Appendix D

Investigation and Analysis Report

Tri-Valley Watershed Project
Tri-Valley Watershed, Wasatch County, Utah

Investigation and Analysis Report

Final

December 2024

Prepared for:

USDA United States Department of Agriculture
Natural Resources Conservation Service

WASATCH COUNTY STATE OF UTAH

Prepared by:

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1.0 Introduction

The purpose of this Investigation and Analysis (I&A) Report is to present information that supports the formulation, evaluation, and conclusions of the Supplemental Watershed Plan and Environmental Assessment (Plan-EA) for the Tri-Valley Watershed (Project), located within the Tri-Valley Watershed in Wasatch County, Utah. The report is required and must be included as an appendix to the Plan-EA.

The procedures, techniques, assumptions, scope, and intensity of the investigations for each subject are described in sufficient detail so that a reader not familiar with the project area or issues can form an opinion on the adequacy of the Plan-EA. This report supplements information contained in the Plan-EA and is not intended to replace or duplicate information contained therein.

The planning studies presented in this I&A Report are based on standard methods and procedures used and approved for use by the United States Department of Agriculture Natural Resources Conservation Service (NRCS). The following information summarizes the investigation and analysis for the key planning studies conducted in the preparation of the Plan-EA. Additional information relevant to each section 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:

NRCS
Wallace F. Bennett Federal Building
125 S State St., Room 4010
Salt Lake City, UT 84138-1100

1.1 Project Location

The Project is located in Wasatch County, Utah and consists of two sites for improvements, Site 1 (Daniel Irrigation) and Site 2 (Center Creek). Site 1 is located within the town of Daniel and Site 2 is located at the intersection of Center Creek Road and S 2400 E Street just east of the town of Daniel within an unincorporated area of Wasatch County (Figure 1-1).

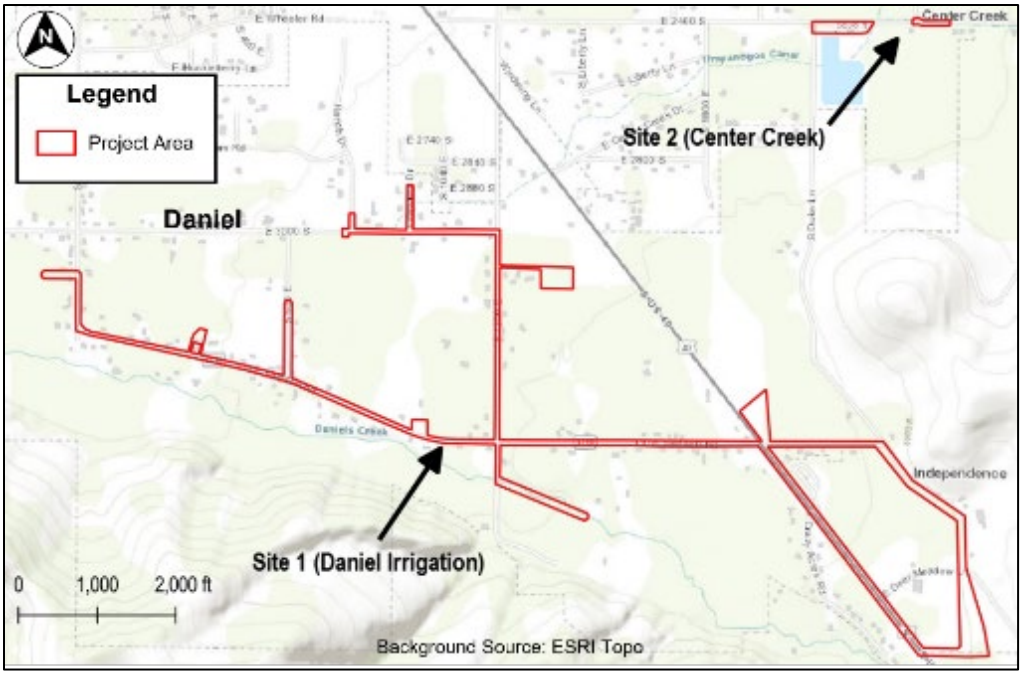

Figure 1-1. Project Location

2.0 Site 1 (Daniel Irrigation) Analysis

Information in this section is summarized from a technical memorandum (TM) completed for the Project (Bowen Collins & Associates [BC&A] 2020). This TM is included in the Project administrative record and can be provided upon request.

2.1 Data Sources

Data sources used to complete engineering analysis are included in Table 2-1. Topographic datum and coordinate system used for analysis included North American Vertical Datum 1988 (vertical datum), North American Datum of 1983 (geodetic datum), and State Plane Utah Central (coordinate system).

Table 2-1. Data Sources

Data	Source	Description
2018 LiDAR Elevation Data	UGRC 2018a	0.5-meter resolution bare-earth Digital Terrain Model (DTM) data set of project vicinity. Data was used to verify elevations at locations throughout the Site 1 (Daniel Irrigation) service areas.
Existing Pipeline Geodatabase	CUWCD 2020a	GIS data listing properties of existing irrigation pipelines.
Irrigation Demands	CUWCD 2020b	Turn-based and On-demand irrigation data in spreadsheet form used to define irrigation system demands.
Hydraulic Model	CUWCD 2020c	EPANet input files used to create the InfoWater model of the Middle Pressure Zone irrigation system.
Hexagon 30cm Imagery	UGRC 2018b	Imagery from an online web map used for report figure backgrounds.

UGRC = Utah Geospatial Resource Center, CUWCD = Central Utah Water Conservancy District

2.2 Demand Analysis

A demand distribution was developed for the Middle Pressure Zone to support the modeling efforts for the hydraulic analysis. Existing demands for each user were determined from irrigation tickets (Wasatch County Water Efficiency Project [WCWEP] 2020) and are defined on a per-turn basis or on-demand basis. Turn-based demands operate on a 14-day, 12-hour basis resulting in 28 individual turns or "sets". Flow rates for a given "set" were calculated by multiplying the number of sprinklers by the defined flow rate per sprinkler head identified in the irrigation tickets. This determined the irrigation flow pattern over a 14-day period for a given field. On-demand operates on an as needed basis and an average daily demand in gallons per minute (gpm) was calculated to determine a Peak Day Demand (PDD) on the system. This was accomplished by using the annual use for a given field from the irrigation tickets and dividing it by the number of minutes in a year (525,600). The PDD was then determined by multiplying the average day demand by a PDD factor (2.4 for AM and 1.7 for PM). The PDD factor was assumed based on engineering judgement and experience in developing water master plans for various entities in Utah. Each on-demand PDD was then applied to each set within the 14-day period to estimate the overall PDD on the system.

Demands were simplified in the hydraulic model by assigning demands from multiple fields to a single junction. Total demands per set were calculated based on a 14-day irrigation period by adding the on-demands to the turn-based demands for each set within the hydraulic model (Table 2-2).

Table 2-2. Demand Distribution Summary

Day	Flow Per Set (gpm)					
	Turn-Based		On-Demand		Total	
	AM	PM	AM	PM	AM	PM
1	3,223	3,300	376	266	3,599	3,566
2	3,424	3,346	376	266	3,800	3,612
3	3,244	3,330	376	266	3,620	3,596
4	4,144	3,822	376	266	4,520	4,088
5	3,845	3,214	376	266	4,221	3,480
6	3,112	2,156	376	266	3,488	2,422
7	3,320	3,174	376	266	3,696	3,440
8	3,320	3,380	376	266	3,696	3,646
9	3,008	3,094	376	266	3,384	3,360
10	3,716	3,506	376	266	4,092	3,772
11	3,580	3,014	376	266	3,956	3,280
12	2,890	1,934	376	266	3,266	2,200
13	30	84	376	266	406	350
14	84	84	376	266	460	350

2.3 Hydraulic Analysis

2.3.1 Modeling Assumptions

A hydraulic model was developed to model the existing and alternative conditions hydraulic performance for the Middle Pressure Zone irrigation system. The model was developed using ArcMap and InfoWater modelling software. GIS modeling data for pipeline diameters, lengths, and junction elevations (CUWCD 2020a) was used for model development. Demands from multiple fields were assigned to nearby model junctions and the hydraulic model was setup to represent demands during a full 14-day irrigation rotation, computed at 12-hour increments. Middle Pond was modeled with a fixed-head reservoir at elevation 5975 feet, corresponding to the lowest anticipated water surface elevation that could still deliver the required demand. Irrigation diversions from Daniel Creek and CUWCD were assumed to provide adequate flow to the Middle Pond when necessary to maintain the minimum water surface elevation. A Hazen-Williams C-value of 110 for Transite pipe and 120 for PVC pipe was used for modeling based on the pipe material and age. It was assumed that 12-inch and 16-inch diameter pipes were Transite and all other diameter pipes were PVC. New PVC pipes proposed for alternatives were assigned a C-value of 130.

2.3.1 Existing Condition Results

Hydraulic performance for velocities and pressures were determined for the irrigation system from the modeling results. The existing condition maximum velocities for pipe segments and minimum pressures at each junction were identified. The existing condition results were compared to pressure and velocity criteria from the following:

1) NRCS Conservation Practice Standard (CPS) 430 for Irrigation Pipeline (NRCS 2023)
2) NRCS National Engineering Handbook (NEH) 652 Irrigation Guide (NRCS 1997)
3) NEH 623, Chapter 11 for Sprinkler Irrigation (NRCS 2016)

Per the referenced NRCS criteria, maximum velocities for sprinkler irrigation are 5 feet per second (fps) and recommended pressures are 40 pounds per square inch (psi). Model results show that all junctions in the existing system were deficient for pressures and segments of pipeline exceeded the maximum velocities (Figure 2-1).

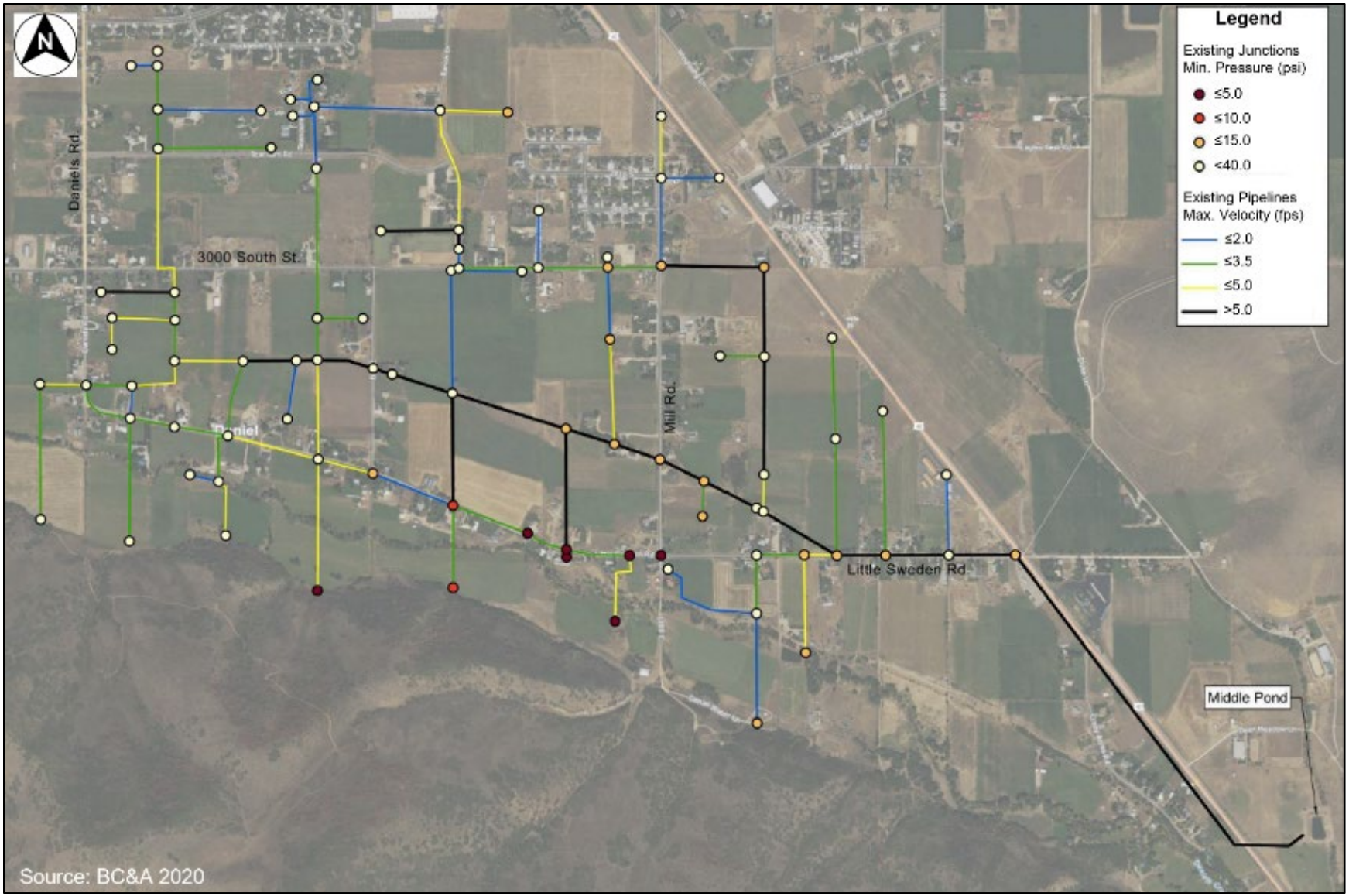

Figure 2-1. Pressure and Velocity Model Results

2.3.2 Alternative Condition Results

Two alternatives were developed and modeled for velocity and pressure performance. The Daniel Irrigation and Center Creek Improvements Alternative is identified as Alternative 1 in the BC&A TM and the Daniel Irrigation Modified Alignment and Center Creek Improvements Alternative is identified as Alternative 2. Please refer to the Plan-EA Sections 5.5.2 and 5.5.3 for detailed description of alternative measures. Both alternatives were determined to reduce pipe velocities under the 5 fps criteria. Both Alternatives 1 and 2 were found to meet the minimum recommended pressure of 40 psi at all water delivery nodes. Some intermediate junctions located higher in the system and closer to the Middle Pond, showed pressures slightly less than the recommended minimum 40 psi. However, these lower-pressure junctions are not located at delivery points and will not hinder water delivery efficiency. Alternative 1 was found to meet the minimum recommended pressures at all but 6 junctions while Alternative 2 met the recommended minimum pressures at all but 3 junctions.

Model results also identified that some of the existing pipelines within the systems for the proposed alternative conditions would exceed the NRCS criteria for maximum pressures at greater than 72% of the pressure rating of the pipes. However, Daniel Irrigation Company nor CUWCD have experienced any issues to date from high pressures. This is due in part to the system being gravity fed by the Middle and Lower Ponds. The lack of pumping in the system, and therefore the lack of a pressure spike due to a pump tripping, removes one potential source of a transient pressure spike. Potentially, rapid closure of a mainline valve could cause transient pressures, but these valves are manually operated, and it is unlikely that they could be shut quickly enough to cause a transient pressure spike. Additionally, the proposed system will have many ways to bleed off pressure or introduce air to attenuate transient pressures through the sprinkler heads themselves and air vacuum/release valves. For these reasons, it is not likely that transient pressures would be an issue. However, to confirm this assumption, it is anticipated that a surge analysis would be performed during final design to determine the magnitude and impact of transient pressures on the distribution system. Measures to adequately protect the pipeline against these transient pressures such as air/vacuum release valves would be provided as needed and determined during final design.

3.0 Site 2 (Center Creek) Analysis

3.1 Existing Conditions

Hydrology and hydraulic analyses, flood evaluations, and flood prevention measures for Center Creek, as a whole, are being evaluated as part of a separate effort and are not part of this Plan-EA. Shallow flooding has been documented near the intersection of Center Creek Road and S 2400 E Street during winter months. This flooding is caused by freezing events followed by runoff events that do not have a predictable flow or recurrence associated with them. Ice induced flooding in Center Creek at this location has resulted in water spilling onto the roadway and freezing causing hazardous conditions for vehicle traffic. Evaluation for this Plan-EA at this location is specific to reducing the ice-induced flood hazard and ice on the road.

Drainage along Center Creek Road is currently conveyed in a drainage swale in the shoulder of the road. The existing capacity of this drainage swale was evaluated to determine the required

conveyance capacity for the alternative measures. The drainage swale was generalized as a triangular open channel with 15:1 side slopes, Manning's n value of 0.03, and average longitudinal slope of 1.5%. With an assumed flow depth of 6 inches, the existing drainage swale flow rate is approximately 9 cfs.

3.2 Alternative Conditions

The conveyance system for the alternative measures considered sizing to capture and convey 9 cfs. The following pipe and inlet features for the alternative were sized and evaluated to accommodate this flow and included:

4) 18-inch reinforced concrete pipe (n = 0.013, slope = 1.5%, flow capacity = 12.9 cfs).
5) Three 24-inch by 24-inch grated inlet boxes (approximate inlet capacity of 2 to 3 cfs each).
6) One 24-inch by 48-inch grated inlet box to tie into the existing culvert at Center Creek (approximate inlet capacity of 4 to 5 cfs).

4.0 Engineering

4.1 Alternatives Evaluation

Two alternatives were developed during the engineering analysis and both were included in detailed study. This consisted of two varying alternatives for irrigation improvements at Site 1 (Daniel Irrigation) and one alternative for improvements at Site 2 (Center Creek). Because Site 2 has one option for improvements, the same measures for that site were applied to the varying irrigation alternatives for Site 1. Please refer to the Plan-EA Sections 5.5.2 and 5.5.3 for detailed descriptions of the two alternatives. These alternatives were developed in enough detail to identify approximate measures and costs to evaluate rationality for implementation. The process of formulating alternatives for the project followed procedures outlined in the National Watershed Program Manual (NRCS 2015); National Watershed Program Handbook (NRCS 2014); Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies (PR&G) (CEQ 2014); and other NRCS watershed planning policy.

The No Action Alternative must also be evaluated for comparison with the action alternatives. The No Action Alternative considers the actions that would take place if no federal action or federal funding were provided. The sponsors would leave Site 1 and Site 2 "as-is" with no improvements for the No Action Alternative. However, O&M activities would still be required to maintain the existing irrigation system.

Engineering concept design drawings were developed for the recommended alternative for advancement in at Site 1 (Daniel Irrigation) and Site 2 (Center Creek) and are included in the BC&A TM in Appendix E of the Plan-EA (BC&A 2020 and 2022a).

4.2 Design Criteria

Design criteria used in conceptual design for alternative measures included the criteria from CPS (NRCS 2023) and the NEH (NRCS 1997 and 2016) listed in Section 2.3.1. For irrigation improvements, pipe selection of C-900 PVC was selected over other PVC pipe options based on the ability for the pipe to withstand higher pressures. With pressures exceeding 100 psi in areas,

C-900 PVC is recommended to maintain compliance with CPS surge safety factor requirements (NRCS 2023) to keep the working pressure at any point below 72 percent of the pressure rating of the pipe. Also, the thicker walls of C-900 PVC provide additional protection against potential damage to the pipe during shipping, handling, and installation of the pipe.

4.3 Cost Estimates

The cost estimate for the alternatives were computed using 2022 dollars. Costs account for estimated quantities of material and labor. O&M costs were determined over a 50-year Project life. Detailed cost estimates for alternatives included in detailed study are provided below.

4.3.1 No Action Alternative

Under the No Action Alternative, existing infrastructure would continue to be operated and maintained. There are no installation costs associated with this alternative.

4.3.2 Daniel Irrigation and Center Creek Improvements Alternative

The construction costs for this alternative are included in Table 4-1 and Table 4-2. All costs are rounded to the nearest thousand.

Table 4-1. Site 1 (Daniel Irrigation) Construction Cost Estimate

Item	Quantity	Units	Unit Cost	Cost[1]
Mob/Demob	1	LS	$151,000	$151,000
Survey	1	LS	$15,000	$15,000
Traffic Control	1	LS	$25,000	$25,000
6" C-900 PVC Pipe	1,600	LF	$60	$96,000
8" C-900 PVC Pipe	950	LF	$65	$62,000
10" C-900 PVC Pipe	2,700	LF	$70	$189,000
12" C-900 PVC Pipe	2,200	LF	$80	$176,000
16" C-900 PVC Pipe	8,700	LF	$100	$870,000
20" C-900 PVC Pipe	7,350	LF	$125	$919,000
Service Connection	75	EA	$1,300	$98,000
Asphalt Replacement (3" Asphalt over 6" Road Base)	225,000	SF	$2.75	$619,000
			Subtotal	$3,220,000
			Contingency (20%)	$644,000
			TOTAL	**$3,864,000**

1-Rounded to the nearest thousand

Table 4-2. Site 2 (Center Creek) Construction Cost Estimate

Item	Quantity	Units	Unit Cost	Cost[1]
Mob/Demob	1	LS	$10,000	$10,000
Survey	1	LS	$5,000	$5,000
SWPPP	1	LS	$10,000	$10,000
Traffic Control	1	LS	$10,000	$10,000
Channel Overflow Pipe (18" Class III Pipe)	450	LF	$110	$50,000
Channel Overflow Inlets	4	EA	$5,000	$20,000
Concrete Ditch	450	LF	$25	$11,000
			Subtotal	$116,000
			Contingency (20%)	$23,000
			TOTAL	**$139,000**

1-Rounded to the nearest thousand

Operations, maintenance and repair costs are estimated to decrease relative to the No Action Alternative at Site 1, and are thus presented as a benefit, and discussed in Section 7.0. O&M costs are estimated at $1,000 for Site 2. Installation costs for the project consist of construction, engineering, permitting, and administrative time for the Sponsor and NRCS. The total installation cost for the Preferred Alternative was estimated at $4,537,000 (Table 4-3). Engineering, permitting, and administrative costs were estimated based on a percentage of the construction subtotals. For Site 1, engineering assumed 10% of the construction subtotal, permitting 0.5%, and administrative 2.5% for both the Sponsor and NRCS portions. For Site 2, engineering was assumed 15% of the construction subtotal and 3.5% administrative for both the Sponsor and NRCS portions. Because of the very low construction cost for Site 2, permitting was based on a lump sum amount of $10,000 rather than a percentage of the construction subtotal.

Table 4-3. Installation Costs

Item	Site 1 Cost	Site 2 Cost	Total Cost
Construction	$3,864,000	$139,000	$4,003,000
Engineering	$322,000	$17,000	$339,000
Permitting	$16,000	$10,000	$26,000
Administrative (Sponsor)	$80,500	$4,000	$84,500
Administrative (NRCS)	$80,500	$4,000	$84,500
TOTAL	**$4,363,000**	**$174,000**	**$4,537,000**

4.3.3 Daniel Irrigation Modified Alignment and Center Creek Improvements

The construction costs for this alternative at Site 1 (Daniel Irrigation) are included in Table 4-4. All costs are rounded to the nearest thousand. The Site 2 (Center Creek) construction costs are the same as provided in Table 4-2 above.

Table 4-4. Construction Cost Estimate

Item	Quantity	Units	Unit Cost	Cost[1]
Mob/Demob	1	LS	$156,000	$156,000
Survey	1	LS	$15,000	$15,000
Traffic Control	1	LS	$20,000	$20,000
6" C-900 PVC Pipe	1,750	LF	$60	$96,000
8" C-900 PVC Pipe	950	LF	$65	$62,000
10" C-900 PVC Pipe	4,700	LF	$70	$189,000
12" C-900 PVC Pipe	2,200	LF	$80	$176,000
16" C-900 PVC Pipe	8,700	LF	$100	$870,000
20" C-900 PVC Pipe	4,850	LF	$125	$606,000
30" C-900 PVC Pipe	1,150	LF	$220	$253,000
Valve Vault	2	EA	$100,000	$200,000
Service Connection	75	EA	$1,300	$98,000
Asphalt Replacement (3" Asphalt over 6" Road Base)	206,000	SF	$2.75	$567,000
			Subtotal	$3,308,000
			Contingency (20%)	$662,000
			TOTAL	**$3,970,000**

1-Rounded to the nearest thousand

Operations, maintenance and repair costs are estimated to decrease relative to the No Action Alternative at Site 1, and are thus presented as a benefit, and discussed in Section 7. O&M costs were estimated at $1,000 for Site 2. Installation costs for the project consist of construction, engineering, permitting, real property rights, and administrative time for the Sponsor and NRCS. Engineering, permitting, and administrative costs were estimated based on a percentage of the construction subtotals as described for Daniel Irrigation and Center Creek Improvements Alternative in Section 4.3.2. The total installation cost for this alternative was estimated at $4,717,000 (Table 4-5).

Table 4-5. Installation Costs

Item	Cost	Site 2 Cost	Total Cost
Construction	$3,970,000	$139,000	$4,109,000
Engineering	$331,000	$17,000	$348,000
Real Property Rights	$60,000	-	$60,000
Permitting	$17,000	$10,000	$27,000
Administrative (Sponsor)	$82,500	$4,000	$86,500
Administrative (NRCS)	$82,500	$4,000	$86,500
TOTAL	**$4,543,000**	**$174,000**	**$4,717,000**

5.0 Cultural

Cultural surveys were conducted and a Cultural Resource Assessment prepared (Certus Environmental Solutions, LLC 2021). A file search and archival review was conducted on June 6, 2021 for a ½-mile buffer around the Project area and included a detailed review of the Utah Division of State History Sego and HUB databases. The field work was performed on June 17, 2021 by a Secretary of the Interior-qualified archaeologist, Sheri Murray Ellis. The field survey included walking parallel transects spaced no more than 15 meters apart on 63 acres of land. Results of the survey are incorporated into the Plan-EA.

6.0 Aquatic Resource Delineation

An aquatic resource delineation was completed and a report prepared to identify jurisdictional waters of the U.S. (BC&A 2022b). The delineation was conducted in accordance with the USACE Wetlands Delineation Manual (USACE 1987) and the Arid West Supplement (USACE 2008). A total of 61 acres were surveyed on October 31, 2020 by BC&A biologist, Merissa Davis. National Wetlands Inventory data from the U.S. Fish and Wildlife Service and NRCS hydric soil data was reviewed prior to performing field work. Results of the survey are incorporated into the Plan-EA and a copy of the report is provided in Appendix E of the Plan-EA.

7.0 Decision-Making Process

The decision-making process for this Project followed the Principles, Requirements, and Guidelines for Federal Investments in Water Resources (PR&G) (Council of Environmental Quality [CEQ] 2013 and 2014), and the National Planning Procedures Handbook (NRCS 2021). The PR&G followed an eight-step evaluation process and NRCS planning followed a nine-step process. The PR&G eight-step planning process completed for the Project is documented in the PR&G Analysis Memorandum included in Appendix E of the Plan-EA. A summary of the NRCS nine-step planning process completed for the Project is provided in Section 1.1.1 of the Plan-EA.

8.0 Economic Evaluation

The economic analysis was completed by Highland Economics and is included in Appendix E of the Plan-EA. Two Future with Federal Investment (FWFI) Alternatives and one Future without Federal Investment (FWOFI) Alternative were included in the detailed economic analysis. The FWFI alternatives include the Daniel Irrigation and Center Creek Improvements Alternative (Alternative 1) and the Daniel Irrigation Modified Alignment and Center Creek Improvements Alternative (Alternative 2).

The analysis included the cost and benefits for each site for improvement consisting of Site 1 (Daniel Irrigation) and Site 2 (Center Creek). Average Annual damage reduction and avoided costs were amortized over 50 years at a discount rate of 2.5 percent. Avoided agricultural damage was calculated for Site 1 and the results are presented in Table 8-1. Flood damage reduction associated with Site 2 could not be calculated due to uncertainty in parameters and was included as a qualitative benefit in the Plan-EA. Both FWFI Alternatives have reduced Operations, Maintenance and Repair (OM&R) costs from the FWOFI Alternative as presented in Table 8-2.

The cost and benefit comparison for the FWFI Alternatives based on the economic analysis performed is presented in Table 8-3.

Table 8-1. Avoided Annual Average Damage for Agriculture

Parameter	Alternative 1, Site 1	Alternative 2, Site 1
Increased Net Returns Per Acre	$98	$126
Affected Acres	990	990
Increased Annual Net Returns in Service Area (Undiscounted)	$97,000	$125,000
Annual Average NEE Benefits	**$92,000**	**$119,000**

Table 8-2. Reduced Annual OM&R Costs

Parameter	Alternative 1	Alternative 2
Average Annual NEE Benefit (Project Group 1)	$70,000	$70,000
Average Annual NEE Benefit (Project Group 2)	$1,000	$1,000

Table 8-3. Comparison of Annual Benefits and Costs

Site	Total Costs	Incremental Costs	Total Benefits	Incremental Benefits	Net Benefits
Alternative 1, Site 1	$152,000		$162,000		$10,000
Alternative 1, Sites 1 & 2	$158,000	$6,000	$1,000	-$5,000	$5,000
Alternative 2, Site 1	$158,000		$189,000		$31,000
Alternative 2, Sites 1 & 2	$164,000	$6,000	$1,000	-$5,000	$26,000

9.0 References

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