ____ %

Community successional stage:

- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☐ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ______
- ☐ Other: ______
- ☐ Other: ______

Comments:

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Santa Clara watershed EA
Project Number:
Stream: Wash 4
Investigator(s): CMeli

Date: 9/10/21
Town: Dammeron
Photo begin file#: 30-31 ; 34-35

Time:
State: UT
Photo end file#:

Y ☒ / N ☐ Do normal circumstances exist on the site?

Y ☐ / N ☒ Is the site significantly disturbed?

Location Details:

Projection: **Datum:**
Coordinates: 37.294670, -113.653975

Potential anthropogenic influences on the channel system:
runnoff from adjacent OHV roads and OHV road crossings

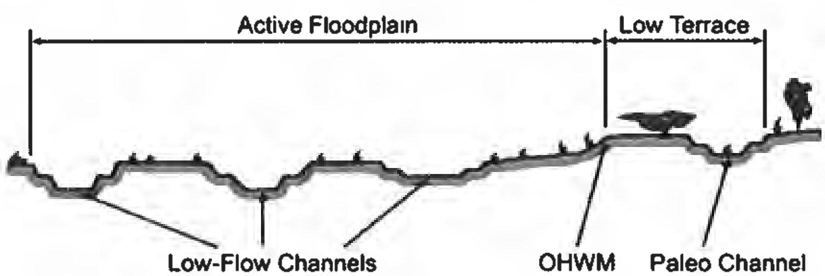
Brief site description:
sagebrush and juniper upland

Checklist of resources (if available):

- ☒ Aerial photography
  Dates:
- ☐ Topographic maps
- ☐ Geologic maps
- ☐ Vegetation maps
- ☐ Soils maps
- ☐ Rainfall/precipitation maps
- ☐ Existing delineation(s) for site
- ☒ Global positioning system (GPS)
- ☐ Other studies

- ☐ Stream gage data
  Gage number:
  Period of record:
  - ☐ History of recent effective discharges
  - ☐ Results of flood frequency analysis
  - ☐ Most recent shift-adjusted rating
  - ☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units

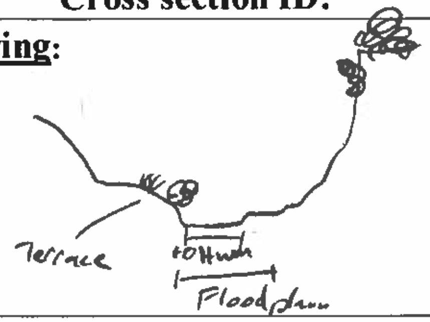


Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:
   ☐ Mapping on aerial photograph ☒ GPS
   ☐ Digitized on computer ☐ Other:

Project ID: Santa Clara **Cross section ID:** Wash 4 **Date:** 9/10 **Time:**

Cross section drawing:



OHWM

GPS point: 37.294670, -113.653975

Indicators:

- [x] Change in average sediment texture
- [ ] Change in vegetation species
- [x] Change in vegetation cover
- [ ] Break in bank slope
- [ ] Other: ____________
- [ ] Other: ____________

Comments:

Floodplain unit: [ ] Low-Flow Channel [x] Active Floodplain [ ] Low Terrace

GPS point: 37.294670, -113.653975

Characteristics of the floodplain unit:

Average sediment texture: fine, pebbles

Total veg cover: 2 % Tree: ____ % Shrub: ____ % Herb: 2 %

Community successional stage:

- [ ] NA
- [ ] Early (herbaceous & seedlings)
- [x] Mid (herbaceous, shrubs, saplings)
- [ ] Late (herbaceous, shrubs, mature trees)

Indicators:

- [x] Mudcracks
- [ ] Ripples
- [x] Drift and/or debris
- [ ] Presence of bed and bank
- [ ] Benches
- [x] Soil development
- [ ] Surface relief
- [ ] Other: ____________
- [ ] Other: ____________
- [ ] Other: ____________

Comments:

Project ID: Santa Clara **Cross section ID:** Wash 4 **Date:** 9/10 **Time:**

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: 37.294170, -113.653775

Characteristics of the floodplain unit:

Average sediment texture: fine

Total veg cover: 20 % Tree: ____ % Shrub: 5 % Herb: 15 %

Community successional stage:

- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☒ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☒ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☒ Soil development
- ☐ Surface relief
- ☐ Other: ____
- ☐ Other: ____
- ☐ Other: ____

Comments:

~~**Floodplain unit:** ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace~~

~~**GPS point:** ____~~

~~**Characteristics of the floodplain unit:**~~

~~Average sediment texture: ____~~

~~Total veg cover: ____ % Tree: ____ % Shrub: ____ % Herb: ____ %~~

~~Community successional stage:~~

- ~~☐ NA~~
- ~~☐ Early (herbaceous & seedlings)~~
- ~~☐ Mid (herbaceous, shrubs, saplings)~~
- ~~☐ Late (herbaceous, shrubs, mature trees)~~

~~**Indicators:**~~

- ~~☐ Mudcracks~~
- ~~☐ Ripples~~
- ~~☐ Drift and/or debris~~
- ~~☐ Presence of bed and bank~~
- ~~☐ Benches~~
- ~~☐ Soil development~~
- ~~☐ Surface relief~~
- ~~☐ Other: ____~~
- ~~☐ Other: ____~~
- ~~☐ Other: ____~~

~~**Comments:**~~

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Santa Clara Watershed EA	**Date:** 5/25/21	**Time:**
Project Number:	**Town:** Dammeron	**State:** UT
Stream: Wash 5	**Photo begin file#:** 32-33	**Photo end file#:**
Investigator(s): C Melis;		

Y ☒ / N ☐ Do normal circumstances exist on the site?	**Location Details:**
Y ☐ / N ☒ Is the site significantly disturbed?	**Projection:** **Datum:** **Coordinates:** 37.289976, -113.658327

Potential anthropogenic influences on the channel system:

culvert

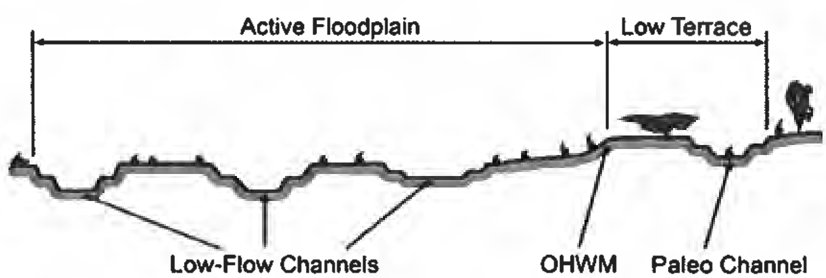
Brief site description:

juniper uplands

Checklist of resources (if available):

- ☒ Aerial photography
  - Dates:
- ☐ Topographic maps
- ☐ Geologic maps
- ☐ Vegetation maps
- ☐ Soils maps
- ☐ Rainfall/precipitation maps
- ☐ Existing delineation(s) for site
- ☒ Global positioning system (GPS)
- ☐ Other studies
- ☐ Stream gage data
  - Gage number:
  - Period of record:
    - ☐ History of recent effective discharges
    - ☐ Results of flood frequency analysis
    - ☐ Most recent shift-adjusted rating
    - ☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units

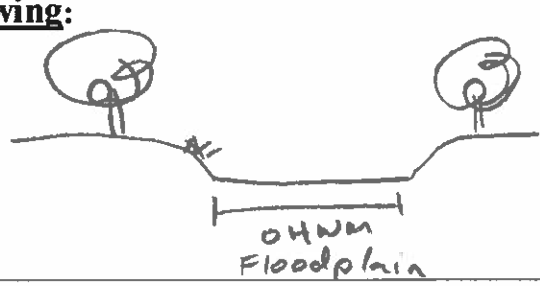


Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:
   - ☐ Mapping on aerial photograph
   - ☒ GPS
   - ☐ Digitized on computer
   - ☐ Other:

Project ID: Santa Clara **Cross section ID:** Wash 5 **Date:** 5/25 **Time:**

Cross section drawing:



OHWM

GPS point: 37.289976 -113.658327

Indicators:

- [x] Change in average sediment texture
- [ ] Change in vegetation species
- [x] Change in vegetation cover
- [ ] Break in bank slope
- [ ] Other: ____________
- [ ] Other: ____________

Comments:

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: 37.289976 -113.658327

Characteristics of the floodplain unit:

Average sediment texture: Sandy

Total veg cover: 75 % Tree: 5 % Shrub: 5 % Herb: 65 %

Community successional stage:

- [ ] NA
- [ ] Early (herbaceous & seedlings)
- [ ] Mid (herbaceous, shrubs, saplings)
- [x] Late (herbaceous, shrubs, mature trees)

Indicators:

- [ ] Mudcracks
- [ ] Ripples
- [ ] Drift and/or debris
- [x] Presence of bed and bank
- [ ] Benches
- [ ] Soil development
- [ ] Surface relief
- [ ] Other: ____________
- [ ] Other: ____________
- [ ] Other: ____________

Comments:

Project ID: Santa Clara **Cross section ID:** Wash 5 **Date:** 5/25 **Time:**

Floodplain unit: ☒ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: 37.289976 -113.658327

Characteristics of the floodplain unit:
Average sediment texture: sandy, pebble
Total veg cover: 0 % Tree: ____ % Shrub: ____ % Herb: ____ %
Community successional stage:
- ☒ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:
- ☐ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☒ Soil development
- ☐ Surface relief
- ☒ Other: slight sediment change
- ☐ Other: ____
- ☐ Other: ____

Comments:

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 37.289976 -113.658327

Characteristics of the floodplain unit:
Average sediment texture: cobble & pebble
Total veg cover: 0 % Tree: ____ % Shrub: ____ % Herb: ____ %
Community successional stage:
- ☒ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:
- ☒ Mudcracks
- ☐ Ripples
- ☒ Drift and/or debris
- ☒ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ____
- ☐ Other: ____
- ☐ Other: ____

Comments:

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Santa Clara Watershed ICA **Project Number:** **Stream:** Wash 6 **Investigator(s):** amelia	**Date:** 9/9/21 **Town:** Dammeron **Photo begin file#:** 36-41	**Time:** **State:** UT **Photo end file#:**
Y ☒ / N ☐ Do normal circumstances exist on the site? Y ☒ / N ☐ Is the site significantly disturbed?	**Location Details:** **Projection:** **Datum:** **Coordinates:** 37.258027, -113.616588	

Potential anthropogenic influences on the channel system:

Dumping, berming, bank reinforcement

Brief site description:

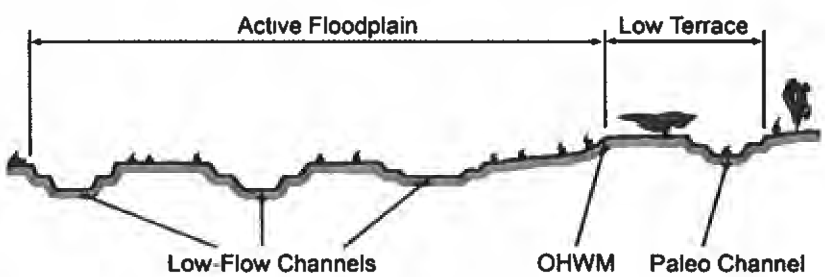
Residential & agricultural area

Checklist of resources (if available):

- ☒ Aerial photography
  Dates:
- ☐ Topographic maps
- ☐ Geologic maps
- ☐ Vegetation maps
- ☐ Soils maps
- ☐ Rainfall/precipitation maps
- ☐ Existing delineation(s) for site
- ☒ Global positioning system (GPS)
- ☐ Other studies

- ☐ Stream gage data
  Gage number:
  Period of record:
  - ☐ History of recent effective discharges
  - ☐ Results of flood frequency analysis
  - ☐ Most recent shift-adjusted rating
  - ☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units

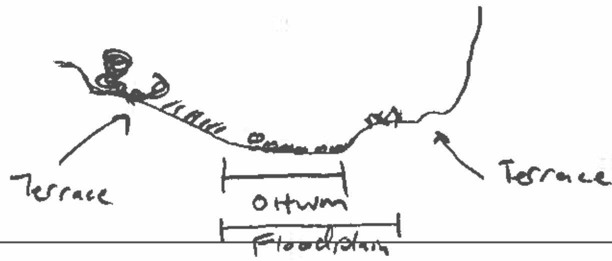


Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:
   - ☐ Mapping on aerial photograph
   - ☐ Digitized on computer
   - ☒ GPS
   - ☐ Other:

Project ID: Santa Clara **Cross section ID:** Wash 6 **Date:** 9/9 **Time:**

Cross section drawing:



OHWM

GPS point: 37.258027, -113.616588

Indicators:

- [x] Change in average sediment texture
- [ ] Change in vegetation species
- [x] Change in vegetation cover
- [ ] Break in bank slope
- [ ] Other: ______
- [ ] Other: ______

Comments:

cobble bottom

Floodplain unit: [ ] Low-Flow Channel [x] Active Floodplain [ ] Low Terrace

GPS point: 37.258027, -113.616588

Characteristics of the floodplain unit:

Average sediment texture: sandy, small rocks

Total veg cover: 10 % Tree: ____ % Shrub: 5 % Herb: 5 %

Community successional stage:

- [ ] NA
- [ ] Early (herbaceous & seedlings)
- [x] Mid (herbaceous, shrubs, saplings)
- [ ] Late (herbaceous, shrubs, mature trees)

Indicators:

- [ ] Mudcracks
- [ ] Ripples
- [x] Drift and/or debris
- [x] Presence of bed and bank
- [ ] Benches
- [ ] Soil development
- [ ] Surface relief
- [ ] Other: ______
- [ ] Other: ______
- [ ] Other: ______

Comments:

Project ID: Santa Clara **Cross section ID:** Wash 6 **Date:** 9/9 **Time:**

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: 37.258027, -113.616588

Characteristics of the floodplain unit:

Average sediment texture: Sandy

Total veg cover: 80 % Tree: ____ % Shrub: 10 % Herb: 70 %

Community successional stage:

- ☐ NA
- ☒ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☐ Mudcracks
- ☐ Ripples
- ☒ Drift and/or debris
- ☐ Presence of bed and bank
- ☒ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ____________
- ☐ Other: ____________
- ☐ Other: ____________

Comments:

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: ____________

Characteristics of the floodplain unit:

Average sediment texture: ____________

Total veg cover: ____ % Tree: ____ % Shrub: ____ % Herb: ____ %

Community successional stage:

- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☐ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ____________
- ☐ Other: ____________
- ☐ Other: ____________

Comments:

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Santa Clara Watershed EA
Project Number:
Stream: ~~Wash/Ditch~~ → Wash 7
Investigator(s): Cmelis

Date: 9/8/21
Town: Dammeron Valley
Photo begin file#: 43-45; 47

Time:
State: UT
Photo end file#:

Y ☐ / N ☒ Do normal circumstances exist on the site?

Y ☒ / N ☐ Is the site significantly disturbed?

Location Details:

Projection:
Datum:
Coordinates: 37.252717, -113.603897

Potential anthropogenic influences on the channel system:

Berm on S side of ditch/wash. Discontinuous OHWM

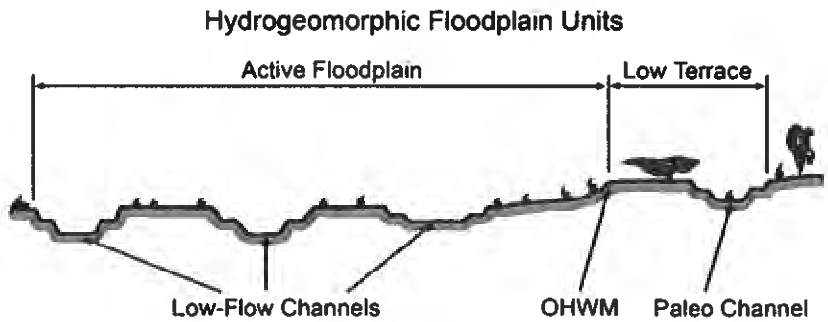
Brief site description:

Very poorly defined draw. OHWM only visible sporadically
heavily vegetated w/in channel

Checklist of resources (if available):

☒ Aerial photography
Dates:
☐ Topographic maps
☐ Geologic maps
☐ Vegetation maps
☐ Soils maps
☐ Rainfall/precipitation maps
☐ Existing delineation(s) for site
☒ Global positioning system (GPS)
☐ Other studies

☐ Stream gage data
Gage number:
Period of record:
☐ History of recent effective discharges
☐ Results of flood frequency analysis
☐ Most recent shift-adjusted rating
☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event



Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

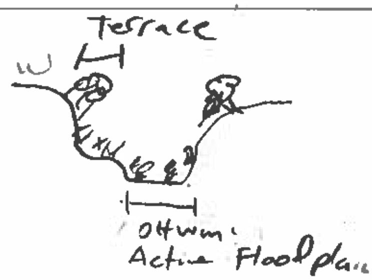
1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:

☐ Mapping on aerial photograph
☐ Digitized on computer

☒ GPS
☐ Other:

Project ID: Santa Clara **Cross section ID:** Wash 7 **Date:** 9/8 **Time:**

Cross section drawing:



OHWM

GPS point: 37.257217, -113.603897

Indicators:

- ☐ Change in average sediment texture
- ☐ Change in vegetation species
- ☐ Change in vegetation cover
- ☒ Break in bank slope
- ☐ Other: ______
- ☐ Other: ______

Comments:

Very poorly defined

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 37.257217, -113.603897

Characteristics of the floodplain unit:

Average sediment texture: ______

Total veg cover: 60 % Tree: 0 % Shrub: 50 % Herb: 10 %

Community successional stage:

- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☒ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☒ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ______
- ☐ Other: ______
- ☐ Other: ______

Comments:

Very poorly defined

Project ID: Santa Clara **Cross section ID:** Wash 7 **Date:** 9/8 **Time:**

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: 37.252717, -113.603897

Characteristics of the floodplain unit:

Average sediment texture: pebble and cobble

Total veg cover: 60 % Tree: ____ % Shrub: 55 % Herb: 5 %

Community successional stage:

☐ NA
☐ Early (herbaceous & seedlings)
☒ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☐ Mudcracks
☐ Ripples
☐ Drift and/or debris
☐ Presence of bed and bank
☒ Benches
☒ Soil development
☐ Surface relief
☐ Other: ____
☐ Other: ____
☐ Other: ____

Comments:

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: ____

Characteristics of the floodplain unit:

Average sediment texture: ____

Total veg cover: ____ % Tree: ____ % Shrub: ____ % Herb: ____ %

Community successional stage:

☐ NA
☐ Early (herbaceous & seedlings)
☐ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☐ Mudcracks
☐ Ripples
☐ Drift and/or debris
☐ Presence of bed and bank
☐ Benches
☐ Soil development
☐ Surface relief
☐ Other: ____
☐ Other: ____
☐ Other: ____

Comments:

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Santa Clara Watershed EA
Date: 9/10/21
Time:
Project Number:
Town: Diamond Valley
State: UT
Stream: Wash 8a
Photo begin file#:
Photo end file#:
Investigator(s): C Melisi

Y [x] / N [ ] Do normal circumstances exist on the site?

Y [ ] / N [x] Is the site significantly disturbed?

Location Details:

Projection:
Datum:
Coordinates: 37.249622, -113.598596

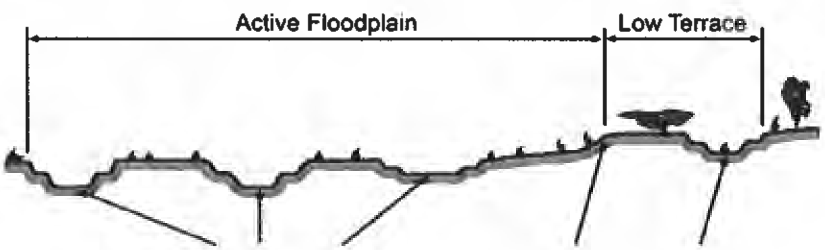
Potential anthropogenic influences on the channel system:
runoff from adjacent OHV road

Brief site description:
juniper upland

Checklist of resources (if available):

- [x] Aerial photography
  Dates:
- [ ] Topographic maps
- [ ] Geologic maps
- [ ] Vegetation maps
- [ ] Soils maps
- [ ] Rainfall/precipitation maps
- [ ] Existing delineation(s) for site
- [x] Global positioning system (GPS)
- [ ] Other studies
- [ ] Stream gage data
  Gage number:
  Period of record:
  - [ ] History of recent effective discharges
  - [ ] Results of flood frequency analysis
  - [ ] Most recent shift-adjusted rating
  - [ ] Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units

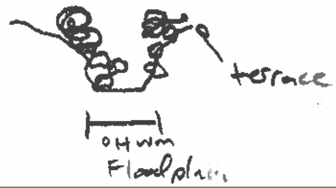


Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:
   - [ ] Mapping on aerial photograph
   - [x] GPS
   - [ ] Digitized on computer
   - [ ] Other:

Project ID: Santa Clara **Cross section ID:** Wash 8a **Date:** 9/10 **Time:**

Cross section drawing:



OHWM

GPS point: 37.249622, -113.598596

Indicators:

- [x] Change in average sediment texture
- [ ] Change in vegetation species
- [x] Change in vegetation cover
- [ ] Break in bank slope
- [ ] Other: ____________
- [ ] Other: ____________

Comments:

Floodplain unit: [ ] Low-Flow Channel [ ] Active Floodplain [x] Low Terrace

GPS point: 37.249622, -113.598596

Characteristics of the floodplain unit:

Average sediment texture: rocky

Total veg cover: 75 % Tree: 2 % Shrub: 58 % Herb: 15 %

Community successional stage:

- [ ] NA
- [ ] Early (herbaceous & seedlings)
- [ ] Mid (herbaceous, shrubs, saplings)
- [x] Late (herbaceous, shrubs, mature trees)

Indicators:

- [ ] Mudcracks
- [ ] Ripples
- [ ] Drift and/or debris
- [ ] Presence of bed and bank
- [ ] Benches
- [x] Soil development
- [ ] Surface relief
- [ ] Other: ____________
- [ ] Other: ____________
- [ ] Other: ____________

Comments:

Project ID: Santa Clara **Cross section ID:** Wash 8a **Date:** 9/10 **Time:**

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 37.249622, -113.598596

Characteristics of the floodplain unit:
Average sediment texture: ______
Total veg cover: 10 % Tree: ____ % Shrub: 8 % Herb: 2 %
Community successional stage:
- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☒ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:
- ☐ Mudcracks
- ☐ Ripples
- ☒ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☒ Soil development
- ☐ Surface relief
- ☐ Other: ______
- ☐ Other: ______
- ☐ Other: ______

Comments:

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: ______

Characteristics of the floodplain unit:
Average sediment texture: ______
Total veg cover: ____ % Tree: ____ % Shrub: ____ % Herb: ____ %
Community successional stage:
- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:
- ☐ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ______
- ☐ Other: ______
- ☐ Other: ______

Comments:

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Santa Clara Watershed EA **Project Number:** **Stream:** Wash 8 **Investigator(s):** Cmelisi	**Date:** 9/10/21 **Time:** **Town:** Diamond Valley **State:** UT **Photo begin file#:** ~~[illegible]~~ **Photo end file#:** 51-52
Y ☒ / N ☐ Do normal circumstances exist on the site?	**Location Details:**
Y ☐ / N ☒ Is the site significantly disturbed?	**Projection:** **Datum:** **Coordinates:** 37.249660, -113.598642

Potential anthropogenic influences on the channel system:
runoff from nearby OHV roads

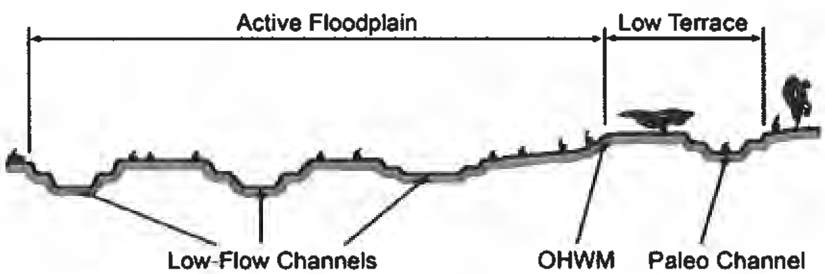
Brief site description:
Juniper upland

Checklist of resources (if available):

- ☒ Aerial photography
  Dates:
- ☐ Topographic maps
- ☐ Geologic maps
- ☐ Vegetation maps
- ☐ Soils maps
- ☐ Rainfall/precipitation maps
- ☐ Existing delineation(s) for site
- ☒ Global positioning system (GPS)
- ☐ Other studies

- ☐ Stream gage data
  Gage number:
  Period of record:
  - ☐ History of recent effective discharges
  - ☐ Results of flood frequency analysis
  - ☐ Most recent shift-adjusted rating
  - ☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units



Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:

☐ Mapping on aerial photograph ☒ GPS
☐ Digitized on computer ☐ Other:

Project ID: Santa Clara **Cross section ID:** Wash 8 **Date:** 9/10 **Time:**

Cross section drawing:

OHWM

GPS point: 37.249660, -113.598642

Indicators:
- ☒ Change in average sediment texture
- ☐ Change in vegetation species
- ☒ Change in vegetation cover
- ☐ Break in bank slope
- ☐ Other: ______
- ☐ Other: ______

Comments:

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 37.249660

Characteristics of the floodplain unit:

Average sediment texture: sandy & rocky

Total veg cover: 10 % Tree: ___ % Shrub: 5 % Herb: 5 %

Community successional stage:
- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☒ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:
- ☒ Mudcracks
- ☐ Ripples
- ☒ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☒ Soil development
- ☐ Surface relief
- ☐ Other: ______
- ☐ Other: ______
- ☐ Other: ______

Comments:

Project ID: Santa Clara **Cross section ID:** Wash 8 **Date:** 9/10 **Time:**

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: 37.249660, -113.598642

Characteristics of the floodplain unit:

Average sediment texture: rocky

Total veg cover: 28 % Tree: 3 % Shrub: 25 % Herb: 10 %

Community successional stage:

- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☒ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☐ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☒ Soil development
- ☐ Surface relief
- ☐ Other: ________
- ☐ Other: ________
- ☐ Other: ________

Comments:

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: ________

Characteristics of the floodplain unit:

Average sediment texture: ________

Total veg cover: ___ % Tree: ___ % Shrub: ___ % Herb: ___ %

Community successional stage:

- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☐ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ________
- ☐ Other: ________
- ☐ Other: ________

Comments:

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Santa Clara Watershed EA
Project Number:
Stream: Wash 8
Investigator(s): cmelisi

Date: 9/10/21
Town: Diamond Valley
Photo begin file#: 48-51

Time:
State:
Photo end file#:

Y [x] / N [ ] Do normal circumstances exist on the site?

Y [x] / N [ ] Is the site significantly disturbed?

Location Details:

Projection:
Datum:
Coordinates: 37.250600, -113.600996

Potential anthropogenic influences on the channel system:

Hiking trail & OHV road are w/in OHWM

Brief site description:

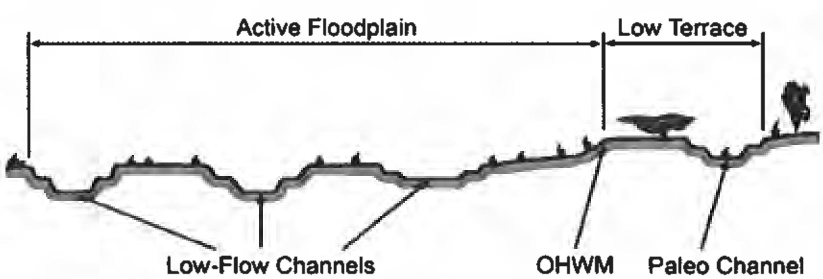
juniper upland

Checklist of resources (if available):

- [x] Aerial photography
  Dates:
- [ ] Topographic maps
- [ ] Geologic maps
- [ ] Vegetation maps
- [ ] Soils maps
- [ ] Rainfall/precipitation maps
- [ ] Existing delineation(s) for site
- [x] Global positioning system (GPS)
- [ ] Other studies

- [ ] Stream gage data
  Gage number:
  Period of record:
  - [ ] History of recent effective discharges
  - [ ] Results of flood frequency analysis
  - [ ] Most recent shift-adjusted rating
  - [ ] Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units

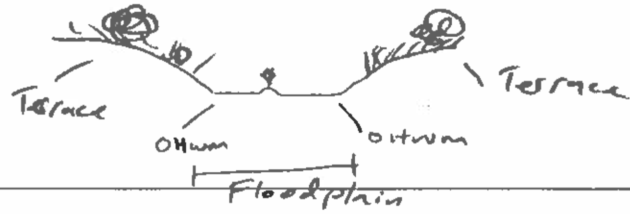


Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:
   - [ ] Mapping on aerial photograph
   - [x] GPS
   - [ ] Digitized on computer
   - [ ] Other:

Project ID: Santa Clara **Cross section ID:** Wash 8 **Date:** 9/10 **Time:**

Cross section drawing:



OHWM

GPS point: 37.250600, -113.600996

Indicators:

- [ ] Change in average sediment texture
- [ ] Change in vegetation species
- [x] Change in vegetation cover
- [x] Break in bank slope
- [ ] Other: ______
- [ ] Other: ______

Comments:

OHV road

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 37.250600, -113.600996

Characteristics of the floodplain unit:

Average sediment texture: fine, gravel

Total veg cover: 5 % Tree: 0 % Shrub: 0 % Herb: 5 %

Community successional stage:

- [ ] NA
- [x] Early (herbaceous & seedlings)
- [ ] Mid (herbaceous, shrubs, saplings)
- [ ] Late (herbaceous, shrubs, mature trees)

Indicators:

- [x] Mudcracks
- [ ] Ripples
- [ ] Drift and/or debris
- [ ] Presence of bed and bank
- [ ] Benches
- [ ] Soil development
- [ ] Surface relief
- [ ] Other: ______
- [ ] Other: ______
- [ ] Other: ______

Comments:

OHV road

Project ID: Santa Clara **Cross section ID:** Wash 8 **Date:** 9/10 **Time:**

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: 37.250600, -113.600796

Characteristics of the floodplain unit:
Average sediment texture: Cne, gravel
Total veg cover: 80 % Tree: 0 % Shrub: 60 % Herb: 20 %
Community successional stage:
- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☒ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:
- ☐ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☒ Soil development
- ☐ Surface relief
- ☐ Other: ______
- ☐ Other: ______
- ☐ Other: ______

Comments:

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: ______

Characteristics of the floodplain unit:
Average sediment texture: ______
Total veg cover: ____ % Tree: ____ % Shrub: ____ % Herb: ____ %
Community successional stage:
- ☐ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:
- ☐ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ______
- ☐ Other: ______
- ☐ Other: ______

Comments:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Santa Clara Watershed EA City/County: Shivwits, Washington Co Sampling Date: 9/10/21
Applicant/Owner: NRCS State: UT Sampling Point: Pit 1
Investigator(s): C Melis, Section, Township, Range: 28, 41S, 17W
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 0
Subregion (LRR): D Lat: 37.185109 Long: -113.764952 Datum:
Soil Map Unit Name: Fluvaquents & torrifluvents, sandy NWI classification: Forested/shrub Riparian
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)
Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___
Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ___	Is the Sampled Area within a Wetland? Yes ✓ No ___
Hydric Soil Present?	Yes ✓ No ___	
Wetland Hydrology Present?	Yes ✓ No ___	

Remarks: Although the depth of the hydric soils is less than 20", many indicators of hydric soils and hydrophytic veg are present

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ___)			
1. Salix spp.	10	YES	FACW
2. Tamarus spp.	3	NO	FAC
3.			
4.			
= Total Cover	13		
Sapling/Shrub Stratum (Plot size: ___)			
1. Salix spp.	5	YES	FACW
2. Populus angustfolia spp.	1	NO	FACW
3.			
4.			
5.			
= Total Cover	6		
Herb Stratum (Plot size: ___)			
1. Tifa angustfalia spp.	70	YES	OBL
2. Phragmites australi	8	NO	FACW
3.			
4.			
5.			
6.			
7.			
8.			
= Total Cover	78		
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 30 % Cover of Biotic Crust 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	70	x 1 = 70
FACW species	24	x 2 = 48
FAC species	3	x 3 = 9
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	89 (A)	127 (B)

Prevalence Index = B/A = 1.41

Hydrophytic Vegetation Indicators:

✓ Dominance Test is >50%
✓ Prevalence Index is ≤3.0[1]
___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks:

SOIL

Sampling Point: ____________

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
½ inch	7.5YR ¾ DBR	100	—				Clayey	Dense / sticky
2½ inch	7.5YR 2.5/1	100	2½ inch 7.5YR 2.5/1	100	Sulfate Redox		loamy Sand	30% organic matter / Sulfur Smell
12 inch	7.5YR 3/3	100	—				Sandy	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- __ Histosol (A1)
- __ Histic Epipedon (A2)
- __ Black Histic (A3)
- ✓ Hydrogen Sulfide (A4)
- ✓ Stratified Layers (A5) (**LRR C**)
- __ 1 cm Muck (A9) (**LRR D**)
- __ Depleted Below Dark Surface (A11)
- __ Thick Dark Surface (A12)
- ✓ Sandy Mucky Mineral (S1)
- __ Sandy Gleyed Matrix (S4)
- __ Sandy Redox (S5)
- __ Stripped Matrix (S6)
- __ Loamy Mucky Mineral (F1)
- __ Loamy Gleyed Matrix (F2)
- __ Depleted Matrix (F3)
- __ Redox Dark Surface (F6)
- __ Depleted Dark Surface (F7)
- __ Redox Depressions (F8)
- __ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- __ 1 cm Muck (A9) (**LRR C**)
- __ 2 cm Muck (A10) (**LRR B**)
- __ Reduced Vertic (F18)
- __ Red Parent Material (TF2)
- __ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present):

Type: Clay / Sand \ bed rock

Depth (inches): ½ inch \ 12 inch

Hydric Soil Present? Yes ______ No ______

Remarks: hydric soil indicators present but do not meet technical depth requirements

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ✓ Surface Water (A1)
- ✓ High Water Table (A2)
- ✓ Saturation (A3)
- __ Water Marks (B1) (**Nonriverine**)
- __ Sediment Deposits (B2) (**Nonriverine**)
- __ Drift Deposits (B3) (**Nonriverine**)
- __ Surface Soil Cracks (B6)
- __ Inundation Visible on Aerial Imagery (B7)
- __ Water-Stained Leaves (B9)
- __ Salt Crust (B11)
- __ Biotic Crust (B12)
- __ Aquatic Invertebrates (B13)
- ✓ Hydrogen Sulfide Odor (C1)
- __ Oxidized Rhizospheres along Living Roots (C3)
- __ Presence of Reduced Iron (C4)
- __ Recent Iron Reduction in Tilled Soils (C6)
- __ Thin Muck Surface (C7)
- __ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ✓ Water Marks (B1) (**Riverine**)
- __ Sediment Deposits (B2) (**Riverine**)
- __ Drift Deposits (B3) (**Riverine**)
- ✓ Drainage Patterns (B10)
- __ Dry-Season Water Table (C2)
- ✓ Crayfish Burrows (C8)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Shallow Aquitard (D3)
- __ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ____	No ✓	Depth (inches): ______
Water Table Present?	Yes ✓	No ____	Depth (inches): 3
Saturation Present? (includes capillary fringe)	Yes ✓	No ____	Depth (inches): 12

Wetland Hydrology Present? Yes ______ No ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Dig was only 12 inch deep due to bed rock Problem hydro soil / soil materials (Restricted layers); hydrology (5 inch standing water); vegetation (significantly indifferent then upland)

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Santa Clara Watershed EA City/County: Shivwits, Washington CO Sampling Date: 9/10/21
Applicant/Owner: NRCS State: UT Sampling Point: Pit 2
Investigator(s): C Melisi Section, Township, Range: 28, 41 S, 17 W
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 0
Subregion (LRR): D Lat: 37.185060 Long: -113.764722 Datum: ____
Soil Map Unit Name: Fluvaquents & torrifluvents, sandy NWI classification: Forested/Shrub Riparian
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ____	Is the Sampled Area within a Wetland? Yes ✓ No ____
Hydric Soil Present?	Yes ✓ No ____	
Wetland Hydrology Present?	Yes ✓ No ____	

Remarks: Although the depth of the hydric soil is less than 20", many indicators of hydric soil and hydrophytic veg are present

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
~~Tree Stratum (Plot size: ____)~~			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ____)			
1. Salix Spp.	3	YES	FACW
2.			
3.			
4.			
5.			
= Total Cover	3		
Herb Stratum (Plot size: ____)			
1. Tifa angustfolia Spp.	90	YES	OBL
2. Phragmites Spp.	5	NO	FACW
3.			
4.			
5.			
6.			
7.			
8.			
= Total Cover	95		
~~Woody Vine Stratum~~ (Plot size: ____)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 5 % Cover of Biotic Crust 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 2 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	90	x 1 = 90
FACW species	8	x 2 = 16
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	98 (A)	106 (B)

Prevalence Index = B/A = 1.08

Hydrophytic Vegetation Indicators:

✓ Dominance Test is >50%
✓ Prevalence Index is ≤3.0[1]
___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks:

SOIL

Sampling Point: ___________

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
1¼ inch	7.5YR 3/4 DBR	100	—	—	—		clayey	Dense/Sticky
2 inch	7.5YR 2.5	100	2½ inch 7.5YR 2.5/3	100	Sulfate Redox		loamy Sand	30% organic matter/Sulfur Smell
6 inch	7.5YR 3/3	100	—	—	—		Sandy	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- __ Histosol (A1)
- __ Histic Epipedon (A2)
- __ Black Histic (A3)
- ✓ Hydrogen Sulfide (A4)
- ✓ Stratified Layers (A5) (**LRR C**)
- __ 1 cm Muck (A9) (**LRR D**)
- __ Depleted Below Dark Surface (A11)
- __ Thick Dark Surface (A12)
- ✓ Sandy Mucky Mineral (S1)
- __ Sandy Gleyed Matrix (S4)
- __ Sandy Redox (S5)
- __ Stripped Matrix (S6)
- __ Loamy Mucky Mineral (F1)
- __ Loamy Gleyed Matrix (F2)
- __ Depleted Matrix (F3)
- __ Redox Dark Surface (F6)
- __ Depleted Dark Surface (F7)
- __ Redox Depressions (F8)
- __ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- __ 1 cm Muck (A9) (**LRR C**)
- __ 2 cm Muck (A10) (**LRR B**)
- __ Reduced Vertic (F18)
- __ Red Parent Material (TF2)
- __ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: clay/Sand \ bedrock

Depth (inches): 1¼ inch \ 6 inch

Hydric Soil Present? Yes ✓ No ____

Remarks: hydric soil indicators present but do not meet technical depth requirements

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ✓ Surface Water (A1)
- ✓ High Water Table (A2)
- ✓ Saturation (A3)
- __ Water Marks (B1) (**Nonriverine**)
- __ Sediment Deposits (B2) (**Nonriverine**)
- __ Drift Deposits (B3) (**Nonriverine**)
- __ Surface Soil Cracks (B6)
- __ Inundation Visible on Aerial Imagery (B7)
- __ Water-Stained Leaves (B9)
- __ Salt Crust (B11)
- __ Biotic Crust (B12)
- __ Aquatic Invertebrates (B13)
- ✓ Hydrogen Sulfide Odor (C1)
- __ Oxidized Rhizospheres along Living Roots (C3)
- __ Presence of Reduced Iron (C4)
- __ Recent Iron Reduction in Tilled Soils (C6)
- __ Thin Muck Surface (C7)
- __ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ✓ Water Marks (B1) (**Riverine**)
- __ Sediment Deposits (B2) (**Riverine**)
- __ Drift Deposits (B3) (**Riverine**)
- ✓ Drainage Patterns (B10)
- __ Dry-Season Water Table (C2)
- ✓ Crayfish Burrows (C8)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Shallow Aquitard (D3)
- __ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ____	No ✓	Depth (inches): ________
Water Table Present?	Yes ✓	No ____	Depth (inches): < 1
Saturation Present? (includes capillary fringe)	Yes ✓	No ____	Depth (inches): 6

Wetland Hydrology Present? Yes ____ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Dig was only 6 inch deep due to bedrock. Problem hydro Soil/Soil materials (Restricted layers); hydrology (saturated soil -); vegetation (significantly different then upland)

APPENDIX E-9C

AQUATIC RESOURCES

APPENDIX D

NRCS CUSTOM SOIL RESOURCE REPORT

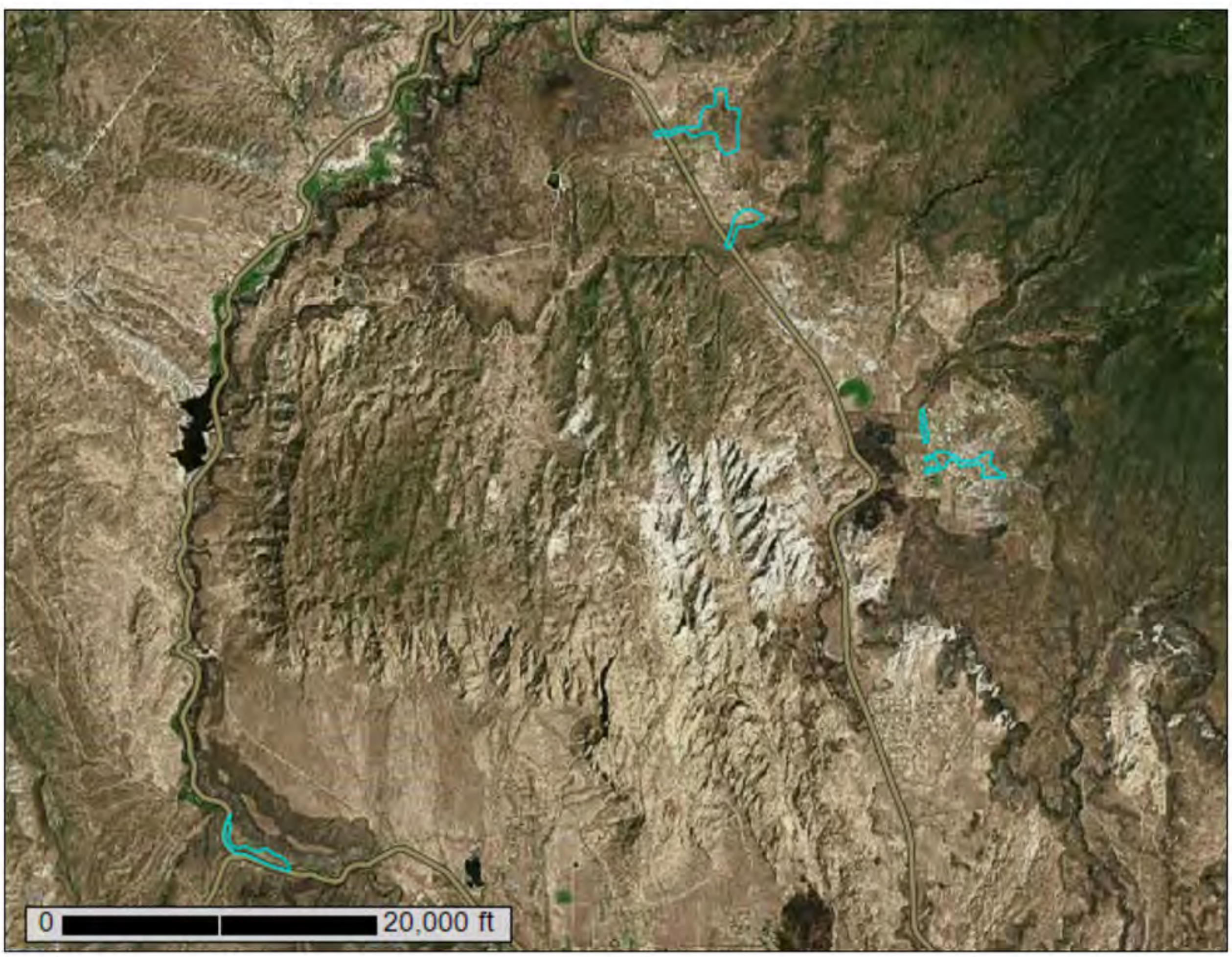
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Washington County Area, Utah



October 8, 2021

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

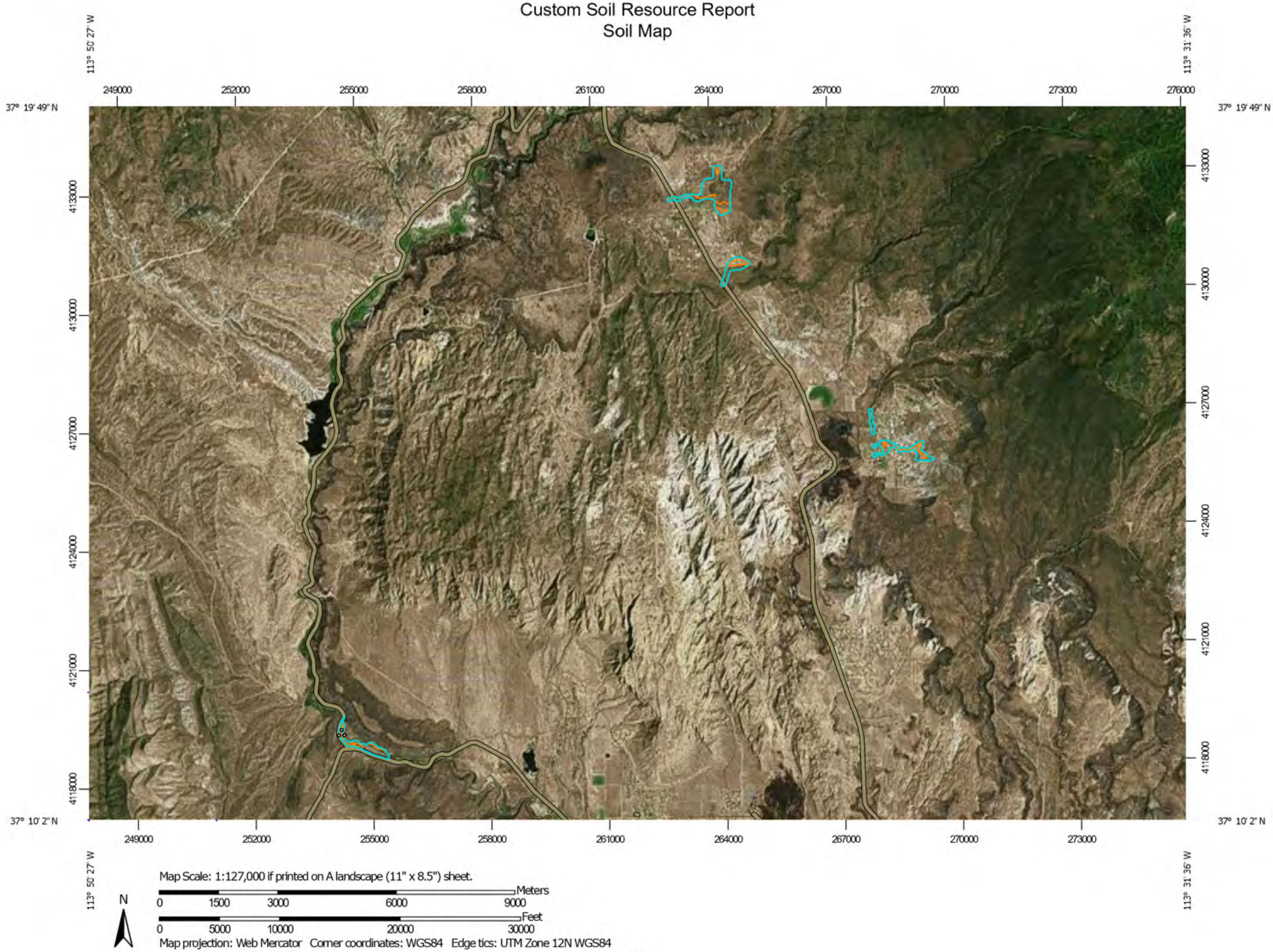
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map


113° 50' 27" W
113° 31' 36" W
37° 19' 49" N
37° 10' 2" N
249000
252000
255000
258000
261000
264000
267000
270000
273000
276000
4133000
4130000
4127000
4124000
4121000
4118000
N
Map Scale: 1:127,000 if printed on A landscape (11" x 8.5") sheet.
0 1500 3000 6000 9000 Meters
0 5000 10000 20000 30000 Feet
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Washington County Area, Utah
Survey Area Data: Version 15, Sep 7, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 7, 2015—Aug 1, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BB	Badland, very steep	6.5	1.8%
EB	Eroded land-Shalet complex, warm	3.6	1.0%
FA	Fluvaquents and torrifluvents, sandy	9.8	2.7%
LeB	Leeds silty clay loam, 1 to 2 percent slopes	43.7	12.2%
MAE	Magotsu-Pastura complex, 2 to 20 percent slopes	138.3	38.4%
NaC	Naplene silt loam, 2 to 6 percent slopes	100.2	27.8%
RaC	Redbank fine sandy loam, 1 to 5 percent slopes	24.8	6.9%
SY	Stony colluvial land	0.0	0.0%
VPD	Veyo-Pastura complex, 1 to 10 percent slopes	0.0	0.0%
W	Water	0.9	0.3%
YAF	Yaki very cobbly loam, 3 to 35 percent slopes	32.0	8.9%
Totals for Area of Interest		**359.8**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Washington County Area, Utah

BB—Badland, very steep

Map Unit Composition

Badland: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Badland

Setting

Landform: Hills, escarpments

Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Side slope, free face

Down-slope shape: Convex

Across-slope shape: Convex

EB—Eroded land-Shalet complex, warm

Map Unit Setting

National map unit symbol: j8ds

Elevation: 3,600 to 5,550 feet

Mean annual precipitation: 10 to 13 inches

Mean annual air temperature: 52 to 56 degrees F

Frost-free period: 165 to 170 days

Farmland classification: Not prime farmland

Map Unit Composition

Eroded land: 78 percent

Shalet and similar soils: 20 percent

Minor components: 2 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Eroded Land

Setting

Landform: Erosion remnants

Parent material: Residuum weathered from shale

Description of Shalet

Setting

Landform: Swales

Down-slope shape: Concave

Across-slope shape: Concave

Parent material: Residuum weathered from shale

Typical profile

H1 - 0 to 4 inches: clay loam

H2 - 4 to 12 inches: clay loam

H3 - 12 to 16 inches: weathered bedrock

Properties and qualities

Slope: 2 to 20 percent
Depth to restrictive feature: 4 to 15 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Gypsum, maximum content: 10 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water supply, 0 to 60 inches: Very low (about 2.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: R030XY134UT - Desert Shallow Loam (Creosotebush)
Hydric soil rating: No

Minor Components

Badland

Percent of map unit: 2 percent

FA—Fluvaquents and torrifluvents, sandy

Map Unit Setting

National map unit symbol: j8dt
Elevation: 2,500 to 3,000 feet
Mean annual precipitation: 8 to 11 inches
Mean annual air temperature: 57 to 67 degrees F
Frost-free period: 190 to 205 days
Farmland classification: Not prime farmland

Map Unit Composition

Fluvaquents and similar soils: 55 percent
Torrifluvents and similar soils: 35 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fluvaquents

Setting

Landform: Swales
Landform position (three-dimensional): Talf

Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Sandy alluvium derived from limestone, sandstone, and shale

Typical profile

H1 - 0 to 5 inches: fine sand
H2 - 5 to 60 inches: stratified fine sand to silt loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: About 6 to 24 inches
Frequency of flooding: Frequent
Frequency of ponding: Rare
Calcium carbonate, maximum content: 20 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 10.0
Available water supply, 0 to 60 inches: Low (about 4.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: A/D
Ecological site: R035XY011UT - Loamy Bottom (Basin Big Sagebrush)
Hydric soil rating: Yes

Description of Torrifluvents

Setting

Landform: Flood plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from limestone, sandstone, and shale

Typical profile

H1 - 0 to 5 inches: loamy fine sand
H2 - 5 to 60 inches: stratified loamy fine sand to silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: About 42 to 72 inches
Frequency of flooding: FrequentNone
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Maximum salinity: Nonsaline to moderately saline (0.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water supply, 0 to 60 inches: Low (about 4.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: A
Ecological site: R035XY011UT - Loamy Bottom (Basin Big Sagebrush)
Other vegetative classification: Loamy Bottom (Basin Big Sagebrush) (035XY011UT)
Hydric soil rating: No

Minor Components

Riverwash

Percent of map unit: 4 percent
Landform: Flood plains
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Tobler, silty clay loam

Percent of map unit: 3 percent

Tobler, fine sandy loam

Percent of map unit: 3 percent

LeB—Leeds silty clay loam, 1 to 2 percent slopes

Map Unit Setting

National map unit symbol: j8fk
Elevation: 2,550 to 3,300 feet
Mean annual precipitation: 8 to 11 inches
Mean annual air temperature: 57 to 67 degrees F
Frost-free period: 190 to 200 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Leeds and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leeds

Setting

Landform: Flood plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from limestone, sandstone, and shale

Typical profile

H1 - 0 to 8 inches: silty clay loam
H2 - 8 to 15 inches: silty clay loam
H3 - 15 to 23 inches: sandy loam
H4 - 23 to 60 inches: silt loam

Properties and qualities

Slope: 1 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water supply, 0 to 60 inches: High (about 10.1 inches)

Interpretive groups

Land capability classification (irrigated): 3s
Hydrologic Soil Group: C
Ecological site: R030XY110UT - Desert Loam (Creosotebush)
Hydric soil rating: No

Minor Components

Leeds

Percent of map unit: 4 percent

Hantz

Percent of map unit: 4 percent

St george

Percent of map unit: 4 percent

Tobler

Percent of map unit: 3 percent

MAE—Magotsu-Pastura complex, 2 to 20 percent slopes

Map Unit Setting

National map unit symbol: j8fm
Elevation: 3,800 to 6,300 feet
Mean annual precipitation: 10 to 13 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 155 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition

Magotsu and similar soils: 55 percent
Pastura and similar soils: 25 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Magotsu

Setting

Landform: Lava flows
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from basalt and some limestone and sandstone

Typical profile

H1 - 0 to 2 inches: very cobbly loam
H2 - 2 to 5 inches: gravelly clay loam
H3 - 5 to 14 inches: clay
H4 - 14 to 17 inches: gravelly clay loam
H5 - 17 to 21 inches: indurated
H6 - 21 to 25 inches: unweathered bedrock

Properties and qualities

Slope: 2 to 20 percent
Depth to restrictive feature: 10 to 20 inches to petrocalcic; 14 to 22 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to low (0.00 to 0.01 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: Very low (about 2.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: R029XY220UT - Semidesert Shallow Hardpan (Blackbrush)
Hydric soil rating: No

Description of Pastura

Setting

Landform: Lava flows
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits derived from sandstone and shale over residuum weathered from basalt

Typical profile

H1 - 0 to 2 inches: gravelly loam
H2 - 2 to 8 inches: gravelly loam

H3 - 8 to 15 inches: gravelly loam
H4 - 15 to 18 inches: gravelly clay loam
H5 - 18 to 22 inches: indurated

Properties and qualities

Slope: 2 to 10 percent
Depth to restrictive feature: 10 to 20 inches to petrocalcic
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 60 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very low (about 2.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: R029XY220UT - Semidesert Shallow Hardpan (Blackbrush)
Hydric soil rating: No

Minor Components

Hardpan soils

Percent of map unit: 5 percent

Veyo

Percent of map unit: 5 percent

Pastura

Percent of map unit: 5 percent

Rock outcrop

Percent of map unit: 5 percent

NaC—Naplene silt loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: j8fz
Elevation: 3,600 to 5,300 feet
Mean annual precipitation: 14 to 15 inches
Mean annual air temperature: 44 to 52 degrees F
Frost-free period: 140 to 160 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Naplene and similar soils: 75 percent

Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Naplene

Setting

Landform: Valleys, alluvial fans
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium derived from igneous and sedimentary rock

Typical profile

H1 - 0 to 2 inches: silt loam
H2 - 2 to 7 inches: silt loam
H3 - 7 to 15 inches: silt loam
H4 - 15 to 22 inches: silty clay loam
H5 - 22 to 39 inches: silt loam
H6 - 39 to 60 inches: silt loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.8 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: R035XY306UT - Upland Loam (Basin Big Sagebrush)
Hydric soil rating: No

Minor Components

Schmutz

Percent of map unit: 5 percent

Redbank

Percent of map unit: 5 percent

Mespun

Percent of map unit: 5 percent

Chilton

Percent of map unit: 5 percent

Clovis

Percent of map unit: 5 percent

RaC—Redbank fine sandy loam, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: j8gm
Elevation: 3,300 to 5,500 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 160 to 170 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Redbank and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Redbank

Setting

Landform: Valleys, alluvial fans
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Concave, linear
Parent material: Alluvium derived from limestone, sandstone, and shale

Typical profile

H1 - 0 to 5 inches: fine sandy loam
H2 - 5 to 16 inches: fine sandy loam
H3 - 16 to 35 inches: fine sandy loam
H4 - 35 to 60 inches: loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 8.4 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: R035XY306UT - Upland Loam (Basin Big Sagebrush)
Hydric soil rating: No

Minor Components

Palma

Percent of map unit: 5 percent

Palma

Percent of map unit: 5 percent

Clovis

Percent of map unit: 5 percent

SY—Stony colluvial land

Map Unit Composition

Stony colluvial land: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

VPD—Veyo-Pastura complex, 1 to 10 percent slopes

Map Unit Setting

National map unit symbol: j8h6
Elevation: 3,800 to 5,000 feet
Mean annual precipitation: 10 to 12 inches
Mean annual air temperature: 45 to 57 degrees F
Frost-free period: 120 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition

Veyo and similar soils: 50 percent
Pastura and similar soils: 40 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Veyo

Setting

Landform: Alluvial fans
Down-slope shape: Concave
Across-slope shape: Convex
Parent material: Material weathered dominantly from basalt

Typical profile

H1 - 0 to 2 inches: cobbly sandy loam
H2 - 2 to 6 inches: very cobbly clay loam
H3 - 6 to 17 inches: very cobbly clay
H4 - 17 to 19 inches: very cobbly sandy clay loam
H5 - 19 to 23 inches: indurated
H6 - 23 to 27 inches: unweathered bedrock

Properties and qualities

Slope: 1 to 10 percent
Depth to restrictive feature: 15 to 20 inches to petrocalcic; 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: R029XY220UT - Semidesert Shallow Hardpan (Blackbrush)
Hydric soil rating: No

Description of Pastura

Setting

Landform: Lava flows
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits derived from sandstone and shale over residuum weathered from basalt

Typical profile

H1 - 0 to 2 inches: gravelly loam
H2 - 2 to 8 inches: gravelly loam
H3 - 8 to 15 inches: gravelly loam
H4 - 15 to 18 inches: gravelly clay loam
H5 - 18 to 22 inches: indurated

Properties and qualities

Slope: 2 to 10 percent
Depth to restrictive feature: 10 to 20 inches to petrocalcic
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 60 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very low (about 2.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D

Ecological site: R029XY220UT - Semidesert Shallow Hardpan (Blackbrush)
Hydric soil rating: No

Minor Components

Rock land

Percent of map unit: 5 percent

Collbran

Percent of map unit: 5 percent

W—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

YAF—Yaki very cobbly loam, 3 to 35 percent slopes

Map Unit Setting

National map unit symbol: j8hc
Elevation: 3,500 to 5,000 feet
Mean annual precipitation: 10 to 13 inches
Mean annual air temperature: 52 to 57 degrees F
Frost-free period: 160 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition

Yaki and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Yaki

Setting

Landform: Mountain slopes
Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Material weathered from limestone and shale

Typical profile

H1 - 0 to 2 inches: very cobbly loam
H2 - 2 to 8 inches: loam
H3 - 8 to 12 inches: very cobbly loam
H4 - 12 to 19 inches: very cobbly loam
H5 - 19 to 23 inches: unweathered bedrock

Properties and qualities

Slope: 3 to 35 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 60 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: R029XY220UT - Semidesert Shallow Hardpan (Blackbrush)
Hydric soil rating: No

Minor Components

Rock land

Percent of map unit: 7 percent

Naplene

Percent of map unit: 4 percent

Tobish

Percent of map unit: 4 percent

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APPENDIX E-10

PUBLIC INVOLVEMENT

SCOPING SUMMARY REPORT

Santa Clara Watershed Plan-Environmental Assessment Project

Prepared for:

U.S. Department of Agriculture
Natural Resources Conservation Service

Prepared by:

Transcon Environmental, Inc.
444 South Main Street, Suite A6
Cedar City, Utah 84720

Transcon environmental | Planners & Scientists

May 2021

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INTRODUCTION AND BACKGROUND

The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS), with assistance of Washington County, Utah, as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. The improvements under consideration will address flood control and protection, agricultural demands, and public safety risks, while enhancing species habitat. The proposed improvements include the construction of stream diversions and detention basins within the Dammeron and Diamond valleys as well as other improvements within the Shivwits Band of Paiutes lands, including stream restoration, irrigation supply, and flood protection.

Cooperating agencies include the Bureau of Land Management and Utah State and Institutional Trust Lands Administration (SITLA). Transcon Environmental (Transcon) has been retained to prepare the project's technical studies and the National Environmental Policy Act (NEPA) document. This report summarizes efforts made to notify interested agencies, Tribes, organizations, and members of the public about the proposed project and to obtain input from those entities regarding issues to be addressed in the NEPA document. This outreach is meant to satisfy scoping requirements and to inform the federal process and decisions under NEPA. The scoping period commenced on January 13, 2021 and concluded on February 12, 2021.

Purpose of Scoping Process

Scoping is an integral part of the NEPA processes. It provides an early opportunity to determine the scope and significance of issues to be addressed in the analysis of the proposed action (40 CFR 1501.7). The objectives of scoping include:

- Identify significant issues related to the proposed project
- Identify social, environmental, and economic review and consultation requirements
- Define the environmental analysis process and technical studies necessary to adequately address the impacts of the proposed project
- Identify and notify interested and affected parties
- Provide information to agencies, Tribes, and the public regarding the proposed project

Public outreach will commence for a second time when the Draft NEPA document is prepared and ready for public review. This report summarizing scoping efforts that help define the scope of the analysis.

Organizational Involvement

Cooperating agencies are working together and contributing to jointly prepared deliverables for the project but are satisfying their regulatory requirements separately, including their decisions under NEPA and the permitting mechanism should they approve the project. As such, this scoping process and the subsequent technical studies and NEPA document have been designed to be comprehensive, support all agencies' decisions, and satisfy all regulatory requirements. All cooperating agencies and Tribes that have contributed to the project's scoping process are as follows:

- Utah State and Institutional Trust Lands Administration
- Office of the Governor, Public Lands Policy Coordinating Office
- Shivwits Band of Paiutes
- Bureau of Land Management St. George Field Office

SCOPING ACTIVITIES

Scoping Material Circulated

Scoping material circulated included the project fact sheet (**Appendix A**), pre-addressed comment form/letter, and newspaper notice. A single project fact sheet—containing roject information, the online public meeting time and call-in info, and instructions for submitting formal scoping comments—was produced in order to ensure consistent messaging.

All mailings to the public, agencies, and Tribes included a project newsletter. Public mailings included a personalized letter and pre-addressed comment form. Agency and Tribes received a scoping letter from the NRCS. Project newsletters were posted at local post offices, and announcements with a brief project summary and online public meeting information placed in a local newspaper.

The Project team strived to get all scoping material circulated and published in a timely manner, so interested parties were notified and had at least one week to plan to attend the online public meeting. Comments were received during public meetings and through direct mail and email. The comment period remained open 16 days past the public meeting date.

Public Scoping

The public was notified of the project through multiple channels, each described in detail below, including project mailings sent to landowners and potentially interested members of the public, project newsletters posted at local post offices, notifications published in local newspapers, online public meetings using Zoom, and a project webpage containing project information and updates established by the NRCS.

Landowner Notification

The project sponsor assembled the landowner mailing list. County data was used to develop a list that included a physical parcel address and the landowner's mailing address. Landowner information was gathered for parcels who own parcels that are directly adjacent to or within the project area and downstream of the proposed detention basins in Diamond and Dammeron valleys.

The mailing list will be updated throughout the project to include those who provide scoping comments, otherwise express interest in the project, or request to be added to the mailing list. The updated mailing list will be referenced for future public outreach efforts.

A total of 106 mailings were sent to landowners in Diamond Valley. A total of 49 mailings were sent to landowners in Dammeron Valley. Mailings were sent on January 11, 2021, two days ahead of the opening of the scoping period. The mailing list of private landowners and copies of the individual scoping letters are not shared as part of this scoping report for privacy purposes. Each agency will receive a copy of the mailing list for their records, and it will be included as part of the project's Administrative Record.

Website

The NRCS maintains a public project webpage that includes basic project information, a project overview map, a copy of the fact sheet, and instructions for submitting comments. A recording of the public scoping meeting was posted to the webpage as well. The website can be accessed at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ut/programs/planning/wpfp/?cid=nrcseprd1726625.

The webpage went live on January 15, 2021 and remains active. The scoping video was posted to the webpage on February 1, 2021. The webpage will be updated as new project material is prepared for public viewing.

Newspaper Notices

The project fact sheet was pared down to include a brief project summary and public meeting information and was posted the local *Spectrum* newspaper (**Appendix B**) on January 13, 2021 and January 20, 2021.

Online Public Meeting

One online public meeting was held via Zoom on January 27, 2021 from 6:30 to 7:30 p.m. The meeting included a brief presentation of project background, location, and information on the environmental review process followed by a question-and-answer period. Representatives from Transcon, Alpha Engineering, Washington County, and the NRCS attended the meeting. A total of 12 members of the public attended the meeting. Participants were encouraged to provide written comments regarding the project by email or mail and to ask any pertinent questions at the meeting.

Agency Scoping

On July 10, 2019, a total of 29 project fact sheets were sent to individuals at federal, state, and local agencies, as well as elected officials. The agency contact list is included as **Appendix D**.

Tribal Outreach

Tribes are being consulted under Section 106 of the National Historic Preservation Act. In an effort to ensure tribal entities were reached and informed about the project, the same Tribes contacted for consultation were also sent mailings under the NEPA process. On January 13, 2021, mailings were sent to individuals at 22 Tribes (**Appendix E**). To ensure consistent messaging, the same newsletter used for public scoping were attached to the letters. The tribal contact list is included as **Appendix F**.

SCOPING RESULTS

Newspaper Coverage

On Wednesday, January 13 and Wednesday, January 20, 2021, the *Spectrum*, a newspaper that services southern Utah, published the information advertising the online public meeting. A copy of the *Spectrum* posting affidavit can found in **Appendix C**.

Agency Responses

Two comment documents were received from federal, state, or local agencies or elected officials (**Appendix G**). One document was received via email and the other via mailed letter. These were organized into 12 individual comments. An additional comment was received from an agency representative during the public meeting. Comments were received from the Office of the Governor, Public Lands Policy Coordinating Office and SITLA.

Tribal Responses

Four tribal comment documents have been received: two from the Shivwits Band of Paiutes Band Council, one from the Navajo Nation Heritage and Historic Preservation Department, and the other from the Hopi Cultural Preservation Office. These were organized into six individual comments. All comments are included in **Appendix H**. Tribal consultation will be ongoing for the duration of the project.

Comments Received

All written and oral comments received—whether from agencies, Tribes, or the public—were collected and will be considered in the NEPA document.

Thirty-five individual comments were received from the public, agencies, and Tribes from a total of 11 comment documents. Twenty-five of the comments are considered substantive for the NEPA process. Comments that identified issues are grouped into four categories to aid in their interpretation and analysis. The specific issues identified will aid in the assessment impacts and analysis of resources in the Environmental Assessment. **Table 1** summarizes concerns raised per category.

Appendix I is a summary table of all comments received. The table includes verbatim comments received but does not include the original comment records. Comment records and scans will be provided to agencies for their records and will be included in the project's Administrative Record.

TABLE 1
COMMENTS RECEIVED PER CATEGORY

Category	Commentor			Total Per Category
	Public	Agency	Tribe	
Alternatives	9	--	--	**9**
Biological Resources	--	11	--	**11**
Cultural Resources	--	--	5	**5**
General	8	1	1	**10**
TOTAL CONCERNS	**17**	**12**	**6**	**35**

APPENDIX A

PROJECT FACT SHEET

Santa Clara Watershed Plan-EA Project-Washington Co, Utah

Scoping Notice - Fact Sheet

Project Information

The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), with assistance of Washington County, Utah as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. The proposed improvements include the construction of stream diversions and detention basins within the Dammeron and Diamond Valleys, as well as other improvements within the Shivwits Band of Paiutes lands including stream restoration, irrigation supply, and flood protection.

USDA-NRCS will hold a virtual public meeting to provide information about the proposed project and to collect written comments. Technical studies are scheduled to take place during spring 2021, with a Draft Plan-EA circulated to the public and agencies for review in fall 2021.

Purpose and Need

Improvements under consideration will address flood control and protection, agricultural demands, and public safety risks, while enhancing species habitat.

At this time, USDA-NRCS is requesting comments on the project to identify issues and resource concerns. Written comments are due within 30 days, postmarked by **February 12, 2021**.

Additional information can be found at the USDA-NRCS project website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/ut/programs/planning/wpfp

Public Meeting

The public is invited to attend, discuss, and submit a written comment during the public meeting. The meeting will begin with an initial presentation by the project team and NRCS, followed by an open-house style question and comment session. Interested parties can join the meeting online or call in via the following:

Virtual Meeting
Wednesday, January 27, 2021
6:30 P.M. – 7:30 P.M.

Zoom: https://zoom.us/join
Meeting ID: 999 8991 1069
Phone: (669) 900-6833

*For those who are unable to attend or view the meeting and would like to meet with the NRCS and/or Washington County to discuss the project, arrangements may be made upon request.

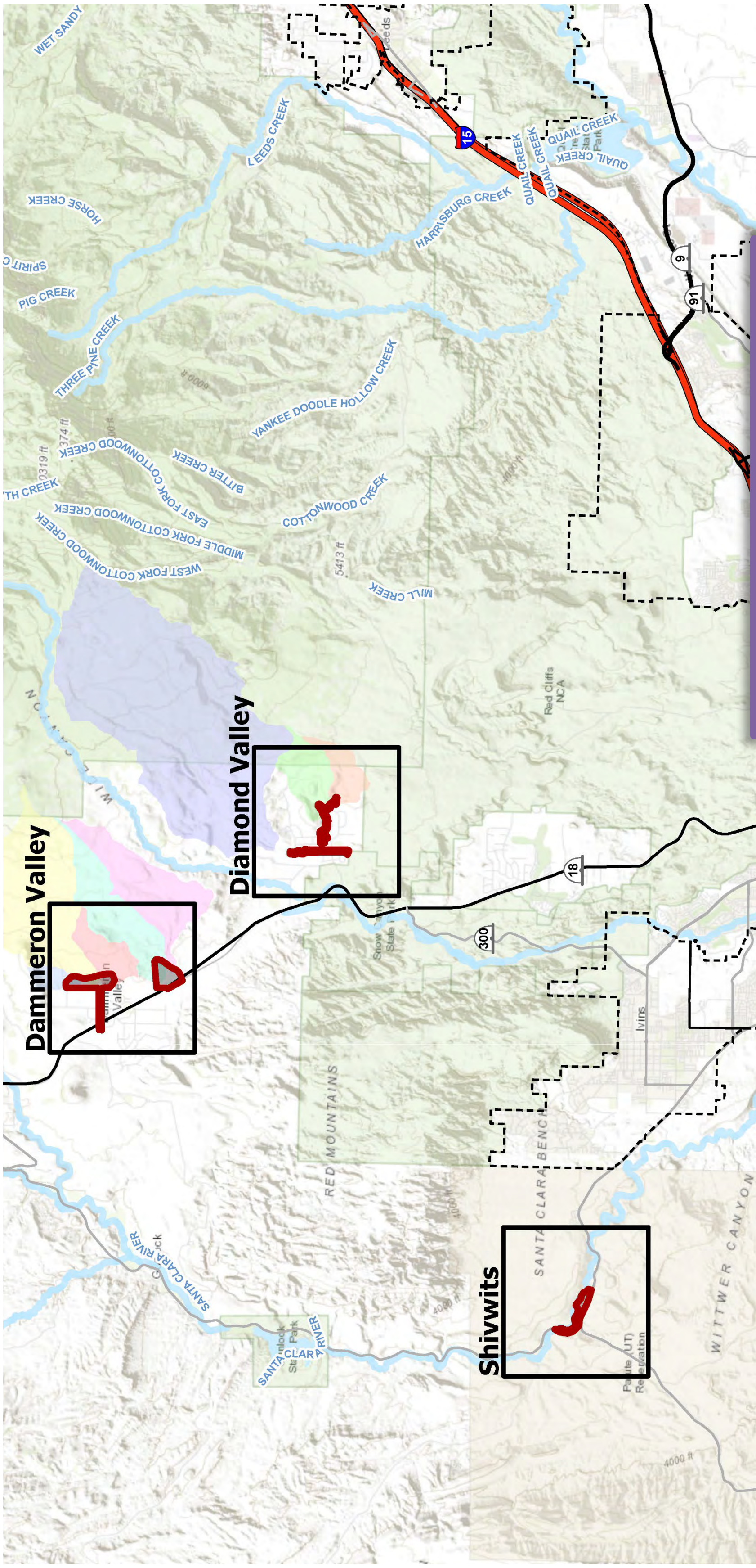
Photo of Shivwits Reservation Land

How to Submit a Comment

All comments should be submitted in writing and directed to Brian Parker:

Transcon Environmental
1745 South Alma School Rd., Suite 220
Phoenix, AZ 85210
Phone: (480) 807-0095
bparker@transcon.com

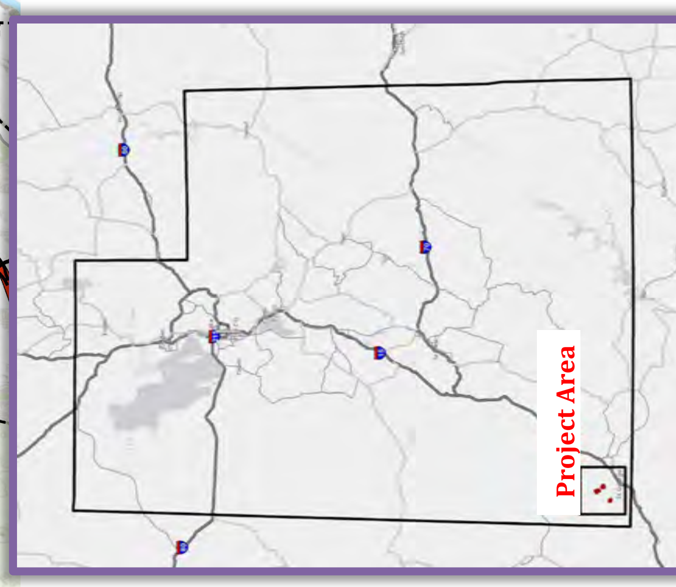
Comments may be mailed or emailed to the above address or submitted during the public scoping meeting. Comments must be received or postmarked by **February 12, 2021**



Project Area (top)

Vicinity Map (bottom right)

Photo of Dammeron Valley (bottom left)



Utah State Office

Natural Resources Conservation Service

nrcs.usda.gov/

APPENDIX B

NEWSPAPER NOTICE

Proposed Santa Clara Watershed Project—Washington County, Utah
Public Scoping Meeting
Wednesday, January 27th, 2021; 6:30 to 7:30 P.M.

The U.S. Department of Agriculture's Natural Resources Conservation Service (USDA--NRCS), with assistance of Washington County, Utah, as the project sponsor, is considering proposed improvements within the Santa Clara Watershed. The proposed improvements include the construction of stream diversions and detention basins within the Dammeron and Diamond valleys as well as other improvements within the Shivwits Band of Paiutes lands, including stream restoration, irrigation supply, and flood protection. Improvements under consideration will address flood control and protection, agricultural demands, and public safety risks, while enhancing species habitat.

At this time, USDA-NRCS is requesting comments on the project to identify issues and resource concerns. USDA--NRCS will hold a virtual public meeting to provide information about the proposed project and collect comments.

Join the virtual public scoping meeting:
The public is invited to attend, discuss, and submit a comment during the public meeting:
Wednesday, January 27, 2021
6:30 P.M. – 7:30 P.M.
Zoom: https://zoom.us/join
Meeting ID: 999 8991 1069
Phone: 669-900-6833

Send us your comments:
All comments should be directed to:
Brian Parker
Transcon Environmental
1745 South Alma School Road, Suite 220
Phoenix, AZ 85210
Phone: 480-807-0095
bparker@transcon.com

Additional information can be found at the USDA-NRCS project website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/ut/programs/planning/wpfp

Comments may be mailed or emailed to the above address or submitted during the public scoping meeting. Comments must be postmarked by February 12th, 2021.

Pub#4544744
Published Jan 13 & 20, 2021
The Spectrum
UPAXLP

APPENDIX C

SPECTRUM POSTINGS AFFIDAVIT

The Spectrum
PART OF THE USA TODAY NETWORK

PROOF OF PUBLICATION

**STATE OF WISCONSIN
COUNTY OF BROWN**

TRANSCOM ENVIRONMENTAL
116 4TH STREET

RAWLINS WY 82301

I, being duly sworn, deposes and says that I am an employee of The Spectrum, a newspaper of general circulation published daily in Saint George, Washington County, State of Utah, also distributed in Iron County and also forwarded to Utahlegals.com, and that the notice is a true copy of which is here to attached, was published in said newspaper dated:

01/13/2021, 01/20/2021

for a total of 2 insertion(s) and per Utahlegals.com will remain on Utahlegals.com for 30 days.

Kathleen Allen

Legal Clerk

Subscribed and sworn before me this 20th of January 2021.

Shelly Hora

NOTARY PUBLIC RESIDING
AT STATE OF WISCONSIN
COUNTY OF BROWN

Notary Expires: 8-25-23

SHELLY HORA
Notary Public
State of Wisconsin

Ad#:0004544744
P O :
This is not an invoice
# of Affidavits 1

APPENDIX D

AGENCY CONTACT LIST

Organization	Person of Contact	Street Address	City	State	Zip
Federal Agencies					
U.S. Army Corps of Engineers, Bountiful Office	Hollis Jencks, Regulatory Project Manager	533 West 2600 South, Suite 150	Bountiful	UT	84010
U.S. Army Corps of Engineers, NV/UT Regulatory Branch	Jason Gipson, Chief	533 West 2600 South, Suite 150	Bountiful	UT	84010
U.S. Fish and Wildlife Service	Yvette Converse, Utah Field Office Supervisor	2369 West Orton Circle, Suite 50	West Valley City	UT	84119
Bureau of Land Management, St. George Field Office	N/A	345 East Riverside Dr.	St. George	UT	84790
US - EPA	Dana Allen	1595 Wynkoop Street	Denver	CO	80202-1129
US Bureau of Reclamation	Regional Director	125 S State Street, Room 8100	Salt Lake City	UT	84138-1147
US Congressional Representative	Chris Stewart	253 W St. George Blvd, Ste 100	St. George	UT	84770
US Senator	Mitt Romney	125 S State Street, Ste 8402	Salt Lake City	UT	84138
US Senator	Mike Lee	285 W Tabernacle, Ste 200	St. George	UT	84770
State & Local Agencies					
Utah State Clearinghouse	Ken Mathews	Utah State Capitol Complex, Suite E210, P.O. Box 142210	Salt Lake City	UT	84114
Utah School and Institutional Trust Lands Administration (SITLA)	N/A	675 East 500 South, #500	Salt Lake City	UT	84102
Utah Division of Wildlife Resources	Main Office	1594 W. North Temple, Suite 2110, P.O. Box 146301	Salt Lake City	UT	84114
Utah Division of Wildlife Resources	Southern Region	1470 N. Airport Rd.	Cedar City	UT	84720
Utah Department of Environmental Quality	N/A	195 North 1950 West	Salt Lake City	UT	84114
Utah Department of Environmental Quality	Erica Gaddis (Director)	P.O. Box 144870	Salt Lake City	UT	84114-4870
Utah Department of Environmental Quality	Bill Damery	P.O. Box 144870	Salt Lake City	UT	84114-4870
Utah Division of Water Rights	Dam Safety	1594 W. North Temple, Suite 220, P.O. Box 146300	Salt Lake City	UT	84114
Utah Division of Water Rights	Southwestern Regional Office	646 North Main Street, P.O. Box 506	Cedar City	UT	84721
Mt. Carmel Irrigation Company	N/A	2651 S. State St. P.O. Box 5566	Mt. Carmel	UT	84755
Utah Department of Heritage and Arts	Chris Merritt	300 S Rio Grande St.	Salt Lake City	UT	84101-1182
Washington County Water Conservancy District	Corey Cram	533 Waterworks Dr.	St. George	UT	84770
Utah Department of Agriculture	Commissioner	P.O. Box 146500	Salt Lake City	UT	84114-6500
Utah Department of Environmental Health	Director	P.O. Box 142104	Salt Lake City	UT	84114-2104
Utah Department of Public Safety	Judy Watanabe	P.O. Box 141775	Salt Lake City	UT	84114-1775
Utah Natural Heritage Program	Sarah Lindsey	P.O. Box 146301	Salt Lake City	UT	84114
Utah Public Lands Policy Coordination Office	Sindy Smith	P.O.Box 14114-1107	Salt Lake City	UT	84114-1107
Utah Governor's Office	Governor Spencer J. Cox	P.O. Box 142220	Salt Lake City	UT	84114-2220
NGOs					
Utah Rivers Council	N/A	1055 East 2100 South, Suite 201	Salt Lake City	UT	84106
Sierra Club Utah Chapter	Chair	423 W 800 S, Ste A103	Salt Lake City	UT	84101

APPENDIX E

AGENCY COMMENTS RECEIVED

State of Utah

SPENCER J. COX
Governor

DEIDRE M. HENDERSON
Lieutenant Governor

Office of the Governor
Public Lands Policy Coordinating Office

REDGE B. JOHNSON
Executive Director

February 11, 2021

Submitted via email: bparker@transcon.com

Brian Parker
Transcon Environmental
1745 South Alma School Road, Suite 220
Phoenix, AZ 85210

Subject: **Santa Clara Watershed Draft Plan—EA**
RDCC Project No. 77725

Dear Mr. Parker:

The state of Utah (State) has reviewed the proposed improvements within the Santa Clara Watershed Plan. The State supports the proposed Santa Clara Watershed Draft Plan project located in Washington County. In collaboration with the Utah Division of Wildlife Resources (UDWR), the State provides the following scoping comments for your consideration.

Native Fish

The Santa Clara River contains the following native fish species: Virgin spinedace (*Lepidomeda mollispinis mollispinis*), desert sucker (*Catostomus clarkii*), and speckled dace (*Rhinichthys osculus*). The Virgin spinedace species are of particular concern in this area and are managed under a Conservation Agreement and Strategy which was implemented to avoid the need for listing under the Endangered Species Act. This species has been petitioned for listing as a T&E species. The U.S. Fish and Wildlife Service (FWS) is currently determining whether listing is warranted for the Virgin spinedace. Desert sucker are identified as a species of greatest conservation need because of their limited distribution.

Because of the importance of the Santa Clara River to native fish species, UDWR recommends, regarding any action developed for this project, to avoid unnecessary take of native fish, and minimize impacts to critical habitat. In addition, UDWR has the following recommendations to avoid and minimize impacts to these species:

UDWR has a lease agreement for water with the Shivwits Band of Paiutes, to provide flows important for restoring the historic distribution of Virgin spinedace and retaining habitat connectivity. The information in the scoping notice does not provide enough detail to clarify whether the lease agreement could be impacted. UDWR would like to ensure that the lease agreement is not impacted.

Avoid crossing the river whenever possible. If it is necessary for equipment to cross or enter the river, do so only once at a pre-identified crossing point approved by UDWR. Channel diversions, crossings, and in-stream work will require fish clearances. Fish-clearance activities must be performed before any construction activities begin in order to minimize take of native fishes. Contact the UDWR's Washington County Field Office personnel, Melinda Bennion at 435-619-1229, at least three business days prior the start of any construction activities that will impact the channel. UDWR personnel will determine if fish clearances are necessary. At a minimum, fish-salvage efforts must occur prior to construction of any diversions and before such diversions are removed. Ongoing fish salvage may be required depending on the length of stream impacted and the duration of the impact. In addition, UDWR also requests authorization to visit the site during construction activities to ensure protection of native fish species and their habitat.

Construction activities that may result in any disturbance to the stream should not be completed during critical spawning months; UDWR recommends no construction activities occur from April 1 to July 31. Exceptions to this should be permitted only when specific conservation actions are formulated through direct consultation with UDWR Native Aquatics biologist Melinda Bennion (435-619-1229).

UDWR recommends that living native woody vegetation, especially willows and cottonwoods, not be disturbed. Any ground that is graded clean, or where salt-cedar (tamarisk) is to be removed, should be required to be re-vegetated with appropriate native woody species. Specifically, UDWR recommends that revegetation using coyote willow and black willow as well as cottonwoods be used at the point of the trail to prevent establishment of non-native plants and protect the trail during high flows.

Applicants for stream alteration permits in Utah are required to provide justification for using rock-wall structures (concrete, riprap, etc.) for stabilizing banks instead of less damaging methods such as bioengineering, large woody debris, root wads, and willow plantings. If the applicant must use rock walls, they are required to explain how their design "incorporates elements that are beneficial to aquatic organisms." UDWR recommends that the applicant justify the use of riprap and consider using bioengineering techniques where feasible.

For more information on the ecological impacts of various types of bank stabilization materials and a review of alternative bioengineering techniques please reference the following publications and the references therein:

http://www.restorationreview.com/downloads/Science_and_Tools_for_Stream_Projects_2011.pdf

https://www.engr.colostate.edu/~bbledsoe/CIVE413/Bioengineering_for_Streambank_Erosion_Control_report1.pdf

Any rock wall/riprap construction or repair work must include measures to prevent the creation of refuge areas for non-native fish (e.g., fabric barriers, jetting, grouting, etc.). The interstitial spaces in typical riprap and other armament structures provide refuge for non-native fish which undermines UDWR's native fish conservation and recovery efforts. Actions to recover endangered and sensitive native fish in the Virgin River and its tributaries are dependent on effective removal of non-native fish.

To avoid creating non-native fish refugia, improve riparian habitat, and increase bank stability, the UDWR recommends that willow plugs are planted within the rip-rap. This can be done effectively by using on site sediment slurry to fill the gaps of the rip-rap and planting willow therein. This practice will allow the roots of the willows to fortify the stability of the rock wall.

Applicants completing bank stabilizations are also required to provide a narrative of current and expected sediment movement, deposition patterns, and erosion conditions in the project area, upstream and downstream. The installation of rip-rap is an action that is proven to change a watercourse's sediment and deposition profile. The applicant must disclose the fact that the project may accelerate erosion to adjacent properties, if rip-rap is used.

Establish a bulldozer-length buffer zone, or maintain an elevation of two feet above the flowing river channel, for all work in the project area. This element is intended to keep all equipment out of the active flowing channel to avoid direct take of conservation fish species. This condition also precludes the need for additional extensive and ongoing fish salvage in the project area during activities.

During any cutting, filling and grading of slopes, machinery and associated sediment should not be allowed in the stream. Excavated material and construction debris may not be wasted in any stream channel or placed in flowing waters or adjacent wetlands; this will include material such as grease, oil, joint coating, or any other possible pollutants. Excess materials must be wasted at an upland site well away from any channel, and excavated material must be removed from stockpiled areas within 12 months of project completion. Fill materials should be free of fines, waste, pollutants, and noxious weeds /seeds. Machinery must be properly cleaned and fueled offsite prior to construction.

In 2009, UDWR completed a statewide management plan to address strategies that prevent the spread of aquatic invasive species (AIS) in Utah. In particular, the UDWR is putting forth an aggressive statewide effort to prevent the spread of the invasive quagga mussel (*Dreissena bugensis*), which is now a substantial threat to Utah's waterways. The Utah Aquatic Invasive Species Management Plan was created to identify threats and provide techniques to protect Utah’s waterways from aquatic nuisance species (Utah AIS Management Plan). Special decontamination procedures are required by the UDWR.

The State appreciates the opportunity to provide comments on the proposed improvements under consideration. The State looks forward to working collaboratively with Natural Resources Conservation Service to continue to conserve Utah’s water resources. Please call or email if you have further questions. Please call Melinda Bennion at UDWR’s Washington County Field Office (435-619-1229) or Gary Bezzant at UDWR’s Cedar City office (435-691-2357) if you have questions or concerns.

Sincerely,

Redge B. Johnson
Executive Director

SITLA
State of Utah
School and Institutional
Trust Lands Administration

David Ure
Director

February 10, 2021

Emily Fife, State Conservationist
Natural Resources Conservation Service
Wallace F Bennett Federal Building
125 South State Street, Room 4010
Salt Lake City, Utah 84138-1100

RE: Santa Clara Watershed Plan-Environmental Assessment (Plan-EA)

Dear Ms. Fife:

In response to a letter dated February 1, 2021 requesting that the Utah School and Institutional Trust Lands Administration becomes a cooperating agency in the planning and development of the Santa Clara Watershed Plan, please be advised that we are happy to comply with that request.

On January 27, 2021, Staff attended the NRCS virtual scoping meeting to learn the details about the proposed project. Our agency has a vested interest in the lands in Dammeron and Diamond Valley; we look forward to working with you in this endeavor.

Aaron Langston (aaronlangston@utah.gov) in our Washington County office has been assigned to this task. Please reach out to him for further information.

Sincerely,

David Ure

David Ure
Director
State of Utah School and Institutional Trust Lands Administration

APPENDIX F
ALL COMMENTS RECEIVED SUMMARY TABLE

CID	Doc ID	Received	Method	Type	Commenter	Organization	Location	Category	Comment	Substantive	Duplicate	Comment Response
1	1	2/11/2021	Email	Agency	Redge Johnson	Office of the Governor - PLPCO	Salt Lake City, UT	Biological Resources	The Santa Clara River contains the following native fish species: Virgin spinedace (Lepidomeda mollispinis mollispinis), desert sucker (Catostomus clarkii), and speckled dace (Rhinichthys osculus). The Virgin spinedace species are of particular concern in this area and are managed under a Conservation Agreement and Strategy which was implemented to avoid the need for listing under the Endangered Species Act. This species has been petitioned for listing as a T&E species. The U.S. Fish and Wildlife Service (FWS) is currently determining whether listing is warranted for the Virgin spinedace. Desert sucker are identified as a species of greatest conservation need because of their limited distribution. Because of the importance of the Santa Clara River to native fish species, UDWR recommends, regarding any action developed for this project, to avoid unnecessary take of native fish, and minimize impacts to critical habitat.	Yes	No	We anticipate no disturbance within the ordinary high water line in armoring the stream channel.
2	1	2/11/2021	Email	Agency	Redge Johnson	Office of the Governor - PLPCO	Salt Lake City, UT	Biological Resources	UDWR has a lease agreement for water with the Shivwits Band of Paiutes, to provide flows important for restoring the historic distribution of Virgin spinedace and retaining habitat connectivity. The information in the scoping notice does not provide enough detail to clarify whether the lease agreement could be impacted. UDWR would like to ensure that the lease agreement is not impacted.	Yes	No	We have no control over the lease agreement for water from the Shivwits Band of Paiutes. This project will not interfere with current commitments with the Shivwits.
3	1	2/11/2021	Email	Agency	Redge Johnson	Office of the Governor - PLPCO	Salt Lake City, UT	Biological Resources	Avoid crossing the river whenever possible. If it is necessary for equipment to cross or enter the river, do so only once at a pre-identified crossing point approved by UDWR. Channel diversions, crossings, and in-stream work will require fish clearances. Fish-clearance activities must be performed before any construction activities begin in order to minimize take of native fishes. Contact the UDWR's Washington County Field Office personnel, Melinda Bennion at 435-619-1229, at least three business days prior the start of any construction activities that will impact the channel. UDWR personnel will determine if fish clearances are necessary. At a minimum, fish-salvage efforts must occur prior to construction of any diversions and before such diversions are removed. Ongoing fish salvage may be required depending on the length of stream impacted and the duration of the impact. In addition, UDWR also requests authorization to visit the site during construction activities to ensure protection of native fish species and their habitat.	Yes	No	It is our understanding that all work will be performed on the South side of the river bank outside the ordinary high water and no crossing of the Santa Clara river channel will be necessary.
4	1	2/11/2021	Email	Agency	Redge Johnson	Office of the Governor - PLPCO	Salt Lake City, UT	Biological Resources	Construction activities that may result in any disturbance to the stream should not be completed during critical spawning months; UDWR recommends no construction activities occur from April 1 to July 31. Exceptions to this should be permitted only when specific conservation actions are formulated through direct consultation with UDWR Native Aquatics biologist Melinda Bennion (435-619-1229).	Yes	No	We do not anticipate disturbing areas within the ordinary high water line.
5	1	2/11/2021	Email	Agency	Redge Johnson	Office of the Governor - PLPCO	Salt Lake City, UT	Biological Resources	UDWR recommends that living native woody vegetation, especially willows and cottonwoods, not be disturbed. Any ground that is graded clean, or where salt-cedar (tamarisk) is to be removed, should be required to be re-vegetated with appropriate native woody species. Specifically, UDWR recommends that revegetation using coyote willow and black willow as well as cottonwoods be used at the point of the trail to prevent establishment of non-native plants and protect the trail during high flows.	Yes	No	We intend to avoid native woody vegetation.
6	1	2/11/2021	Email	Agency	Redge Johnson	Office of the Governor - PLPCO	Salt Lake City, UT	Biological Resources	Applicants for stream alteration permits in Utah are required to provide justification for using rock-wall structures (concrete, riprap, etc.) for stabilizing banks instead of less damaging methods such as bioengineering, large woody debris, root wads, and willow plantings. If the applicant must use rock walls, they are required to explain how their design "incorporates elements that are beneficial to aquatic organisms." UDWR recommends that the applicant justify the use of riprap and consider using bioengineering techniques where feasible. Any rock wall/riprap construction or repair work must include measures to prevent the creation of refuge areas for non-native fish (e.g., fabric barriers, jetting, grouting, etc.). The interstitial spaces in typical riprap and other armament structures provide refuge for non-native fish which undermines UDWR's native fish conservation and recovery efforts. Actions to recover endangered and sensitive native fish in the Virgin River and its tributaries are dependent on effective removal of non-native fish. For more information on the ecological impacts of various types of bank stabilization materials and a review of alternative bioengineering techniques please reference the following publications and the references therein: http://www.restorationreview.com/downloads/Science_and_Tools_for_Stream_Projects_2011.pdf https://www.engr.colostate.edu/~bbledsoe/CIVE413/Bioengineering_for_Streambank_Erosion_Control_report1.pdf	Yes	No	It is our understanding that we will be using buried riprap outside of the ordinary high water line which will allow for native vegetation to continue to promulgate.
7	1	2/11/2021	Email	Agency	Redge Johnson	Office of the Governor - PLPCO	Salt Lake City, UT	Biological Resources	To avoid creating non-native fish refugia, improve riparian habitat, and increase bank stability, the UDWR recommends that willow plugs are planted within the rip-rap. This can be done effectively by using on site sediment slurry to fill the gaps of the rip-rap and planting willow therein. This practice will allow the roots of the willows to fortify the stability of the rock wall.	Yes	No	This strategy will be considred in the Plan-EA.
8	1	2/11/2021	Email	Agency	Redge Johnson	Office of the Governor - PLPCO	Salt Lake City, UT	Biological Resources	Applicants completing bank stabilizations are also required to provide a narrative of current and expected sediment movement, deposition patterns, and erosion conditions in the project area, upstream and downstream. The installation of rip-rap is an action that is proven to change a watercourse's sediment and deposition profile. The applicant must disclose the fact that the project may accelerate erosion to adjacent properties, if rip-rap is used.	Yes	No	Any effects of the use of rip-rap will be disclosed in the Plan-EA.
9	1	2/11/2021	Email	Agency	Redge Johnson	Office of the Governor - PLPCO	Salt Lake City, UT	Biological Resources	Establish a bulldozer-length buffer zone, or maintain an elevation of two feet above the flowing river channel, for all work in the project area. This element is intended to keep all equipment out of the active flowing channel to avoid direct take of conservation fish species. This condition also precludes the need for additional extensive and ongoing fish salvage in the project area during activities.	Yes	No	The plan is to implement the project outside of the ordinary high water line.
10	1	2/11/2021	Email	Agency	Redge Johnson	Office of the Governor - PLPCO	Salt Lake City, UT	Biological Resources	During any cutting, filling and grading of slopes, machinery and associated sediment should not be allowed in the stream. Excavated material and construction debris may not be wasted in any stream channel or placed in flowing waters or adjacent wetlands; this will include material such as grease, oil, joint coating, or any other possible pollutants. Excess materials must be wasted at an upland site well away from any channel, and excavated material must be removed from stockpiled areas within 12 months of project completion. Fill materials should be free of fines, waste, pollutants, and noxious weeds /seeds. Machinery must be properly cleaned and fueled offsite prior to construction.	Yes	No	It is the intent to follow these guidelines
11	1	2/11/2021	Email	Agency	Redge Johnson	Office of the Governor - PLPCO	Salt Lake City, UT	Biological Resources	In 2009, UDWR completed a statewide management plan to address strategies that prevent the spread of aquatic invasive species (AIS) in Utah. In particular, the UDWR is putting forth an aggressive statewide effort to prevent the spread of the invasive quagga mussel (Dreissena bugensis), which is now a substantial threat to Utah's waterways. The Utah Aquatic Invasive Species Management Plan was created to identify threats and provide techniques to protect Utah's waterways from aquatic nuisance species (Utah AIS Management Plan). Special decontamination procedures are required by the UDWR.	Yes	No	We will follow the procedures outlined by the UDWR.
12	2	1/23/2021	Email	Public	Dean & Sherma Bergevin; Rick and Cindy Kirkpatrick		Diamond Valley, UT	Alternatives	Lots 134, 135, and 136 are bounded on the west side by state trust lands and the north-south wash identified on Google Maps as Rock Hollow Wash. Lot 134 is also bounded on the west side by private property. This wash is subject to periodic flooding which substantially widens and deepens the wash each time a flood occurs. Since we (the Bergevins) bought lot #135 in late 2008 the wash has doubled in width in our area, moving substantially closer to our property line. The wash crosses lot #134, resulting in significant loss of usable private property as the wash has widened. On the west side of lot #136 the wash has divided its channel and has substantially widened. It now encroaches to, or near, the property line for that lot. In the area of the wash behind these three lots, the wash runs through ground consisting primarily of fine dirt with occasional small layers or lenses of sand and gravel. The gradient of the wash across these three lots is also significant, resulting in fast moving water that easily erodes and collapses the soft banks of the wash. The fast moving water quickly washes away the dirt and rocks that are cut from the banks. After previous floods the current owners of lots 134 and 135 were told by various state and local officials that we were responsible for protecting our own lots, since no funding was available to help us. Since then we have spent a large number of labor hours trying to shore up the sides of the wash to protect our property. Rick Kirkpatrick (lot #134) estimates he has spent over 100 hours of time and labor on his personal tractor trying to prevent the wash from encroaching further into his usable property. Dean and Sherma Bergevin have spent over 20 hours of tractor time and many additional hours of hand labor building fences and berms to prevent the wash from encroaching on their land. We also had a large amount of help from Rick Kirkpatrick and Scott Warner, the previous owner of lot 136. Scott Warner and other previous owners of lot 136 also rented backhoes to create berms to protect their property. Those berms were largely washed away during the most recent floods. I have attached two pictures of the wash during the most recent heavy flood in March 2019. The first picture was taken at the height of the flood from a location approximately at the north end of lot 135, looking upstream at the water crossing behind lot 136. The second picture was taken of the same general area after the water had receded somewhat. As property owners heavily affected by flooding in Rock Hollow Wash, we request that any plan for managing the Santa Clara watershed include plans and funding to stop further eastward erosion of this wash behind our lots. Although these comments do not represent the interests of private lots and properties further south of us, we recognize that the wash is also heavily damaging private property in that area. The management plan should also include provisions for preventing flood damage by the water moving south past our lots.	Yes	No	The existing wash that runs behind Lots 126, 127, 134, 135, 136 and 143 have been included for analysis and will be designed to adequately handle large storm events and prevent further erosion.
13	3	1/20/2021	Email	Public	Cathy Jones		Diamond Valley, UT	General	Based upon the map included with your letter dated January 8, 2021, in which you solicited comments from residents concerning the plan, it is impossible to pinpoint the exact location or nature of your proposed improvements. I realize this is still in preliminary stages, however, I do not know if the red lines represent water flow pathways, or actual streets, which would directly affect any potential questions and comments. Can you clarify for me exactly what the red lines represent? Also, the letter does not indicate what KIND of project is being proposed. What is the actual "plan"? I look forward to hearing from one or both of you prior to the scheduled "zoom" meeting. I would like to be able to participate in the meeting, but it is hard to plan cogent comments or questions with so little information. Thank you for your anticipated response.	No	No	Information was provided in response to these questions and comments regarding content of scoping meeting.
14	4	2/12/2021	Email	Tribal	Carmen Clark, Chairperson	Shivwits Band of Paiutes Band Council	Washington Cou nty, UT	Cultural Resources	As a preliminary matter, the Band requests consultation with NRCS directly on this matter. Pursuant to Executive Order 13175 and the NRCS General Manual 410, the Shivwits Band request direct consultation with NRCS in relation to the Proposed Santa Clara Watershed Plan (Plan). The Band looks forward to meeting with NRCS representatives soon.	Yes	No	The NRCS is very aware of the importance Shivwits Band of Paiutes Water Rights Settlement Act and Public Law 106-263. We will ensure that project components do not adversely impact the Band's water rights or the lands that are held in trust by the US governent and the aborigial and ceded lands.
15	4	2/12/2021	Email	Tribal	Carmen Clark, Chairperson	Shivwits Band of Paiutes Band Council	Washington Cou nty, UT	Cultural Resources	The Shivwits Band has existed as a sovereign Band since time immemorial on the lands underlying this Project (Subject Lands). The Band is interested and impacted because the Subject Lands are, as you know, within the Band's aboriginal and ceded territory, as well as the Band's current Reservation land held in trust by the United States government. In addition, the Shivwits Band has water rights established by U.S. Congress in Public Law 106-263, the Shivwits Band of Paiutes Water Rights Settlement Act that are impacted by the Plan. We are concerned about the stream diversions and detention basins, and want to make sure that the stream restoration, irrigation supply and flood protection plans do not harm our water rights or the related lands.	Yes	No	The NRCS is very aware of the importance Shivwits Band of Paiutes Water Rights Settlement Act and Public Law 106-263. We will ensure that project components do not adversely impact the Band's water rights or the lands that are held in trust by the US governent and the aborigial and ceded lands.

16	4	2/12/2021	Email	Tribal	Carmen Clark, Chairperson	Shivwits Band of Paiutes Band Council	Washington Cou nty, UT	Cultural Resources	The Project Plan should not disregard or adversely impact the Band's cultural and traditional interests in the area. The Shivwits Band has culturally sensitive areas within the area impacted by the Plan, as well as historic sites. The Subject Lands are associated with the cultural practices, traditions, beliefs, and social institutions of the Band's traditional community. The Band wants to ensure that any of the proposed improvements affecting land which is part of the Band's aboriginal territory, ceded land, and current Reservation do not disturb Band graves, artifacts, ceremonial sites, historic properties and cultural resources.	Yes	No	As part of the EA, Transcon will be completing an intensive cultural resources inventory of the undertaking to identify all cultural resources sites within the APE. From working in the area, the NRCS is also already aware of historic sites in the project area. We also know of the high sensitivity of the Band sharing exact locations of certain site types and we want to work with the Band to make sure those sites can be avoided (i.e. graves, ceremonial sites). The NRCS wants to coordinate closely with the Band to identify all graves, ceremonical sites, historic properties, and cultural resources within the project area. It is NRCS' policy to avoid these sites whenever possible. If we cannot avoid them, then we will develop a Memorandum of Agreement and Treatment Plan to mitigation any adverse affects, and this would be in very close coordination with the Band. As a final note,for highly culturally sensitive sites such as graves, we do not need to include the exact location in the cultural resources report, and that general location only needs to be known in order for it to be avoided by construction activities. Similar situations occured on the Shem Dam project. The NRCS looks forward to meeting with the Band to discuss timing of a meeting to identify cultural sensitive areas known by the Band within the project area.
17	5	1/28/2021	Email	Public	Norm Slauenwhite			Alternatives	I attended the meeting last night and have one concern. First, let me say that I am supportive of this project. My neighborhood will benefit from this. My house is on the east side of Dammeron Valley and is the one with the drainage gullies running both to the east and south side of my property. It is also one of the only houses in my area with a full basement and was flooded the worst. One of the things I love about this house is the view from my windows and backyard out to the desert and Pine Valley mountains. My concern and the point I would like to express is I don't want to lost that view. At one point last night the comment was made the detention pond could be built behind the high spot about 500 feet out behind the east property lines. I would support this if that is the case. I just don't want this built up to the east property lines. As we move forward with this project I would appreciate this concern being kept in mind. If I can be of any help in the decisions being made, please feel free to contact me.	Yes	No	The preliminary location of the dam structure was correctly stated in the meeting as about 500 feet from the property line. While the final embankment design and appurtenant construction may encroach into this 500-foot buffer, the dam cannot feasibly shift much closer than 500 feet to the property line.
18	6	1/29/2021	Email	Public	Steve Kamlowsky		Diamond Valley, UT	Alternatives	I live at 1424 W. Agate Ct. in Diamond Valley and my house backs up to a significant wash channel. This channel frequently floods during heavy rain events and has been eroding away my property line for years. Below are some pictures of the most recent storm (included in email). I lost about 3,000 square feet of my lot over the years due to erosion and I am requesting assistance in filling back in my lost property and armoring the slope to prevent further erosion. I am not the only property owner that backs up to this wash and all the other properties are experiencing similar erosion problems. A detention basin upstream would further help the erosion problems as sometimes the flood waters run 4 feet deep. As you can see in the pictures (see saved email) there are power poles dangerously close to the top edge and if left unchecked could one day fall into the wash.	Yes	No	While an upstream detention basin would be non-feasible, the existing wash that runs behind Lots 126, 127, 134, 135, 136 and 143 have been included for analysis and will be designed to adequately handle large storm events and prevent further erosion.
19	7	1/29/2021	Email	Tribal	Travis Duran	Shivwits Band of Paiutes Band Council	Washington Cou nty, UT	General	Shivwits land resource; I was trying to get the zoom information earlier, nobody was in our office today. I will save information and pass it to band council.	No	No	For subsequent Zoom meetings we will be sure to convey the meeting info more widely.
20	8	2/10/2021	Email	Tribal	Timothy Begay	Navajo Nation Heritage and Historic Preservation Department	Window Rock, AZ	Cultural Resources	The Navajo Nation Heritage and Historic Preservation Department's (NNHPD) Traditional Culture Program is (TCP) in receipt of your letter regarding USDA Natural Resources Conservation Service Santa Clara Watershed plan EA Project within Washington Cunty, Utah. After reviewing your letter and cross referencing our Traditional Cultural Properties (TCP's) database, NNHHPD-TCP has determined that there are No Navajo TCP's within the project area and you may proceed without further consultation for this project.	Yes	No	The NRCS thanks the NNHPD for their comment on the Santa Clara Watershed Plan EA and that there are no Navajo TCPs within the project area. In the even that historic properties are identified by the cultural resources survey, the NRCS is still planning to reach out to the NNHPD to confirm that there are no concerns regarding these properties, especially in the event that these properties may be adversely affected by the undertaking.
21	9	1/27/2021	Meeting Q&A	Public	Rick Dunford			Alternatives	I live at lot 8 Dammeron Valley farms. I understand the topographic constraints. However detention basins in our backyard will be problematic. What kind of buffer strip can be provided East of the Subdivision boundary.	Yes	No	The preliminary location of the dam structure was correctly stated in the meeting as about 500 feet from the property line. While the final embankment design and appurtenant construction may encroach into this 500-foot buffer, the dam cannot feasibly shift much closer than 500 feet to the property line.
22	9	1/28/2021	Meeting Q&A	Agency	Aaron Langston	SITLA		General	The School and Institutional Trust Lands Administration owns a lot of the subject land in Diamond Valley. Is it possible to see what type of permenant structures would be built on our property if this project were to move forward? Similarly, we own property in Dammeron Valley - not sure if any structures would be directly on our property there or not.	Yes	No	The SITLA property within the subject area appears to be SITLA 7233-TR. This project will not encroach onto this property with temporary or permanent measures. Preliminary design of permanent structures have been provided for reference.
23	9	1/29/2021	Meeting Q&A	Public	Austin Wheatley			General	Is BLM going to be a part of the project?	Yes	No	The NRCS will reach out to the BLM to participate in the project.
24	9	1/30/2021	Meeting Q&A	Public	James Sclimenti			General	Will propertey owners be physically contacted before construction starts?	No	No	We plan to keep affected property owners informed along each step of the process. Any construction will be advertised in the local newspaper and on-line on the County Website. Negotiations with those property owners directly impacted will be needed to obtain any neccesary easements.
25	9	1/31/2021	Meeting Q&A	Public	Dean Bergevin			General	Will all three project areas (Dammeron, Diamond, and Shivwits) be done on the same timeline?	No	No	Probably not. It may be more advataeous to stagger the construction to get better bids and meet any needed environmental contraints.
26	9	2/1/2021	Meeting Q&A	Public				Alternatives	Will there be any engineering design for the properties on the west side of Highway 18. Currently the water is diverted to the west side cutting our properties in half. Our fence is washed out as well as large amount if soil.	Yes	No	It is unclear which properties are referenced in this comment, but it appears to relate to properties along Carters Pond Road in Dammeron Valley. Engineering design will extend beyond all Dammeron Valley properties into the existing drainage corridor along Lower Sand Cove Road, which includes the properties along Carters Pond Road.
27	9	2/2/2021	Meeting Q&A	Public	Rick Dunford			Alternatives	Please during design try and obtain maximum separation between proposed basins and the east boundary of Dammeron Valley farms.	Yes	No	The preliminary location of the dam structure was correctly stated in the meeting as about 500 feet from the property line. While the final embankment design and appurtenant construction may encroach into this 500-foot buffer, the dam cannot feasibly shift much closer than 500 feet to the property line.
28	9	2/3/2021	Meeting Q&A	Public	Austin Wheatley			General	Is there any liquidated damages?	No	No	Liquidated damages are generally part of any construction contract to assure the project is completed in a timely manner. Reasonable liquidated damages are part of our Washington County standard contract for construction of public works projects.
29	9	2/4/2021	Meeting Q&A	Public	Dean Bergevin			General	As I understand the presentation, preliminary designs will not be available until fall of 2021. Is that correct?	No	No	We do not have a timeline for construction at this time.
30	9	2/5/2021	Meeting Q&A	Public	Anonymous			Alternatives	Follow up on East v west side of Dammeron. Mitigating water on the east side is great, what will the mitigation be on the west side. Currently the water is flowing through our west side property. We would like to know what will happen there.		No	It is unclear which properties are referenced in this comment, but it appears to relate to properties along Carters Pond Road in Dammeron Valley. Engineering design will extend beyond all Dammeron Valley properties into the existing drainage corridor along Lower Sand Cove Road, which includes the properties along Carters Pond Road.
31	9	2/6/2021	Meeting Q&A	Public	Austin Wheatley			General	When will bids need to be put in by?	No	No	We do not have a timeline for construction at this time.
32	9	2/7/2021	Meeting Q&A	Public	Rick Dunford			Alternatives	Are there any options that don't include detention basins East of Dammeron Valley on the BLM ?	Yes	No	Alternatives to eliminate the smaller detention basins and adequately channelize flows were analyzed but discovered to be nonfeasible due to topographical constraints. The Dammeron Valley Detention Basin 4 may potentially be eliminated and a new channel installed to convey flows into an existing drainage corridor to the south.
33	9	2/8/2021	Meeting Q&A	Public	Dean Bergevin			Alternatives	Given the amount of water from the recent snowfall, we expect there to be water in the wash on the west side of Diamond Valley sometime this spring. Is there any mitigation available before this project starts?	Yes	No	We are monitering the snowpack. No mitigation is planned at this time.
34	10	2/10/2021	Mail	Agency	David Ure	SITLA		General	In response to a letter dated February 1, 2021 requesting that the Utah School and Institutional Trust Lands Administration becomes a cooperating agency in the planning and development of the Santa Clara Watershed Plan, please be advised that we are happy to comply with that request. On January 27, 2021, staff attended the NRCS virtual scoping meeting to learn the details about the proposed project. Our agency has a vested interest in the lands in Dammeron and Diamond Valleys; we look forward to working with you in this endeavor. Aaron Langston in our Washington County office has been assigned to this task. Please reach out to him for further information.	No	No	The NRCS will reach out to the provided SITLA point of contact throughout the project.
35	11	2/10/2021	Mail	Tribal	Stewart B. Koyiyumptewa	Hopi Cultural Preservation Office	Kykotsmovi, AZ	Cultural Resources	The Hopi Tribe claims cultural affiliation to prehistoric cultural groups in Utah. The Hopi Cultural Preservation Office supports the identification and avoidance of prehistoric archaeological sites and we consider the prehistoric archaeological sites of our ancestors to be "footprints" and Traditional Cultural Properties. The Hopi Cultural Preservation Office concurs that informed and valid NRCS decisions are best made when based upon scientifically derived data. We request consultation on any proposal in Utah with the potential to adversely affect prehistoric cultural resources. If the cultural resources report identifies prehistoric sites that may be adversely affected by project activities, We request ongoing consultation including being provided with copies of the cultural resources survey report and any proposed treatment plans for review and comment.	No	No	The NRCS will be in consultation with the Hopi Tribe throughout the development of the EA and will consult on any NRCS undertaking in Utah that has the potential to adversely affect cultural resources. We will be sending the Hopi Tribe a copy of the cultural resources survey report (hard and in electronic form) for review as part of the Section 106 consultation process and if cultural resources will be adversely affected, wemwill invite the Hopi to be part of the development of a Memorandum of Agreement and Archaeological Treatment Plan. This includes review and comment of drafts of the MOA and Treatment Plan. Throughout the development of the EA and initiation and continuation of the Section 106 process, the NRCS at all levels maintains an open communication and collaboration policy which welcomes emails and telephone calls from the Hopi Tribe, and this is in addition to official Government-to-Government consultation.

APPENDIX E-11

BLM ENVIRONMENTAL DOCUMENTS

United States Department of the Interior
Bureau of Land Management

Categorical Exclusion Not Established By Statute
DOI-BLM-UT-C030-2021-0035-CX

July 2021

Diamond & Dammeron Valley Soil Testing
Land Use Permit

Location:

(Diamond Valley)
Salt Lake Meridian, Utah
T. 41 S, R. 16 W.,
sec. 1, NE¼SW¼.

(Dammeron Valley)
Salt Lake Meridian, Utah
T. 40 S, R. 16 W.,
sec. 16, W½.

Applicant/Address: Washington County
St. George, UT 84770

St. George Field Office
345 E. Riverside Drive
St. George, UT 84790
435-688-3200
435-688-3252

BLM

CATEGORICAL EXCLUSION DOCUMENTATION FORMAT WHEN USING CATEGORICAL EXCLUSIONS NOT ESTABLISHED BY STATUTE

A. BACKGROUND

BLM Office: St. George Field Office

NEPA Number: DOI-BLM-UT-CO30-2021-0035-CX

Lease/Serial/Case File No: UTU-95649

Proposed Action Title/Type: Diamond & Dammeron Valley Soil Testing Land Use Permit

Location of Proposed Action: The location of the proposed action is near the communities of Diamond Valley and Dammeron Valley in the following described locations:

(Diamond Valley)
Salt Lake Meridian, Utah
T. 41 S, R. 16 W.,
sec. 1, NE¼SW¼.

(Dammeron Valley)
Salt Lake Meridian, Utah
T. 40 S, R. 16 W.,
sec. 16, W½.

Description of Proposed Action: The BLM St. George Field Office is considering whether to approve a short term permit application for soil testing. Washington County has submitted an application to conduct geotechnical testing using test pits and drilling methods in the locations specified above and shown on the maps below. The testing is expected to take approximately 60 days and is needed to further refine analysis areas as part of the Santa Clara Watershed EA process being led by the NRCS (Natural Resources Conservation Service). The request is as follows:

1. Dammeron Valley

There are three proposed detention basin sites in Dammeron Valley. See the attached Dammeron Valley Test Hole Locations exhibit for the three sites and the locations for the borings and test pits. Boring and test pit locations would generally require access using wheeled and tracked equipment over undisturbed ground without prior clearing of existing vegetation. Exceptions to this include the access to DA1-1, which would run along an existing road that extends from Homestead Drive and then branches off with a new 12-foot-wide access requiring prior vegetation removal, and the access to DA3-1, which would be on an existing road that extends from Dammeron Valley Farms Drive. The disturbed area for each boring and test pit location is approximately 20 feet by 20 feet. Borings would be up to 8 inches in diameter and after testing would be backfilled with grout or bentonite. Test pits would be backfilled with excavated materials.

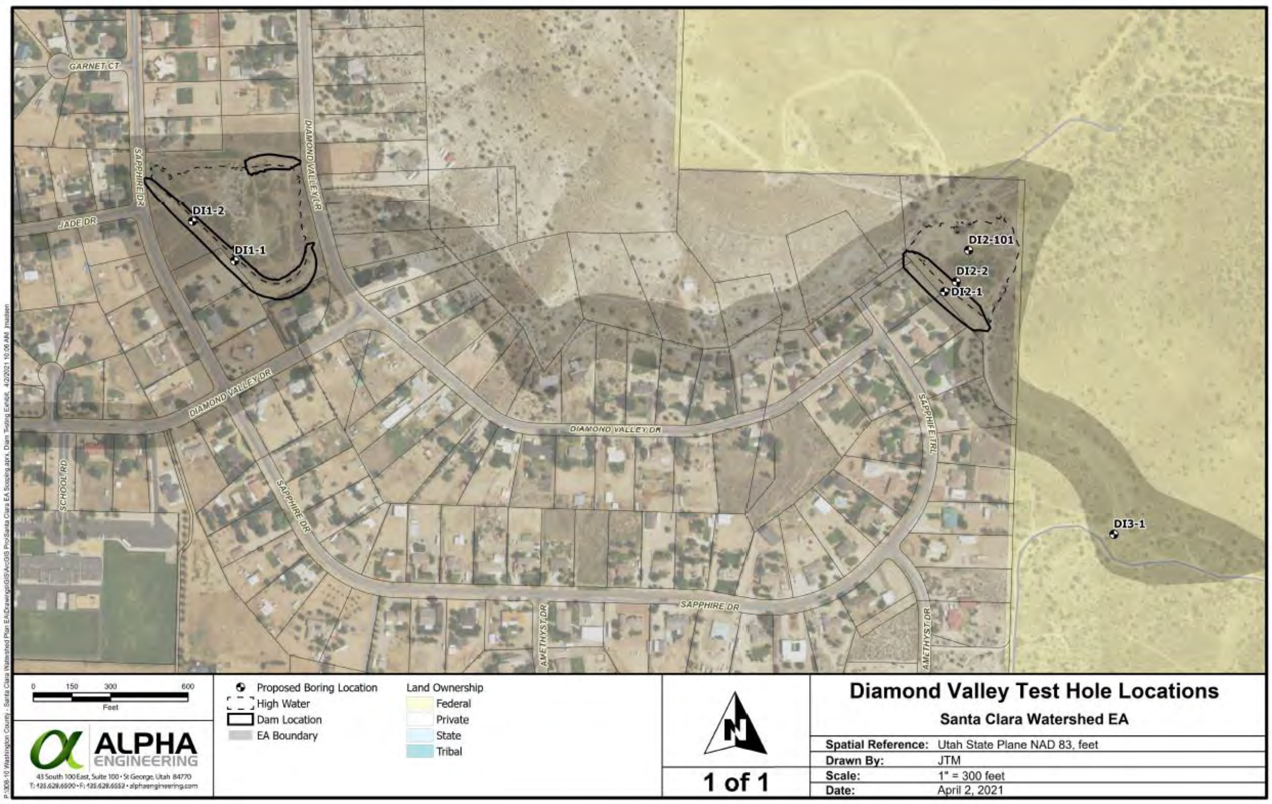
2. Diamond Valley

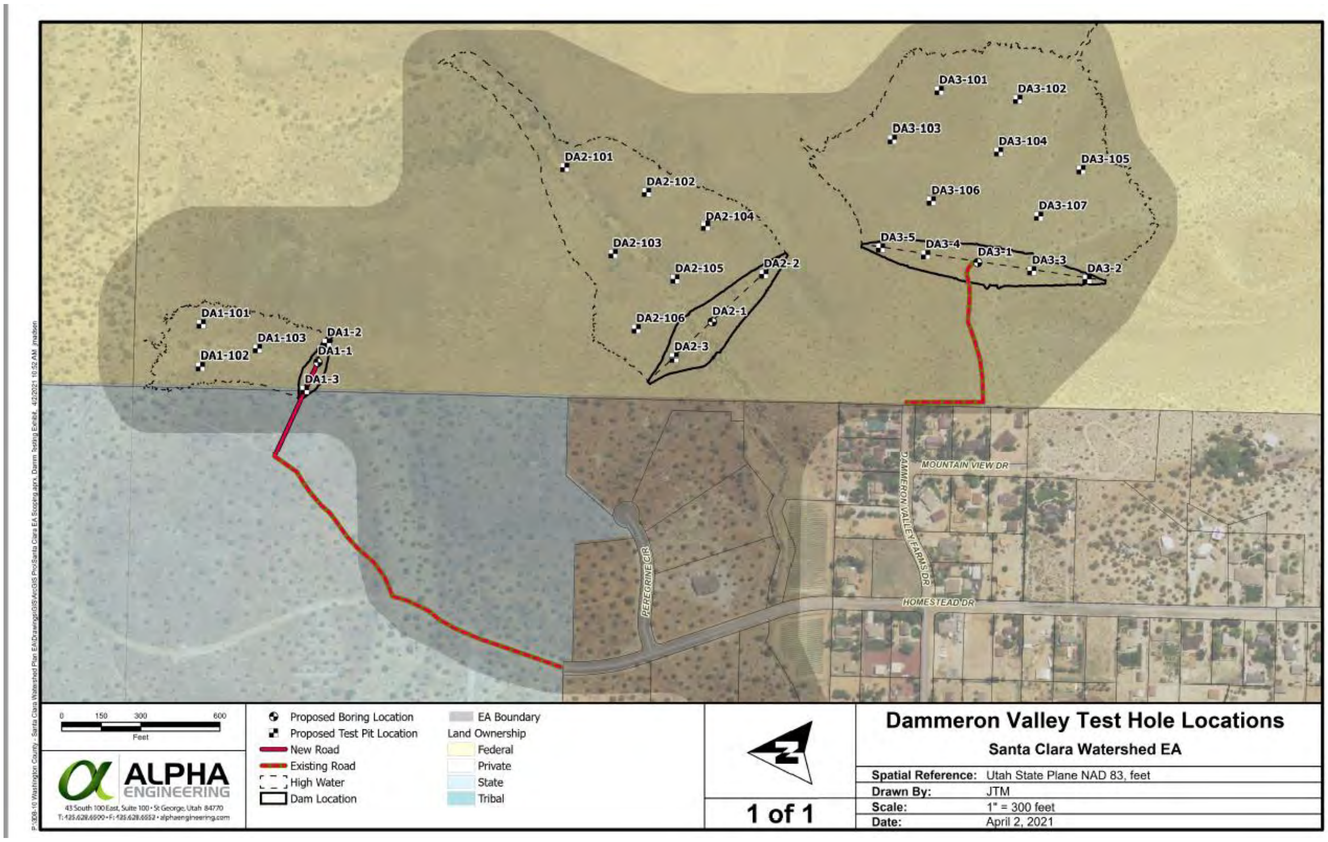
There are three existing detention basin sites in Diamond Valley. See the attached Diamond Valley Test Hole Locations exhibit for the three sites and the locations for the borings. Test pits would not be required at these sites. Boring locations would be accessed along existing roads using wheeled equipment. The disturbed area for each boring location is approximately 20 feet by 20 feet. Borings would be up to 8 inches in diameter and after testing would be backfilled with grout or bentonite.

After the geotechnical investigations have been completed or if the project is to be terminated or abandoned after the site has been disturbed, a joint inspection would be held with the authorized officer(s) of the BLM prior to termination. The County would make all feasible efforts to restore the conditions to the original environment where any disturbance has taken place. This would include re-contouring the ground to existing conditions and re-seeding with an approved seed mix. The joint inspection would identify additional restoration measures that may be required in determining an acceptable and specific rehabilitation plan for the area.

A full POD can be found in the project folder at: S:\SGFO\Programs\Lands & Realty\2920- Permits_Leases_Easements\Leases & Permits\Land Use Permits\Santa Clara Watershed Drilling&Test Pits_UTU-95649.

If the application is approved, the County would receive a 3-year Land Use Permit to conduct the testing in support of the Santa Clara EA process.





B. Land Use Plan Conformance

Land Use Plan Name: St. George Field Office Record of Decision and Resource Management Plan

Date Approved/Amended: March 1999/amended December 2016

The proposed action is in conformance with the LUP, even though it is not specifically provided for, because it is clearly consistent with the following LUP decision(s) (objectives, terms, and conditions):

LD-12 States: *"Applications for new rights-of-way, leases and permits on public land will be considered and analyzed on a case-by-case basis. Proposals will be reviewed for consistency with planning decisions and evaluated under requirements of the National Environmental Policy Act and other applicable laws for resource protection."* .....

C. Compliance with NEPA

The applicable Categorical Exclusion references in 516 DM 11.9, are:

E. (19) ... "Issuance of short term (3 years or less) rights-of-way or land use authorizations for such uses as storage sites, apiary sites, and construction sites where the proposal includes rehabilitation to restore the land to its natural or original condition."

This categorical exclusion is appropriate in this situation because there are no extraordinary circumstances potentially having effects that may significantly affect the environment. The proposed action has been reviewed, and none of the extraordinary circumstances described in 43 CFR Part 46.215 apply.

I considered:

- Public health or safety
- Natural resources and unique geographic characteristics such as historic or cultural resources; parks, recreation or refuge lands; wilderness areas; wild or scenic rivers; national natural landmarks; sole or principal drinking water aquifers; prime farmlands; wetlands; national monuments; migratory birds; and other ecologically significant or critical areas.
- Unresolved conflicts concerning alternative uses of available resources
- Unique or unknown environmental risks
- Precedent for future actions
- Relationship to other actions with individually insignificant but cumulatively significant environmental effects.
- Properties listed or eligible for listing on the National Register of Historic Places as determined by either the bureau or office.
- Species listed, or proposed to be listed, on the List of Endangered or Threatened Species or have significant impacts on designated Critical Habitat for these species.
- Federal, state, local or tribal law
- Low income or minority populations
- Access to and ceremonial use of Indian sacred sites on Federal lands by Indian religious practitioners and potential effect of the physical integrity of such sacred sites.
- Introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area

And determined that none of the above “Extraordinary Circumstances” would be negatively affected by the Proposed Action.

D: Signature

Authorizing Official: ______________________________________ Date: _______________

Keith Rigtrup
Field Office Manager

Contact Person

For additional information concerning this CX review, contact Shawnna Dao at sdao@blm.gov.

Categorical Exclusion Review Record

Resource	Yes/No*	Assigned Specialist Signature	Date
Air Quality	No	R. Reese/J. Frost-Perkins	6/7/21
Areas of Critical Environmental Concern	No	S. Taylor	6/4/21
Cultural Resources	No	Amber Van Alfen	7/2/21
Environmental Justice	No	C. Goff	6/17/21
Farm Lands (prime or unique)	No	R. Reese/J. Frost-Perkins	6/7/21
Floodplains	No	R. Reese/J. Frost-Perkins	6/7/21
Geology	No	K. Voyles	6/22/21
Livestock Grazing	No	R. Reese/J. Frost-Perkins	6/7/21
Invasive Species/Noxious Weeds	No	R. Reese/J. Frost-Perkins	6/7/21
Migratory Birds	No	S. Taylor	6/4/21
Native American Religious Concerns	No	Amber Van Alfen	7/21/21
Threatened, Endangered, or Candidate Species	No	S. Taylor	6/4/21
Wastes (hazardous or solid)	No	C. Goff	6/17/21
Water Quality (drinking or ground)	No	R. Reese/J. Frost-Perkins	6/7/21
Wetlands / Riparian Zones	No	R. Reese/J. Frost-Perkins	6/7/21
Wild and Scenic Rivers	No	B. Wells	6/22/21
Wilderness	No	B. Wells	6/22/21
Lands and Realty	No	S. Dao	6/3//21

*Extraordinary Circumstances apply.

Environmental Coordinator: ______________________________________Date: _________

Exceptions to Categorical Exclusion Documentation

The action has been reviewed to determine if any of the extraordinary circumstances (43 CFR 46.215) apply. The project would:

Extraordinary Circumstances		
1. Have significant impacts on public health or safety.		
Yes	**No** X	**Rationale:** The proposed action would not have significant impacts on public health and safety due to the small scale and temporary duration of the proposed soil testing.
2. Have significant impacts on such natural resources and unique geographic characteristics as historic or cultural resources; park, recreation or refuge lands; wilderness areas; wild or scenic rivers; national natural landmarks; sole or principal drinking water aquifers; prime farmlands; wetlands (Executive Order 11990); floodplains (Executive Order 11988); national monuments; migratory birds; and other ecologically significant or critical areas.		
Yes	**No** X	**Rationale:** No new or adverse impacts to sensitive resources are anticipated to occur. The testing locations have been surveyed and no significant impacts are anticipated for cultural resources. The other resources are not present in the proposed action area. To avoid impacts to nesting and breeding migratory birds, vegetation removal/crushing activities would occur outside of breeding season (February 1-August 31), OR pre-construction survey would need to be completed by a qualified biologist within 7-10 days before the work occurs. If an active nest is identified, a no-activity buffer (ranging from 100-feet to 1-mile, depending on species) will be established around the nest site and remain in place until the young have fledged and/or the nest becomes non-active.
3. Have highly controversial environmental effects or involve unresolved conflicts concerning alternative uses of available resources [NEPA section 102 (2) (E)].		
Yes	**No** X	**Rationale:** There are no known controversial environmental effects or unresolved resource conflicts related to this proposal.
4. Have highly uncertain and potentially significant environmental effects or involve unique or unknown environmental risks.		
Yes	**No** X	**Rationale:** There is nothing in the proposed action that would lead to significant, unknown, or unique environmental risks as the proposed action is a common permitted activity related to flood control studies.
5. Establish a precedent for future action or represent a decision in principal about future actions with potentially significant environmental effects.		
Yes	**No** X	**Rationale:** Authorization of the proposed action is standard practice and no significant environmental effects are likely to occur as a result. As specified, the applicant has submitted a reclamation plan for the sites.

Extraordinary Circumstances		
6. Have a direct relationship to other actions with individually insignificant but cumulatively significant environmental effects.		
Yes	**No** X	**Rationale:** The proposed action is related to the concurrent analysis of flood protection structures in the Santa Clara Watershed EA. These together are not expected to have cumulatively significant environmental effects due to the reclamation of test areas.
7. Have significant impacts on properties listed, or eligible for listing, on the National Register of Historic Places as determined by the bureau.		
Yes	**No** X	**Rationale:** NRCS (Natural Resources Conservation Service) is the lead agency conducting Section 106 procedures for the proposed undertaking. Class III inventory (U21TN0316) was completed for the entire project area identified in the Santa Clara Watershed EA. One eligible archeological site is within the project area. The property is a historic road. The segment within the project area lacks integrity and has been found to be not contributing. The NRCS and the BLM have consulted and have agreeance on a finding of “no adverse effect” for the geotechnical testing.
8. Have significant impacts on species listed, or proposed to be listed, on the List of Endangered or Threatened Species, or have significant impacts on designated Critical Habitat for these species.		
Yes	**No** X	**Rationale:** No threatened, endangered, or candidate species nor critical habitats would be impacted by the proposed action as the areas have been surveyed and cleared.
9. Violate a Federal law, or a State, local or tribal law or requirement imposed for the protection of the environment.		
Yes	**No** X	**Rationale***:* The proposed project would not violate laws/ordinances such as the Migratory Bird Treaty Act, Fish and Wildlife Coordination Act, county ordinances, and state statutes.
10. Have a disproportionately high and adverse environmental consequences or effects on low income or minority populations (Executive Order 12898).		
Yes	**No** X	**Rationale:** The proposed action would not have a disproportionately high or adverse effect on low income or minority populations due to the temporary duration and reclamation plan.
11. Limit access to and ceremonial use of Indian sacred sites on Federal lands by Indian religious practitioners or significantly adversely affect the physical integrity of such sacred sites (Executive Order 13007).		
Yes	**No** X	**Rationale:** The proposed action would not limit access to, or ceremonial use of sacred sites, nor would it adversely impact the integrity of any known sites.

<table>
<tr><th colspan="3">Extraordinary Circumstances</th></tr>
<tr><td colspan="3">12. Contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area or actions that may promote the introduction, growth, or expansion of the range of such species (Federal Noxious Weed Control Act and Executive Order 13112).</td></tr>
<tr><td>Yes</td><td>No

X</td><td>Rationale: The possibility of distribution of noxious weeds would be reduced through a permit stipulation that permittee would be responsible for power washing all equipment prior to entering each site.</td></tr>
</table>

CATEGORICAL EXCLUSION
NOT ESTABLISHED BY STATUTE
DECISION DOCUMENT

Decision

It is my decision to implement the action described in Categorical Exclusion **DOI-BLM-UT-C030-2021-0035-CX.**

Decision Rationale

I have reviewed the attached Categorical Exclusion documentation, including plan conformance, NEPA compliance review, and extraordinary circumstances review, and have determined that the action involves no significant impact to the human environment and no further analysis is required.

Administrative Remedies

This decision may be appealed to the Interior Board of Land Appeals, Office of the Secretary, in accordance with the regulations contained in 43 CFR Part 4.

This decision shall take effect immediately upon the date it is signed by the Authorized Officer and shall remain in effect while any appeal is pending unless the Interior Board of Land Appeals (IBLA) issues a stay (43 CFR 2801.10(b)). Any appeal of this decision must follow the procedures set forth in 43 CFR Part 4. Within 30 days of the decision, a notice of appeal must be filed in the office of the Authorized Officer at St. George Field Office, 345 East Riverside Drive, St. George, UT 84790. If a statement of reasons for the appeal is not included with the notice, it must be filed with the Interior Board of Land Appeals, Office of Hearings and Appeals, U.S. Department of the Interior, 801 North Quincy St. Suite 300, Arlington, VA 22203 within 30 days after the notice of appeal is filed with the Authorized Officer.

If you wish to file a petition for stay pursuant to 43 CFR Part 4.21(b), the petition for stay should accompany your notice of appeal and shall show sufficient justification based on the following standards:

(1) The relative harm to the parties if the stay is granted or denied,

(2) The likelihood of the appellant's success on the merits,

(3) The likelihood of irreparable harm to the appellant or resources if the stay is not granted, and

(4) Whether the public interest favors granting the stay.

If a petition for stay is submitted with the notice of appeal, a copy of the notice of appeal and petition for stay must be served on each party named in the decision from which the appeal is taken, and with the IBLA at the same time it is filed with the Authorized Officer.

A copy of the notice of appeal, any statement of reasons and all pertinent documents must be served on each adverse party named in the decision from which the appeal is taken and on the Office of the Regional Solicitor, U.S. Department of the Interior, 6201 Federal Building, 125 South State Street, Salt Lake City, Utah 84138-1180, not later than 15 days after filing the document with the Authorized Officer and/or IBLA.

Authorizing Official

______________________________ ______________________________
Authorized Officer Date