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Appendix E Document Location

Appendix E1.

- Aquatic Resource Delineation (ARD)

Appendix E2.

- Biological Assessment (BA)
- Benefit-Cost Analysis of Alternatives
- Cultural Resources Report, redacted
- Best Management Practices (BMPs)
- Emission Calculation Memorandum

Appendix E3.

- Technical Memorandum (TM) 001
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- TM 020
- TM 021

TM 016 Capital/Construction Costs Estimates

TECHNICAL MEMORANDUM 016

Date:	July 2024
To:	NRCS-Utah
Cc:	
From:	Lance Houser, PE Franson Civil Engineers, Inc. Kyler Olsen, EIT Franson Civil Engineers, Inc. Franson Civil Engineers, Inc.
Project:	Logan River Watershed Plan-EIS
Subject:	Capital Cost Estimate

1.0 Introduction

To arrive at a benefit-cost ratio for the project, an estimate for construction costs for project measures under each alternative was required. This technical memo describes the process employed to arrive at the final construction costs for each alternative that will be carried forward to the EIS. A summary of the assumptions and calculations is given in this Technical Memorandum to provide context and clarity on the estimating process. Cost estimates, discussion, and comparison are then provided.

2.0 Summary of Methods, Assumptions and Tools

An appropriate cost estimate is dependent on an appropriate design (30% designated for environmental impact analysis). The following paragraphs describe the methods, assumptions, and tools used to complete a 30% design of the proposed project measures. Project measures under all alternatives are listed in alphabetical order, with pump stations grouped together due to similarity. 30% designs were completed for the following project measures: distribution system, first dam intake, flood control actions, hydropower equipment, canal enclosure, all pump stations, reconstruction and removal of Crockett Diversion Dam, and the lagoons storage facility. 100% design drawings for the Crockett Diversion Dam reconstruction were previously completed by Anderson Consulting Engineers (ACE). All design drawings are included in Attachment A of this document.

2.1 Distribution System

The pressurized irrigation distribution system was designed to service all current shareholders and all residential parcels within the current service area. Large concentrations of commercial parcels (identified through zoning and a QC review) were excluded from construction due to their negligible secondary water demand. The system was designed to have two pressure zones, as the existing Benson Irrigation Company (BIC) pressurized system is limited to a design pressure of 65 psi. The pressure zones would be isolated through a combination of a

smaller head pump station at the West Lagoons and isolating pressure reducing valves (PRVs) in strategic locations. In order to design the pipe network, multiple tools were used.

First, a pipe network model (using Bentley WaterCAD) was used to lay out and size the distribution pipe network. The pressurized distribution system was laid out to service every residence within the existing Crockett service area. Commercial areas (identified using municipal zoning) were not serviced, as outdoor water use is not substantial enough to create savings through a secondary hookup. This also minimized crossings of Main Street (US 91), which are extremely costly due to traffic control and after-hours work that would be required.

Once the distribution system was laid out, water demands were applied at the pipe intersections (called nodes). These demands were determined using spatial analysis software (ArcGIS Pro). An estimated “percent irrigated” multiplier was assigned to each zoning type for the service area. Each parcel was then assigned a “percent irrigated” through the zoning to calculate an “irrigated acreage” at each parcel. Agricultural parcels were identified through municipal zoning and a manual verification of parcels greater than 0.5 acres. A buildout scenario was also created, where all agricultural parcels in the area were assumed to be developed for the future zoning in the service area.

Finally, secondary system design values identified in UT R-309 510 were assigned to each parcel (3.96 gpm/non-ag irrigated acre peak day use, 7.92 gpm/non-ag residential irrigated acre instantaneous use, 7gpm/ag irrigated acre peak day use) for the initial and buildout conditions. Using the appropriate design flow and the irrigated acreage, a design demand at each parcel was calculated for the initial and buildout scenarios. Each parcel’s demand was then assigned to the closest pipe intersection node. Total Demand assigned to each node was summed and used as input for the WaterCAD model.

WaterCAD allows for the creation of multiple scenarios with varied underlying alternatives. Alternate demands and pipe distribution systems were created to allow for scenarios representing initial and buildout conditions for each action alternative. Additionally, due to the flexibility of the pressurized irrigation system, additional sub-scenarios were created to ensure that pipes were sized to meet demands (staying at or below 5 fps per NRCS standards) under a complete upper supply, complete lower supply, and 50/50 upper/lower supply conditions that may be experienced throughout the irrigation season.

WaterCAD allows for slight seasonal variation to demands in an extended time period simulation, but additional analysis on seasonal variation of water availability, demands, and operations was desired by project sponsors to gain confidence in the viability of the project. Additionally, there was a need to quantify estimated power generation and consumption impacts under each alternative. These values are discussed in TM013 Power Consumption and Generation and TM017 Operation and Maintenance Costs.

To meet these needs, a spreadsheet model of the Logan River Reaches 1–8 (see TM002 for river reach definition) below First Dam was created with a daily timestep for the length of the irrigation season (April 1 to October 15). Percentile hydrographs of the Logan River above First Dam (see TM002 Hydrology and Hydraulics for description of hydrograph development) were utilized as upstream model inputs. Seasonal demands for the Crockett Irrigation Company (CIC)

were developed using historical average daily diversion for agricultural demands, state secondary design rates for non-shareholder parcels that will be served by the distribution system, and estimated seepage losses (see TM004 Seepage Losses). The model used a rule-based operations scenario, ensuring 25 cfs instream flow, storing water when possible, and prioritizing diversion upstream while following the Kimball Decree Revised Schedule A when Logan River flows diminish. When available water supply fell below demand, stored water was used to meet a proportional amount of demand. See TM013 Power Consumption and Generation for additional details on model inputs and parameters.

This model was used to size each pump station capacity and identify an estimated peak supply to the system. Large transmission lines throughout the distribution system were sized using the supply value rather than the demand value calculated through WaterCAD, as the demand value would artificially increase pipe sizes because it assumes that every parcel is experiencing peak instantaneous demand constantly. The reality of culinary or secondary systems is that not everyone is consuming water at the same time. Although agriculture uses more water than secondary and users are more consistent in their use, they also do not water every field at the same time. So, while the laterals that service parcels were sized for the peak instantaneous demand, the main transmission lines were sized for supply amounts. This method was used for the design and construction of the Benson Pressurized Irrigation system and has functioned successfully since 2019.

It should be noted that pipe sizes are dependent on looping and interconnecting, which helps reduce the overall size of pipe required. This should be taken into account during incremental analysis of the system, as the removal of some key looping/interconnecting lines may impact the required sizing of other pipelines.

2.2 First Dam Intake

The First Dam Intake design supply value was taken from the spreadsheet model described above. Site visits and photographs were used to prepare the 30% design. It is currently unknown how far the penstocks extend from the control house concrete face, as the area is submerged by hydropower tailwater and flow over the spillway. The complete design of the connection point will be finished during the design phase of this project. The design includes removal of the existing hydropower turbine and connecting to the penstocks as they leave the control building. The pipe network was laid out to minimize impacts to existing concrete. A metered turnout was sized to provide the full water right of the Providence-Logan Irrigation Company into the Logan River. The pressurized irrigation system meter is located downstream of the turnout. Supply pipe size (60-inch) was selected to balance the ability to take the full water right and the anticipated demands by the system users. Steel was selected for the area near the intake, with a transition to plastic pipe after the alignment crosses the parking lot and joins the current Logan-Hollow supply line alignment.

2.3 Flood Control Actions

Flood control actions are described in TM007. For the purposes of cost estimation, landscaping fill quantities on two properties were estimated using design surfaces generated during

hydraulic modeling. Design surfaces were compared with existing LIDAR data for the parcels to quantify required fill.

2.4 Hydropower Equipment

Hydropower equipment was designed for a maximum flow rate of 40 cfs, which balances generating capacity during spring runoff and equipment costs. Hydropower head was obtained from the WaterCAD distribution system model described in section 2.1 and takes into account pipe friction losses. Based on head and anticipated flow rates, a 510 kW Francis turbine was selected.

2.5 Canal Enclosure

The initial section of canal to be enclosed is located along the edge of the Island hillside. CIC requested that a box culvert be used. The box culvert was sized to carry 80 cfs with the elevation drop from the upstream bridge to downstream road crossing. A preliminary quote for the enclosure materials was requested from a market vendor with installation costs estimated in addition.

Other areas of future canal enclosure had the following assumptions made: sized to carry the respective irrigation company water rights to which it delivers water; each canal reduces in conveyance need, and pipeline and manholes were found to be suitable and more cost effective for all enclosure below the Crockett Main Branch division at 200 E and Center Street in Logan; pipelines were sized for gravity flow with 1 foot of headspace and manholes every 500 feet for cleanout operations; and valves were located at the head of each irrigation company for flow control and isolation.

2.6 Pump Stations

The spreadsheet model discussed in section 2.1 was used to size pump station capacity for all except the Cow Pasture pump station. The Cow Pasture pump station was sized to pump all external ground and surface water rights owned by the Cow Pasture Irrigation Company. These flow rates are listed below in Table 2-1. The West Lagoon Pump Station services two pressure zones. To reduce pumping costs, two design pump heads were used.

Table 2-1 Pump Station Design Capacity

Pump Station	Design Flow Rate (cfs)
Cow Pasture	40
Crockett	120
West Lagoons	90
Low Head	30
High Head	60
West River	30

Pump station 30% design drawings were completed to identify the appropriate appurtenances at each location. These details were used to identify line items and quantities for each project measure.

2.7 Reconstruct Crockett Diversion Dam

Crockett Diversion Dam reconstruction is a project measure under the No Federal Action alternative and has construction drawings that have previously been completed by ACE. No additional design was required at this phase.

2.8 Remove Crockett Diversion Dam

Diversion dam removal actions include dam removal and river channel restoration using rock weirs. Quantities of armoring rip-rap, excavation, and rock for weirs were estimated using design surfaces developed through hydraulic modeling and rock weir design. See TM007 for additional information regarding rock weir design.

2.9 Storage Facility

TM010 details the process carried out to identify the necessary infrastructure improvements needed at the Logan Lagoons storage facility. Quantities of excavation for internal berm removal, fill for external berm rehabilitation, and excavation of dried sludge are provided in TM010. Concrete overflow spillway design parameters are also discussed in TM010.

3.0 Estimated Project Costs

Following the organizational format provided in TM006, costs for each alternative were broken down by individual project measures. Where needed, project measures were split into specific line items that facilitated appropriate cost estimates. Lists of project measures and individual line items (with quantities) were provided to an independent construction cost estimator. Transformer costs were estimated using recent purchase prices from Logan Light and Power, and the budgetary cost estimate for the hydropower equipment was provided by Canyon Hydro. The tables seen in the body of this report summarize costs by project measure, and expanded tables are provided in Attachment A. Cost estimates include the cost to furnish and install items, including contractor overhead. Contingency is applied to the full project cost, and engineering design, construction management, permitting, and administration is not included.

3.1 No Federal Action Alternative

Capital costs required for this alternative were limited to two project measures: rehabilitation of the Crockett Diversion Dam and enclosing a section of the Crockett Canal. CIC has previously made plans to rehabilitate the diversion dam and has design drawings that were approved for bidding. These plans served as the basis creating line items for cost estimating. An approximate length of canal was measured for estimates on that line item. Table 3-1 below shows the initial capital cost estimates for this alternative, while Table 3-2 illustrates the future capital costs over the project lifetime.

Table 3-1 No Federal Action Initial Capital Cost Estimate

Project Measure	Price ($)
Reconstruct Crockett Diversion Dam	990,000
Line Section of Canal	3,000,000
Project Measures Subtotal	***1,280,000***
Contractor Overhead	220,000
Subtotal	**4,210,000**
Contingency (20%)	840,000
Final Amount	**5,050,000**

Table 3-2 No Federal Action Future Capital Cost Estimate

Project Measure	Price ($)
Future Canal Enclosure	24,000,000
Contractor Overhead	1,300,000
Subtotal	**25,300,000**
Contingency (20%)	5,050,000
Final Amount	**30,350,000**

3.2 First Dam Alternative

Capital costs identified for the project measures under this alternative can be seen below in Table 3-3. It should be noted that during the final selection of a Preferred alternative, the First Dam Alternative was slightly modified, borrowing one item from the Crockett Diversion Alternative to better meet public desires. Instead of removing the Crockett Diversion Dam and restoring the river, the dam would be reconstructed to maintain existing connectivity and river levels upstream of the dam but allow for improved flood conveyance. The First Dam Alternative cost description below indicates the original cost estimate, including the removal of Crockett Diversion Dam. For this reason, total costs included in the following sections may differ slightly from the totals indicated in the economic analysis.

Table 3-3 First Dam Alternative Capital Cost Estimate

Project Measure	Price ($)
First Dam Intake	17,600,000
Pressurized Irrigation System	102,470,000
West River Pump Station	2,420,000
West Lagoon Pump Station	1,830,000
Storage Facility	7,910,000
Hydropower equipment	1,360,000
Cow Pasture Pump Station	2,310,000
Removal of Crockett Diversion Dam	1,290,000
Removal of Providence Pioneer Diversion Dam	200,000
Flood Control Actions	20,000
Project Measures Subtotal	***137,400,000***
Contractor Overhead	9,700,000
Subtotal	**147,100,000**
Contingency (20%)	29,400,000
Final Alternative Amount	**176,500,000**

3.3 Crockett Diversion Alternative

Capital costs identified for the project measures under this alternative can be seen below in Table 3-4

Table 3-4 Crockett Diversion Alternative Capital Cost Estimate

Project Measure	Price ($)
Crockett Dam Reconstruction	680,000
Crockett Pump Station	1,210,000
Distribution System	102,470,000
West River Pump Station	2,420,000
West Lagoon Pump Station	1,830,000
Storage Facility	7,910,000
Cow Pasture Pump Station	2,310,000
Removal of Providence Pioneer Diversion Dam	180,000
Flood Control Actions	20,000
Project Measures Subtotal	***119,000,000***
Contractor Overhead	8,340,000
Subtotal	**127,000,000**
Contingency (20%)	25,400,000
Final Alternative Amount	**152,400,000**

4.0 Attachment A

The following reference documents are attached to this Technical Memorandum.

30% design drawings:

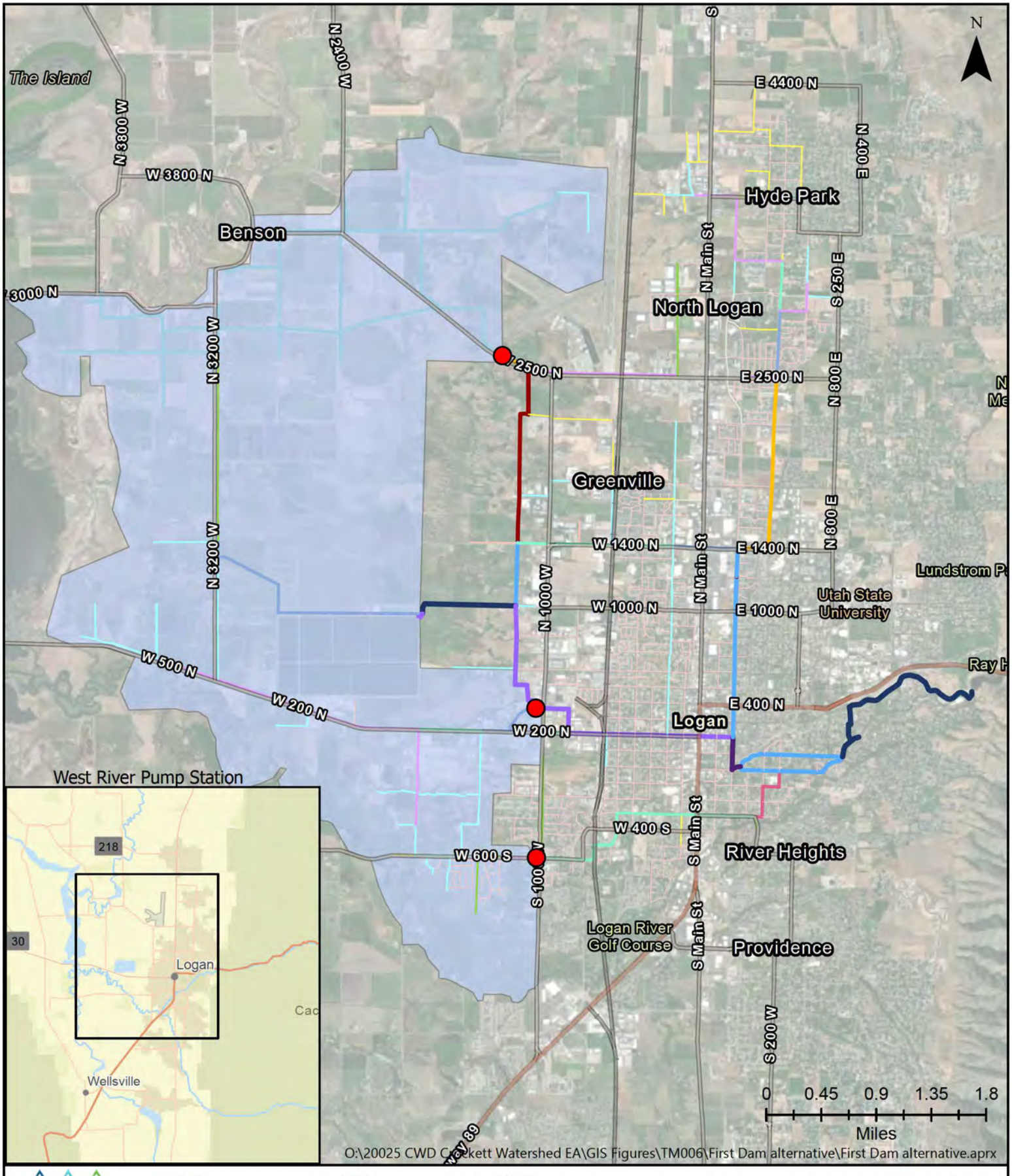
- Distribution system
- First Dam Intake
- Cow Pasture Pump Station
- Crockett Pump Station
- West Lagoon Pump and Hydro Station
- West Lagoon Pump Station
- West River Pump Station
- Crockett Diversion Removal
- Lagoons Storage Facility

100% design drawings:

- Crockett Diversion Dam

Bid tab sheets:

- No Federal Action Bid Tab sheet
- First Dam Alternative Bid Tab sheet
- Crockett Diversion Alternative Bid Tab sheet



CACHE WATER DISTRICT

4" Pipe
6" Pipe
8" Pipe
10" Pipe
12" Pipe
15" Pipe
18" Pipe
21" Pipe
24" Pipe
27" Pipe
30" Pipe
36" Pipe
42" Pipe
48" Pipe
54" Pipe
60" Pipe
Existing Pipe
Low_Pressure_Zone
PRV Locations

E-1703

DISTRIBUTION SYSTEM 30% DESIGN

Logan River Watershed Plan-EIS

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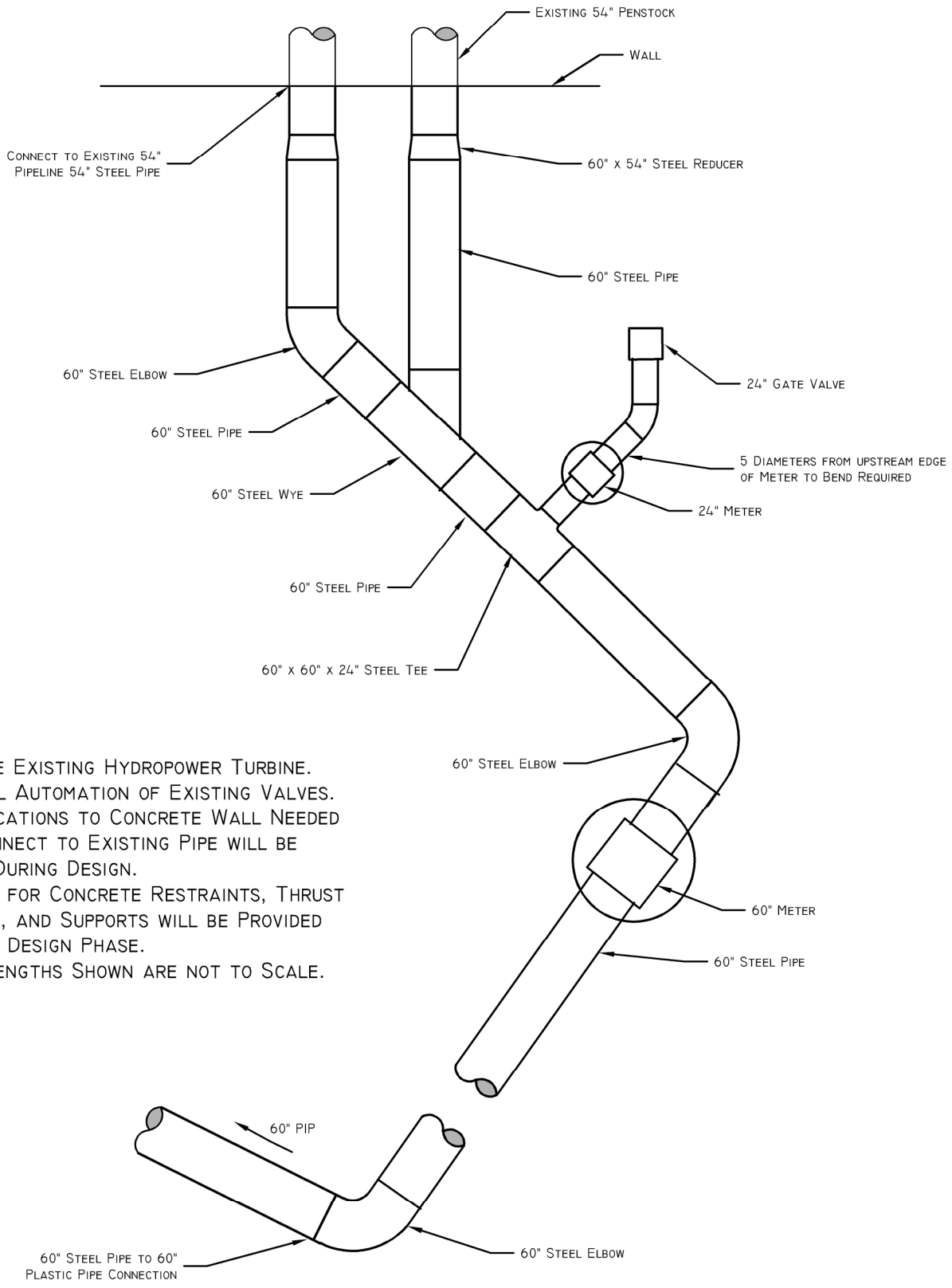
FIRST DAM INTAKE

Logan River Watershed Plan EIS



NOTES:

1. REMOVE EXISTING HYDROPOWER TURBINE.
2. INSTALL AUTOMATION OF EXISTING VALVES.
3. MODIFICATIONS TO CONCRETE WALL NEEDED TO CONNECT TO EXISTING PIPE WILL BE MADE DURING DESIGN.
4. DESIGN FOR CONCRETE RESTRAINTS, THRUST BLOCKS, AND SUPPORTS WILL BE PROVIDED DURING DESIGN PHASE.
5. PIPE LENGTHS SHOWN ARE NOT TO SCALE.

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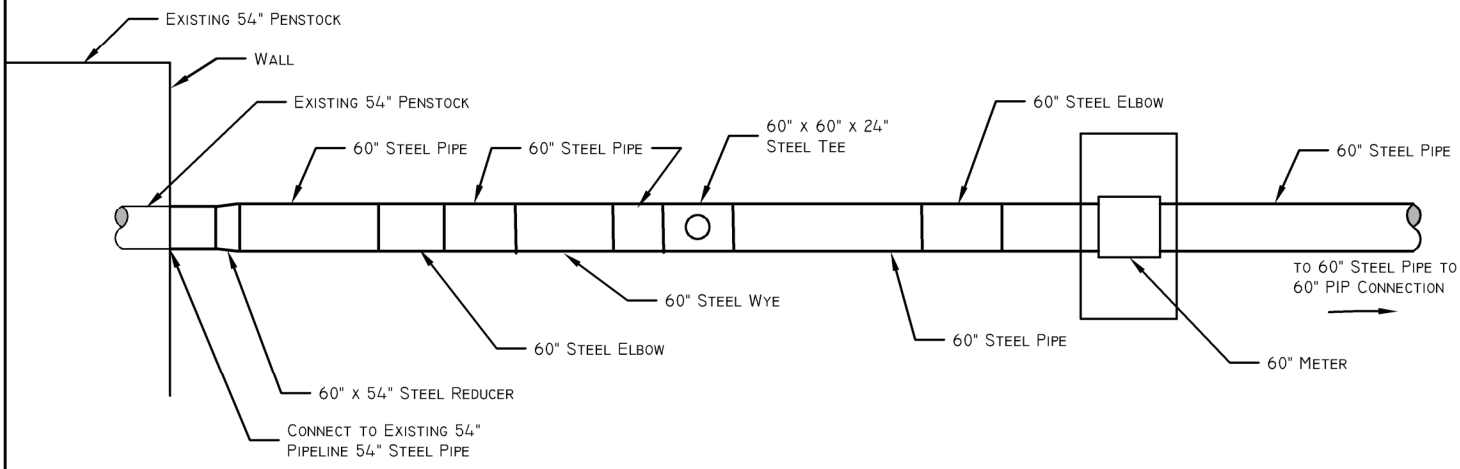
FIRST DAM INTAKE PLAN

Logan River Watershed Plan EIS



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FIRST DAM INTAKE PROFILE

Logan River Watershed Plan EIS

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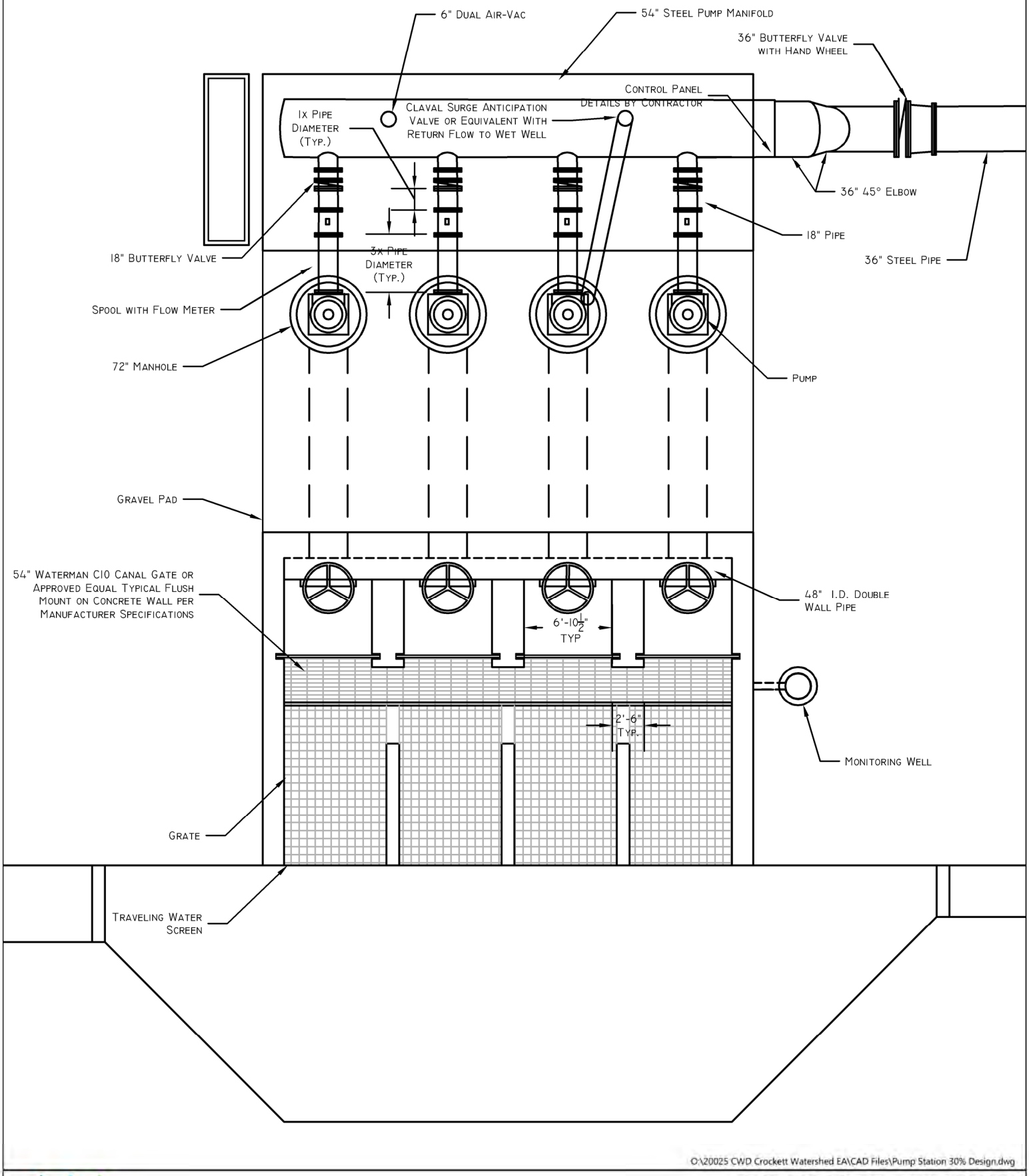
COW PASTURE PUMP STATION LOCATION

Logan River Watershed Plan EIS



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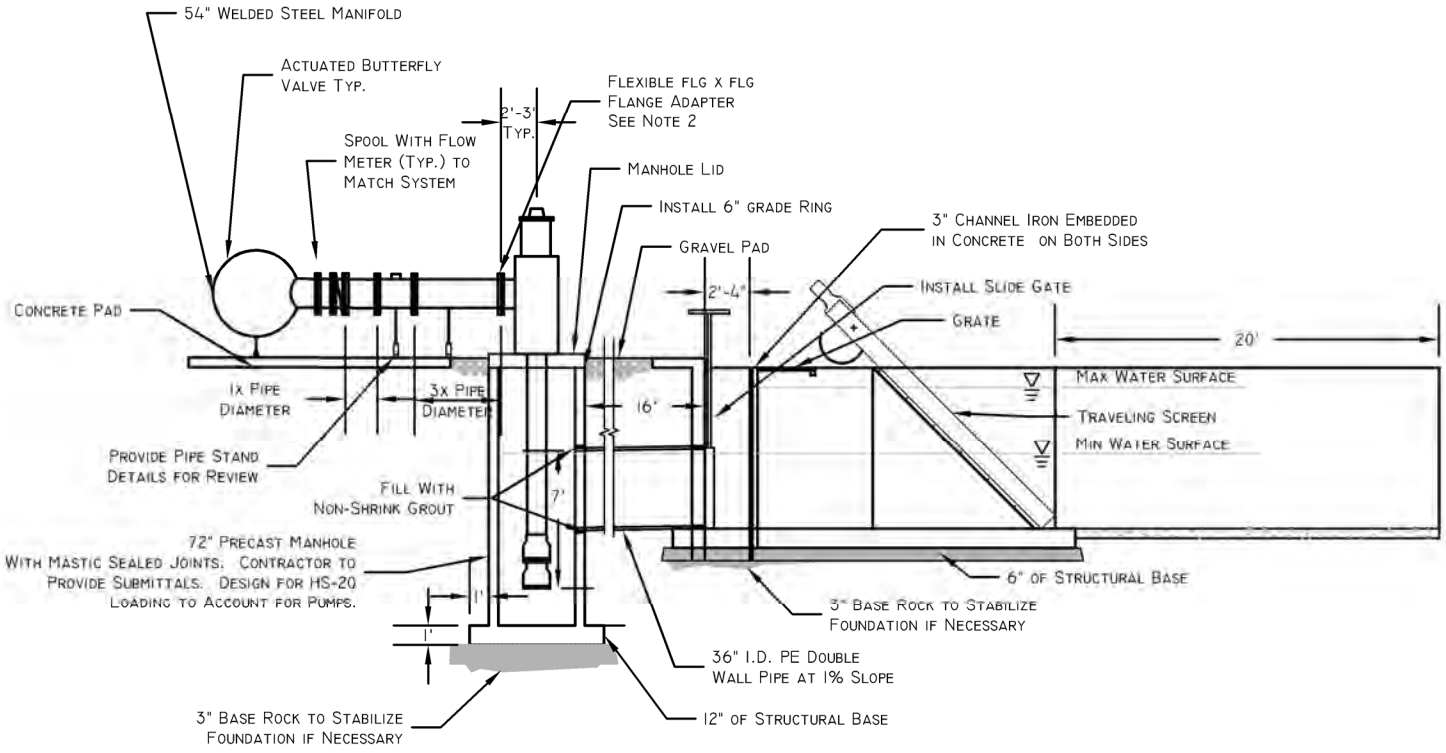
COW PASTURE PUMP PLAN VIEW

Logan River Watershed Plan EIS



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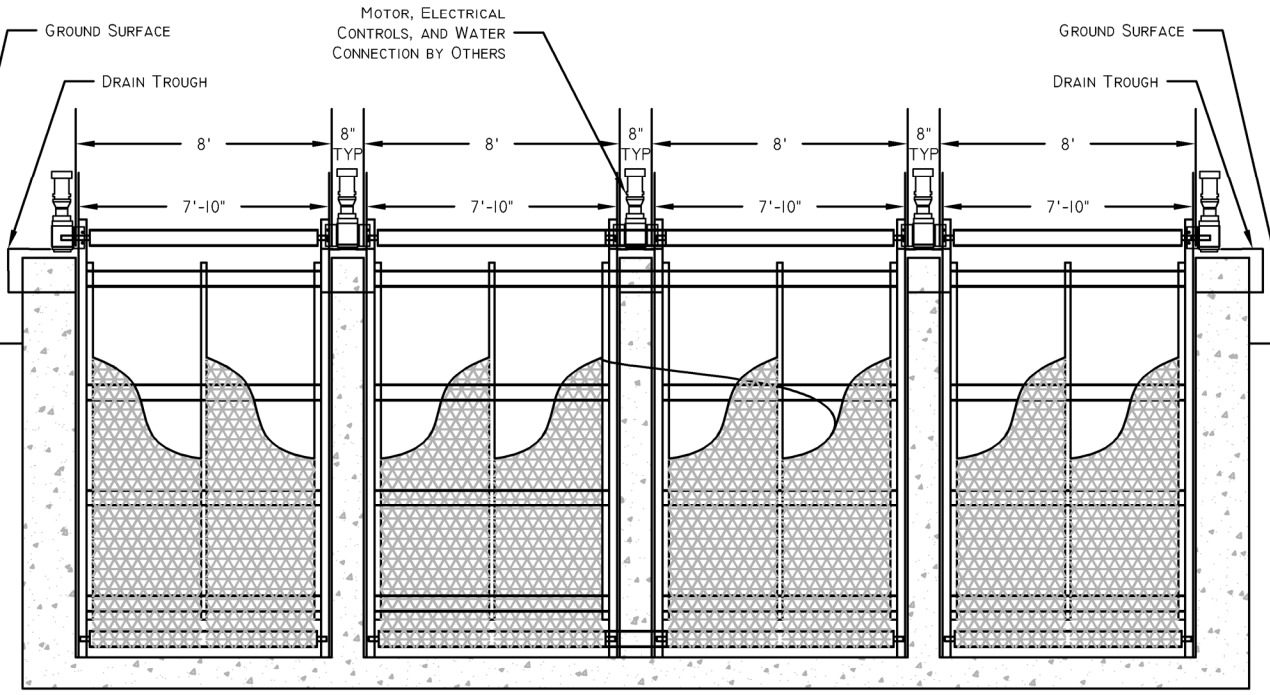
COW PASTURE PUMP STATION PROFILE

Logan River Watershed Plan EIS



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COW PASTURE PUMP STATION SECTION

Logan River Watershed Plan EIS

CACHE WATER DISTRICT

COW PASTURE PUMP STATION LOCATION

Logan River Watershed Plan EIS

CROCKETT PUMP STATION LOCATION

Logan River Watershed Plan EIS

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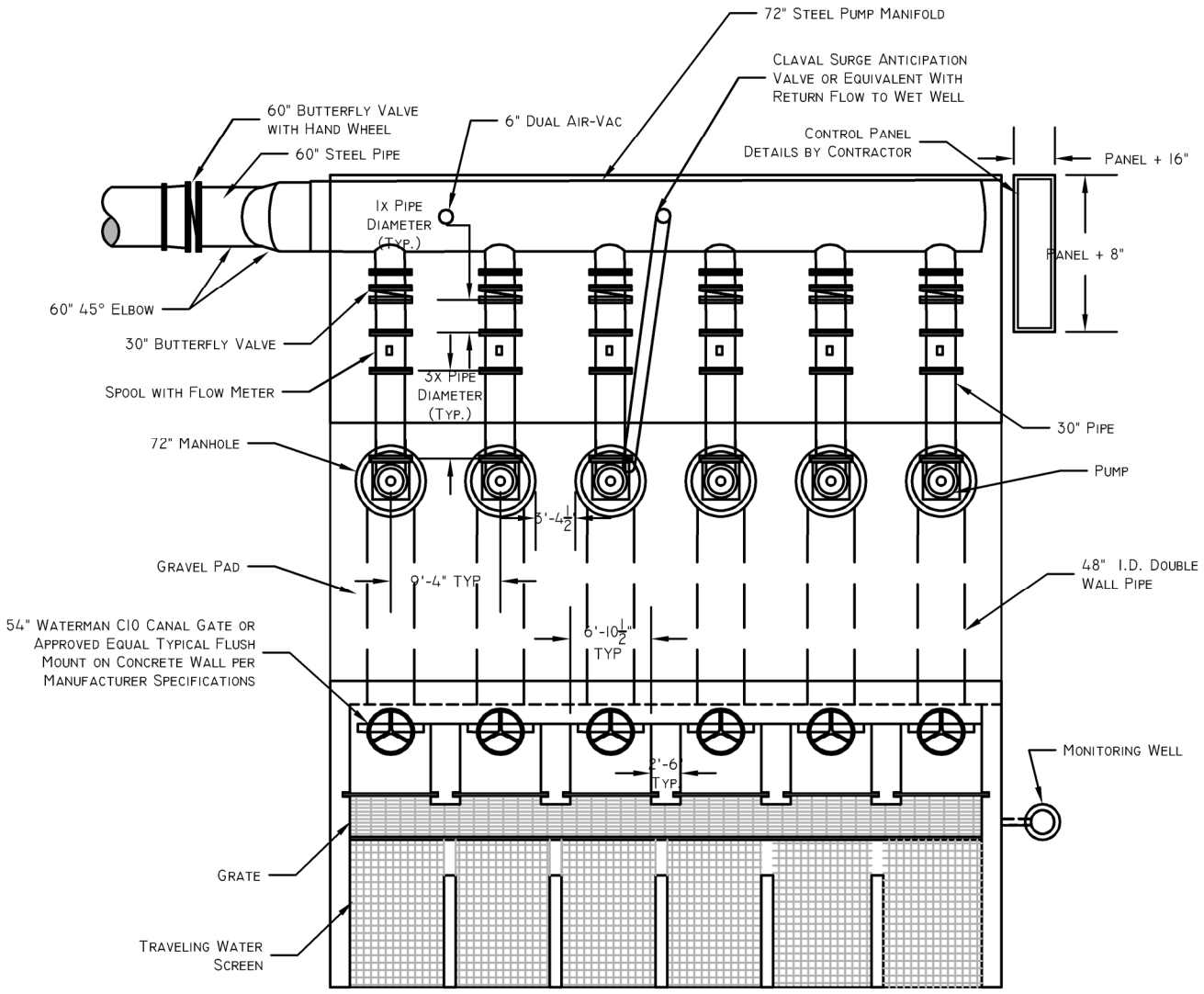

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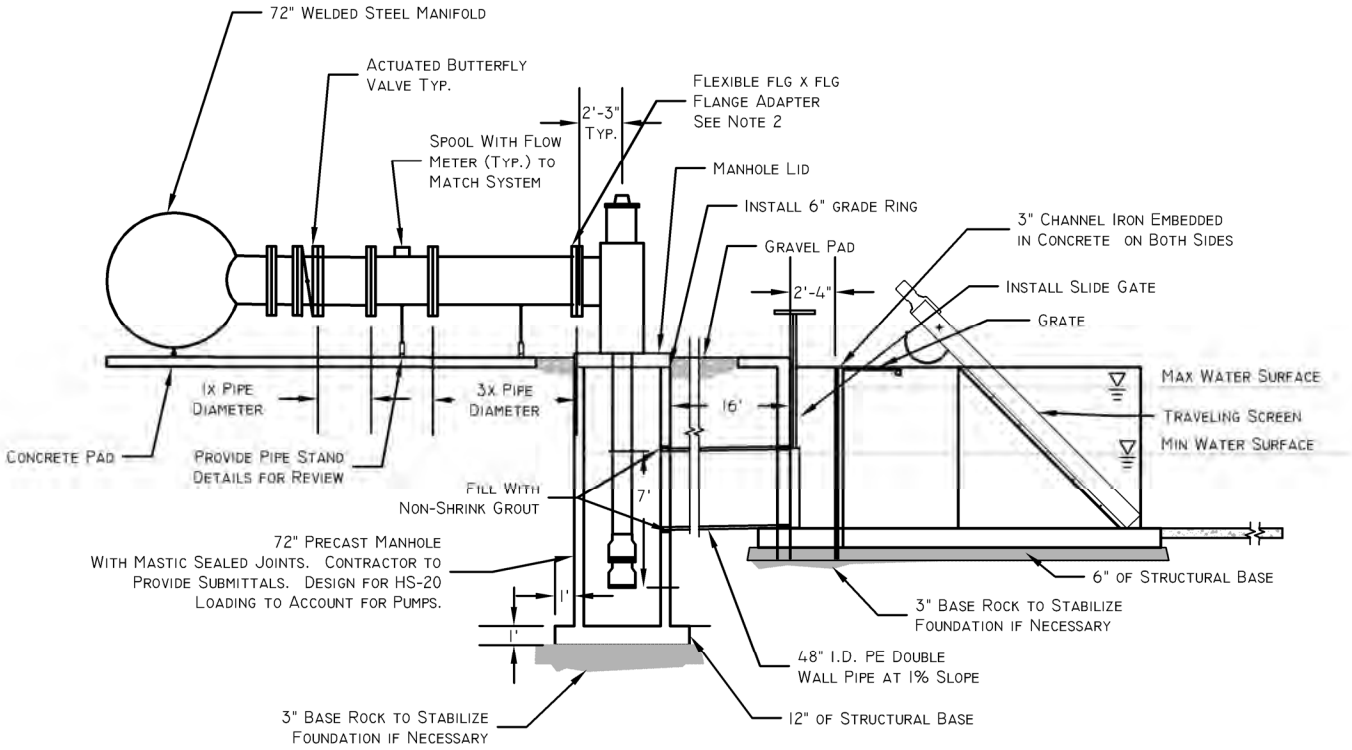
CROCKET PUMP STATION PLAN

Logan River Watershed Plan EIS



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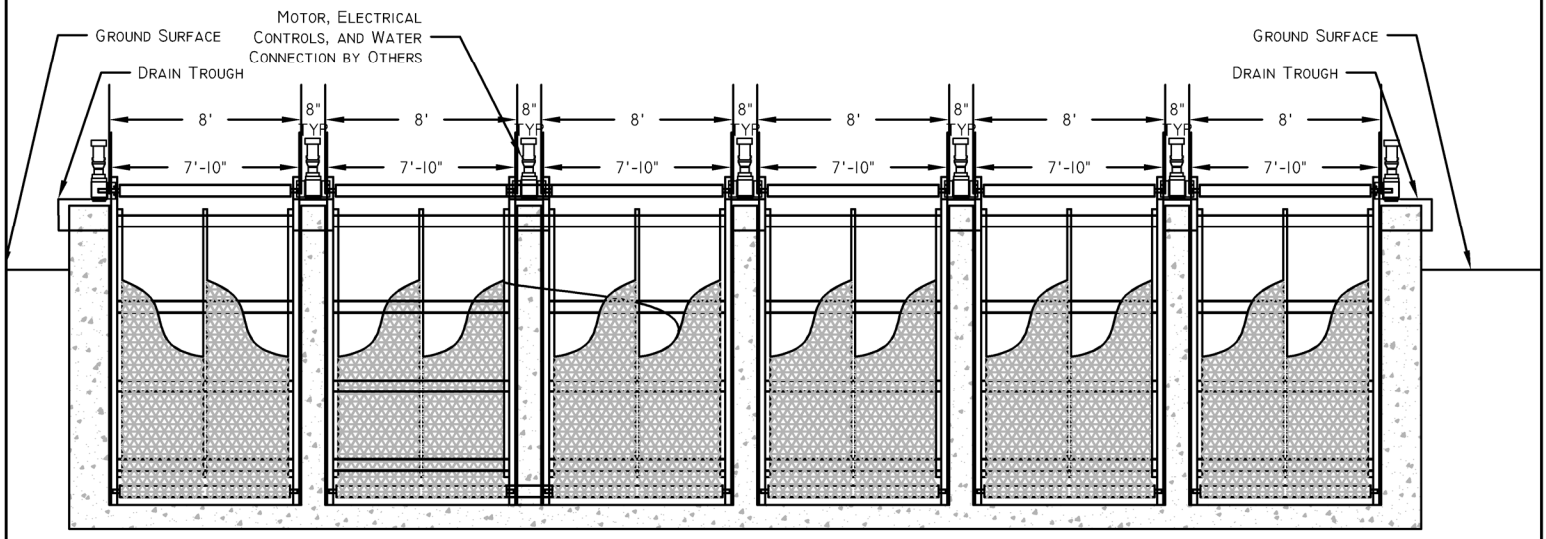
CROCKET PUMP STATION PROFILE

Logan River Watershed Plan EIS



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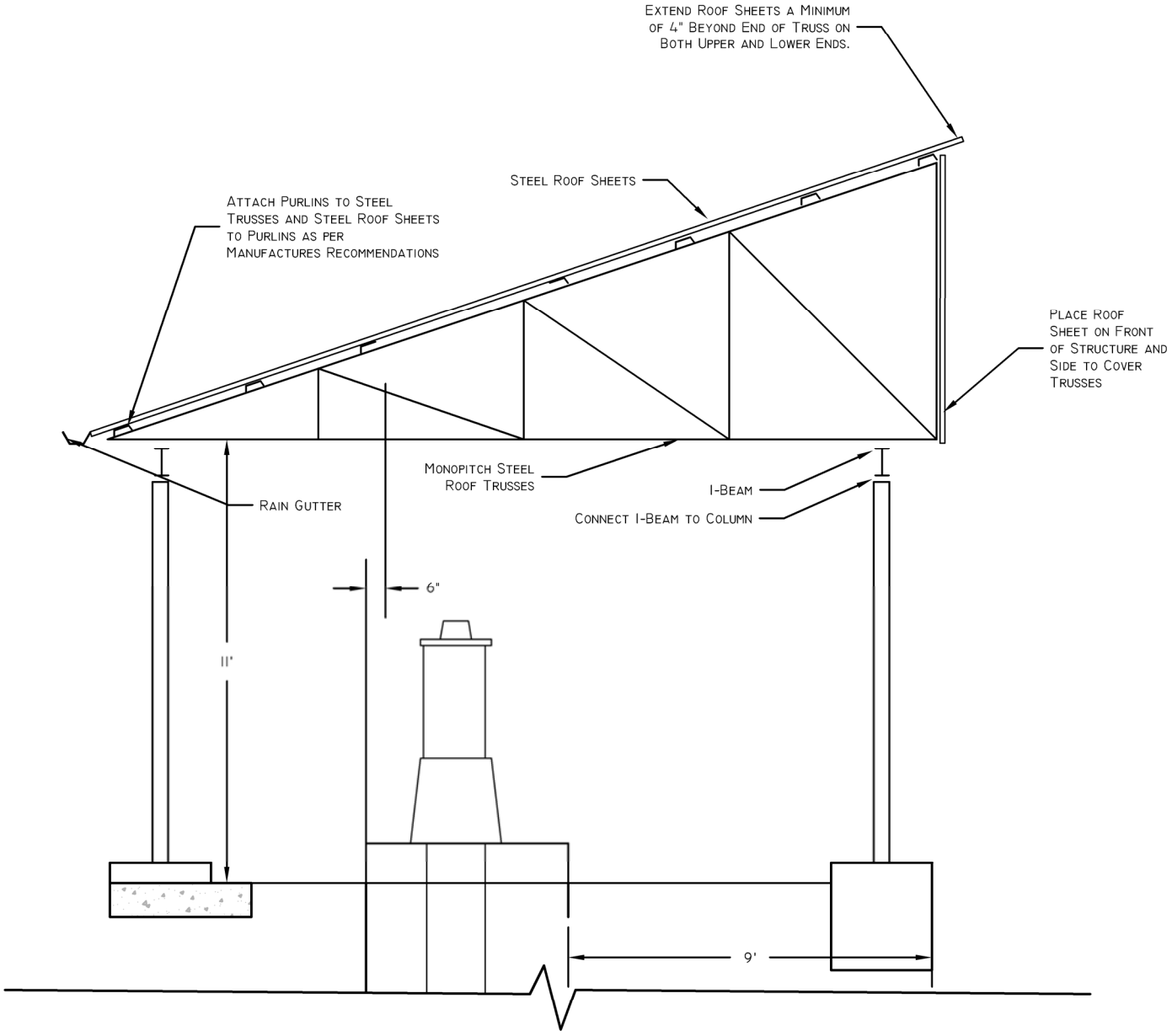
CROCKETT PUMP SECTION

Logan River Watershed Plan EIS



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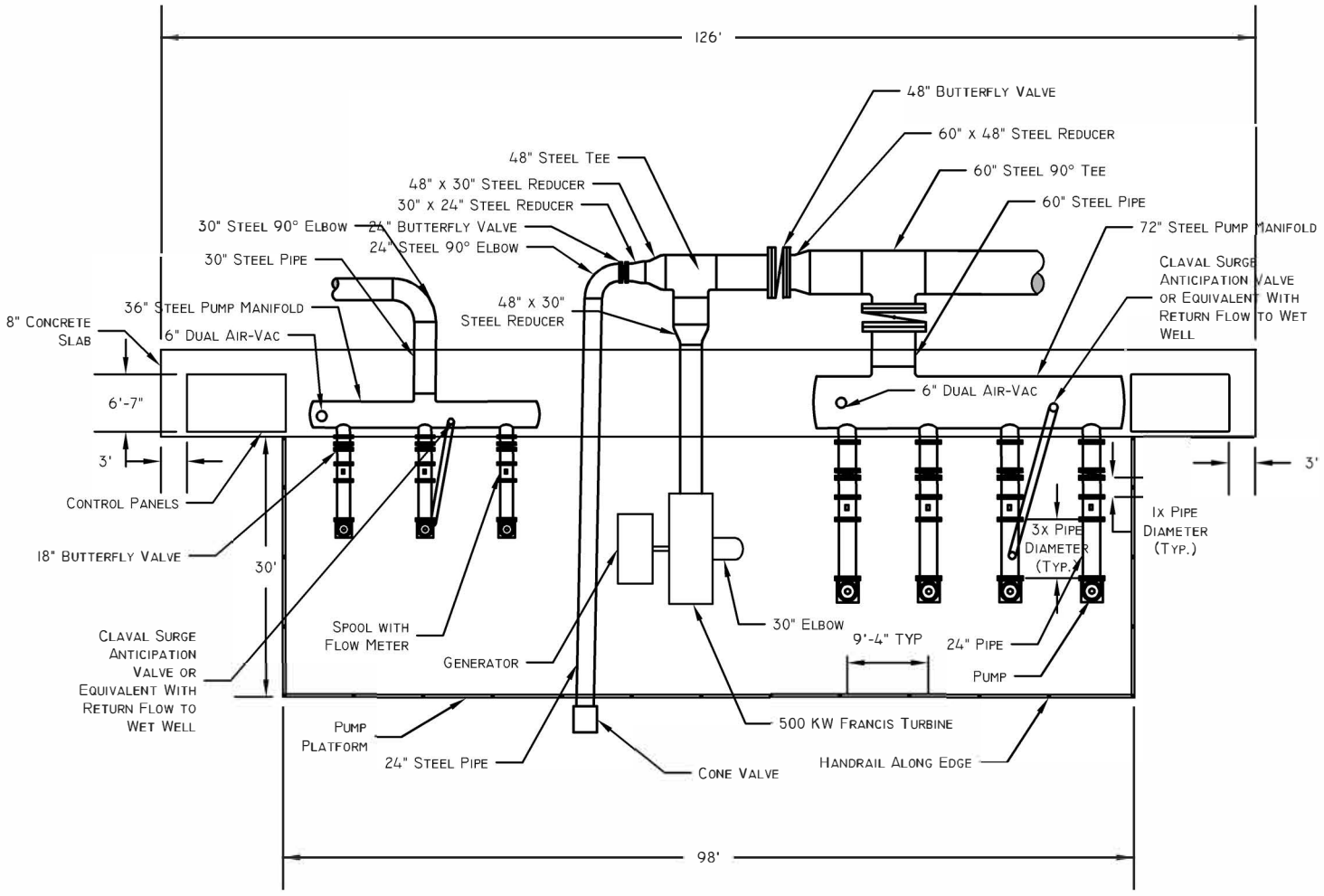
ROCK WEIR DESIGN

Logan River Watershed Plan EIS

CACHE WATER DISTRICT

WEST LAGOON PUMP & HYDRO STATION LOCATION
(FIRST DAM ALTERNATIVE)
Logan River Watershed Plan EIS



Note: Roof Not Shown for Clarity

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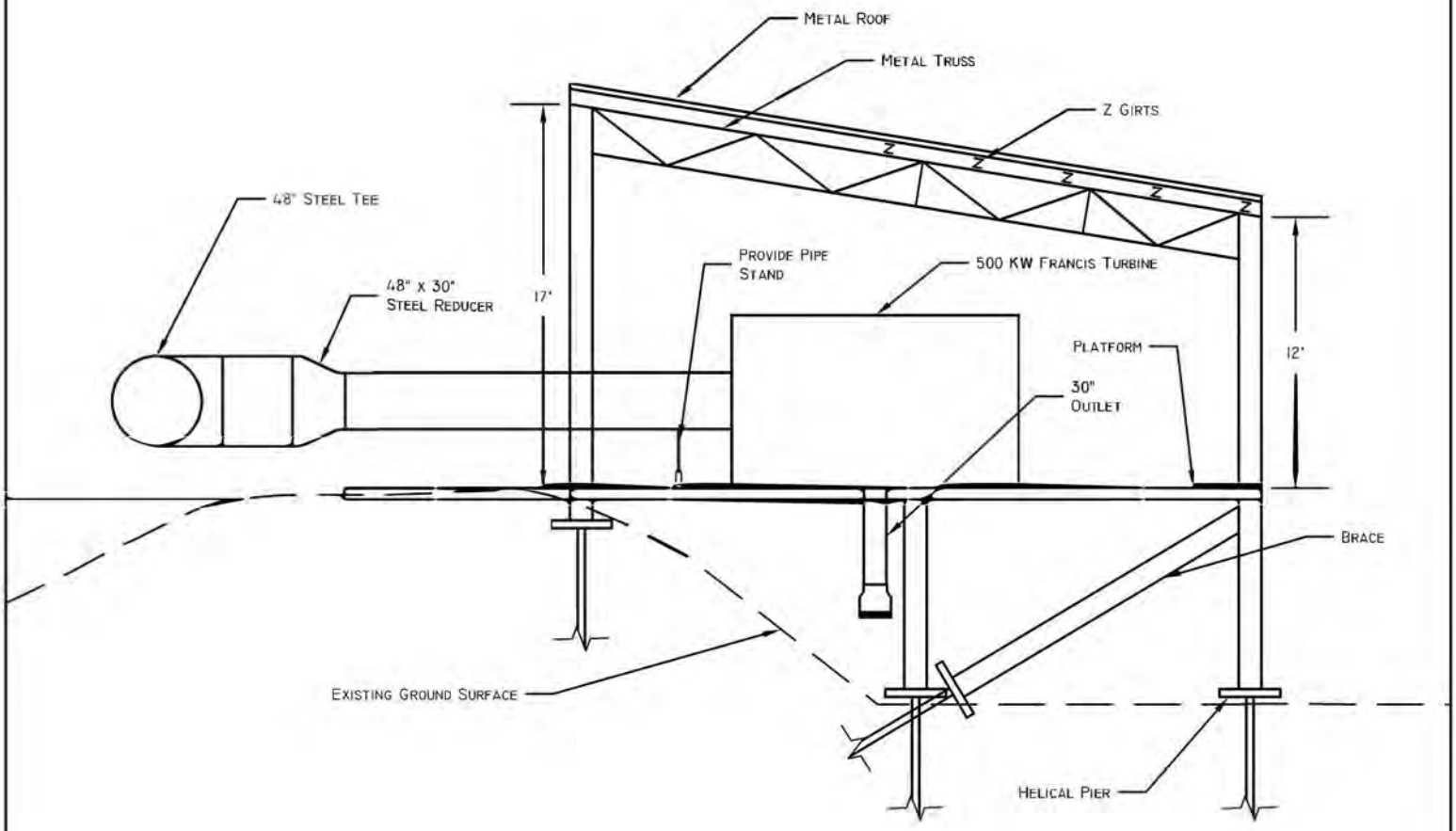
WEST LAGOON PUMP & HYDRO STATION PLAN
(FIRST DAM ALTERNATIVE)
Logan River Watershed Plan EIS



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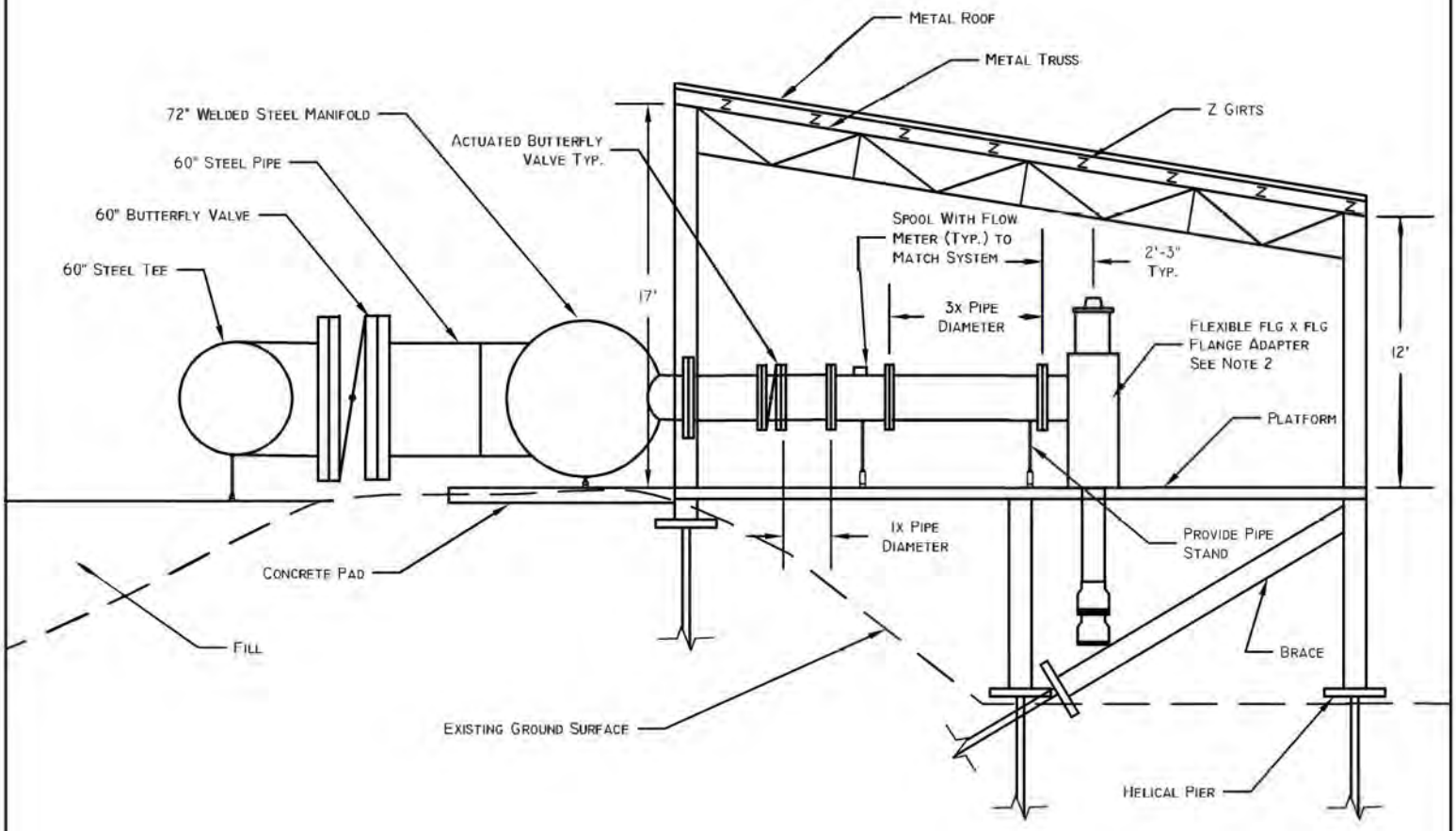
WEST LAGOON PUMP & HYDRO STATION PROFILE 1
(FIRST DAM ALTERNATIVE)
Logan River Watershed Plan EIS



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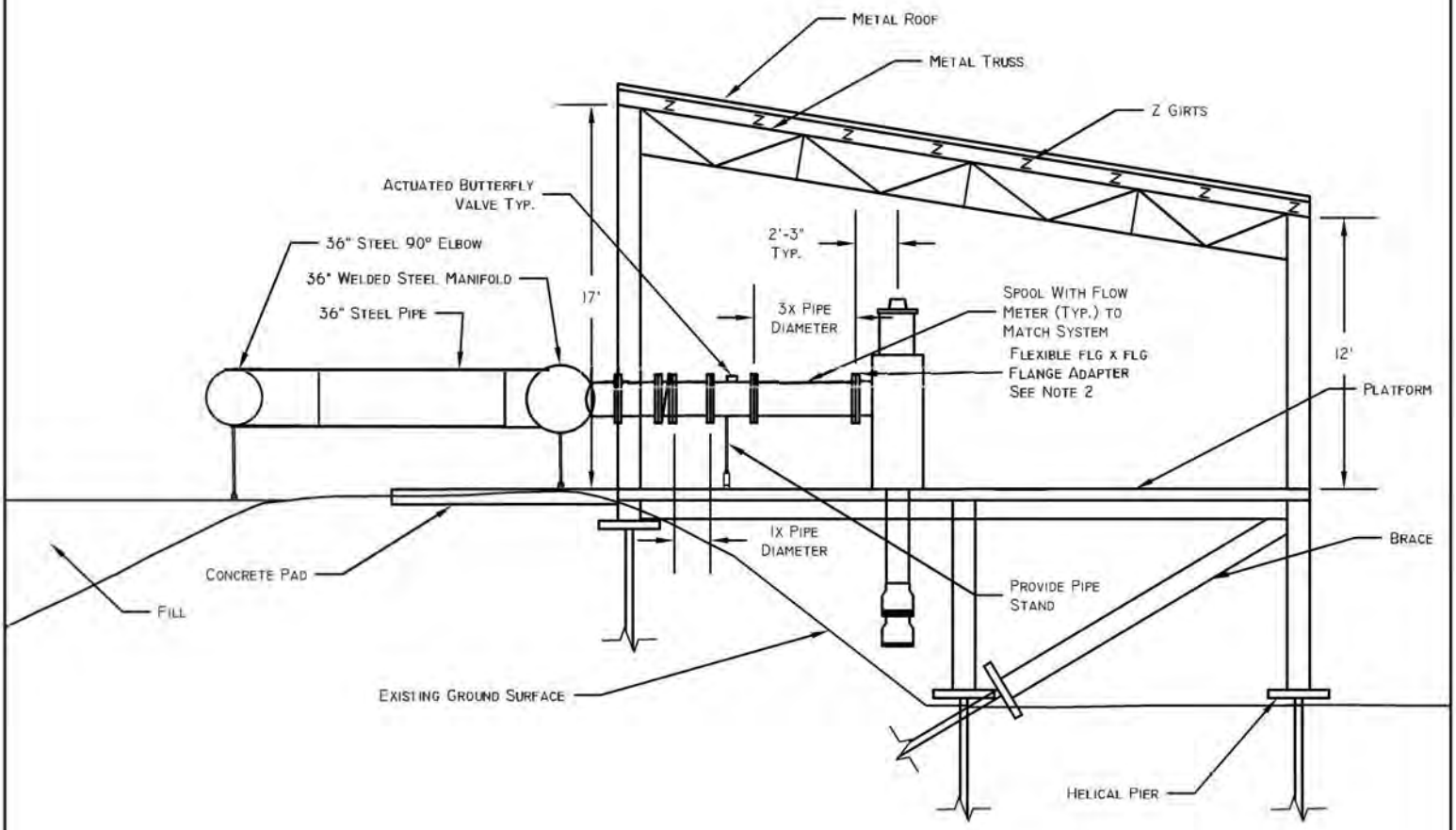
WEST LAGOON PUMP & HYDRO STATION PROFILE 2
(FIRST DAM ALTERNATIVE)
Logan River Watershed Plan EIS



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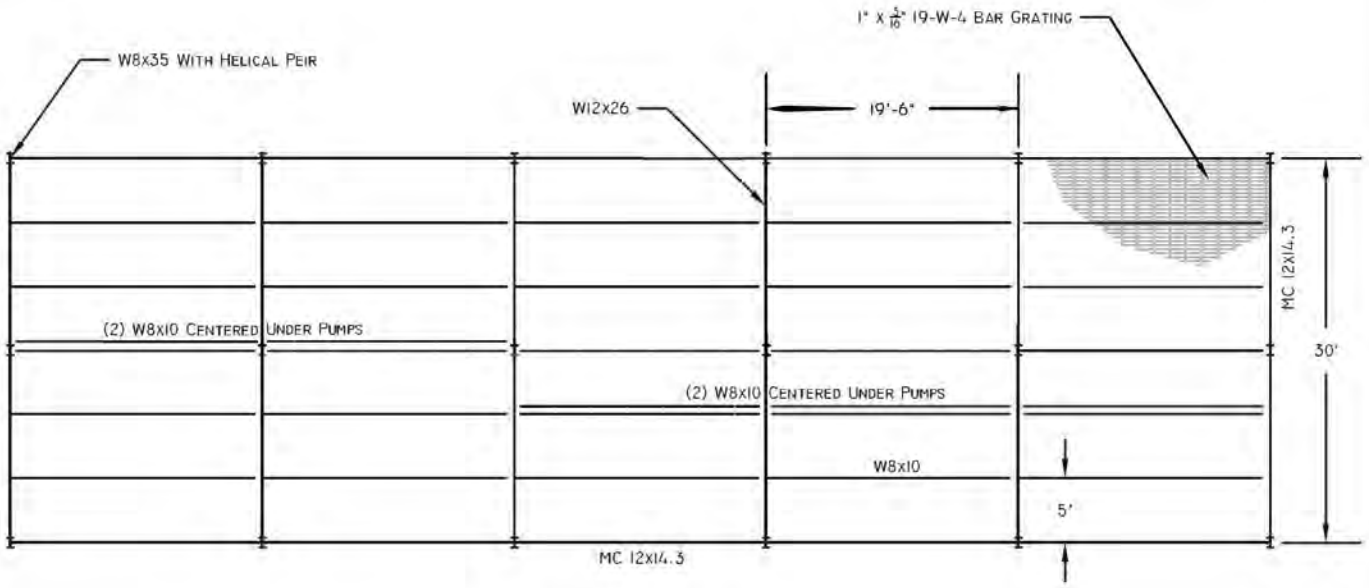
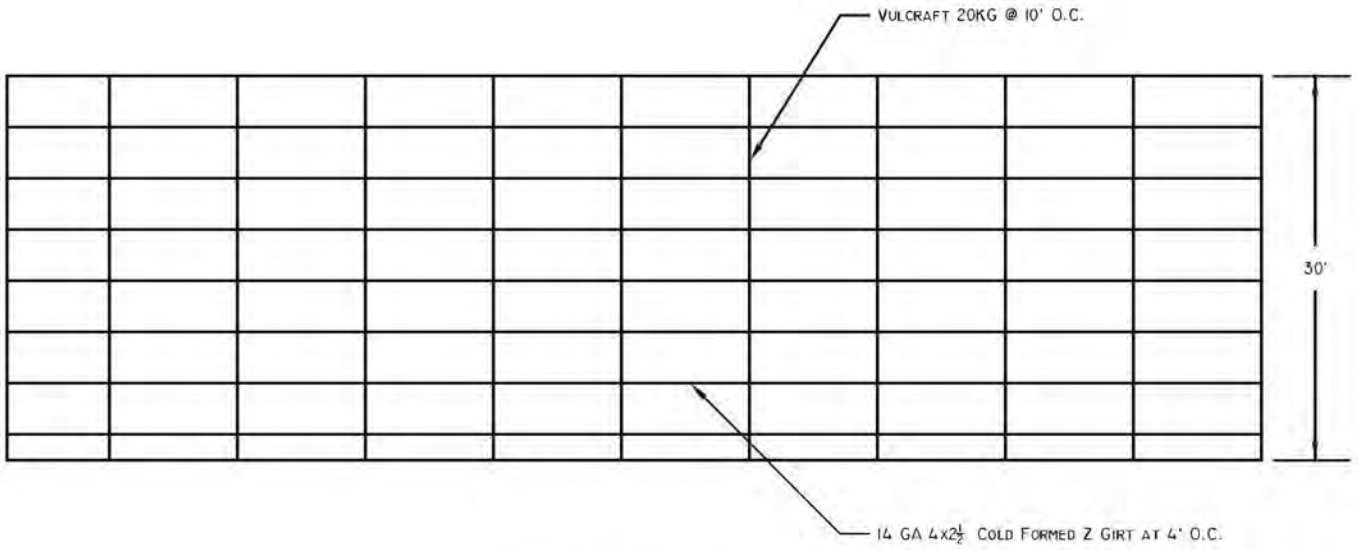
CACHE WATER DISTRICT

WEST LAGOON PUMP & HYDRO STATION PROFILE
(FIRST DAM ALTERNATIVE)
Logan River Watershed Plan EIS



PLATFORM PLAN



ROOF PLAN

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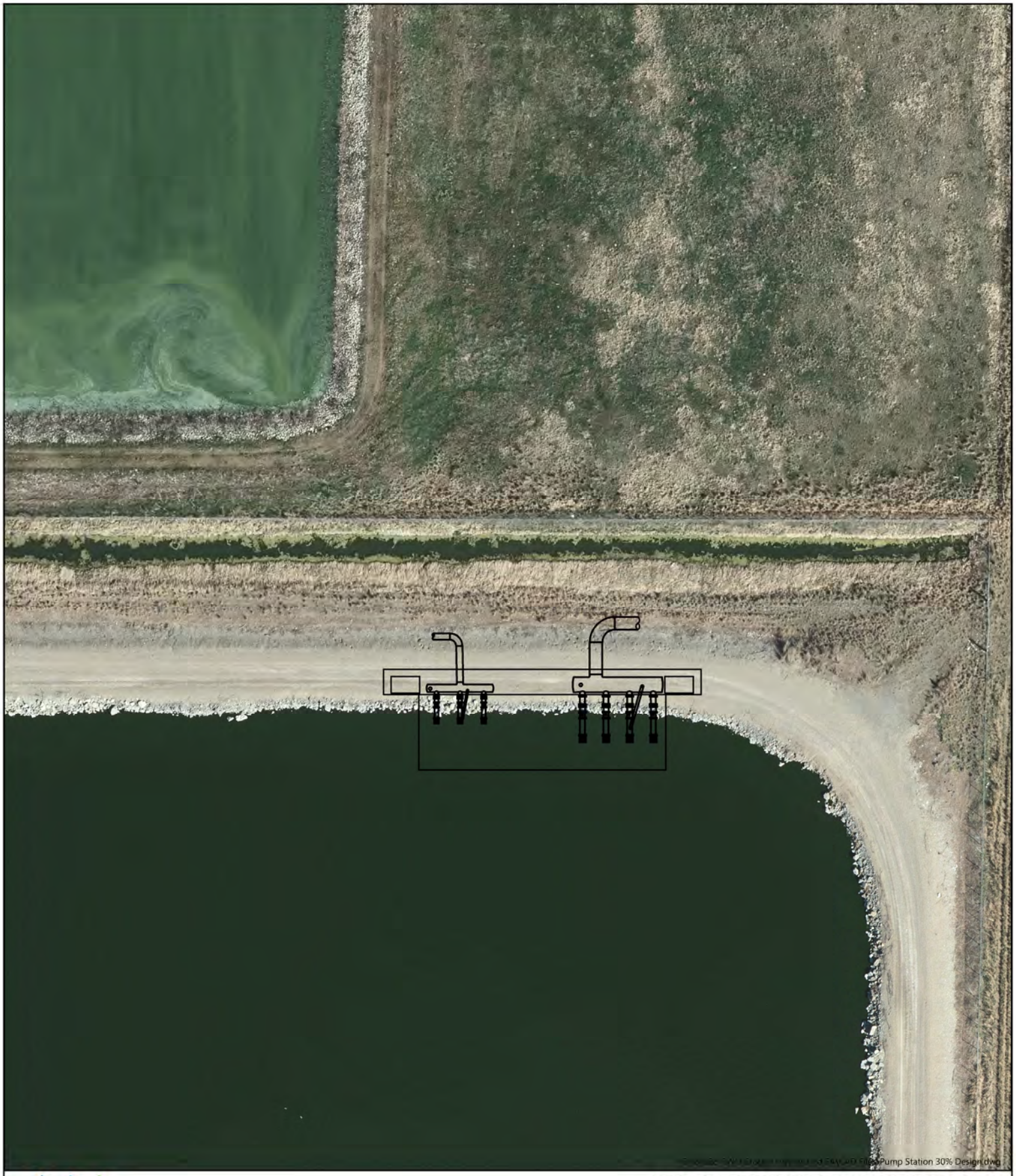
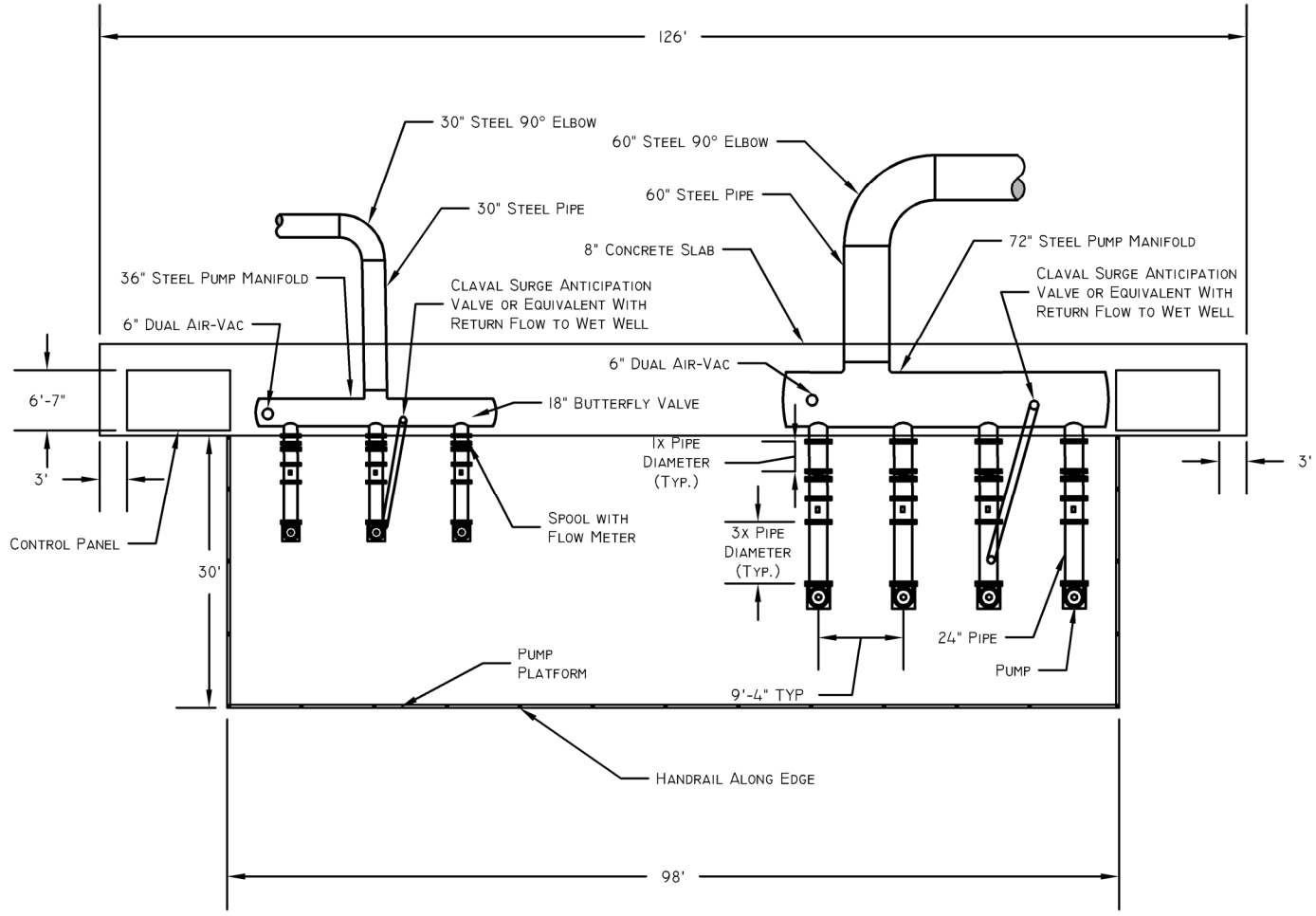
CACHE WATER DISTRICT

WEST LAGOON PUMP & HYDRO STATION PROFILE 3
(FIRST DAM ALTERNATIVE)
Logan River Watershed Plan EIS



WEST LAGOON PUMP STATION LOCATION
(CROCKETT DIVERSION ALTERNATIVE)
Logan River Watershed Plan EIS

CACHE WATER DISTRICT



Note: Roof Not Shown for Clarity

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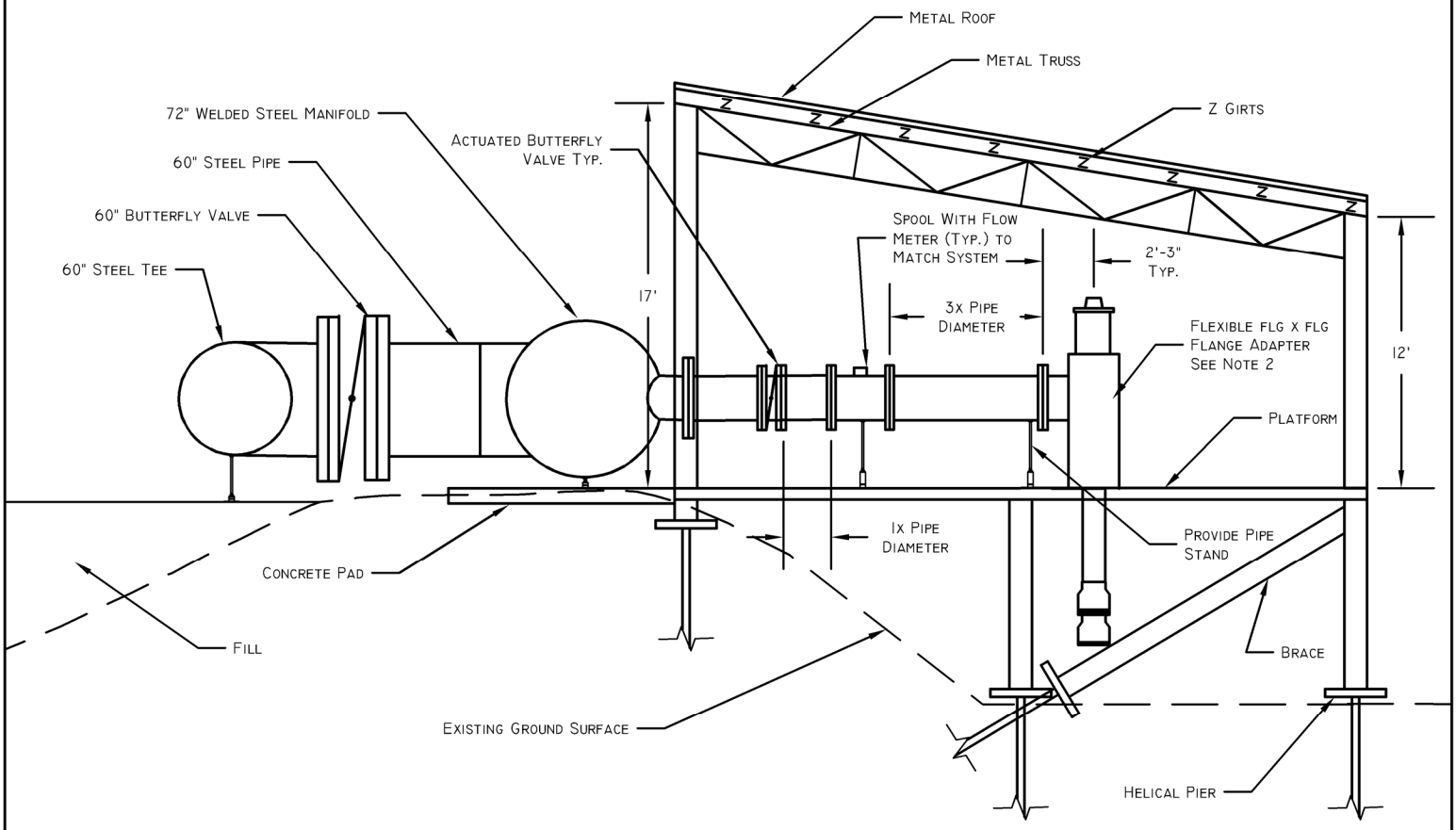
CACHE WATER DISTRICT

WEST LAGOON PUMP STATION PLAN
(CROCKETT DIVERSION ALTERNATIVE)
Logan River Watershed Plan EIS



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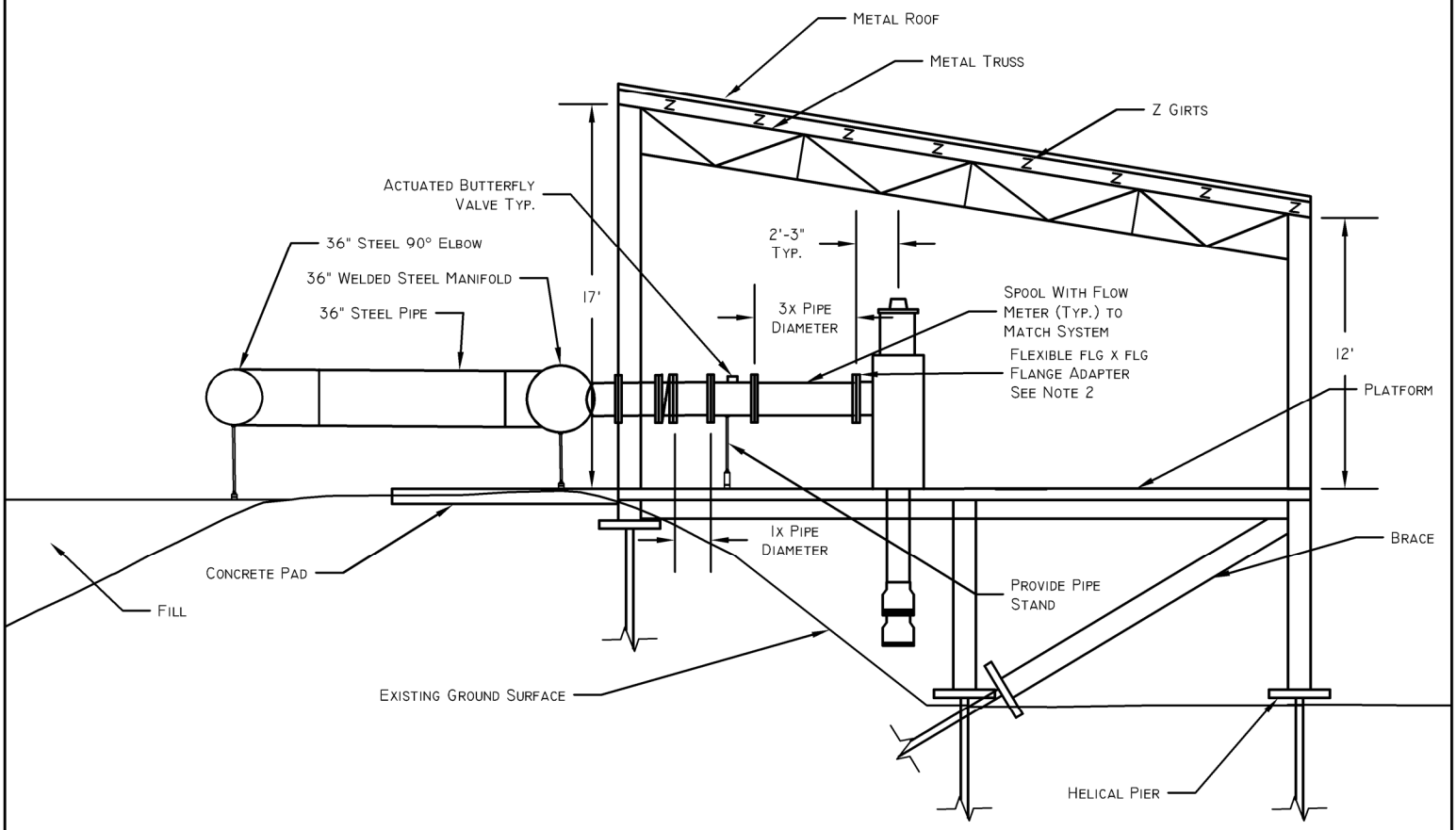
CACHE WATER DISTRICT

WEST LAGOON PUMP STATION PROFILE
(CROCKETT DIVERSION ALTERNATIVE)
Logan River Watershed Plan EIS



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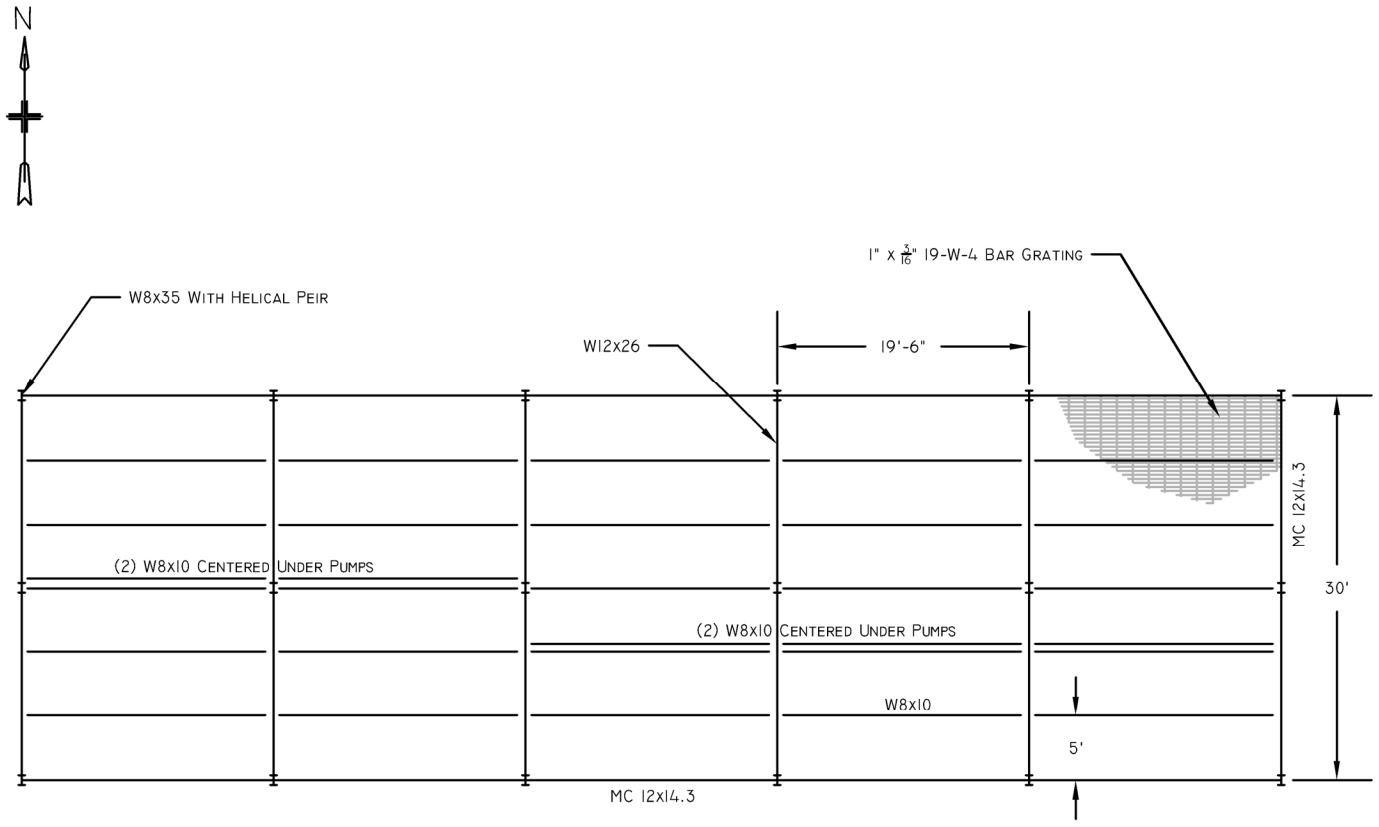
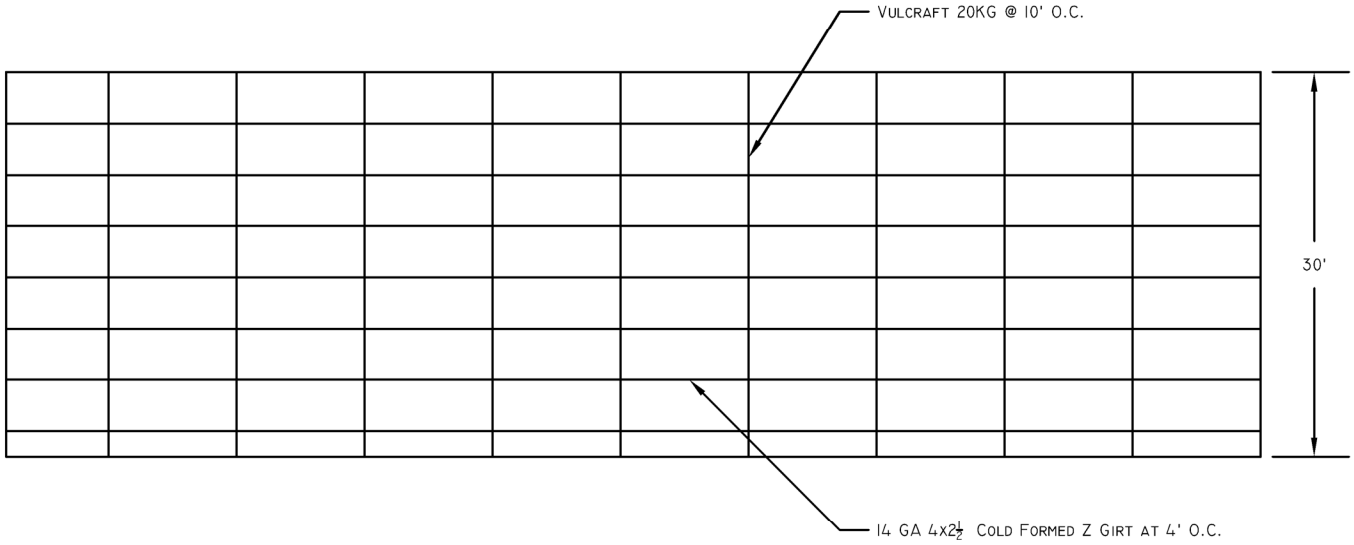
CACHE WATER DISTRICT

WEST LAGOON PUMP STATION PROFILE
(CROCKETT DIVERSION ALTERNATIVE)
Logan River Watershed Plan EIS



PLATFORM PLAN



ROOF PLAN

O:\20025 CWD Crockett Watershed EA\CAD Files\Pump Station 30% Design.dwg

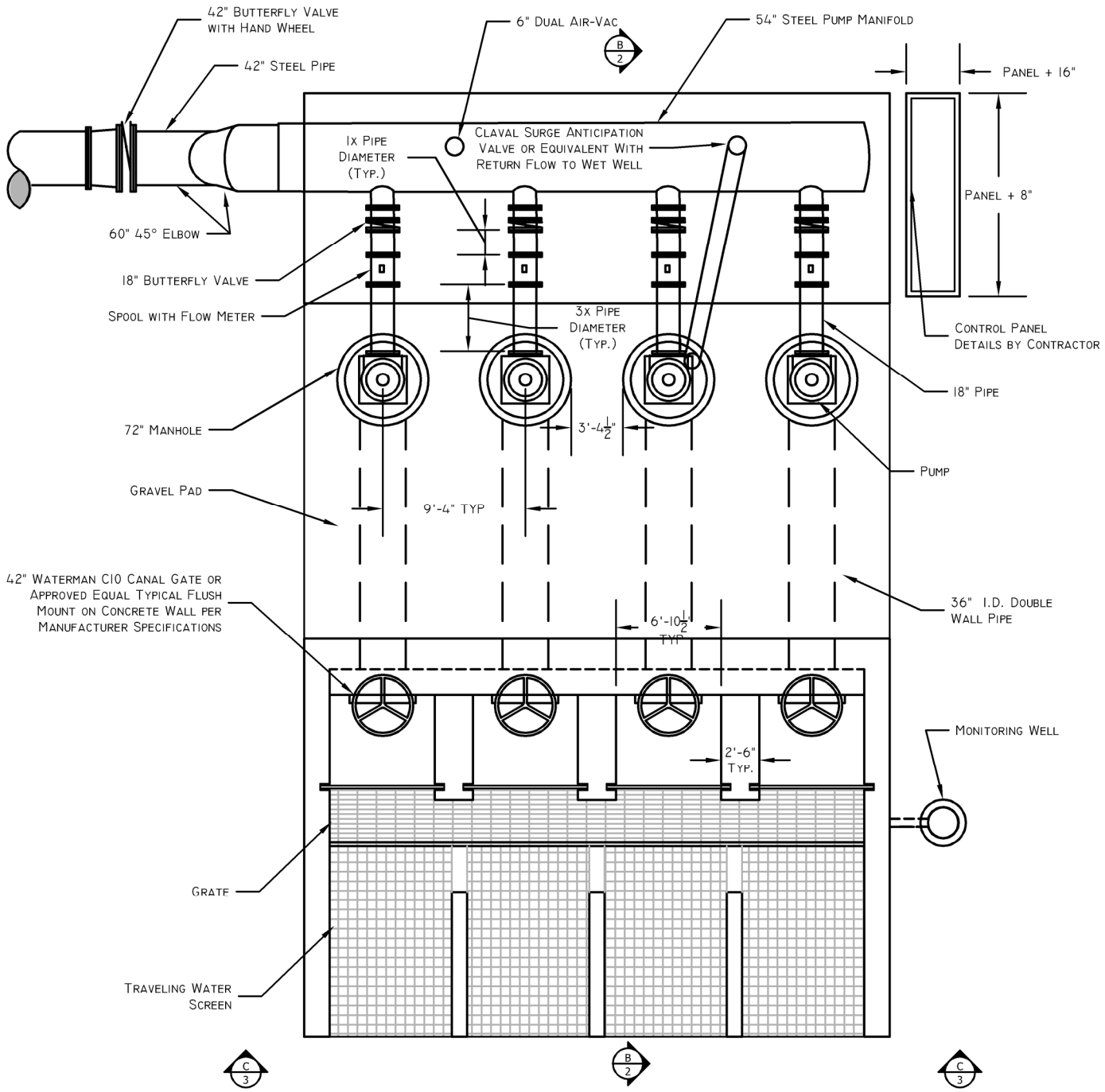
CACHE WATER DISTRICT

WEST LAGOON PUMP STATION PLATFORM AND ROOF PLAN
(CROCKETT DIVERSION ALTERNATIVE)
Logan River Watershed Plan EIS

CACHE WATER DISTRICT

WEST RIVER PUMP STATION LOCATION

Logan River Watershed Plan EIS



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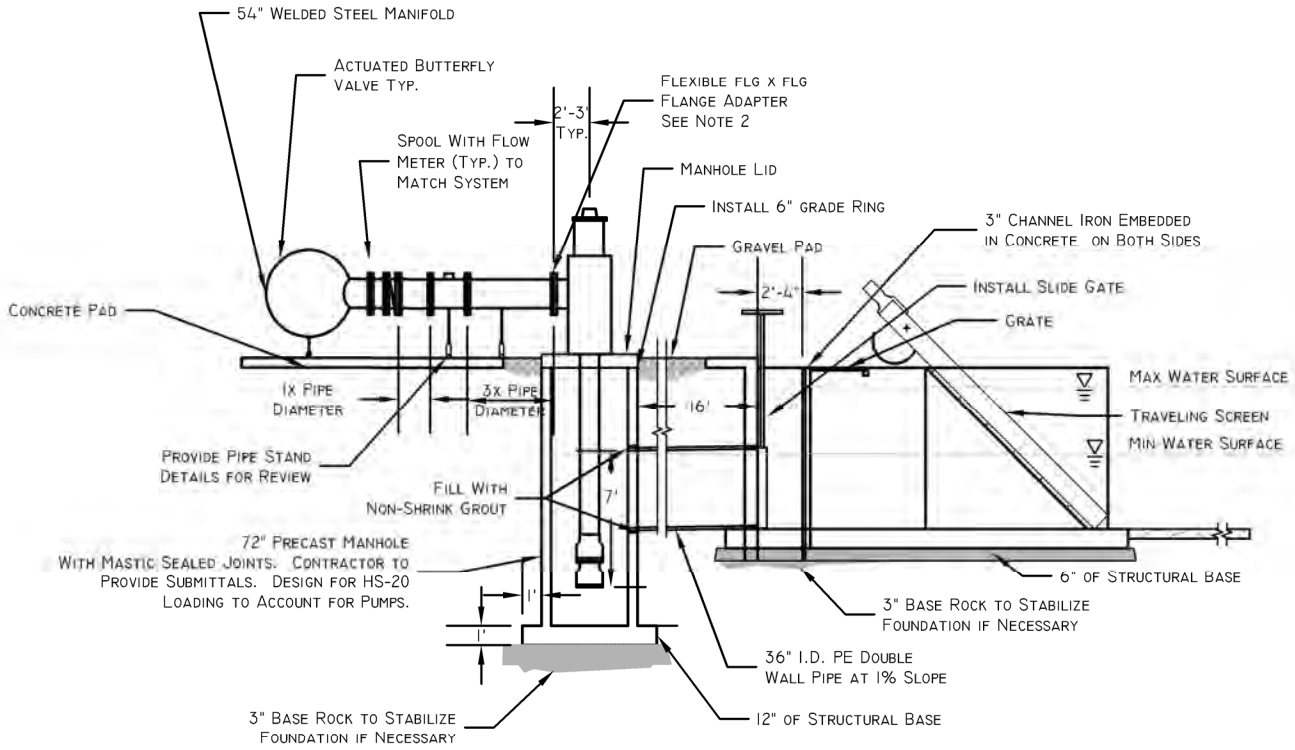
CACHE WATER DISTRICT

WEST RIVER PUMP STATION PLAN

Logan River Watershed Plan EIS



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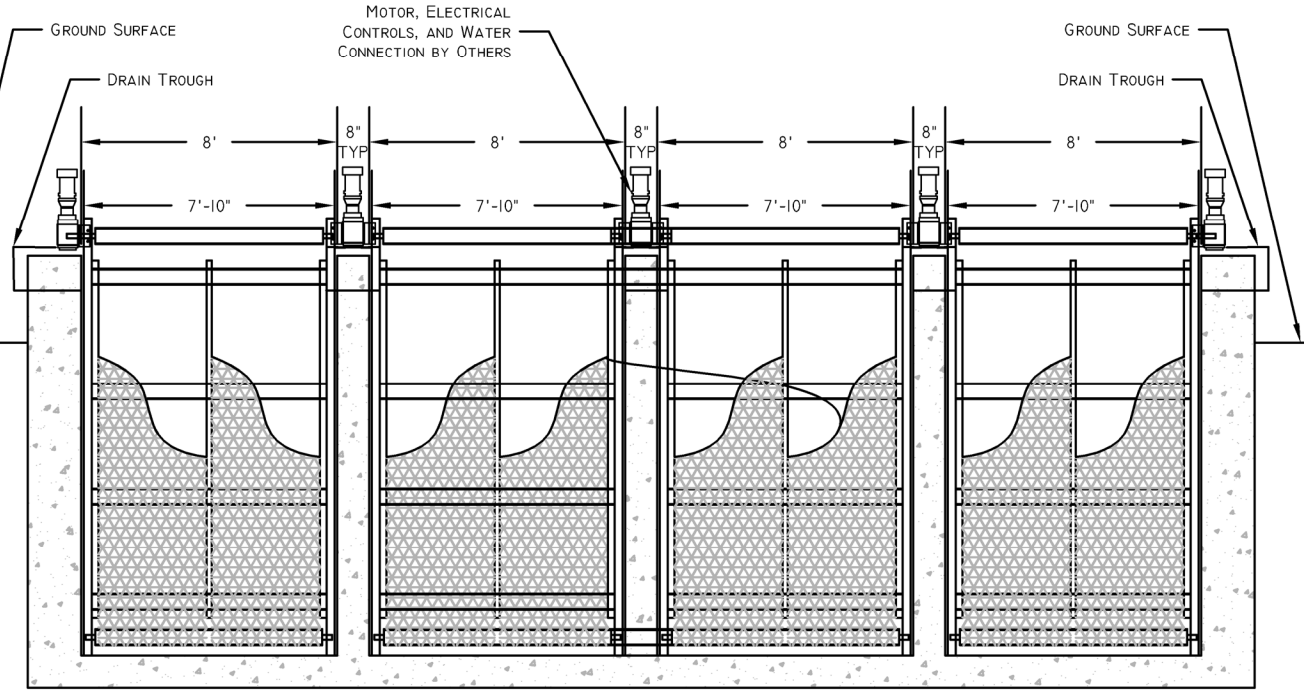
CACHE WATER DISTRICT

WEST RIVER PUMP STATION PROFILE

Logan River Watershed Plan EIS



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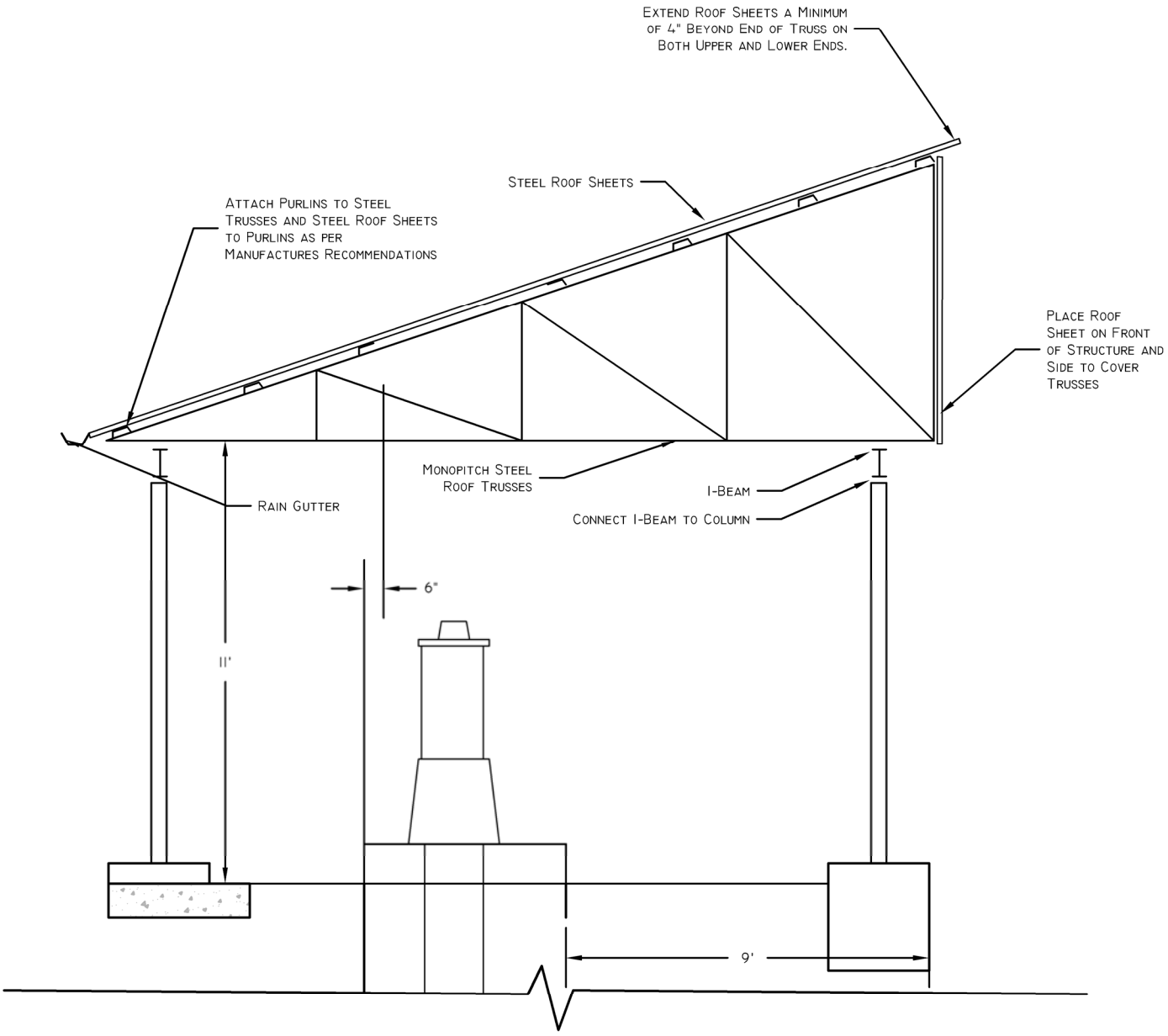
CACHE WATER DISTRICT

WEST RIVER PUMP STATION SECTION

Logan River Watershed Plan EIS



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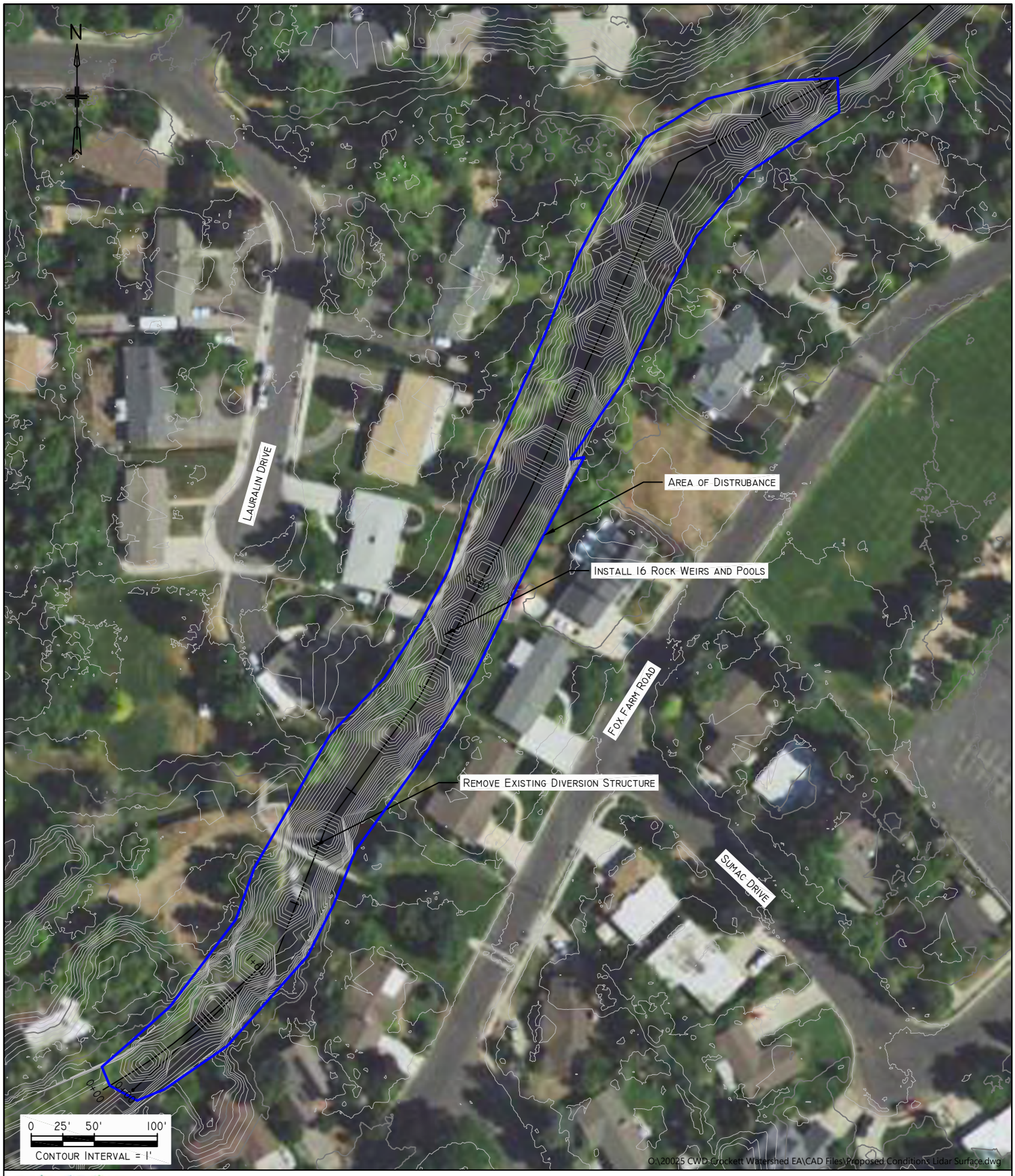
CACHE WATER DISTRICT

WEST RIVER PUMP STATION ROOF

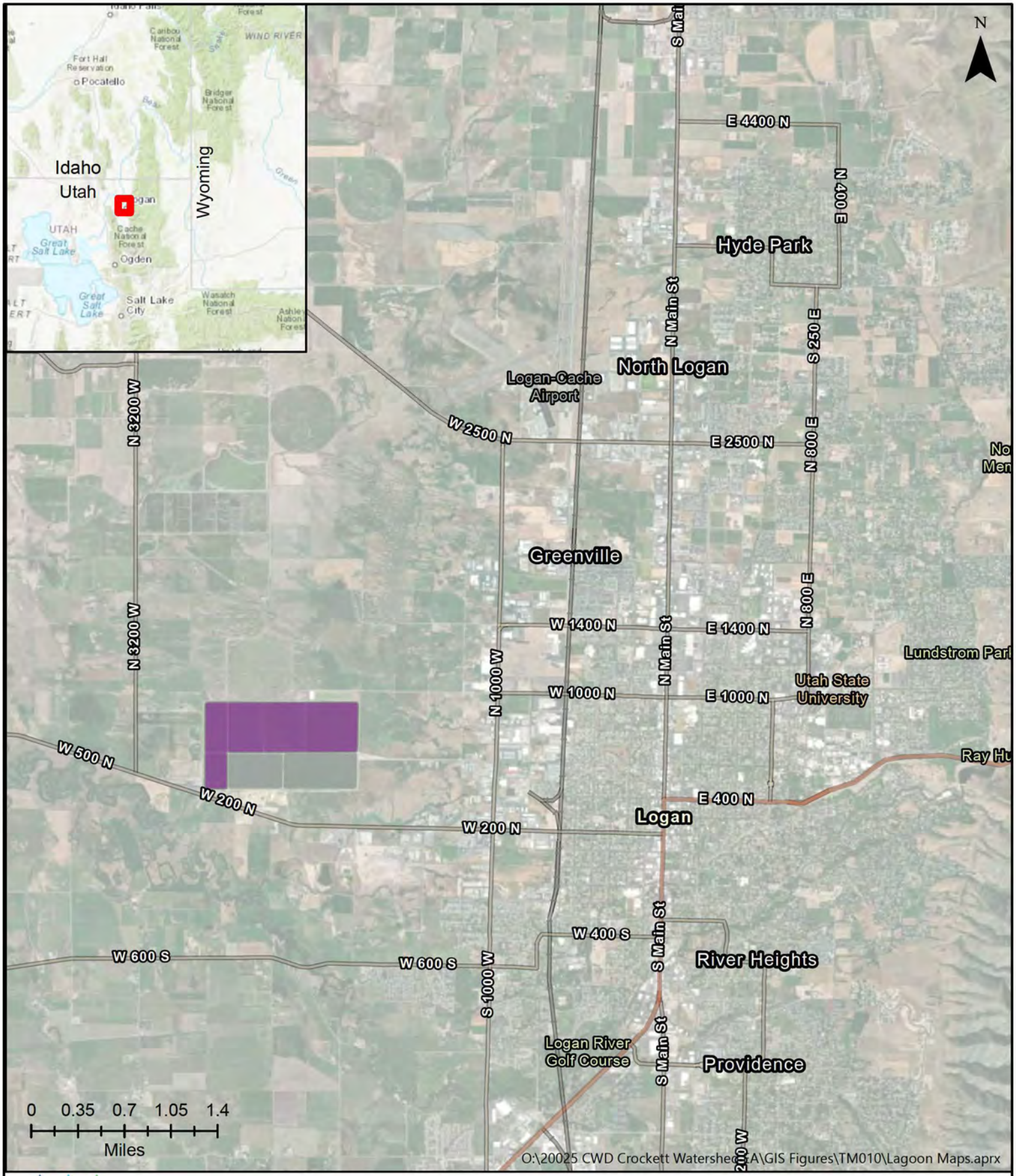
Logan River Watershed Plan EIS



CACHE WATER DISTRICT

CROCKETT DIVERSION REMOVAL 30% PLAN VIEW DRAWINGS

Logan River Watershed Plan EIS



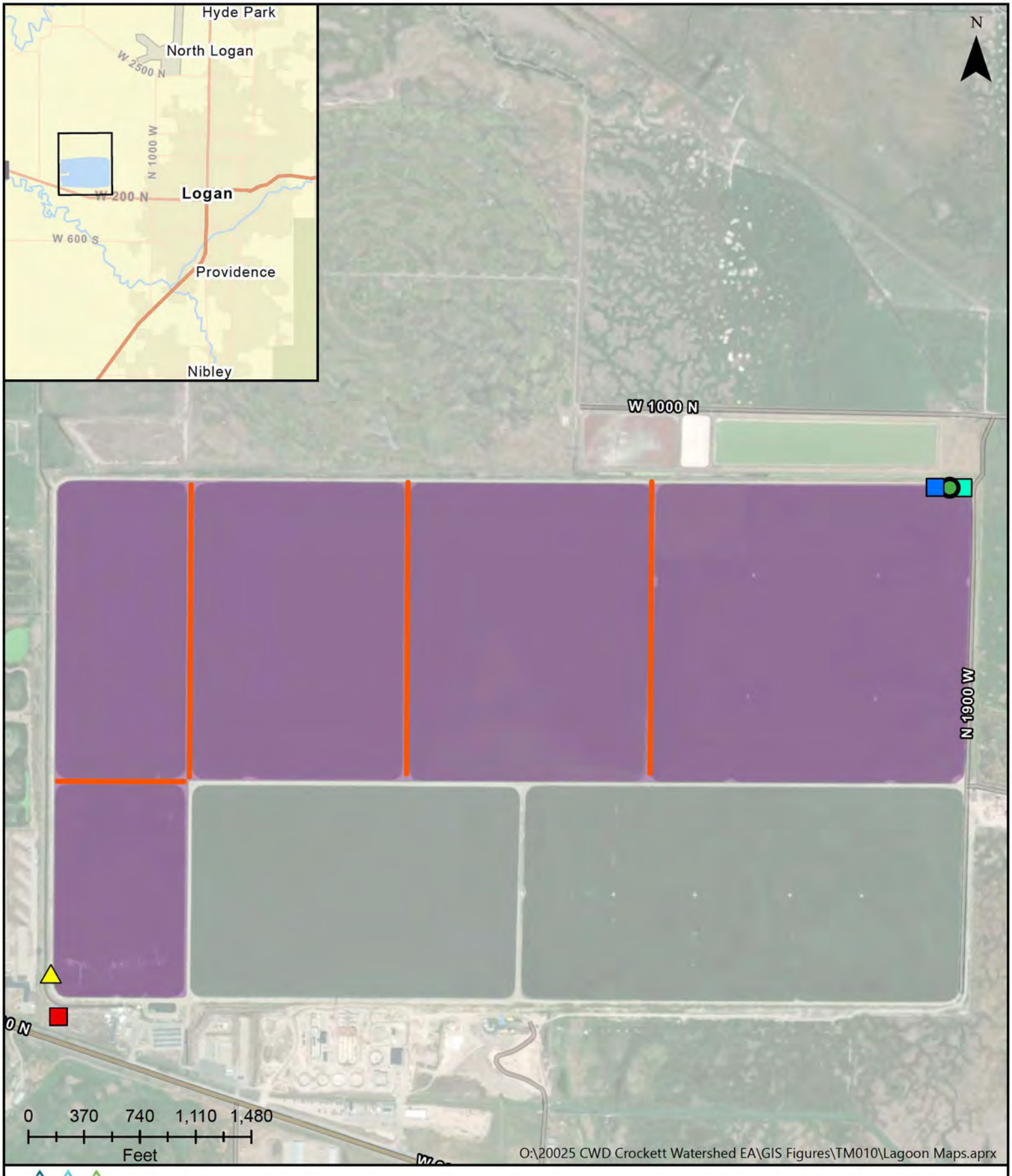
CACHE WATER DISTRICT

Proposed Storage Reservoir

LAGOON STORAGE RESERVOIR LOCATION MAP

Logan River Watershed Plan-EIS

E-1734



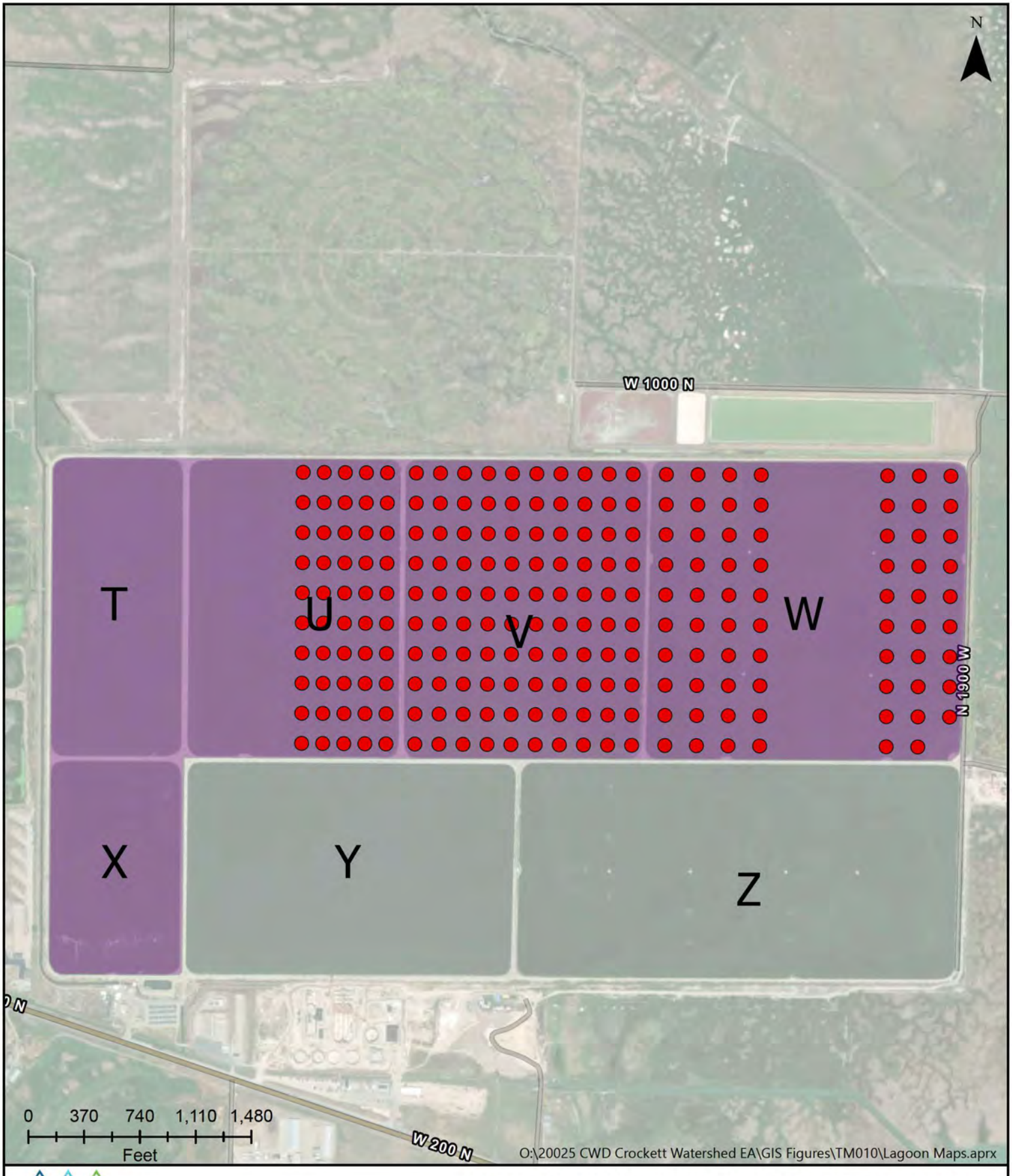
CACHE WATER DISTRICT

- Inside Berm Removal
- Benson Pump Station
- Cow Pasture Pump Station
- Hydropower
- Spillway
- West Lagoon Pump Station
- Proposed Storage Reservoir

E-1735

LAGOON CONCEPT MAP

Logan River Watershed Plan-EIS



CACHE WATER DISTRICT

LAGOON STORAGE RESERVOIR LOCATION MAP

Logan River Watershed Plan-EIS

Survey Point

Proposed Storage Reservoir

E-1736

LAGOON SURVEY INFORMATION

Dates of Survey:
May 23rd and 24th
Personell
Brady…
Phil Harold
Scott Mershon

Overall Average Depth:	**10.99**	Inches
Total Volume of Sludge:	**604,177.75**	Cubic Yards

W ,U, V, T, X **351,644.35**

Summary Pond W		
Total Average Depth:	14.28	Inch
Total Average Depth:	1.19	Ft
Area of Pond W:	94.40	Acres
Area of Pond W:	4,112,064.00	Square Ft
Volume of Sludge:	4,892,730.65	Cubic Ft
Volume of Sludge:	181,212.25	Cubic Yard

Summary Pond X		
Total Avera	-	Inch
Total Avera	-	Ft
Area of Por	28.20	Acres
Area of Por	1,228,392.00	Square Ft
Volume of	-	Cubic Ft
Volume of	-	Cubic Yard

Summary Pond V		
Total Average Depth:	13.17	Inch
Total Average Depth:	1.10	Ft
Area of Pond W:	71.00	Acres
Area of Pond W:	3,092,760.00	Square Ft
Volume of Sludge:	3,395,490.48	Cubic Ft
Volume of Sludge:	125,758.91	Cubic Yard

Summary Pond T		
Total Avera	-	Inch
Total Avera	-	Ft
Area of Por	39.30	Acres
Area of Por	1,711,908.00	Square Ft
Volume of	-	Cubic Ft
Volume of	-	Cubic Yard

Summary Pond U		
Total Average Depth:	5.20	Inch
Total Average Depth:	0.43	Ft
Area of Pond W:	63.90	Acres
Area of Pond W:	2,783,484.00	Square Ft
Volume of Sludge:	1,206,176.40	Cubic Ft
Volume of Sludge:	44,673.20	Cubic Yard

Summary Y		
Total Average Depth:	9.61	Inch
Total Average Depth:	0.80	Ft
Area of Pond W:	71.00	Acres
Area of Pond W:	3,092,760.00	Square Ft
Volume of Sludge:	2,477,889.86	Cubic Ft
Volume of Sludge:	91,773.70	Cubic Yard

Summary Pond Z		
Total Average Depth:	12.67	Inch
Total Average Depth:	1.06	Ft
Area of Pond W:	94.40	Acres
Area of Pond W:	4,112,064.00	Square Ft
Volume of Sludge:	4,340,512.00	Cubic Ft
Volume of Sludge:	160,759.70	Cubic Yard

Pond W

A	Depth of Sludge (in)
1	13
2	13
3	14
4	18
5	13
6	19
7	18
8	14
9	18
10	18
Average:	15.8

B	Depth of Sludge (in)
1	13
2	13
3	18
4	18
5	14
6	18
7	18
8	18
9	18
10	12
Average:	16.0

C	Depth of Sludge (in)
1	16
2	13
3	13
4	16
5	15
6	11
7	13
8	14
9	12
10	12
Average:	13.5

D	Depth of Sludge (in)
1	15
2	13
3	15
4	16
5	14
6	15
7	15
8	16
9	15
10	13
Average:	14.7

H	Depth of Sludge (in)
1	13
2	15
3	11
4	15
5	14
6	12
7	16
8	15
9	12
10	8
Average:	13.1

I	Depth of Sludge (in)
1	NA
2	15
3	7
4	15
5	16
6	16
7	23
8	20
9	13
10	12
Average:	15.2

Pond W

J	Depth of Sludge (in)
1	NA
2	9
3	11
4	16
5	15
6	11
7	14
8	8
9	9
10	NA
Average:	11.6

Summary Pond W		
Total Average Depth:	14.3	Inch
Total Average Depth:	1.2	Ft
Area of Pond W:	94.4	Acres
Area of Pond W:	4,112,064.00	Square Ft
Volume of Sludge:	4,892,730.65	Cubic Ft
Volume of Sludge:	181,212.25	Cubic Yard

Pond V

A	Depth of Sludge (in)
1	16
2	18
3	16
4	16
5	16
6	16
7	16
8	16
9	17
10	17
Average:	16.4

B	Depth of Sludge (in)
1	18
2	12
3	14
4	13
5	13
6	12
7	12
8	12
9	13
10	16
Average:	13.5

C	Depth of Sludge (in)
1	16
2	15
3	12
4	12
5	11
6	12
7	12
8	12
9	12
10	16
Average:	13

D	Depth of Sludge (in)
1	NA
2	13
3	12
4	12
5	8
6	12
7	12
8	13
9	13
10	14
Average:	12.1

E	Depth of Sludge (in)
1	17
2	10
3	10
4	12
5	12
6	14
7	10
8	10
9	9
10	14
Average:	11.8

F	Depth of Sludge (in)
1	17
2	12
3	12
4	13
5	14
6	11
7	13
8	11
9	12
10	13
Average:	12.8

Pond V

G	Depth of Sludge (in)
1	16
2	13
3	11
4	12
5	14
6	15
7	11
8	12
9	13
10	16
Average:	13.3

H	Depth of Sludge (in)
1	16
2	11
3	14
4	12
5	11
6	12
7	12
8	12
9	12
10	14
Average:	12.6

I	Depth of Sludge (in)
1	15
2	7
3	11
4	7
5	11
6	14
7	13
8	15
9	13
10	16
Average:	12.2

J	Depth of Sludge (in)
1	4
2	14
3	14
4	13
5	10
6	11
7	10
8	13
9	12
10	NA
Average:	11.2

Summary Pond V		
Total Average Depth:	13.2	Inch
Total Average Depth:	1.1	Ft
Area of Pond W:	71	Acres
Area of Pond W:	3,092,760.00	Square Ft
Volume of Sludge:	3,395,490.48	Cubic Ft
Volume of Sludge:	125,758.91	Cubic Yard

Time to Drain Ponds Calculations

Height_Initial	8.8	ft
Heigh_Final	0	ft
Gravity	32.2	ft/s2
Area_Ponds	296	acre
Area_Ponds	12,893,760	ft2
Area_Orifice	7.1	ft2
Diameter_Orifice	36	in
Diameter_Orifice	3	ft
Discharge Coeficient	0.98	

$$Q = -A\frac{dh}{dt}$$

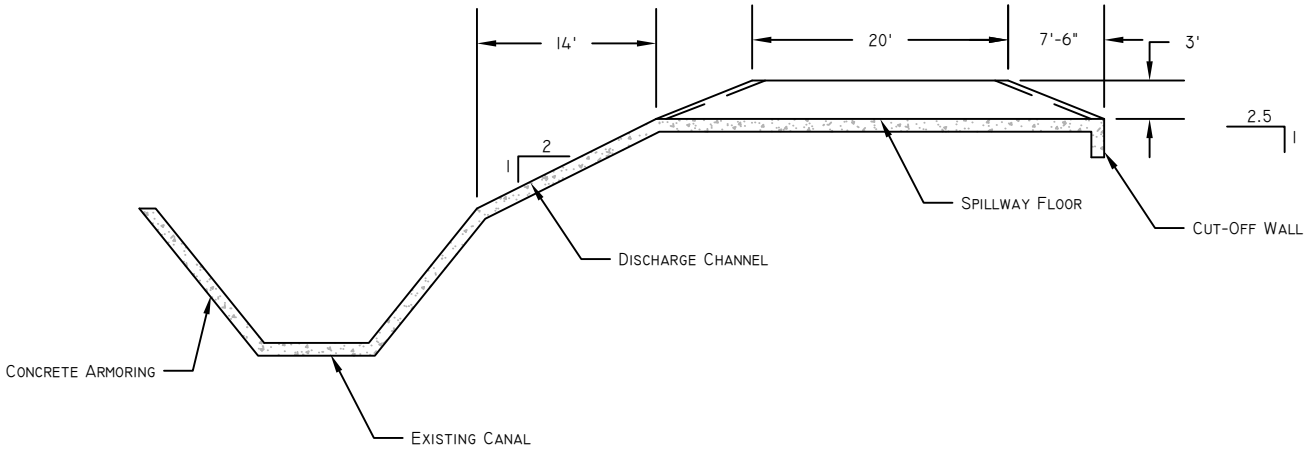
$$t = \frac{A}{a\ C}\left(\sqrt{H_i} - \sqrt{H_f}\right)\sqrt{\frac{2}{g}}$$

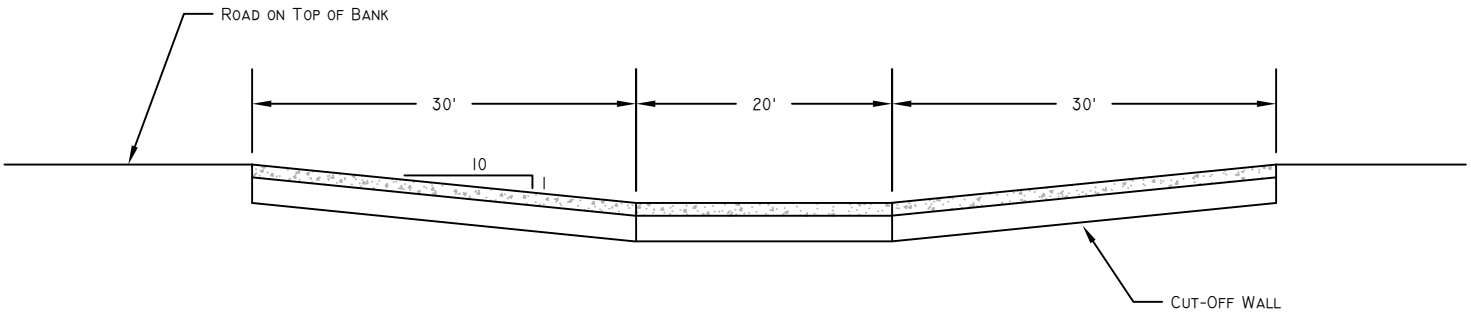
Time to Drain	(1,376,098.5)	s
Time to Drain	(22,934.97)	min
Time to Drain	(382.25)	hour
Time to Drain	(15.93)	day

CACHE WATER DISTRICT

LAGOON SPILLWAY LOCATION

Logan River Watershed Plan EIS





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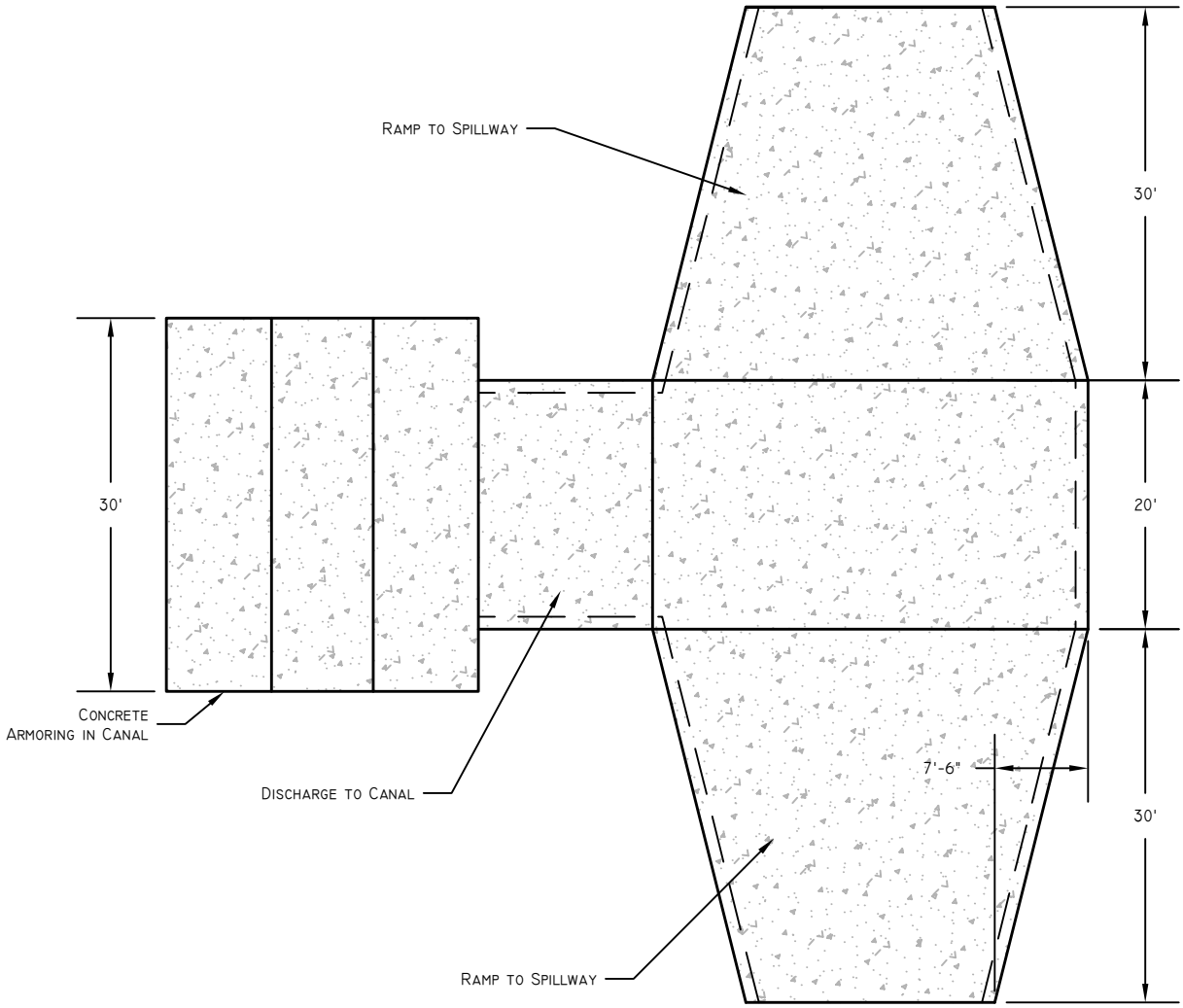
CACHE WATER DISTRICT

LAGOON SPILLWAY SECTIONS

Logan River Watershed Plan EIS



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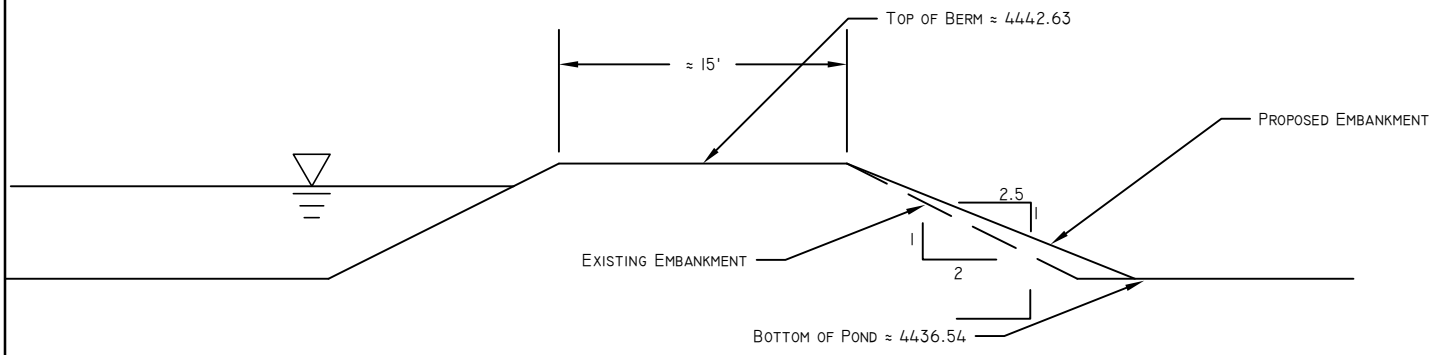
LAGOON SPILLWAY PLAN

Logan River Watershed Plan EIS



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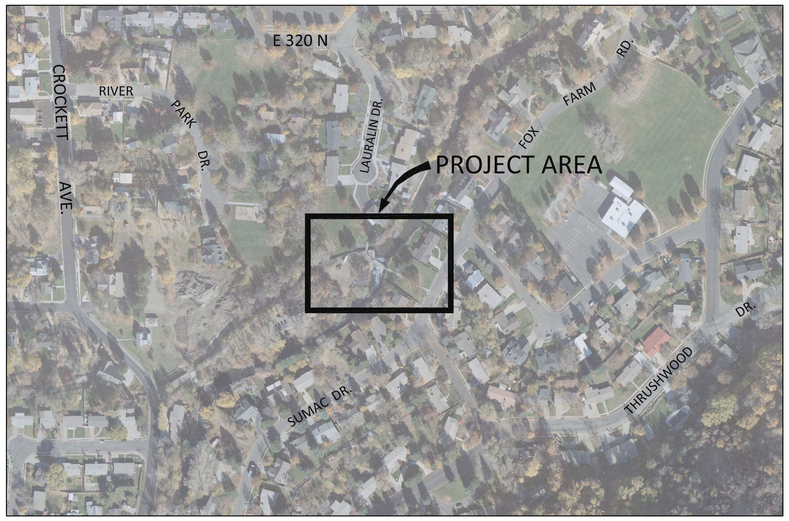
WEST LAGOON BERM SECTION

Logan River Watershed Plan EIS

CONSTRUCTION DRAWINGS FOR THE LOGAN RIVER AND BLACKSMITH FORK RIVER FLOOD MITIGATION/CHANNEL RESTORATION MASTER PLAN: CROCKETT DAM IMPROVEMENTS (LC-14)
FEBRUARY 2014

FINAL FOR CONSTRUCTION



VICINITY MAP – LOGAN, UTAH

GRAPHICAL SCALE IN FT:
0 100 200 400

811 Know what's **below.** **Call** before you dig.

OWNER:

LOGAN CITY
PUBLIC WORKS
ENGINEERING DEPARTMENT
290 NORTH 100 WEST
LOGAN, UT 84321

ENGINEERS:

Anderson Consulting Engineers, Inc
Civil · Water Resources · Environmental
375 E. Horsetooth Road, Building #5, Fort Collins, CO 80525
Phone (970) 226-0120 / Fax (970) 226-0121
www.acewater.com

SKYLINE A/E/S, INC.
95 WEST GOLF COURSE ROAD, SUITE 101
LOGAN, UT 84321

THESE PLANS HAVE BEEN REVIEWED AND APPROVED BY THE FOLLOWING:

PUBLIC WORKS DIRECTOR:	MARK NIELSEN, P.E.	DATE
STREETS DIVISION MANAGER:	JED AL-IMARI	DATE
CITY ENGINEER:	BILL YOUNG, P.E.	DATE
CROCKETT AVE. CANAL CO.:	RICK REESE, PRESIDENT	DATE

SHEET LIST

SHEET NO.	DESCRIPTION
	CROCKETT DAM IMPROVEMENTS
C1	COVER SHEET
C2	PROJECT INFORMATION
C3	SURVEY CONTROL
C4	RIVER CONTROL AND DEWATERING PLAN
C5	DEMOLITION PLAN
C6	CONDUIT AND PIPING PLAN
C7	GRADING PLAN
C8	INFLATABLE WEIR CONCEPTUAL DETAILS
C9	FENCE AND RAILING PLAN
C10	LOW FLOW BYPASS PLAN
DIS01	STRUCTURAL CONCRETE NOTES
DIS02	STRUCTURAL CONCRETE LAYOUT
DIS03	STRUCTURAL CONCRETE DETAILS
	CROCKETT DAM CONTROL HOUSE
AS01	ARCHITECTURAL SITE PLAN
CHA01	MAIN FLOOR PLAN AND EXTERIOR ELEVATIONS
CHA02	BUILDING SECTIONS AND DETAILS
CHS01	STRUCTURAL NOTES
CHS02	STRUCTURAL SCHEDULES AND PLANS
CHS03	STRUCTURAL DETAILS
E001	ABBREVIATIONS, LEGEND, G.P.N. & SHEET INDEX
E002	ELECTRICAL SPECIFICATIONS
E101	ELECTRICAL PLANS

TO THE BEST OF MY KNOWLEDGE, THESE PLANS MEET APPLICABLE NRCS STANDARDS.

PROFESSIONAL ENGINEER
No. 7842087-2202
GREGORY JOHN KOCH
5/20/2014
STATE OF UTAH

SHEET:
C1

P:\UT\LOGI_CROCKETTDAM\CAD\DESIGN\UTLOGI-CROCKETT-COVER.DWG 5/7/14

2/5/2014, 12:44 PM

STORM WATER POLLUTION PREVENTION INFORMATION

CONTACT INFORMATION AND RESPONSIBLE PARTIES:
OWNER: LOGAN CITY
290 NORTH 100 WEST
LOGAN, UT 84321
(435) 716-9152 (PUBLIC WORKS)

MANAGING PROJECT ENGINEER:
LANCE HOUSER, P.E.
LOGAN CITY ENGINEERING
290 NORTH 100 WEST
LOGAN, UT 84321
(435) 716-9161
LANCE.HOUSER@LOGANUTAH.ORG

STORM WATER MANAGER AND SWPPP CONTACT
TO BE DETERMINED

OPERATOR/STORM WATER MANAGER/ SWPPP CONTACT/STORM WATER INSPECTOR
TO BE DETERMINED

(FOR SITES WITH DISTURBED AREA LESS THAN 1 ACRE USE EROSION AND SEDIMENT CONTROL PLAN.)

GENERAL NOTES

1. ALL CONSTRUCTION SHALL MEET CITY OF LOGAN STANDARDS AND SPECIFICATIONS (APWA 2007, AS AMENDED BY LOGAN CITY AS OF DATE APPROVED FOR CONSTRUCTION BY ENGINEER). STANDARDS AND SPECIFICATIONS CAN BE VIEWED AND PRINTED AT: WWW.LOGANUTAH.ORG\PUBLIC_WORKS\ENGINEERING\INDEX.CFM .
2. UTILITY LOCATIONS ARE NOT SHOWN ON THE PLANS. CONTRACTOR SHALL FIELD VERIFY ALL UTILITY LOCATIONS BY CONTACTING BLUE STAKES AT 1-800-662-4111 OR 811 AND OTHER APPLICABLE UTILITIES PRIOR TO EXCAVATION. CONTRACTOR SHALL ALSO POT-HOLE AND LOCATE UTILITIES AT THE CONTRACTOR'S EXPENSE WHEN REQUIRED. CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR COSTS AND REPAIRS DUE TO DAMAGE OF EXISTING UTILITIES. ALL UTILITIES MAY NOT BE SHOWN ON PLANS.
3. CONTRACTOR SHALL POTHOLE ALL GAS SERVICES, COMMUNICATIONS LINES, AND POSSIBLE INTERFERING WATER SERVICES IN ORDER TO VERIFY ADEQUATE CLEARANCE TO THE NEW CONSTRUCTION. THIS SHALL BE DONE AT THE BEGINNING OF THE PROJECT IN ORDER TO PROVIDE UTILITY OWNERS ADEQUATE TIME TO RELOCATE SERVICE(S).
4. CONTRACTOR SHALL PROVIDE A TRAFFIC CONTROL PLAN, ADEQUATE TRAFFIC CONTROL, SIGNING, BARRICADING, AND PEDESTRIAN DIRECTION THROUGH AND AROUND THE CONSTRUCTION WORK ZONE IN COMPLIANCE WITH THE MUTCD, 2009 EDITION.
5. CONTRACTOR SHALL REPAIR DISTURBED SURFACES TO EXISTING CONDITIONS, INCLUDING, BUT NOT LIMITED TO UTILITY LINES AND SERVICES, ASPHALT REPAIR, DRIVEWAYS, PLANTER STRIPS, SPRINKLER AND IRRIGATION SYSTEMS AND GENERAL CLEANUP EXCEPT WHERE INSTRUCTED OTHERWISE.
6. ALL UTILITIES SHALL BE KEPT IN WORKING ORDER EXCEPT FOR THE MINIMUM TIME NEEDED FOR EXCAVATION, TRENCHING, CONNECTIONS, ETC.
7. APPROVAL FROM THE ENGINEER IS REQUIRED PRIOR TO WATER AND SEWER SHUT-DOWNS IF REQUIRED TO COMPLETE THIS PROJECT. ALL AFFECTED ENTITIES AND PROPERTY OWNERS SHALL BE NOTIFIED 24 HOURS PRIOR TO APPROVED SHUTDOWNS.
8. ALL PERSONNEL ARE REQUIRED TO WEAR HARD-HATS, ORANGE VESTS OR CLOTHING, AND ANY OTHER REQUIRED PERSONAL PROTECTIVE EQUIPMENT TO SAFELY COMPLETE THIS PROJECT, AND CONFORM TO APPLICABLE OSHA RULES AND REGULATIONS WHILE WORKING ON THIS PROJECT.
9. ALL MATERIALS AND WORKMANSHIP SHALL BE SUBJECT TO INSPECTION BY THE OWNER. THE OWNER RESERVES THE RIGHT TO ACCEPT OR REJECT ANY SUCH MATERIALS AND WORKMANSHIP THAT DOES NOT CONFORM TO THE STANDARDS AND SPECIFICATIONS SET FORTH HEREIN.
10. THE CONTRACTOR SHALL NOTIFY THE OWNER IMMEDIATELY OF ANY FIELD CONDITION NOT CONSISTENT WITH THE CONTRACT DOCUMENTS.
11. THE CONTRACTOR SHALL PROVIDE EROSION CONTROL DURING CONSTRUCTION. THE CONTRACTOR SHALL PROVIDE A FINAL EROSION CONTROL PLAN TO THE OWNER FOR APPROVAL PRIOR TO MOBILIZATION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE INSPECTION AND MAINTENANCE OF EROSION CONTROL DEVICES.
12. THE CONTRACTOR SHALL MAINTAIN A SAFE WORK AREA IN ACCORDANCE WITH ALL LOCAL, STATE AND FEDERAL REGULATIONS, AND SHALL PROVIDE ACCESS TO THE SITE FOR ALL EMERGENCY VEHICLES.
13. THE STREETS ADJACENT TO THE CONSTRUCTION AREA SHALL BE CLEANED, BY THE CONTRACTOR, OF ANY DEBRIS GENERATED BY THE PROJECT AT THE EARLIEST OPPORTUNITY, OR IMMEDIATELY WHEN DEEMED NECESSARY BY THE OWNER FOR THE SAFETY OF TRAFFIC OR PEDESTRIANS, BUT IN NO CASE SHALL THE STREET BE LEFT UNCLEANED AFTER THE COMPLETION OF THE DAY'S WORK. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO PROVIDE THE NECESSARY EQUIPMENT AND MATERIALS TO SATISFACTORILY CLEAN THE ADJACENT ROADWAY AT NO ADDITIONAL COST TO THE PROJECT.
14. THE CONTRACTOR SHALL BE RESPONSIBLE FOR RECORDING AS-BUILT INFORMATION ON A SET OF RECORD DRAWINGS KEPT ON THE CONSTRUCTION SITE AND AVAILABLE TO THE LOCAL ENTITY'S INSPECTOR AT ALL TIMES.
15. DIMENSIONS FOR LAYOUT AND CONSTRUCTION ARE NOT TO BE SCALED FROM ANY DRAWING. IF PERTINENT DIMENSIONS ARE NOT SHOWN, CONTACT THE DESIGNER FOR CLARIFICATION, AND ANNOTATE THE DIMENSION ON THE AS-BUILT RECORD DRAWINGS.
16. ALL STRUCTURAL EROSION CONTROL MEASURES SHALL BE INSTALLED AT THE LIMITS OF CONSTRUCTION AND AT AREAS WITH DISTURBED SOIL, ON-OR OFF-SITE, PRIOR TO ANY OTHER GROUND-DISTURBING ACTIVITY. ALL EROSION CONTROL MEASURES SHALL BE MAINTAINED IN GOOD REPAIR BY THE CONTRACTOR, UNTIL SUCH TIME AS THE ENTIRE DISTURBED AREAS ARE STABILIZED WITH HARD SURFACE OR LANDSCAPING. TO MITIGATE EROSION, THE CONTRACTOR SHALL USE STANDARD EROSION CONTROL TECHNIQUES DESCRIBED IN "UDOT EROSION AND SEDIMENT CONTROL FIELD GUIDE" AS PUBLISHED BY THE UTAH DEPARTMENT OF TRANSPORTATION.
17. BEST MANAGEMENT PRACTICES TO BE DETERMINED AND SPECIFIED BY CONTRACTOR.
18. PROPOSED GROUND AS NOTED IN THE ATTACHED DRAWINGS IS DEFINED AS THE RESTORATION OF ERODED BANKS AND CHANNELS TO THE ESTIMATED LOCATION OF PRE-FLOOD CONDITIONS.

PERMITS

1. CONTRACTOR SHALL OBTAIN A WORK IN THE RIGHT OF WAY PERMIT (CITY OF LOGAN) PRIOR TO INITIATING ANY SITE DISTURBANCE OR CONSTRUCTION.
2. CONTRACTOR SHALL MAINTAIN A COPY OF NWP-37 AND GP-40 WHILE WORKING ON THIS PROJECT.
3. CONTRACTOR SHALL MAINTAIN A COPY OF THE CONSTRUCTION ACCESS AGREEMENT ON SITE AT ALL TIMES.
4. CONTRACTOR SHALL PREPARE A STORM WATER POLLUTION PREVENTION PLAN FOR A SITE LARGER THAN 1.0 ACRE AND MAINTAIN SWPPP AND SWPPP INSPECTION RECORDS ON SITE WEEKLY AS REQUIRED IN WORKING AROUND AND IN SENSITIVE AREAS. SWPPP SHALL BE AVAILABLE FOR REVIEW DURING NORMAL WORK HOURS.
5. CONTRACTOR SHALL COMPLY WITH THE TERMS OF ALL PERMITS REQUIRED FOR THIS PROJECT.
6. CONTRACTOR SHALL OBTAIN AND KEEP COPIES OF ALL REQUIRED PERMITS AT PROJECT LOCATION DURING REASONABLE WORKING HOURS.

WORK LOGS MANDATORY

1. EACH CONTRACTOR SHALL MAINTAIN A DAILY LOG OF THE FOLLOWING:
   1.1. ALL LABOR RESOURCES AND TIME ON THE PROJECT
   1.2. ALL MATERIAL QUANTITIES, INVOICES, AND RESOURCES USED DAILY.
   1.3. ALL FEES, PERMITS, AND OTHER DOCUMENTED COSTS INCLUDING LANDFILL FEES.
2. ALL DAILY LOGS SHALL BE TURNED IN TO LANCE HOUSER WEEKLY.
3. PHOTOGRAPHS, WITH A GPS CAMERA AND DATE AND TIME STAMP, SHALL BE TAKEN BEFORE STARTING WORK, DAILY DURING WORK, AND AT THE END OF WORK ON EACH SEPARABLE PROJECT.
4. VIDEO OF THE JOBSITE AND CONDITIONS PRIOR TO STARTING WORK AND AFTER FINISHING WORK SHALL BE TAKEN INCLUDING DATE AND TIME STAMPS AND AUDIO DISCUSSION OF WHAT IS BEING SEEN ON SITE AND WHERE IT IS.
5. ALL VIDEOS AND PHOTOGRAPHS SHALL BE TURNED IN TO LANCE HOUSER WEEKLY WITH IDENTIFICATION OF THE SEPARABLE PROJECT ASSOCIATED WITH EACH PHOTO OR MOVIE.

ACCESS IMPACTS

1. PROPERTY OWNERS SHALL BE GIVEN 24 HOURS NOTICE OF DRIVEWAY ACCESS RESTRICTIONS DURING CONSTRUCTION.
2. PRIMARY ACCESS ROUTES WERE IDENTIFIED BY THE NRCS IN THE EARLY EVALUATIONS. WHERE PROPERTY OWNERS HAVE AGREED, THEY HAVE BEEN MAINTAINED IN THIS DESIGN.
3. SECONDARY ACCESS ROUTES HAVE BEEN IDENTIFIED IN COOPERATION WITH LAND OWNERS TO FACILITATE CONSTRUCTION.
4. ALL ACCESS ROUTES ARE TO BE REPAIRED AND RESTORED TO PRE-PROJECT CONDITIONS.
5. ACCESS SHALL BE RESTRICTED TO THE ROUTES MARKED BY THE ENGINEER AND THE PROPERTY OWNERS.

RECEIVING WATERS

THE RECEIVING WATER FOR THIS PROJECT IS THE LOGAN RIVER.
ALL AREAS IMPACTED BY THIS PROJECT HAVE BEEN PERMITTED UNDER THE NWP-37 PERMIT.

REVEGETATION AND STABILIZATION

1. DISTURBED SOILS SHALL BE STABILIZED TO PREVENT EROSION FROM WIND AND WATER.
2. DISTURBED SOILS SHALL BE COVERED WITH EITHER CLEAN WEED FREE STRAW MATTING COCONUT FIBER MATTING OR APPROVED EQUAL TO PREVENT EROSION AFTER CONSTRUCTION.
3. DISTURBED SOILS, INCLUDING RIPRAP BANKS THAT HAVE BEEN BACKFILLED WITH NATIVE SOIL, SHALL BE REVEGETATED WITH ONE OF THE FOLLOWING SEED MIXES (AS SPECIFIED ON PROJECT GRADING SHEET):
   3.1. CACHE COUNTY APPROVED PASTURE SEED MIX.
   3.2. CACHE COUNTY APPROVED DRY LAND SEED MIX.
4. HERBICIDES ARE NOT ALLOWED ON THIS SITE FOR NOXIOUS WEED CONTROL.
5. SIX INCHES OF TOP SOIL SHALL BE PLACED PRIOR TO REVEGETATION.
6. FERTILIZERS ARE NOT ALLOWED ON THIS SITE.
7. NOXIOUS WEEDS SHALL BE MANUALLY OR MECHANICALLY REMOVED MONTHLY UNTIL THE SITE IS REVEGETATED.
8. ALL OTHER EROSION AND SEDIMENT CONTROL REQUIREMENTS SHALL BE ADDRESSED IN STORM WATER POLLUTION PREVENTION PLAN.
9. COYOTE WILLOW SHRUB (SALICACEAE SALIX EXIGUA) OR RED OSIER DOGWOOD (CORNUS SERICEA) POLE PLANTINGS (2 BRANCHES PER PLANTING) SHALL BE PLANTED ALONG RIPRAP SLOPES EVERY 10 FEET APPROXIMATELY 2-FEET VERTICALLY ABOVE THE TOE OF SLOPE. PLANTINGS SHALL PROTRUDE 0.5-FEET INTO SURFACE BELOW RIPRAP.
10. EVERY ATTEMPT SHALL BE MADE TO PROTECT THE TREES AND OTHER VEGETATION AS SHOWN. HOWEVER, THEY MAY BE REMOVED TO FACILITATE CONSTRUCTION OF THE PLANS AS REQUIRED. REPLACEMENT TRESS MAY BE INSTALLED AT THE DISCRETION OF LOGAN CITY.

DEBRIS REMOVAL

1. DISPOSAL OF DEBRIS SHALL INCLUDE REMOVAL FROM SITE AND PLACEMENT IN AN APPROVED WASTE AREA OR DISPOSAL FACILITY. THE CONTRACTOR SHALL BE RESPONSIBLE FOR APPLYING FOR, PAYING FOR, AND MAINTAINING ALL NECESSARY PERMITS TO COMPLETE THE WORK. ANY LANDFILL FEES ASSOCIATED WITH THE WORK SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL EXPENSES ACCRUED DURING WORK ON THIS PROJECT.
2. CROSSING LIVE STREAMS WITH CONSTRUCTION EQUIPMENT SHALL BE KEPT TO A MINIMUM. ALL WORK ACTIVITIES IN JURISDICTIONAL WATERS SHALL BE COMPLETED IN ACCORDANCE WITH THE NWP-37 PERMIT OBTAINED BY CACHE COUNTY AND THE NRCS. THE CONTRACTOR SHALL ADHERE TO ALL PROTOCOL AND REGULATIONS AS REQUIRED BY THE UNITED STATES ARMY CORPS OF ENGINEERS AND UTAH DEPARTMENT OF NATURAL RESOURCES FOR WORK ACTIVITIES IN JURISDICTIONAL WATERS.
3. NON WOODY DEBRIS, OTHER THAN CLEAN GRAVELS AND SEDIMENTS, SHALL BE DISPOSED OF OFF SITE AT AN APPROVED DISPOSAL FACILITY. CLEAN GRAVELS AND SEDIMENTS MAY BE USED ON SITE FOR PART OF THE RESTORATION ACTIVITIES AT NO ADDITIONAL COST TO THE CITY.

POTENTIAL SOURCES OF POLLUTION

POTENTIAL POLLUTANT MATERIAL	ACTUAL POLLUTANT	POLLUTANT SOURCE	MANAGEMENT PRACTICE
SEDIMENT/TOTAL SUSPENDED SOLIDS	SEDIMENT	DISTURBED BANK AND RIVER BED	MANAGE DISTURBANCE TO CONTROL SEDIMENT MOBILIZATION
SOILS STABILIZATION MATERIAL	VARIOUS MATERIALS BOTH FLOATABLE AND SOLUBLE	DISTURBED AREAS WHERE SLOPES OR SUSCEPTIBLE SOIL TYPES ARE EXPOSED	INSTALL SEDIMENT CONTROL BMPS LISTED
CONCRETE-WHITE/SOLID GREY	LIMESTONE, SAND, pH, CHROMIUM	EXTRA CONCRETE WHEN POURING CONCRETE	CLEAN UP EXCESS AND EXTRA CONCRETE AND DISPOSE OF AT SPECIFIED LOCATION
OILS-BROWN OILY PETROLEUM AND HYDROCARBONS	MINERAL OIL, HYDRAULIC FLUID, MOTOR OIL, ETC.	VEHICLES AND EQUIPMENT USED IN CONSTRUCTION	NO OILS WILL BE CHANGED ON SITE. LEAKS WILL BE REPAIRED IMMEDIATELY.
ASPHALT AND PAVING - BLACK SOLIDS	OIL AND PETROLEUM DISTILLAGES	ASPHALT PAVING OPERATIONS	PAVING OPERATIONS WILL NOT BE PERFORMED WITHIN 8 HOURS OF EXPECTED STORMS EXCEEDING 0.5 INCH.
GREASE	GREASE AND LUBE OIL	VEHICLES AND EQUIPMENT USED IN CONSTRUCTION	KEEP EQUIPMENT CLEAN AND WIPED DOWN
ANTIFREEZE	ETHYLENE GLYCOL	ENGINE COLLUANT	FIX LEAKS IMMEDIATELY. REPAIRS WILL NOT BE MADE ON SITE
CONSTRUCTION DEWATERING	TSS/SEDIMENTS	DEWATERING ACTIVITIES	PUMP ONTO VEGETATED AREAS OR THROUGH A FILTER BAG
FUELS	BENZENE, ETHYL BENZENE, TOULENE, XYLENE, MTBE, PETROLEUM DISTALLATE, OILS/GREASES, NAPHTHALEN, COL OIL	USED IN VEHICLES AND POWER EQUIPMENT	FUELING WILL NOT BE ALLOWED ON SITE UNLESS OVER AN IMPERMEABLE SURFACE WITH AN EMERGENCY CLEANUP KIT AT THE LOCATION
~~PESTICIDES AND INSECTICIDES, FUNGICIDES, HERBICIDES, AND RODENTICIDES~~	~~CHLORINATED HYDROCARBONS, ORANOPHOSPHATES, CARBAMATES, ARSENIC~~	~~USED FOR CONTROL OF PESTS DURING REVEGETATION~~	~~APPLICATION WILL BE PER MANUFACTURER INSTRUCTIONS. EXCESS OR LEFT OVER PESTICIDES WILL BE IMMEDIATELY REMOVED FROM SITE~~
CONCRETE CURING COMPOUNDS - CREAMY WHITE LIQUID	NAPHTHA	USED TO CONTROL CURING AND SEALING OF CONCRETE	EXCESS COMPOUND WILL BE REMOVED FROM SITE
CONCRETE WASHOUT WATER	pH	CONCRETE TRUCKS AND PUMP TRUCKS	WASH WATER FROM CONCRETE TRUCKS WILL BE CONTAINED AT THE DESIGNATED SITE
TRASH	SOLID WASTES	TRASH LEFT OVER FROM CONSTRUCTION ACTIVITES	REMOVE ALL TRASH FROM SITE DAILY. DO NOT DISPOSE OF TRASH IN HOLES OR TRENCHES
SANITARY WASTE MANAGEMENT	BACTERIA, PARASITES, VIRUSES	FECAL COLIFORM, BACTERIA ASSOCIATED WITH HUMAN OR ANIMAL WASTES	PUBLIC RESTROOMS ARE AVAILABLE ON SITE AND WILL BE AVAILABLE TO CONSTRUCTION WORKERS
~~FERTILIZERS - LIQUID AND SOLID GRAIN~~	~~NITROGEN, PHOSPHORUS~~	~~FERILIZERS USED IN RESTORING VEGETATION~~	~~APPLICATION WILL BE PER MANUFACTURER INSTRUCTIONS. EXCESS WILL BE PROMPTLY REMOVED FROM SITE~~

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PROJECT INFORMATION

LOGAN CITY
CROCKETT DAM IMPROVMENTS

PROFESSIONAL ENGINEER
No. 7840987-2202
GREGORY JOHN KOCH
STATE OF UTAH
1/24/2014

DRAWN BY:	SRP
DESIGNED BY:	SRP
CHECKED BY:	SRP
PROJECT NUMBER:	UTLC03
DATE:	01/24/14
SHEET:	C2

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SURVEYING AND CONSTRUCTION STAKING:

1. PROJECT CONTROL WAS ESTABLISHED BY:

   SKYLINE A/E/S, INC.
   95 W. GOLF COURSE RD. #101
   LOGAN, UTAH 84321
   PHONE: 435.752.8501

2. THE ENGINEER SHALL PROVIDE ALL CONSTRUCTION STAKING FOR THE PROJECT. CONTRACTOR IS RESPONSIBLE FOR COORDINATING WITH THE PROJECT ENGINEER AT (435) 716-9161 A MINIMUM OF 24 HOURS BEFORE NEEDING STAKING.

3. ALL CONSTRUCTION AT THIS SITE SHALL HAVE VERTICAL CONTROL AND ELEVATION CONTROL BASED ON LOGAN CITY MONUMENTS.

4. THE CONTRACTOR SHALL HAVE A REGISTERED LAND SURVEYOR TIE-OUT AND RESET ANY PROPERTY CORNERS OR SECTION CORNERS DISTURBED DURING CONSTRUCTION.

5. THE HORIZONTAL DATUM FOR THIS SET OF CONSTRUCTION DRAWINGS IS THE NORTH AMERICAN DATUM OF 1983 (UTAH STATE PLANE, ZONE 4301, UTAH NORTH.)

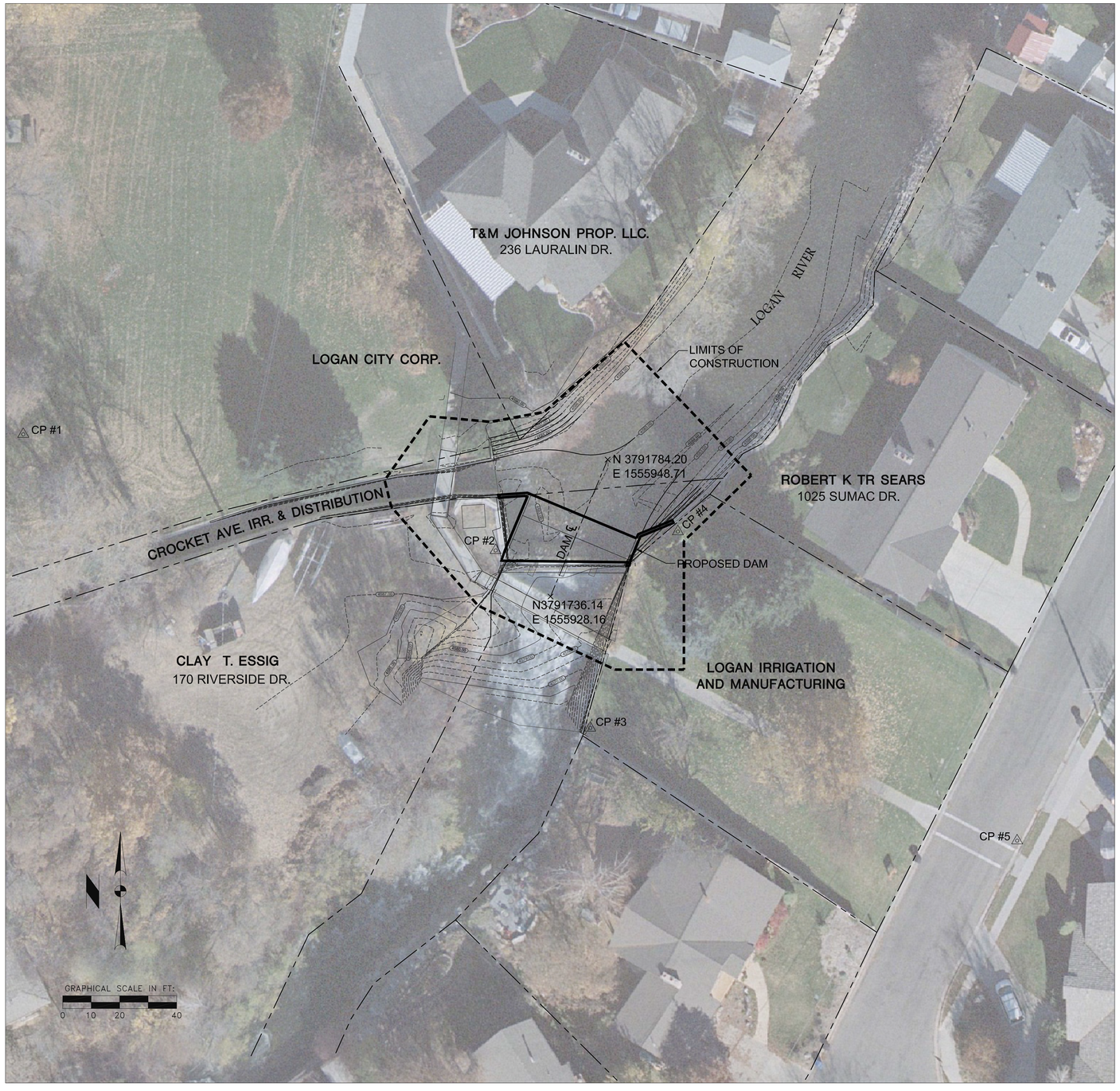
6. THE VERTICAL DATUM FOR THIS SET OF CONSTRUCTION DRAWINGS IS NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.

7. PROJECT SHALL BE TIED TO LOGAN CITY BASE STATION OR UTAH H.A.R.N. NETWORK.

8. ALL PROJECT CONTROL LISTED HERE IS PROVIDED AS A REFERENCE. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY THE ACCURACY OF THE COORDINATES AND ELEVATIONS SHOWN PRIOR TO USING THEM FOR ANY PURPOSES.

9. TEMPORARY CONTROL POINTS ARE AS FOLLOWS:

CONTROL POINT NO.	NORTHING	EASTING	ELEVATION	DESC.
1	3791793.09	1555743.55	4589.43	CP H/T
2	3791752.32	1555909.42	4588.01	CP H/T
3	3791689.98	1555942.61	4585.90	CP H/T
4	3791758.94	1555973.39	4587.36	CP H/T
5	3791650.42	1556092.47	4585.49	CP H/T



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SURVEY CONTROL

LOGAN CITY
CROCKETT DAM IMPROVMENTS

PROFESSIONAL ENGINEER
STATE OF UTAH
No. 7840387-2202
GREGORY JOHN KOCH
01/24/2014

DRAWN BY:	SRP
DESIGNED BY:	SRP
CHECKED BY:	SRP
PROJECT NUMBER:	UTLC03
DATE:	01/24/14
SHEET:	C3

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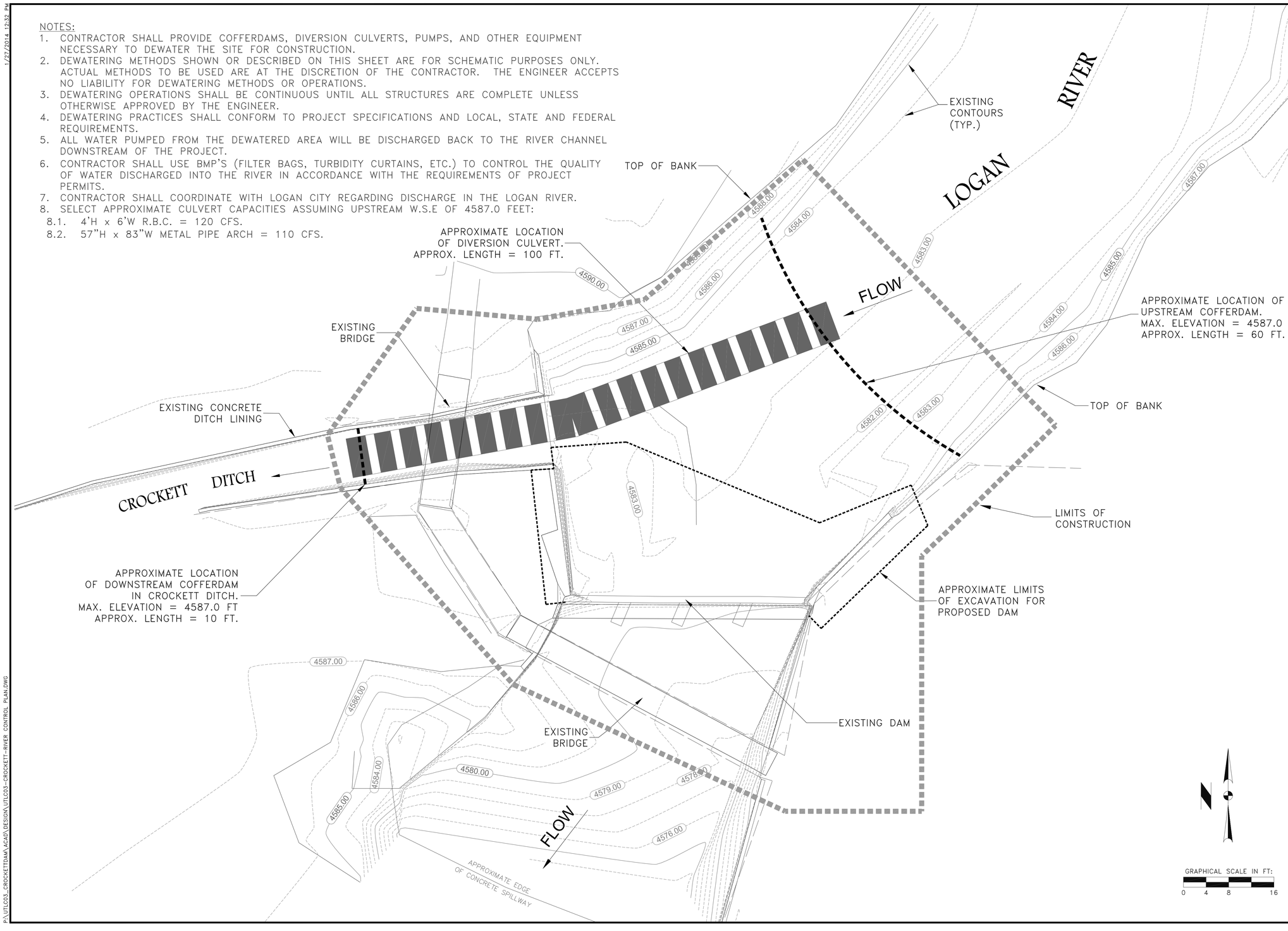
NOTES:

1. CONTRACTOR SHALL PROVIDE COFFERDAMS, DIVERSION CULVERTS, PUMPS, AND OTHER EQUIPMENT NECESSARY TO DEWATER THE SITE FOR CONSTRUCTION.
2. DEWATERING METHODS SHOWN OR DESCRIBED ON THIS SHEET ARE FOR SCHEMATIC PURPOSES ONLY. ACTUAL METHODS TO BE USED ARE AT THE DISCRETION OF THE CONTRACTOR. THE ENGINEER ACCEPTS NO LIABILITY FOR DEWATERING METHODS OR OPERATIONS.
3. DEWATERING OPERATIONS SHALL BE CONTINUOUS UNTIL ALL STRUCTURES ARE COMPLETE UNLESS OTHERWISE APPROVED BY THE ENGINEER.
4. DEWATERING PRACTICES SHALL CONFORM TO PROJECT SPECIFICATIONS AND LOCAL, STATE AND FEDERAL REQUIREMENTS.
5. ALL WATER PUMPED FROM THE DEWATERED AREA WILL BE DISCHARGED BACK TO THE RIVER CHANNEL DOWNSTREAM OF THE PROJECT.
6. CONTRACTOR SHALL USE BMP'S (FILTER BAGS, TURBIDITY CURTAINS, ETC.) TO CONTROL THE QUALITY OF WATER DISCHARGED INTO THE RIVER IN ACCORDANCE WITH THE REQUIREMENTS OF PROJECT PERMITS.
7. CONTRACTOR SHALL COORDINATE WITH LOGAN CITY REGARDING DISCHARGE IN THE LOGAN RIVER.
8. SELECT APPROXIMATE CULVERT CAPACITIES ASSUMING UPSTREAM W.S.E OF 4587.0 FEET:
   - 8.1. 4'H x 6'W R.B.C. = 120 CFS.
   - 8.2. 57"H x 83"W METAL PIPE ARCH = 110 CFS.



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RIVER CONTROL AND DEWATERING PLAN

LOGAN CITY
CROCKETT DAM IMPROVEMENTS

PROFESSIONAL ENGINEER
No. 7644087-2202
GREGORY JOHN KOCH
01/24/2014
STATE OF UTAH

DRAWN BY:	SRP
DESIGNED BY:	SRP
CHECKED BY:	SRP
PROJECT NUMBER:	UTLC03
DATE:	01/24/14
SHEET:	C4

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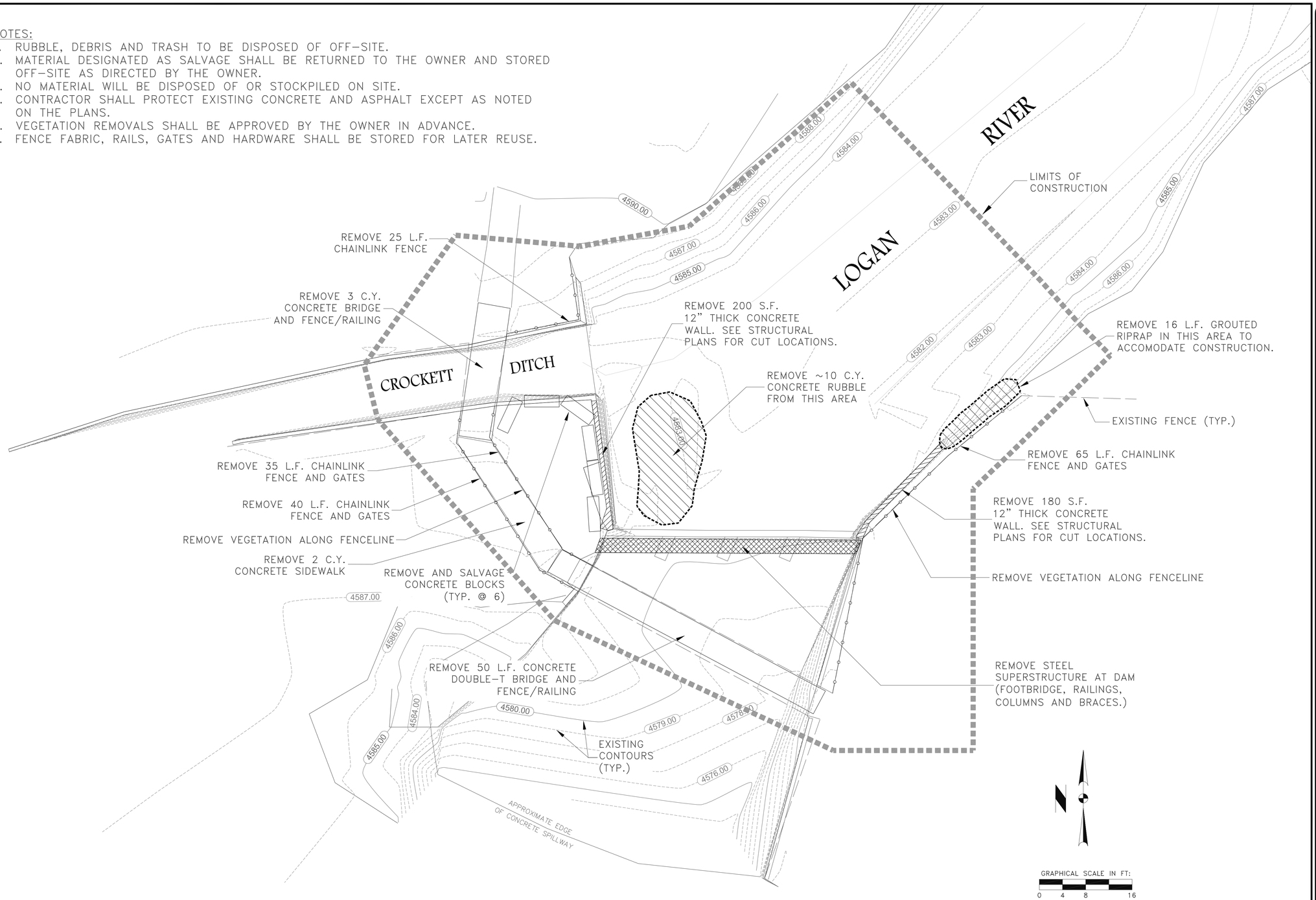
NOTES:
1. RUBBLE, DEBRIS AND TRASH TO BE DISPOSED OF OFF-SITE.
2. MATERIAL DESIGNATED AS SALVAGE SHALL BE RETURNED TO THE OWNER AND STORED OFF-SITE AS DIRECTED BY THE OWNER.
3. NO MATERIAL WILL BE DISPOSED OF OR STOCKPILED ON SITE.
4. CONTRACTOR SHALL PROTECT EXISTING CONCRETE AND ASPHALT EXCEPT AS NOTED ON THE PLANS.
5. VEGETATION REMOVALS SHALL BE APPROVED BY THE OWNER IN ADVANCE.
6. FENCE FABRIC, RAILS, GATES AND HARDWARE SHALL BE STORED FOR LATER REUSE.



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DEMOLITION PLAN

LOGAN CITY
CROCKETT DAM IMPROVEMENTS

PROFESSIONAL ENGINEER
No. 7554987-2202
GREGORY JOHN KOCH
STATE OF UTAH

DRAWN BY:	SRP
DESIGNED BY:	SRP
CHECKED BY:	SRP
PROJECT NUMBER:	UTLC03
DATE:	1/24/14
SHEET:	C5

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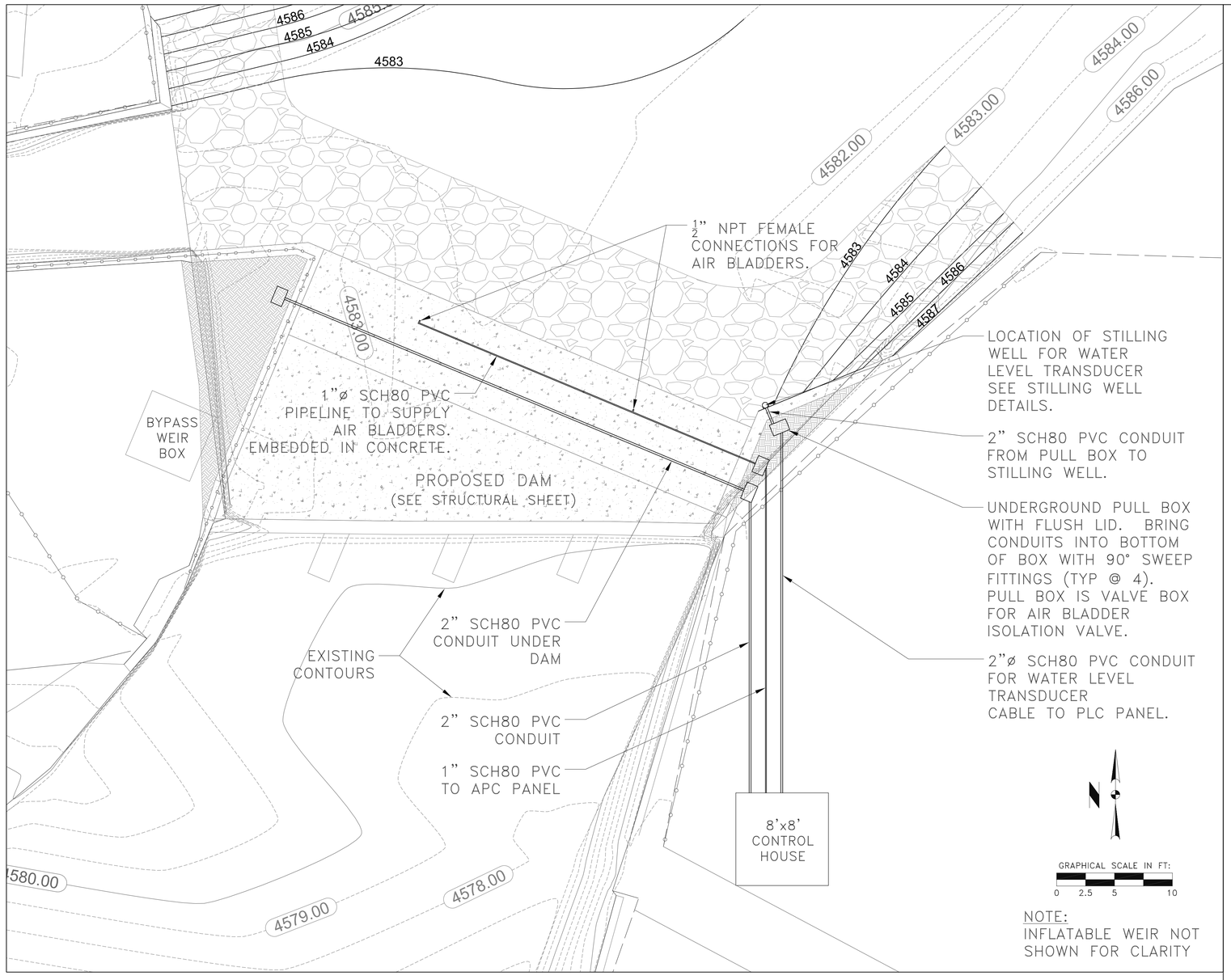

NOTE:
INFLATABLE WEIR NOT SHOWN FOR CLARITY

NOTES:
1. CONTRACTOR SHALL SUPPLY ALL CONDUIT, PIPE, PULLBOXES, AND RELATED MATERIAL AND HARDWARE.
2. CONTRACTOR SHALL SUPPLY ALL MATERIALS AND FABRICATION FOR THE STILLING WELL EXCEPT AS NOTED IN THE DETAIL.
3. CONTRACTOR SHALL SUPPLY SUCH HARDWARE AS NECESSARY TO ISOLATE AND PROTECT CONDUIT AND PIPE PASSING THROUGH CONCRETE WALLS.
4. CONNECTIONS BETWEEN EMBEDDED PIPE AND AIR BLADDERS SHALL BE AS SPECIFIED BY THE INFLATABLE WEIR MANUFACTURER ON THEIR SHOP DRAWINGS INCLUDING CONNECTION TYPE, LOCATION, AND DIMENSIONS OF CONCRETE BOXOUTS NEEDED TO MAKE THE CONNECTION. CONTRACTOR SHALL CONFIRM THESE DETAILS PRIOR TO BEGINNING THE WORK.
5. CONTROL HOUSE CONSTRUCTION DETAILS SHALL BE AS SHOWN ON SHEETS AS01, CHA01–02 AND CHS01–03.
6. CONTROL HOUSE LAYOUT SHALL BE AS SPECIFIED BY THE INFLATABLE WEIR MANUFACTURER ON THEIR SHOP DRAWINGS. PIPE AND CONDUIT LOCATIONS MAY VARY FROM THE LOCATIONS SHOWN. CONTRACTOR SHALL CONFIRM THESE DETAILS PRIOR TO BEGINNING THE WORK.
7. EMBEDDED ITEMS, SUCH AS CONDUITS AND PIPE SLEEVES SHALL BE IN POSITION PRIOR TO PLACING CONCRETE.

STILLING WELL DETAILS

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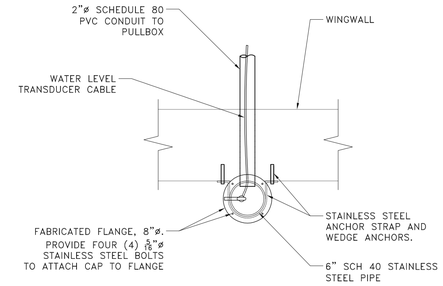

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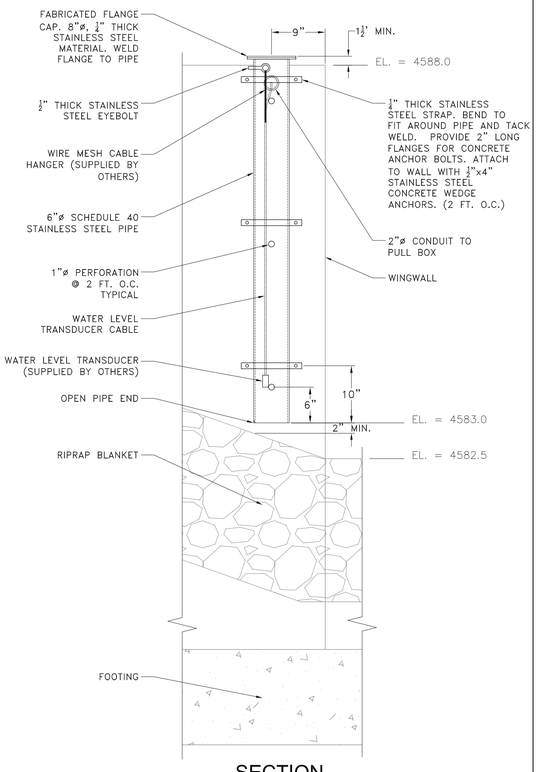

SECTION

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CONDUIT AND PIPING PLAN

LOGAN CITY
CROCKETT DAM IMPROVEMENTS

PROFESSIONAL ENGINEER
No. 7654987
2202
GREGORY JOHN KOCH
STATE OF UTAH

DRAWN BY:	SRP
DESIGNED BY:	SRP
CHECKED BY:	SRP
PROJECT NUMBER:	UTLC03
DATE:	01/13/14
SHEET:	C6

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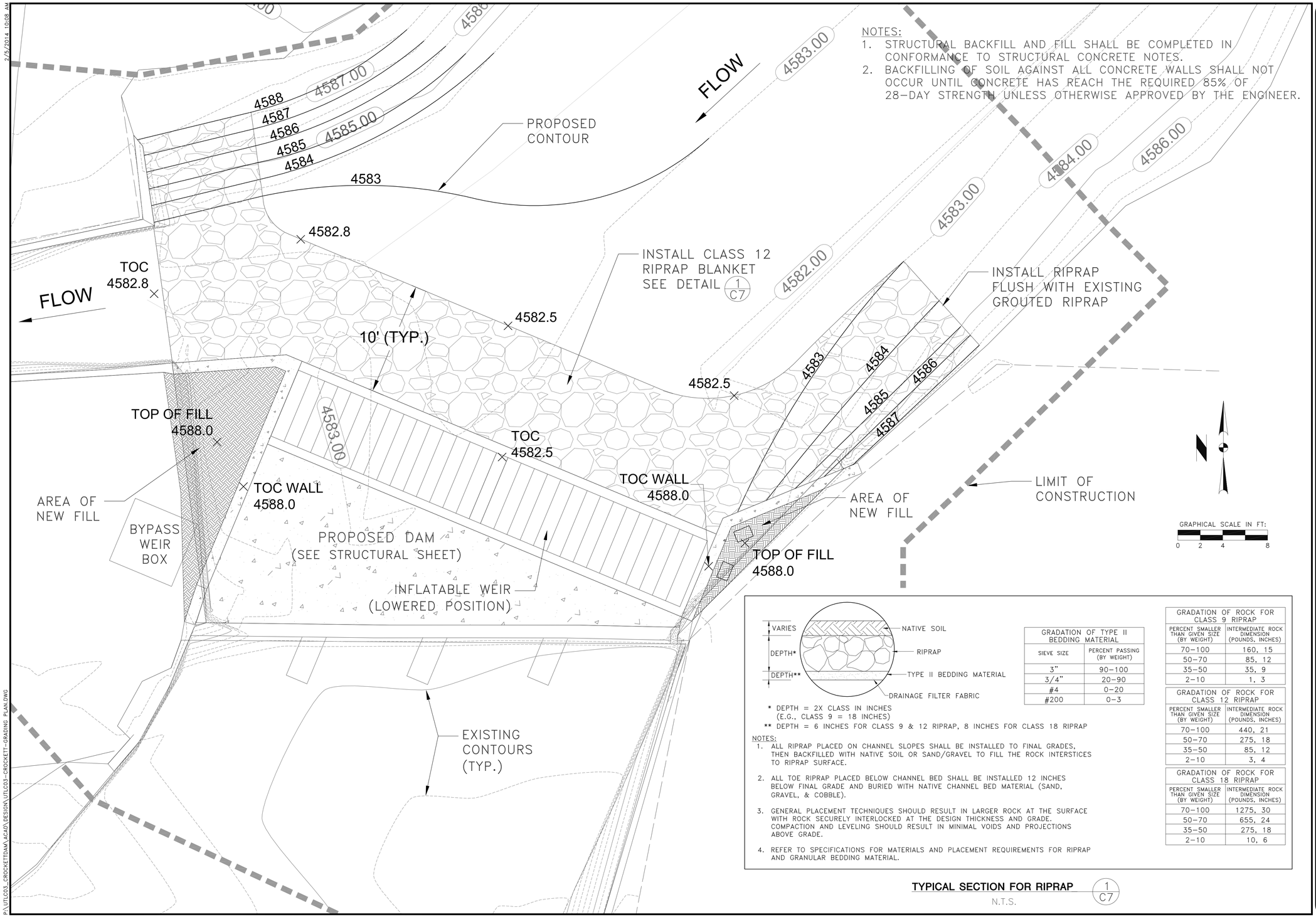

* DEPTH = 2X CLASS IN INCHES (E.G., CLASS 9 = 18 INCHES)

** DEPTH = 6 INCHES FOR CLASS 9 & 12 RIPRAP, 8 INCHES FOR CLASS 18 RIPRAP

GRADATION OF TYPE II BEDDING MATERIAL	
SIEVE SIZE	PERCENT PASSING (BY WEIGHT)
3"	90–100
3/4"	20–90
#4	0–20
#200	0–3

GRADATION OF ROCK FOR CLASS 9 RIPRAP	
PERCENT SMALLER THAN GIVEN SIZE (BY WEIGHT)	INTERMEDIATE ROCK DIMENSION (POUNDS, INCHES)
70–100	160, 15
50–70	85, 12
35–50	35, 9
2–10	1, 3

GRADATION OF ROCK FOR CLASS 12 RIPRAP	
PERCENT SMALLER THAN GIVEN SIZE (BY WEIGHT)	INTERMEDIATE ROCK DIMENSION (POUNDS, INCHES)
70–100	440, 21
50–70	275, 18
35–50	85, 12
2–10	3, 4

GRADATION OF ROCK FOR CLASS 18 RIPRAP	
PERCENT SMALLER THAN GIVEN SIZE (BY WEIGHT)	INTERMEDIATE ROCK DIMENSION (POUNDS, INCHES)
70–100	1275, 30
50–70	655, 24
35–50	275, 18
2–10	10, 6

NOTES:

1. ALL RIPRAP PLACED ON CHANNEL SLOPES SHALL BE INSTALLED TO FINAL GRADES, THEN BACKFILLED WITH NATIVE SOIL OR SAND/GRAVEL TO FILL THE ROCK INTERSTICES TO RIPRAP SURFACE.
2. ALL TOE RIPRAP PLACED BELOW CHANNEL BED SHALL BE INSTALLED 12 INCHES BELOW FINAL GRADE AND BURIED WITH NATIVE CHANNEL BED MATERIAL (SAND, GRAVEL, & COBBLE).
3. GENERAL PLACEMENT TECHNIQUES SHOULD RESULT IN LARGER ROCK AT THE SURFACE WITH ROCK SECURELY INTERLOCKED AT THE DESIGN THICKNESS AND GRADE. COMPACTION AND LEVELING SHOULD RESULT IN MINIMAL VOIDS AND PROJECTIONS ABOVE GRADE.
4. REFER TO SPECIFICATIONS FOR MATERIALS AND PLACEMENT REQUIREMENTS FOR RIPRAP AND GRANULAR BEDDING MATERIAL.

TYPICAL SECTION FOR RIPRAP 1/C7

N.T.S.

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GRADING PLAN

LOGAN CITY
CROCKETT DAM IMPROVEMENTS

DRAWN BY:	SRP
DESIGNED BY:	SRP
CHECKED BY:	SRP
PROJECT NUMBER:	UTLC03
DATE:	01/24/14
SHEET:	C7

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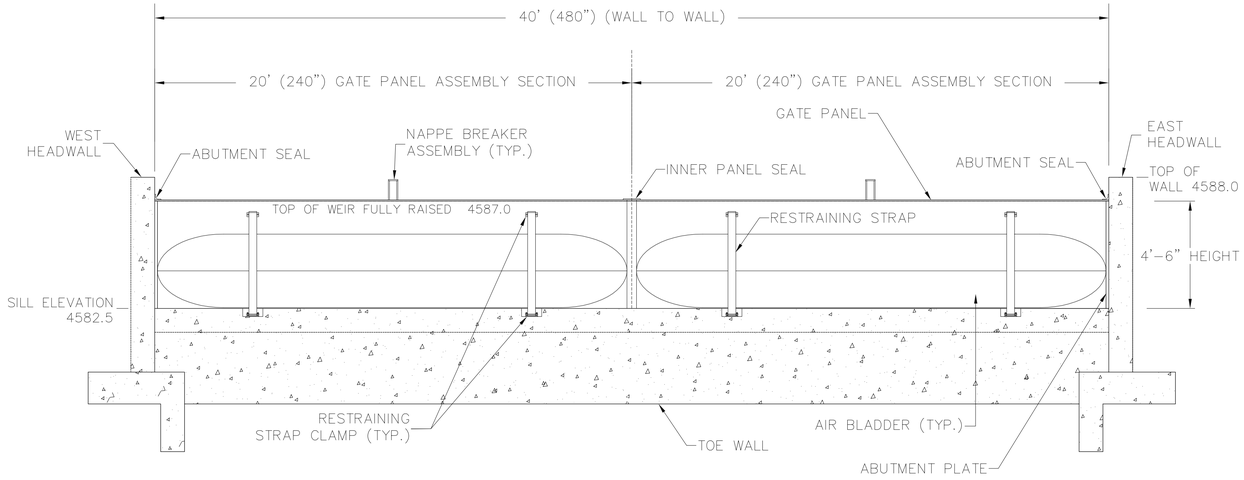
NOTES:

1. THIS DRAWING IS NOT TO SCALE AND IS INTENDED ONLY TO CONVEY THE CONCEPTUAL DETAILS OF THE INFLATABLE WEIR SPECIFIED FOR THIS PROJECT.
2. THE INFLATABLE WEIR SHALL BE MANUFACTURED BY OBERMEYER HYDRO, INC., P.O. BOX 668, FORT COLLINS, CO 80522, USA. TELEPHONE: 970-568-9844, FAX: 970-568-9845, EMAIL: hydro@obermeyerhydro.com, WWW: http:/www.obermeyerhydro.com.
3. THE INFLATABLE WEIR SHALL HAVE THE DIMENSIONS SHOWN ON THIS DRAWING.
4. THE SHOP DRAWINGS FROM OBERMEYER HYDRO, INC. (OHI) WILL CONVEY DESIGN DETAILS RELATED TO THE ATTACHMENT OF THE WEIR AND THE LAYOUT OF THE CONTROLS THAT ARE NOT REFLECTED IN THESE DRAWINGS.
5. THE CONTRACTOR SHALL CONFIRM CONSTRUCTION DETAILS RELATED TO THE INFLATABLE WEIR WITH OHI PRIOR TO BEGINNING WORK.
6. OHI DOES NOT SUPPLY THE FOLLOWING ITEMS:
   - 6.1. CONDUIT, PIPE AND WIRING.
   - 6.2. STILLING WELL AND HARDWARE.
   - 6.3. INSTALLATION EXCEPT FOR TRAINING AND SUPERVISION AS PURCHASED.
   - 6.4. CONTROL HOUSE OR BUILDING.
   - 6.5. CONCRETE FOUNDATION AND WALLS SEE SHEETS DIS01-03.



INFLATABLE WEIR NORTH ELEVATION

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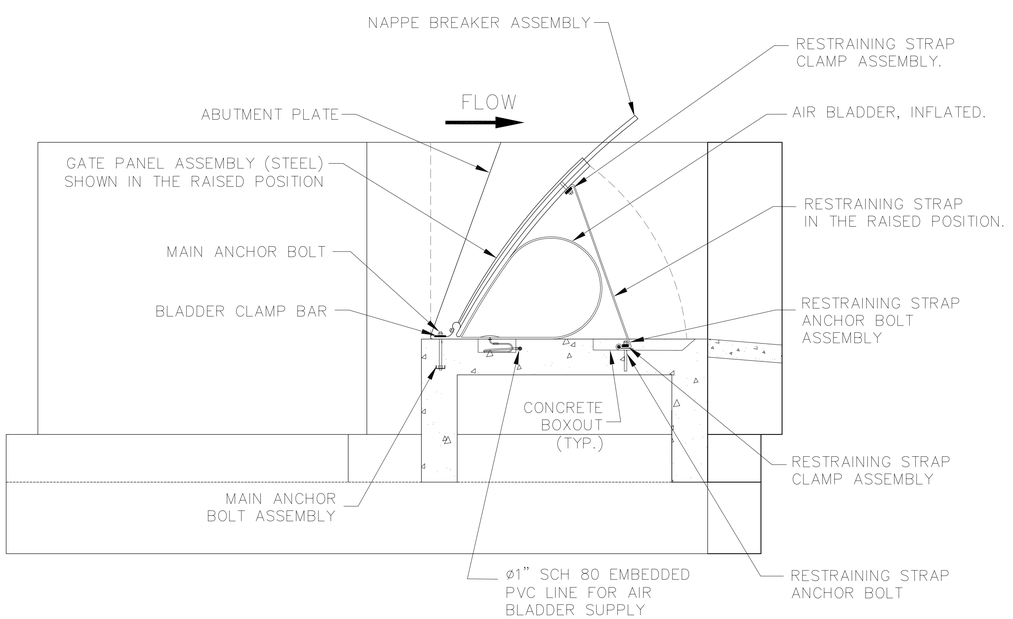

INFLATABLE WEIR SECTION - RAISED (EAST HEADWALL ELEVATION)

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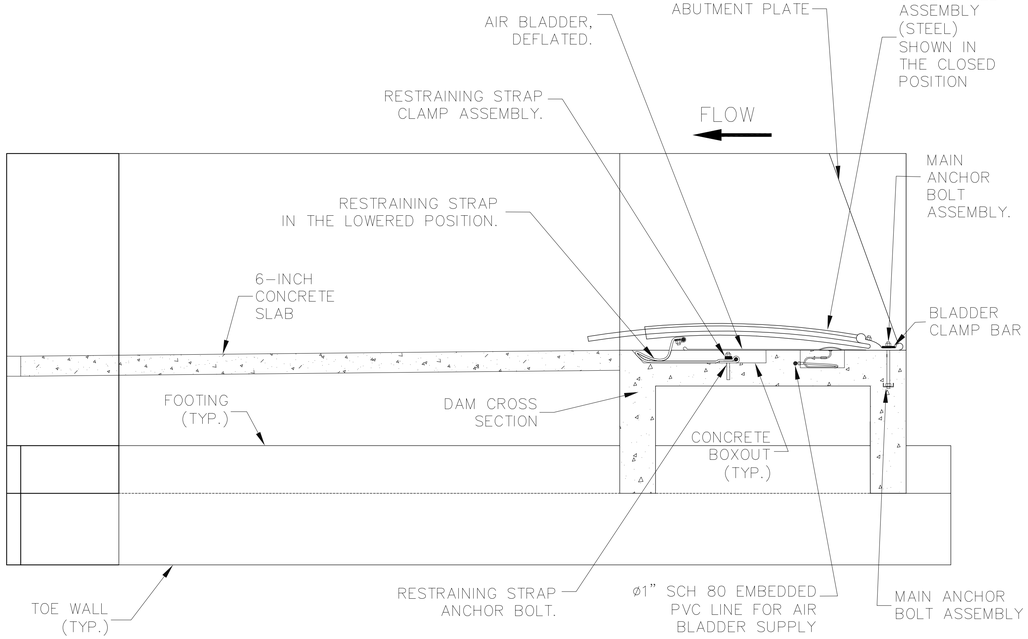

INFLATABLE WEIR SECTION - LOWERED (WEST HEADWALL ELEVATION)

N.T.S.

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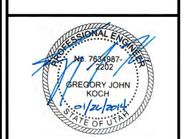
INFLATABLE WEIR CONCEPTUAL DETAILS

LOGAN CITY
CROCKETT DAM IMPROVEMENTS



DRAWN BY:	TAW
DESIGNED BY:	SRP
CHECKED BY:	SRP
PROJECT NUMBER:	UTLC03
DATE:	01/24/14
SHEET:	C8

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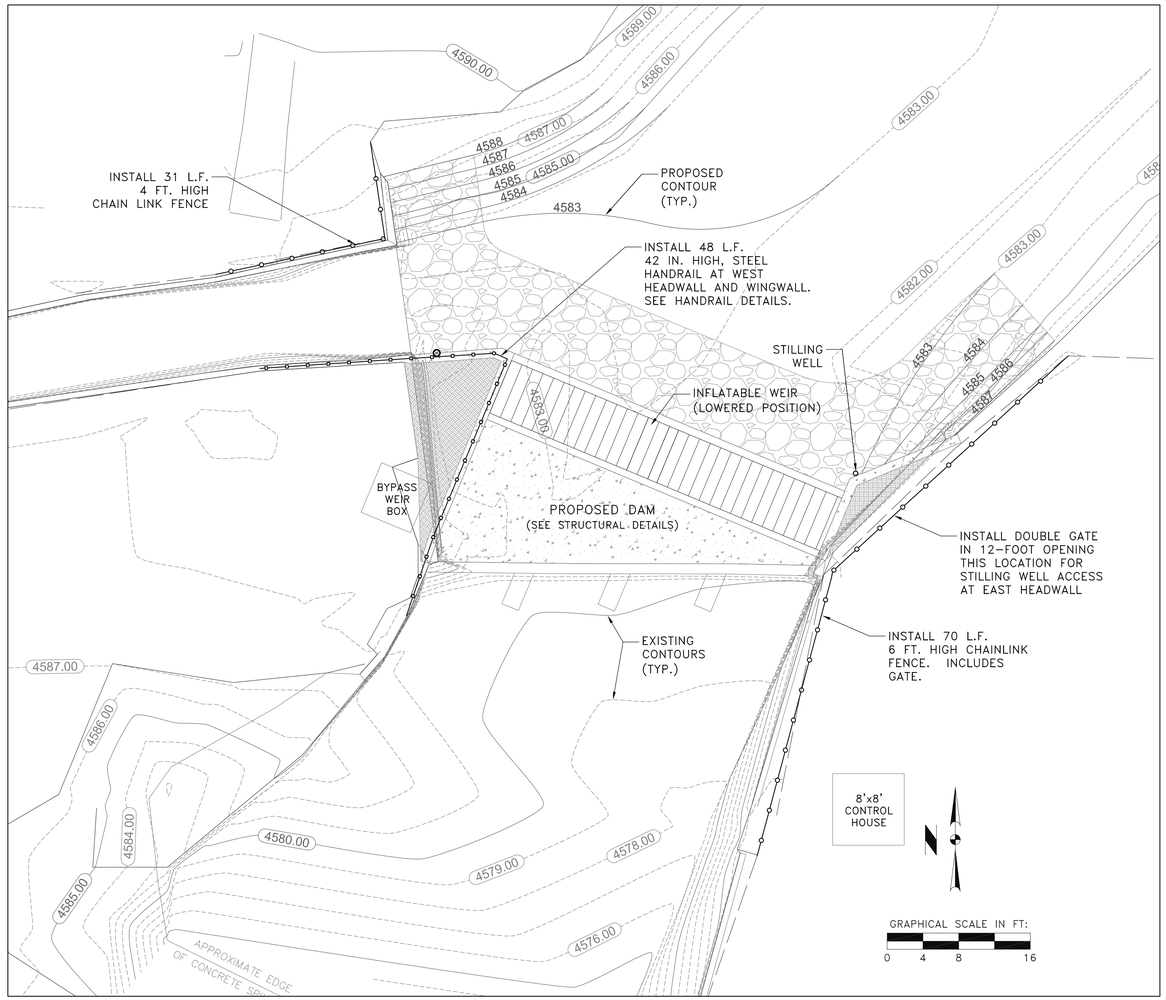
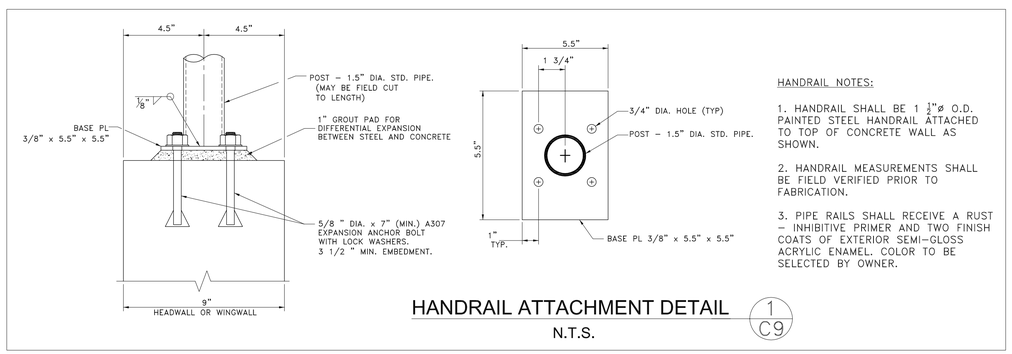




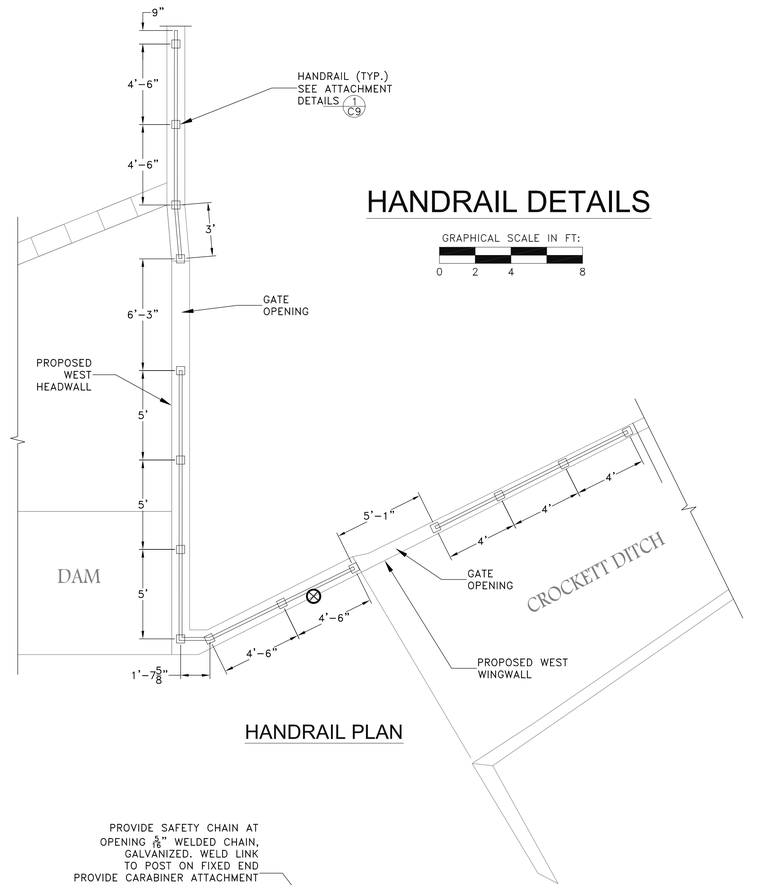
HANDRAIL ATTACHMENT DETAIL (1 / C9)

N.T.S.

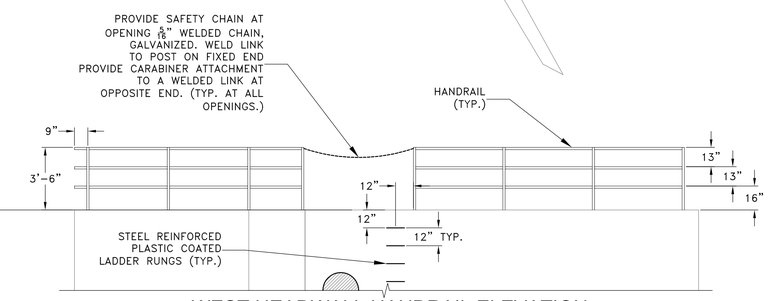
HANDRAIL NOTES:

1. HANDRAIL SHALL BE 1 1/2"ø O.D. PAINTED STEEL HANDRAIL ATTACHED TO TOP OF CONCRETE WALL AS SHOWN.
2. HANDRAIL MEASUREMENTS SHALL BE FIELD VERIFIED PRIOR TO FABRICATION.
3. PIPE RAILS SHALL RECEIVE A RUST – INHIBITIVE PRIMER AND TWO FINISH COATS OF EXTERIOR SEMI-GLOSS ACRYLIC ENAMEL. COLOR TO BE SELECTED BY OWNER.

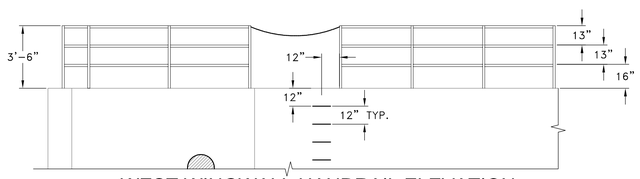
HANDRAIL DETAILS



HANDRAIL PLAN



WEST HEADWALL HANDRAIL ELEVATION



WEST WINGWALL HANDRAIL ELEVATION

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FENCE AND RAILING PLAN

LOGAN CITY
CROCKETT DAM IMPROVEMENTS

PROFESSIONAL ENGINEER
No 764387-2202
GREGORY JOHN KOCH
1/24/2014
STATE OF UTAH

DRAWN BY:	SRP
DESIGNED BY:	SRP
CHECKED BY:	SRP
PROJECT NUMBER:	UTLC03
DATE:	01/24/14
SHEET:	C9

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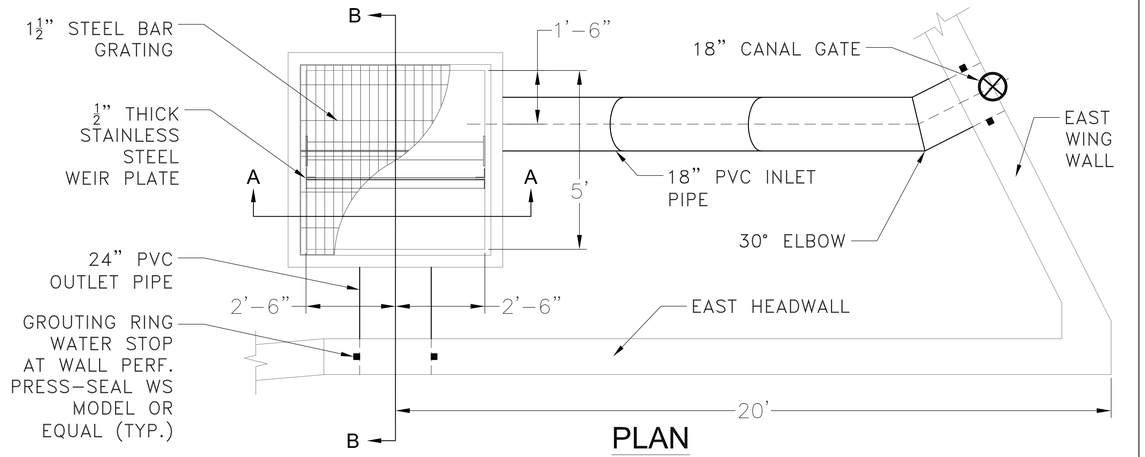
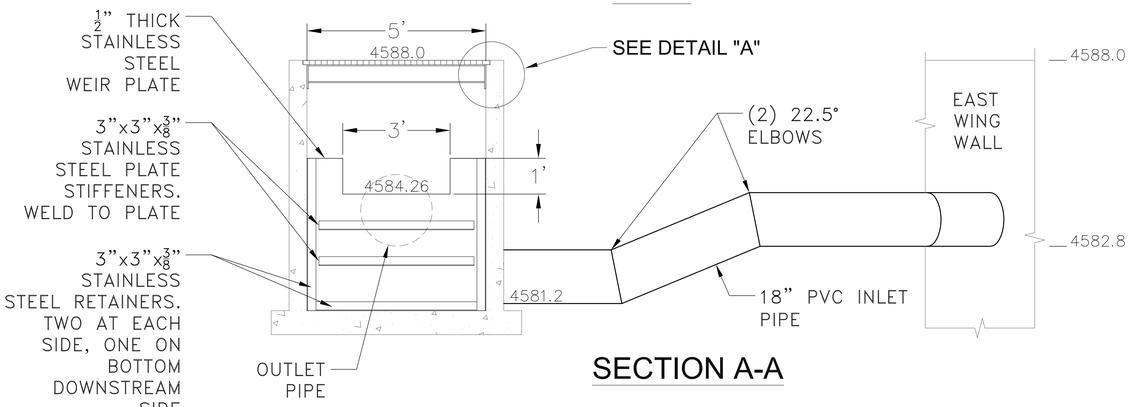


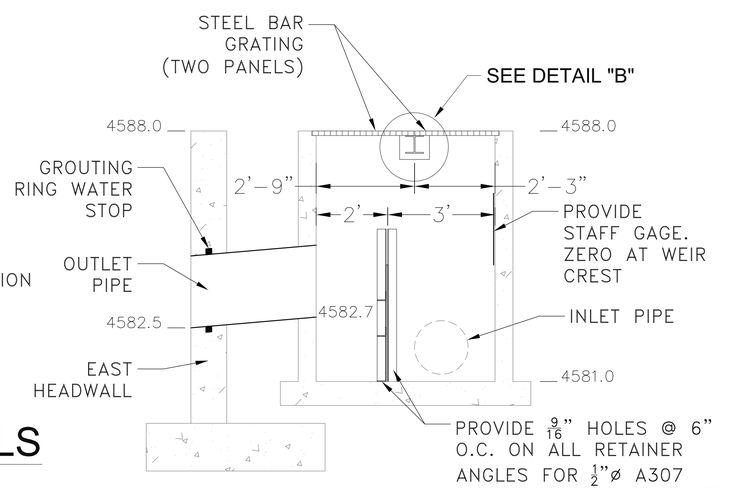
PLAN



SECTION A-A

PRECAST NOTE:

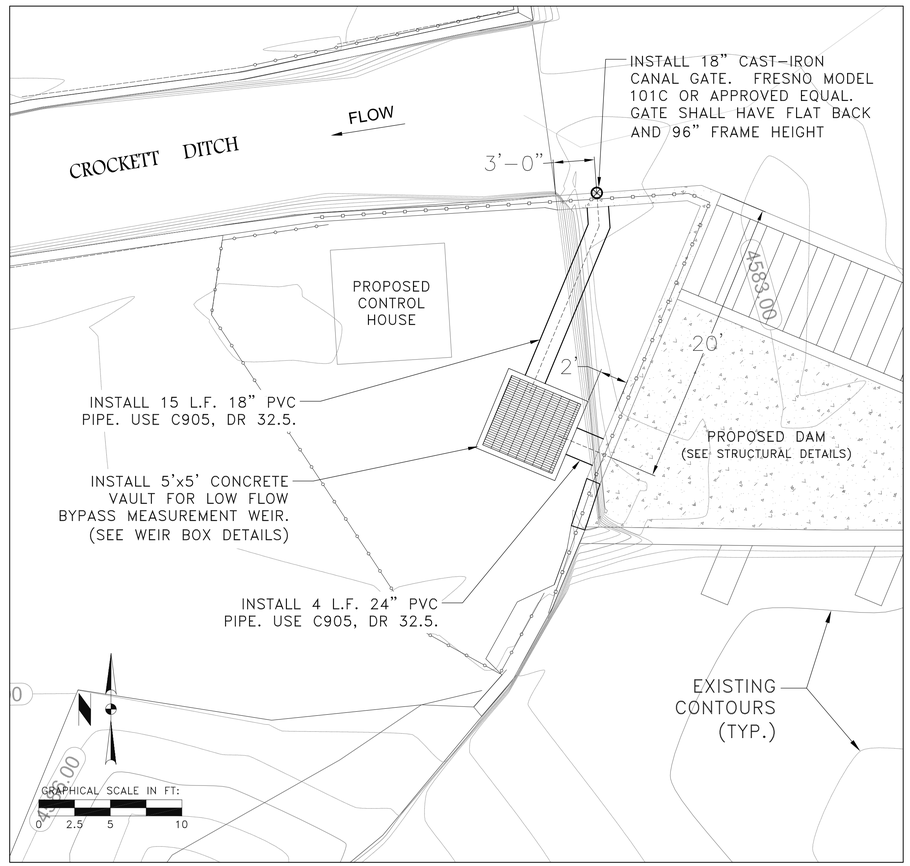
5'x5' RECTANGULAR PRECAST CONCRETE VAULT. SINGLE UNIT OR BASE AND RISER SECTION(S) ACCEPTABLE. PRECAST VAULT SECTIONS SHALL CONFORM TO SPECIFICATION ASTM C478. VAULT SUPPLIER TO PROVIDE MANHOLE COUPLINGS, WATERSTOP OR CONNECTION PORTS SUITABLE FOR PVC PIPE AND APPLICATION. PRECAST VAULT SHALL BE DESIGNED FOR SMALL VEHICLE LOADING.

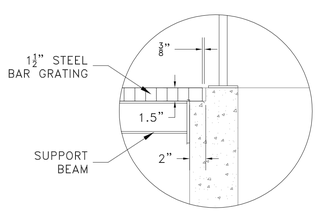


SECTION B-B

WEIR BOX DETAILS

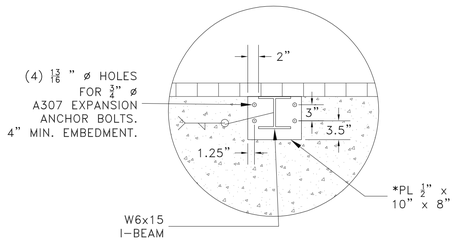
GRAPHICAL SCALE IN FT:
0 1 2 4





DETAIL "A"

(GRATING ANGLE IMBED ASSEMBLY DETAIL)
N.T.S.



DETAIL "B"

(GRATING SUPPORT ATTACHMENT DETAIL)
N.T.S.

GRATING NOTES:

1. I-BAR SHALL BE AMICO 1½" x 3/16" 15-W-4 I-BAR GRATING OR EQUAL. GALVANIZE AFTER FABRICATION.
2. GRATING SUPPORT BEAMS SHALL BE W6X15.
3. FURNISH AND INSTALL HOLD DOWN CLIPS AND FASTENERS IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.
4. TRIM AND BAND GRATING TO LINES SHOWN ON DRAWINGS.
5. STEEL FRAMING MEMBERS SHALL AND GRATINGS SHALL BE HOT GALVANIZED AFTER FABRICATION.

GRATING DETAILS

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LOW FLOW BYPASS PLAN

LOGAN CITY
CROCKETT DAM IMPROVEMENTS

PROFESSIONAL ENGINEER
No. 7649387-2202
GREGORY JOHN KOCH
STATE OF UTAH

DRAWN BY:	SRP
DESIGNED BY:	SRP
CHECKED BY:	SRP
PROJECT NUMBER:	UTLC03
DATE:	01/24/14
SHEET:	C10

GENERAL

1. THE STRUCTURAL NOTES ARE INTENDED TO COMPLEMENT THE PROJECT SPECIFICATIONS. SPECIFIC NOTES AND DETAILS IN THE DRAWINGS SHALL GOVERN OVER THE STRUCTURAL NOTES AND TYPICAL DETAILS.
2. TYPICAL DETAILS AND SECTIONS SHALL APPLY WHERE SPECIFIC DETAILS ARE NOT SHOWN
3. THE CONTRACTOR SHALL VERIFY ALL SITE CONDITIONS AND DIMENSIONS. IF ACTUAL CONDITIONS DIFFER FROM THOSE SHOWN IN THE CONTRACT DRAWINGS, THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE ARCHITECT/ENGINEER BEFORE PROCEEDING WITH THE FABRICATION OR CONSTRUCTION OF ANY EFFECTED ELEMENTS.
4. OMISSIONS OR CONFLICTS BETWEEN THE CONTRACT DRAWINGS AND/OR SPECIFICATIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ARCHITECT/ENGINEER BEFORE PROCEEDING WITH ANY WORK INVOLVED. IN CASE OF CONFLICT, FOLLOW THE MOST STRINGENT REQUIREMENT AS DIRECTED BY THE ARCHITECT/ENGINEER AT NO ADDITIONAL COST TO THE OWNER.
5. THE CONTRACTOR SHALL SUBMIT A WRITTEN REQUEST TO THE ARCHITECT/ENGINEER BEFORE PROCEEDING WITH ANY CHANGES, SUBSTITUTIONS OR MODIFICATIONS. ANY WORK DONE BY THE CONTRACTOR BEFORE RECEIVING WRITTEN APPROVAL WILL BE AT THE CONTRACTOR'S RISK.
6. THE CONTRACTOR SHALL COORDINATE WITH ALL TRADES ANY ITEMS THAT ARE TO BE INTEGRATED INTO THE STRUCTURAL SYSTEM SUCH AS OPENINGS, PENETRATIONS, MECHANICAL AND ELECTRICAL EQUIPMENT, ETC. SIZES AND LOCATIONS OF MECHANICAL AND OTHER EQUIPMENT THAT DIFFERS FROM THOSE SHOWN ON THE CONTRACT DRAWINGS SHALL BE REPORTED TO THE ARCHITECT/ENGINEER.
7. THE CONTRACTOR SHALL PROVIDE ADEQUATE SHORING AND BRACING AS REQUIRED FOR HIS METHOD OF ERECTION. SHORING AND BRACING SHALL REMAIN IN PLACE UNTIL FINAL CONNECTIONS FOR THE PERMANENT MEMBERS ARE COMPLETED. THE BUILDING SHALL NOT BE CONSIDERED STABLE UNTIL ALL CONNECTIONS ARE COMPLETED. WALLS SHALL NOT BE CONSIDERED SELF SUPPORTING AND SHALL BE BRACED UNTIL THE FLOOR/ROOF SYSTEM IS COMPLETED.
8. SITE OBSERVATIONS BY SKYLINE A/E/S/ INC'S FIELD REPRESENTATIVE SHALL NOT BE CONSTRUED AS APPROVAL OF CONSTRUCTION PROCEDURES NOR SPECIAL INSPECTION.
9. DETAILING AND SHOP DRAWING PRODUCTION FOR STRUCTURAL ELEMENTS WILL REQUIRE INFORMATION (INCLUDING DIMENSIONS) CONTAINED IN THE ARCHITECTURAL, STRUCTURAL AND/OR OTHER CONSULTANTS' DRAWINGS. THE STRUCTURAL DRAWINGS SHALL BE USED IN CONJUNCTION WITH THE ARCHITECTURAL AND OTHER CONSULTANT'S DRAWINGS. SOME DIMENSIONS AND ELEMENTS SUCH AS ELEVATIONS, DEPRESSIONS, SLOPES, MECHANICAL HOUSEKEEPING PADS, ETC. MAY NOT BE SHOWN IN THE STRUCTURAL DRAWINGS.
10. REVIEW OF SHOP DRAWING SUBMITTALS BY SKYLINE A/E/S INC. IS FOR GENERAL COMPLIANCE ONLY AND IS NOT INTENDED FOR APPROVAL. THE SHOP DRAWING REVIEW SHALL NOT RELIEVE THE CONTRACTOR FROM THE RESPONSIBILITY OF COMPLETING THE PROJECT ACCORDING TO THE CONTRACT DOCUMENTS.
11. SHOP DRAWINGS MADE FROM REPRODUCTIONS OF THE CONTRACT DRAWINGS WILL BE REJECTED UNLESS THE CONTRACTOR SIGNS A RELEASE AGREEMENT PRIOR TO THE SHOP DRAWINGS BEING REVIEWED.

FOUNDATION

1. SOILS INVESTIGATION TESTPIT: SKYLINE A/E/S, INC.
2. SOIL BEARING PRESSURE: 2000 PSF - ASSUMED.
3. FROST PROTECTION: 36 INCHES MINIMUM
4. CLEAR EXCAVATIONS OF DEBRIS AND LOOSE SOIL PRIOR TO PLACING FOOTINGS. ALL FOOTINGS SHALL BEAR ON UNDISTURBED NATURAL SUB-GRADE OR ENGINEERED COMPACTED FILL AS NOTED IN THESE DRAWINGS.

EARTHWORK

1. CLEARING: THE ENTIRE BUILDING AREA SHALL BE SCRAPED TO REMOVE THE TOP 4 INCHES OF SOIL, INCLUDING ALL VEGETATION AND DEBRIS.
2. PROOF ROLLING: THE NATURAL UNDISTURBED SOIL BELOW ALL FOOTINGS SHALL BE PROOF ROLLED PRIOR TO PLACING CONCRETE. REMOVE ALL SOFT SPOTS AND REPLACE WITH COMPACTED STRUCTURAL FILL.
3. COMPACTED STRUCTURAL FILL: ALL FILL MATERIAL SHALL BE A WELL-GRADED GRANULAR MATERIAL WITH A MAXIMUM SIZE LESS THAN 4 INCHES AND WITH NOT MORE THAN 10 PERCENT PASSING A NO. 200 SIEVE. IT SHALL BE COMPACTED TO 95 PERCENT OF THE MAXIMUM LABORATORY DENSITY AS DETERMINED BY ASTM D 1557. ALL FILL SHALL BE TESTED.

CONCRETE

1. MATERIALS, UNLESS NOTED OTHERWISE:
   - A. NORMAL WEIGHT AGGREGATES ..... ASTM C 33
   - B. LIGHT WEIGHT AGGREGATES ..... ASTM C 330
     LIGHTWEIGHT CONCRETE SHALL NOT EXCEED 110 POUNDS PER CUBIC FOOT AND SHALL BE MADE OF LIGHTWEIGHT COURSE AGGREGATES AND A BLEND OF LIGHTWEIGHT AND NORMAL WEIGHT FINES.
   - C. REINFORCING STEEL ASTM 615 GRADE 60 (FY = 60 KSI), USE GRADE 40 (FY = 40 KSI) FOR FIELD BENT DOWELS WITH SPACINGS INDICATED REDUCED BY 1/3.
   - D. DEFORMED BAR ANCHORS (DBA) ..... ASTM A496
   - E. HEADED STUD ANCHORS (HSA) ..... ASTM A108
   - F. ANCHOR BOLTS: ASTM A307 WITH ASTM A563 HEAVY HEX NUTS WITH HARDENED WASHERS
   - G. ADMIXTURES: AIR-ENTRAINING ADMIXTURES, COMPLY WITH ASTM C 260 (WHEN USED). CALCIUM CHLORIDE SHALL NOT BE ADDED TO THE CONCRETE MIX.
   - H. NO ALUMINUM CONDUIT OR PRODUCT CONTAINING ALUMINUM OR ANY OTHER MATERIAL INJURIOUS TO CONCRETE SHALL BE EMBEDDED IN CONCRETE.
2. COMPRESSIVE STRENGTHS OF CONCRETE AT 28 DAYS SHALL BE AS FOLLOWS:
   - A. FOOTINGS ..... 3000 PSI
   - B. INTERIOR SLABS ON GRADE ..... 3000 PSI
   - C. FOUNDATION WALLS ..... 4000 PSI
   - D. COLUMNS ..... 4000 PSI
   - E. JOISTS, BEAMS AND SUSPENDED SLABS ..... 4000 PSI
   - F. TILT UP WALL PANELS ..... 4000 PSI
   - G. NORMAL WEIGHT CONCRETE OVER STEEL DECK ..... 3500 PSI
   - H. ALL SITE CAST CONCRETE ..... 4500 PSI
3. 2-1/2" THICK (4" OVERALL) NORMAL WEIGHT CONCRETE SLAB SHALL BE POURED OVER THE STEEL DECK. REINFORCE SLAB WITH 6" X 6" - W1.4/W1.4 WELDED WIRE FABRIC MINIMUM, UNLESS NOTED OTHERWISE. WELDED WIRE FABRIC SHALL BE PLACED 1" TO 1-1/2" BELOW THE TOP OF THE SLAB
4. ONLY ONE GRADE OR TYPE OF CONCRETE SHALL BE POURED ON THE SITE AT ANY GIVEN TIME.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN, DETAILING, CARE, PLACEMENT AND REMOVAL OF ALL FORM WORK AND SHORES.
   - A. SUPPORTING FORMS AND SHORING SHALL NOT BE REMOVED UNTIL STRUCTURAL MEMBERS HAVE ACQUIRED SUFFICIENT STRENGTH TO SAFELY SUPPORT THEIR OWN WEIGHT AND ANY CONSTRUCTION LOAD TO WHICH THEY MAY BE SUBJECTED. IN NO CASE, HOWEVER,SHALL FORMS AND SHORING BE REMOVED IN LESS THAN 24 HOURS AFTER CONCRETE PLACEMENT.
   - B. SUSPENDED SLABS SHALL BE RESUPPORTED AFTER FORM REMOVAL UNTIL CONCRETE REACHES ITS 28 DAY SPECIFIED COMPRESSIVE STRENGTH.

CONCRETE CONTINUED

6. REINFORCEMENT SHALL HAVE THE FOLLOWING CONCRETE COVER:

	CLEAR COVER
CAST-IN-PLACE CONCRETE:	
A. CAST AGAINST AND PERMANENTLY EXPOSED TO EARTH	3"
B. FORMED CONCRETE EXPOSED TO EARTH OR WEATHER:	
#6 THRU #18 BARS	2"
#5 AND SMALLER BARS	2"
C. CONCRETE NOT EXPOSED TO WEATHER OR IN CONTACT WITH GROUND:	
SLABS, WALLS, JOISTS; #11 BARS AND SMALLER	3/4"
BEAMS, COLUMNS: PRIMARY REINF., TIES, STIRRUPS, SPIRALS	1-1/2"
CONCRETE TILT-UP PANELS (MANUFACTURED UNDER PLANT CONTROLLED CONDITIONS)	
#8 BARS AND SMALLER	1"
#9 THRU #18 BARS	1-1/2"
PRE-CAST CONCRETE:	
A. CONCRETE EXPOSED TO EARTH OR WEATHER:	
WALL PANELS:	
#11 BARS AND SMALLER	3/4"
#14 AND #18 BARS	1-1/2"
OTHER MEMBERS:	
#11 BARS AND SMALLER	1-1/2"
#14 AND #18 BARS	2"
B. CONCRETE NOT EXPOSED TO WEATHER OR IN CONTACT WITH GROUND:	
SLABS, WALLS, JOISTS:	
#11 BARS AND SMALLER	5/8"
#14 AND #18 BARS	1-1/2"
BEAMS, COLUMNS:	
PRIMARY REINFORCEMENT	1-1/2"
TIES, STIRRUPS, SPIRALS	3/8"

7. CONSTRUCTION JOINTS AND CONTROL JOINTS:
   - A. PROVIDE A FORMED AND BEVELED 2 X 4 X CONTINUOUS KEYWAY IN ALL HORIZONTAL AND VERTICAL CONSTRUCTION JOINTS INCLUDING BETWEEN TOP OF FOOTING AND FOUNDATION WALLS. IN ADDITION, ALL JOINTS SHALL BE INTENTIONALLY ROUGHENED TO A FULL AMPLITUDE OF APPROXIMATELY 1/4 INCH.
   - B. CONTROL JOINTS SHALL BE INSTALLED IN SLABS ON GRADE SO THE LENGTH TO WIDTH RATIO OF THE SLAB IS NO MORE THAN 1.25:1. CONTROL JOINTS SHALL BE COMPLETED WITHIN 12 HOURS OF CONCRETE PLACEMENT. CONTROL JOINTS MAY BE INSTALLED BY: SAW CUT A DEPTH OF 1/4 THE THICKNESS OF THE SLAB TOOLED JOINTS A DEPTH OF 1/4 THE THICKNESS OF THE SLAB
   - C. INSTALL CONSTRUCTION OR CONTROL JOINTS IN SLABS ON GRADE AT A SPACING NOT TO EXCEED 30 TIMES THE SLAB THICKNESS IN ANY DIRECTION FOR UNREINFORCED SLABS AND 75 TIMES THE SLAB THICKNESS IN ANY DIRECTION FOR REINFORCED SLABS, UNLESS NOTED OTHERWISE. CONSTRUCTION JOINTS SHALL NOT EXCEED A DISTANCE OF 125'-0" O.C. IN ANY DIRECTION.
8. CONSTRUCTION
   - A. USE CHAIRS OR OTHER SUPPORT DEVICES RECOMMENDED BY THE CRSI TO SUPPORT AND TIE REINFORCEMENT BARS AND WWF PRIOR TO PLACING CONCRETE. WWF SHALL BE CONTINUOUSLY SUPPORTED AT 36" O.C. MAXIMUM. REINFORCING STEEL FOR SLABS ON GRADE SHALL BE ADEQUATELY SUPPORTED ON PRECAST CONCRETE UNITS. LIFTING THE REINFORCING OFF THE GRADE DURING PLACEMENT OF CONCRETE IS NOT PERMITTED
   - B. CONTRACTOR SHALL COORDINATE PLACEMENT OF ALL OPENINGS, CURBS, DOWELS, SLEEVES, CONDUITS, BOLTS, INSERTS AND OTHER EMBEDDED ITEMS PRIOR TO CONCRETE PLACEMENT.
   - C. ALL EMBEDS AND DOWELS SHALL BE SECURELY TIED TO FORM WORK OR TO ADJACENT REINFORCING PRIOR TO THE PLACEMENT OF CONCRETE.
   - D. NO PIPES, DUCTS, SLEEVES, ETC SHALL BE PLACED IN STRUCTURAL CONCRETE UNLESS SPECIFICALLY DETAILED OR APPROVED BY THE STRUCTURAL ENGINEER. PENETRATIONS THROUGH WALLS, WHEN APPROVED, SHALL BE BUILT INTO THE WALL PRIOR TO CONCRETE PLACEMENT. PENETRATIONS WILL NOT BE ALLOWED IN FOOTINGS OR GRADE BEAMS UNLESS DETAILED. PIPING SHALL BE ROUTED AROUND THESE ELEMENTS AND FOOTINGS STEPPED TO AVOID PIPING.
   - E. REINFORCING BARS SHALL NOT BE WELDED UNLESS SPECIFICALLY SHOWN ON DRAWINGS. IN SUCH CASES, USE ONLY AWS STANDARDS. DO NOT SUBSTITUTE REINFORCING BARS FOR DBAS OR HSAS.
   - F. THE STRUCTURE IS DESIGNED TO FUNCTION AS A UNIT UPON COMPLETION. CONTRACTOR IS RESPONSIBLE FOR FURNISHING ALL TEMPORARY FALSEWORK, SHORING AND LATERAL BRACING OF THE STRUCTURE AND RELATED FALSEWORK DURING CONSTRUCTION DEMOLITION OR ERECTION.
9. DETAILING:
   - A. LAP LENGTHS SHALL BE AS FOLLOWS:
     FOR F'C = 3000 PSI
     #6 AND SMALLER 44 BD.
     #7 AND LARGER 55 BD.
     FOR F'C = 4000 PSI
     #6 AND SMALLER 38 BD.
     #7 AND LARGER 47 BD.
   - B. AT JOINTS PROVIDE REINFORCING DOWELS TO MATCH THE MEMBER REINFORCING, UNLESS NOTED OTHERWISE.
   - C. AT ALL DISCONTINUOUS CONTROL OR CONSTRUCTION SLAB ON GRADE JOINTS, PROVIDE 2 - #4 X 48 INCHES.
   - D. PROVIDE CORNER BARS AT INTERSECTING WALL CORNERS USING THE SAME BAR SIZE AND SPACING AS THE HORIZONTAL WALL REINFORCING.
   - E. ALL VERTICAL REINFORCING SHALL BE DOWELED TO FOOTINGS, OR TO THE STRUCTURE BELOW WITH THE SAME SIZE AND SPACING AS THE VERTICAL REINFORCING FOR THE ELEMENT ABOVE. DOWELS EXTENDING INTO FOOTINGS SHALL TERMINATE WITH A 90 DEGREE STANDARD HOOK AND SHALL EXTEND TO WITHIN 4" OF THE BOTTOM OF THE FOOTING. FOOTING DOWELS (#8 BARS AND SMALLER) WITH HOOKS NEED NOT EXTEND MORE THAN 20" INTO FOOTINGS.
   - F. HORIZONTAL WALL REINFORCING SHALL TERMINATE AT ENDS OF WALLS AND OPENINGS INTO THE FAR END OF THE JAMB COLUMN WITH A 90 DEGREE STANDARD HOOK PLUS A 6 BAR DIAMETER EXTENSION. . . HORIZONTAL WALL REINFORCING SHALL BE CONTINUOUS THROUGH CONSTRUCTION AND CONTROL JOINTS. SPLICES IN HORIZONTAL REINFORCEMENT SHALL BE STAGGERED. SPLICES IN TWO CURTAINS WHERE USED SHALL NOT OCCUR IN THE SAME LOCATION.
   - G. PROVIDE 2- #5 BARS AROUND ALL OPENINGS LARGER THAN 8 INCHES IN ANY DIRECTION AND SMALLER THAN 36 INCHES, UNLESS NOTED OTHERWISE. EXTEND REINFORCING BARS A MINIMUM OF 24" BEYOND THE CORNER OF THE OPENINGS. WHERE 24" IS NOT AVAILABLE, EXTEND BARS AS FAR BEYOND THE OPENING AS POSSIBLE AND TERMINATE THEM WITH A 90 STANDARD HOOK. FOR LARGER UNREINFORCED OPENINGS CONTACT THE ENGINEER.
   - H. PROVIDE 2-#5 X 4'-0" DIAGONAL BARS (OR 1 - #7 X 4'-0" BAR IN 10" WALLS AND THINNER) AT THE CORNERS OF ALL OPENINGS. DIAGONAL BARS SHALL BE CENTERED ON THE CORNER OF THE OPENING. ALL RECESSES IN CONCRETE WALLS THAT INTERRUPT REINFORCING STEEL SHALL BE REINFORCED THE SAME AS AN OPENING.
   - I. ALL EXPOSED CONCRETE WALLS SHALL BE 3/4" CHAMFERED.

REV#:	REVISION DESCRIPTION:	DATE:

Skyline A/E/S, INC.
Architecture / Engineering / Surveying
95 W. Golf Course Rd. #101, Logan, UT 84321
(435) 752-8501 / Fax (435) 752-8597

Professional Seal:

LICENSED PROFESSIONAL ENGINEER — GARY R. KNIGHTON — #170411 — 1-16-2014 — STATE OF UTAH

Project Title:

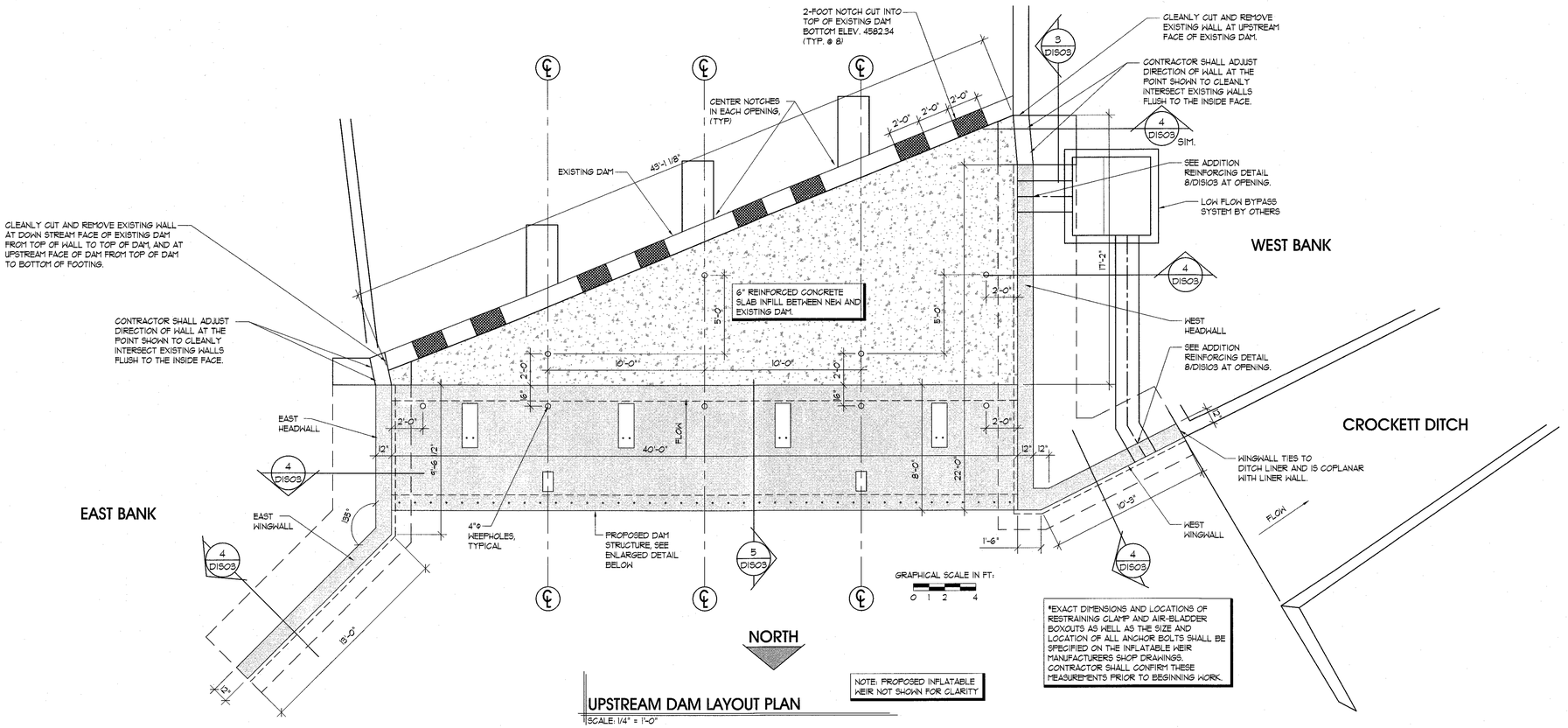
CROCKET DAM IMPROVEMENTS

LOGAN CITY, UTAH

Sheet Title:

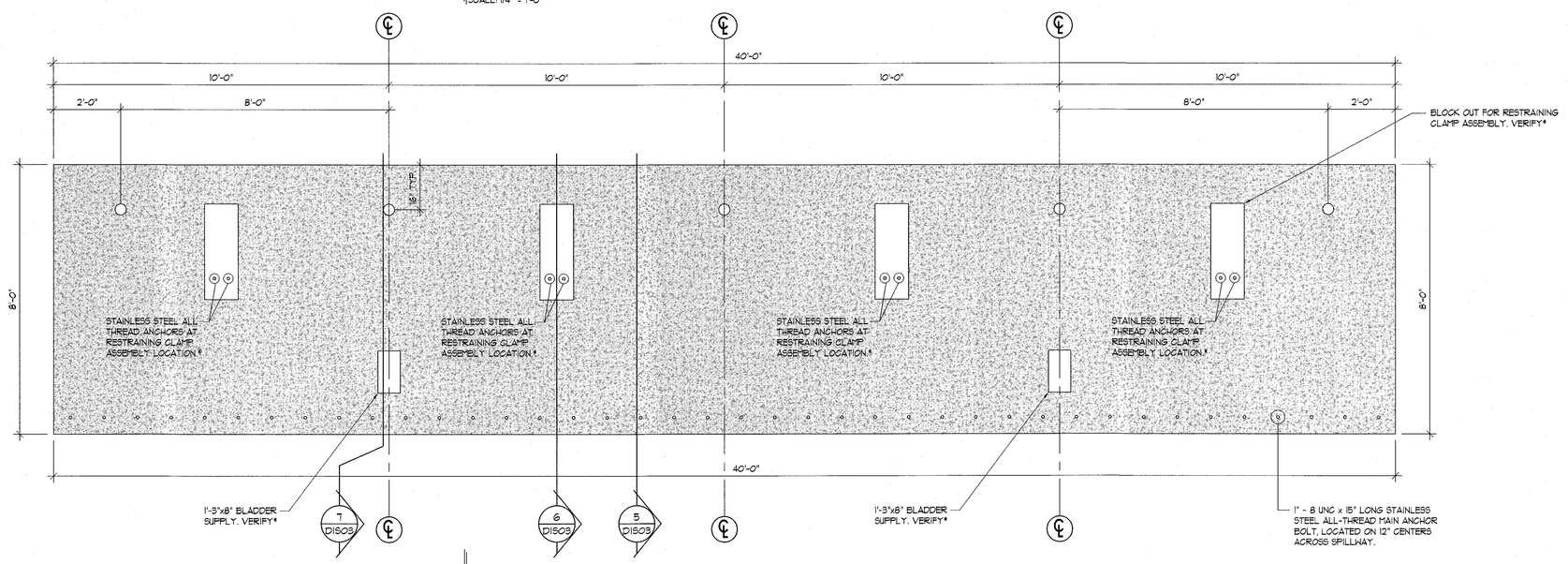
STRUCTURAL CONCRETE NOTES

Drawn By: T. EKINS	Project Number: 10-097	Drawing Type:
Designed By: G. KNIGHTON	Date: 1-10-14	Sheet Number: DIS01
Reviewed By: G. KNIGHTON	Sheet Scale: NONE	of



UPSTREAM DAM LAYOUT PLAN

SCALE: 1/4" = 1'-0"



ENLARGED LAYOUT PLAN

SCALE: 1/2" = 1'-0"

REV#:	REVISION DESCRIPTION:	DATE:

Skyline A/E/S, INC.
Architecture / Engineering / Surveying
95 W. Golf Course Rd. #101, Logan, UT 84321
(435) 752-8501 / Fax (435) 752-8597

Professional Seal:

GARY R. KNIGHTON #170414 1/10/2014 PROFESSIONAL ENGINEER STATE OF UTAH

Project Title:

CROCKET DAM IMPROVEMENTS

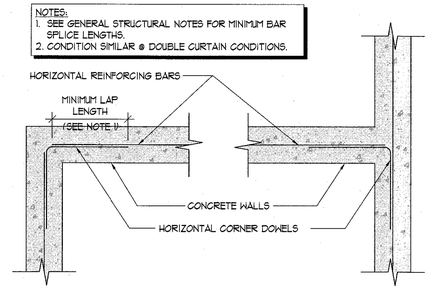
LOGAN CITY, UTAH

Sheet Title:

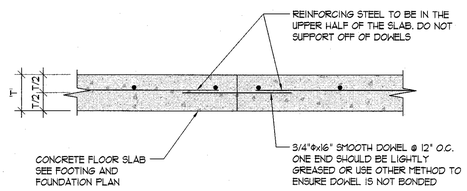
STRUCTURAL CONCRETE LAYOUT

Drawn By: T. EKINS	Project Number: 10-097	Drawing Type:
Designed By: G. KNIGHTON	Date: 1-10-14	Sheet Number: DIS02
Reviewed By: G. KNIGHTON	Sheet Scale: NONE	of

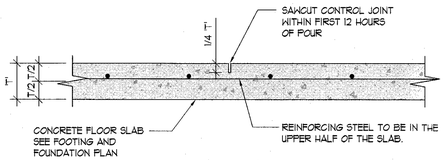
NOTES:
1. SEE GENERAL STRUCTURAL NOTES FOR MINIMUM BAR SPLICE LENGTHS.
2. CONDITION SIMILAR @ DOUBLE CURTAIN CONDITIONS.



DETAIL — SCALE: 3/4" = 1'-0" — 1 / DIS03



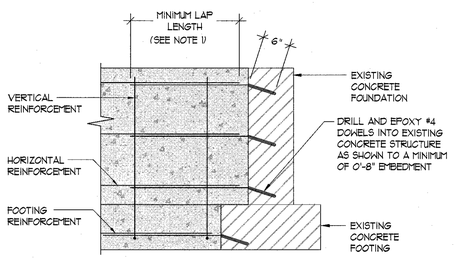
CONSTRUCTION JOINT



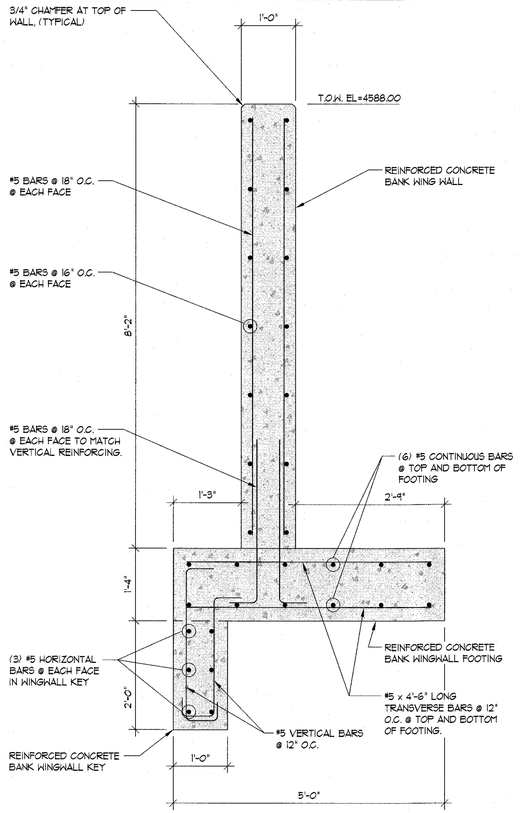
CONTROL JOINT

DETAIL — SCALE: 3/4"=1'-0" — 2 / DIS03

NOTES:
1. SEE GENERAL STRUCTURAL NOTES FOR MINIMUM BAR SPLICE LENGTHS.
2. CONDITION SIMILAR @ DOUBLE CURTAIN CONDITIONS.

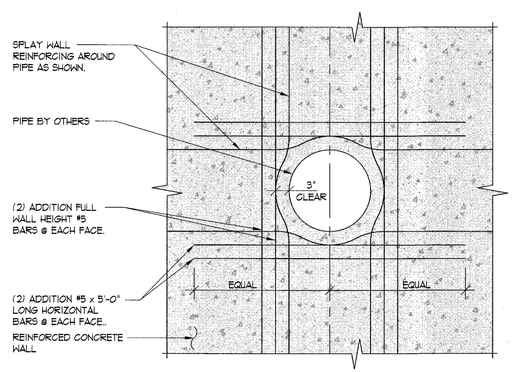


NEW CONC. WALL TO EXIST. CONC. WALL CONNECTION DETAIL — SCALE: 3/4" = 1'-0" — 3 / DIS03

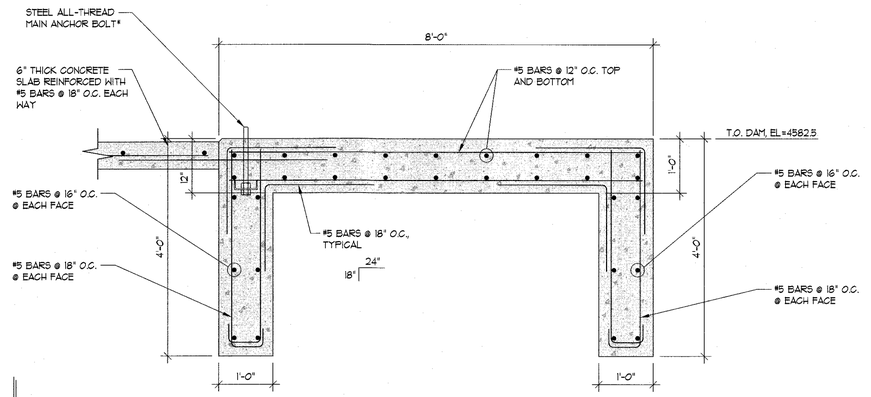


*EXACT DIMENSIONS AND LOCATIONS OF RESTRAINING CLAMP AND AIR-BLADDER BOXOUTS AS WELL AS THE SIZE AND LOCATION OF ALL ANCHOR BOLTS SHALL BE SPECIFIED ON THE INFLATABLE WEIR MANUFACTURERS SHOP DRAWINGS. CONTRACTOR SHALL CONFIRM THESE MEASUREMENTS PRIOR TO BEGINNING WORK.

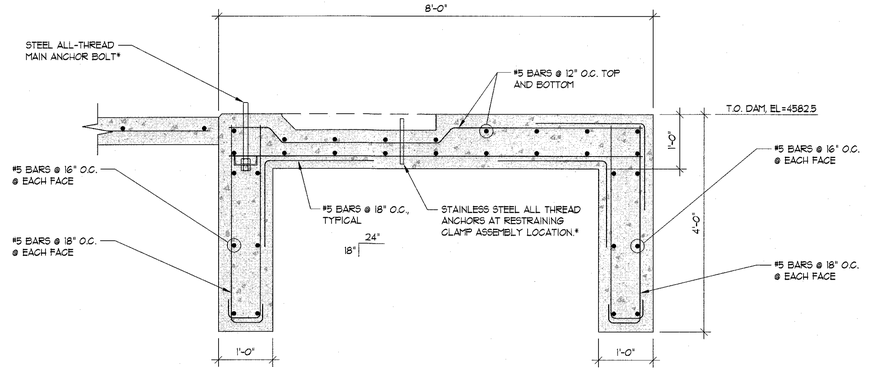
DETAIL — SCALE: 3/4" = 1'-0" — 4 / DIS03



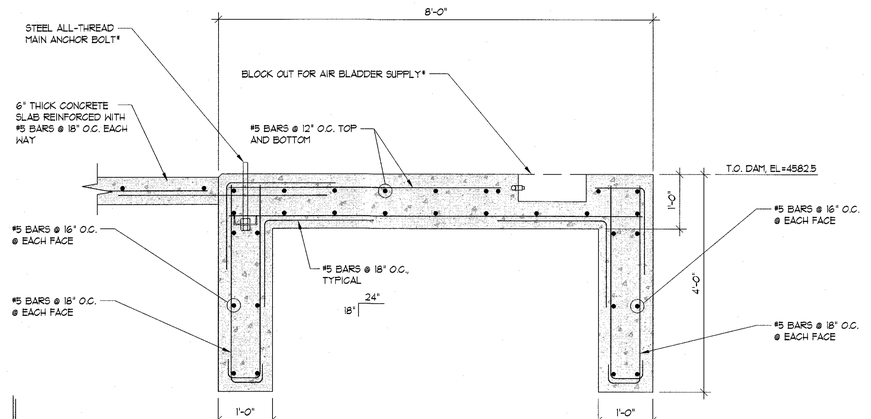
DETAIL — SCALE: 3/4"=1'-0" — 8 / DIS03



DETAIL — SCALE: 3/4" = 1'-0" — 5 / DIS03



DETAIL — SCALE: 3/4" = 1'-0" — 6 / DIS03



DETAIL — SCALE: 3/4" = 1'-0" — 7 / DIS03

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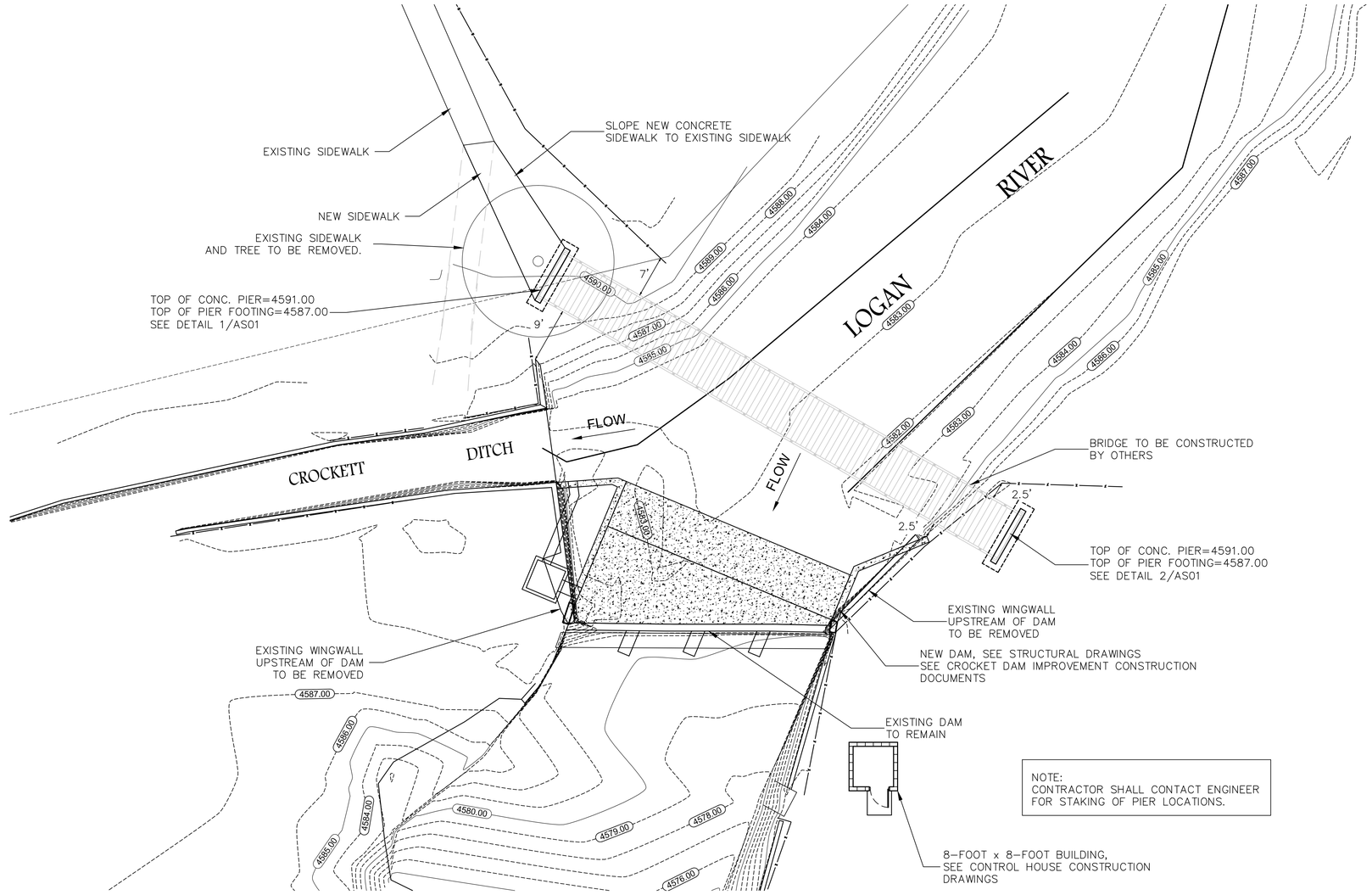
(435) 752-8501 / Fax (435) 752-8597

Professional Seal: LICENSED PROFESSIONAL ENGINEER — GARY L. KNIGHTON — #170411 — 1/10/2014 — STATE OF UTAH

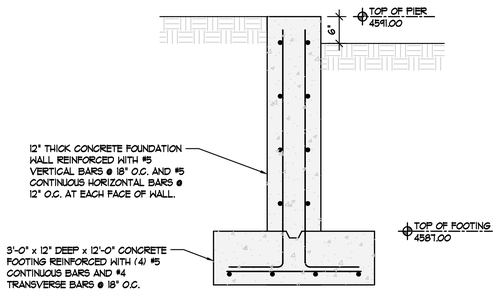
Project Title:
CROCKET DAM IMPROVEMENTS
LOGAN CITY, UTAH

Sheet Title:
STRUCTURAL CONCRETE DETAILS

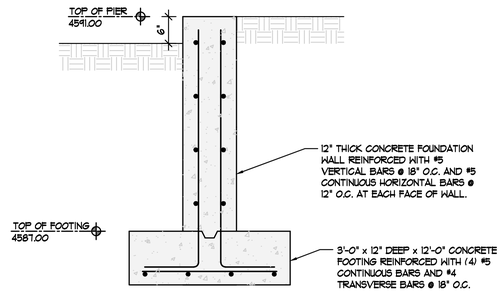
Drawn By: T. EKINS	Project Number: 1-10-14	Drawing Type:
Designed By: G. KNIGHTON	Date: 8-19-13	Sheet Number: DIS03
Reviewed By: G. KNIGHTON	Sheet Scale: NONE	of



NOTE:
CONTRACTOR SHALL CONTACT ENGINEER FOR STAKING OF PIER LOCATIONS.



BRIDGE PIER DETAIL 1 / AS01
SCALE: NONE



BRIDGE PIER DETAIL 2 / AS01
SCALE: NONE

GRAPHICAL SCALE IN FT:
0 5 10 20

REV#:	REVISION DESCRIPTION:	DATE:

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Architecture / Engineering / Surveying
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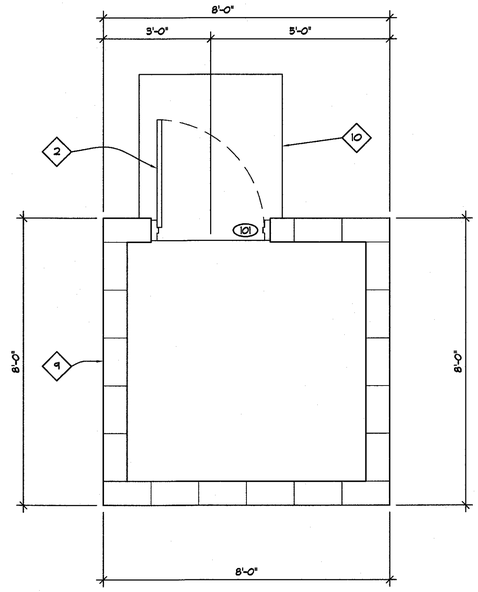
(435) 752-8501 / Fax (435) 752-8597

Professional Seal:
LICENSED PROFESSIONAL ENGINEER
GARY E. KNIGHTON #170411
STATE OF UTAH

Project Title:
CROCKET DAM IMPROVEMENTS
LOGAN CITY, UTAH

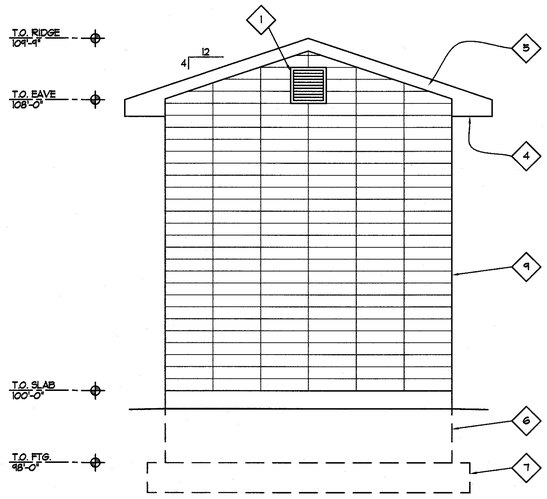
Sheet Title:
ARCHITECTURAL SITE PLAN

Drawn By:	Project Number:	Drawing Type:
T. EKINS	10-027	
Designed By:	Date:	Sheet Number:
G. KNIGHTON	1-10-14	AS01
Reviewed By:	Sheet Scale:	1 of 1
G. KNIGHTON	AS NOTED	



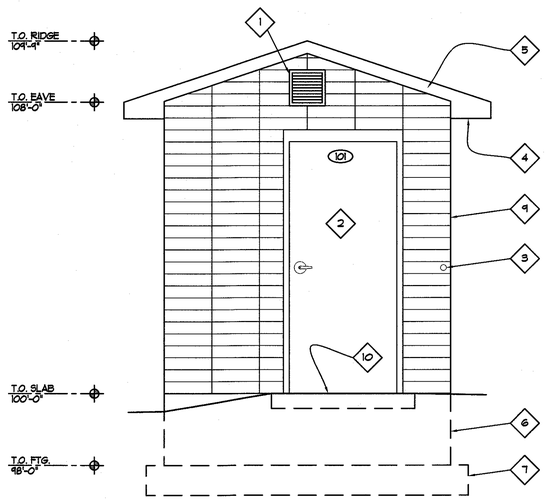
MAIN FLOOR PLAN

SCALE: 1/2" = 1'-0"



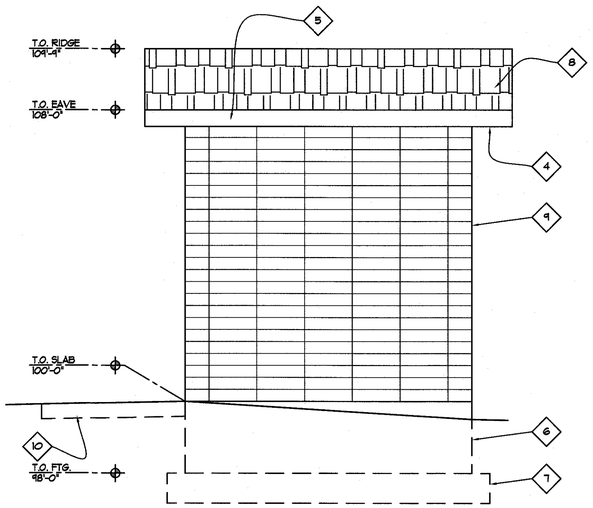
NORTH ELEVATION

SCALE: 1/2" = 1'-0"



SOUTH ELEVATION

SCALE: 1/2" = 1'-0"



EAST AND WEST ELEVATION

SCALE: 1/2" = 1'-0"

KEY NOTES

1. 12"x12" ATTIC VENT
2. DOOR; SEE DOOR SCHEDULE SHEET: A401
3. DOOR STOP
4. ALUMINUM SOFFIT
5. ALUMINUM FASCIA
6. LINE OF CONCRETE FOUNDATION WALL
7. LINE OF CONCRETE FOOTING
8. WOOD SHINGLES OVER (2) LAYERS OF #30 ROOFING FELT
9. 8"x4"x16" ATLAS BLOCK
10. 4'-0"x4'-0"x5" THICK EXTERIOR CONCRETE SLAB

NOTE:
BUILDING COLORS ARE TO BE SELECTED BY LOGAN CITY.

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Professional Seal:

LICENSED PROFESSIONAL ARCHITECT
GARY E. KNIGHTON
#170414
1-10-2014
STATE OF UTAH

Project Title:

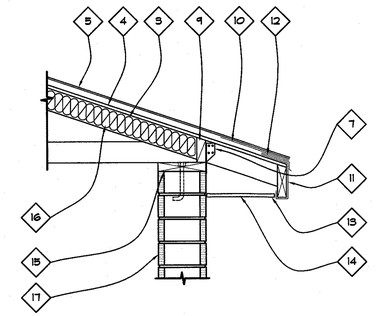
CROCKET DAM CONTROL HOUSE

LOGAN CITY, UTAH

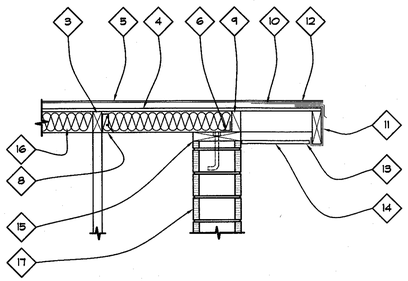
Sheet Title:

MAIN FLOOR PLAN AND EXTERIOR ELEVATIONS

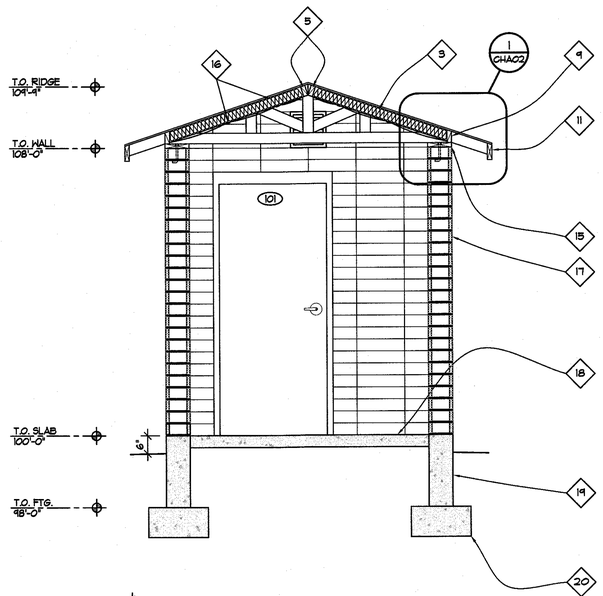
Drawn By: T. EKINS	Project Number: 10-027	Drawing Type:
Designed By: G. KNIGHTON	Date: 1-10-14	Sheet Number: CHA01
Reviewed By: G. KNIGHTON	Sheet Scale: NONE	of



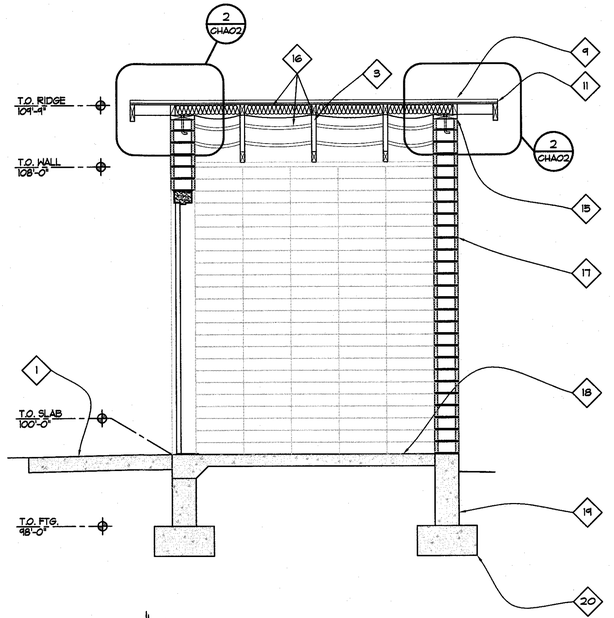
DETAIL 1 / CHA02
SCALE: 1" = 1'-0"



DETAIL 2 / CHA02
SCALE: 1" = 1'-0"



BUILDING SECTION A / CHA02
SCALE: 1/2" = 1'-0"

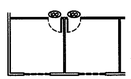


BUILDING SECTION B / CHA02
SCALE: 1/2" = 1'-0"

KEY NOTES

1. 4'-0"x4'-0"x5" THICK EXTERIOR CONCRETE SLAB
2. 2x4 SOLID BLOCKING BETWEEN EACH TRUSS, STAGGERED.
3. PRE-ENGINEERED WOOD TRUSSES @ 24" O.C.
4. ROOF SHEATHING, SEE STRUCTURAL DRAWINGS
5. WOOD SHINGLES OVER #30 ROOFING FELT
6. 'SIMPSON' A34 FRAMING ANCHOR @ EA. TRUSS, SEE STRUCTURAL DRAWINGS.
7. 'SIMPSON' H2.5 JOIST HANGER @ EA. TRUSS, SEE STRUCTURAL DRAWINGS.
8. 'SIMPSON' U2.5 JOIST HANGER @ EA. OUTRIGGER, SEE STRUCTURAL DRAWINGS.
9. 2x FULL HEIGHT SOLID BLOCKING BETWEEN EACH FRAMING MEMBER.
10. SELF-ADHERING POLYMER MODIFIED BITUMINOUS ICE SHEET.
11. 2x6 FASCIA WRAPPED W/ ALUMINUM
12. CONTINUOUS ALUMINUM FLASHING
13. "J" MOLD @ EACH END OF PERFORATED ALUMINUM SOFFIT
14. PERFORATED ALUMINUM SOFFIT
15. 2x CONT. WOOD 'E' W/ 5/8"ø ANCHOR BOLTS @ 32" O.C.
16. R-30 BATT. INSULATION FASTENED TO BOTTOM TOP CHORD OF WOOD TRUSS MEMBER. PROVIDE LIGHT GAUGE METAL STRAPS TO REINFORCE BATT. INSULATION PLACEMENT.
17. 8"x4"x16" ATLAS BLOCK
18. 4" THICK CONCRETE SLAB; SEE STRUCTURAL DRAWINGS
19. 8" WIDE REINFORCED CONCRETE FOUNDATION WALL; SEE STRUCTURAL DRAWINGS
20. REINFORCED CONCRETE FOOTING; SEE STRUCTURAL DRAWINGS

DOOR SCHEDULE

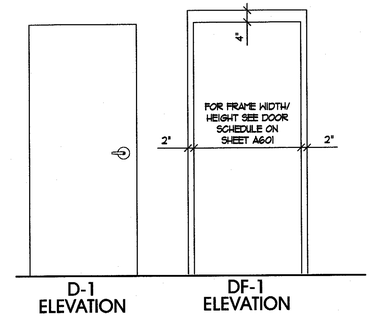


DR#	TYPE	SIZE	MATERIAL: INSUL. HOLLOW METAL DOOR	MATERIAL: TYPE (SEE SHEET A701)	FINISH: PAINTED	FRAME: HOLLOW METAL	FRAME: TYPE (SEE SHEET A701)	FINISH: PAINTED	HARDWARE: HARDWARE GROUP #1	NOTES: PAINT COLOR BY OWNER
103	EXT.	3'-0" x 7'-0"	●	D-1	●	●	DF-1	●	●	●

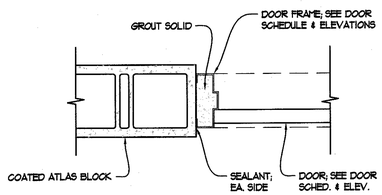
DOOR HARDWARE

HARDWARE GROUP #1

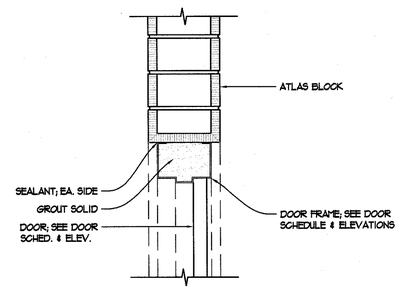
EXIT LOCK SET	SCHLAGE D12D
LOCK CYLENDER	SCHLAGE 20-700 SERIES
3-BUTT HINGES	HAGAR BB1191
CLOSER	NORTON 8501BF
THRESHOLD	PEMKO 172 A
WEATHER STRIP	PEMKO 588D
DOOR SWEEP	PEMKO 368 AN



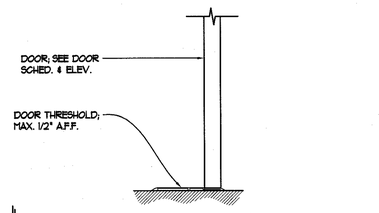
DOOR ELEVATION
SCALE: 1/2" = 1'-0"



MASONRY WALL: DOOR JAMB
HOLLOW METAL FRAME SYSTEM
SCALE: 1-1/2" = 1'-0"



MASONRY WALL: DOOR HEAD
HOLLOW METAL FRAME SYSTEM
SCALE: 1-1/2" = 1'-0"



DOOR SILL DETAIL
SCALE: 1-1/2" = 1'-0"

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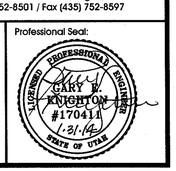
Professional Seal:



Project Title:

CROCKET DAM CONTROL HOUSE

LOGAN CITY, UTAH

Sheet Title:

BUILDING SECTIONS AND DETAILS

Drawn By: T. EKINS	Project Number: 10-027	Drawing Type:
Designed By: G. KNIGHTON	Date: 1-10-14	Sheet Number: CHA02
Reviewed By: G. KNIGHTON	Sheet Scale: AS NOTED	of

GENERAL

1. THE STRUCTURAL NOTES ARE INTENDED TO COMPLEMENT THE PROJECT SPECIFICATIONS. SPECIFIC NOTES AND DETAILS IN THE DRAWINGS SHALL GOVERN OVER THE STRUCTURAL NOTES AND TYPICAL DETAILS.
2. TYPICAL DETAILS AND SECTIONS SHALL APPLY WHERE SPECIFIC DETAILS ARE NOT SHOWN
3. THE CONTRACTOR SHALL VERIFY ALL SITE CONDITIONS AND DIMENSIONS. IF ACTUAL CONDITIONS DIFFER FROM THOSE SHOWN IN THE CONTRACT DRAWINGS, THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE ARCHITECT/ENGINEER BEFORE PROCEEDING WITH THE FABRICATION OR CONSTRUCTION OF ANY EFFECTED ELEMENTS.
4. OMISSIONS OR CONFLICTS BETWEEN THE CONTRACT DRAWINGS AND/OR SPECIFICATIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ARCHITECT/ENGINEER BEFORE PROCEEDING WITH ANY WORK INVOLVED. IN CASE OF CONFLICT, FOLLOW THE MOST STRINGENT REQUIREMENT AS DIRECTED BY THE ARCHITECT/ENGINEER AT NO ADDITIONAL COST TO THE OWNER.
5. THE CONTRACTOR SHALL SUBMIT A WRITTEN REQUEST TO THE ARCHITECT/ENGINEER BEFORE PROCEEDING WITH ANY CHANGES, SUBSTITUTIONS OR MODIFICATIONS. ANY WORK DONE BY THE CONTRACTOR BEFORE RECEIVING WRITTEN APPROVAL WILL BE AT THE CONTRACTOR'S RISK.
6. THE CONTRACTOR SHALL COORDINATE WITH ALL TRADES ANY ITEMS THAT ARE TO BE INTEGRATED INTO THE STRUCTURAL SYSTEM SUCH AS OPENINGS, PENETRATIONS, MECHANICAL AND ELECTRICAL EQUIPMENT, ETC. SIZES AND LOCATIONS OF MECHANICAL AND OTHER EQUIPMENT THAT DIFFERS FROM THOSE SHOWN ON THE CONTRACT DRAWINGS SHALL BE REPORTED TO THE ARCHITECT/ENGINEER.
7. THE CONTRACTOR SHALL PROVIDE ADEQUATE SHORING AND BRACING AS REQUIRED FOR HIS METHOD OF ERECTION. SHORING AND BRACING SHALL REMAIN IN PLACE UNTIL FINAL CONNECTIONS FOR THE PERMANENT MEMBERS ARE COMPLETED. THE BUILDING SHALL NOT BE CONSIDERED STABLE UNTIL ALL CONNECTIONS ARE COMPLETED. WALLS SHALL NOT BE CONSIDERED SELF SUPPORTING AND SHALL BE BRACED UNTIL THE FLOOR/ROOF SYSTEM IS COMPLETED.
8. SITE OBSERVATIONS BY SKYLINE A/E/S/ INC'S FIELD REPRESENTATIVE SHALL NOT BE CONSTRUED AS APPROVAL OF CONSTRUCTION PROCEDURES NOR SPECIAL INSPECTION.
9. DETAILING AND SHOP DRAWING PRODUCTION FOR STRUCTURAL ELEMENTS WILL REQUIRE INFORMATION (INCLUDING DIMENSIONS) CONTAINED IN THE ARCHITECTURAL, STRUCTURAL AND/OR OTHER CONSULTANTS' DRAWINGS. THE STRUCTURAL DRAWINGS SHALL BE USED IN CONJUNCTION WITH THE ARCHITECTURAL AND OTHER CONSULTANTS DRAWINGS. SOME DIMENSIONS AND ELEMENTS SUCH AS ELEVATIONS, DEPRESSIONS, SLOPES, MECHANICAL HOUSEKEEPING PADS, ETC. MAY NOT BE SHOWN IN THE STRUCTURAL DRAWINGS.
10. REVIEW OF SHOP DRAWING SUBMITTALS BY SKYLINE A/E/S INC. IS FOR GENERAL COMPLIANCE ONLY AND IS NOT INTENDED FOR APPROVAL. THE SHOP DRAWING REVIEW SHALL NOT RELIEVE THE CONTRACTOR FROM THE RESPONSIBILITY OF COMPLETING THE PROJECT ACCORDING TO THE CONTRACT DOCUMENTS.
11. SHOP DRAWINGS MADE FROM REPRODUCTIONS OF THE CONTRACT DRAWINGS WILL BE REJECTED UNLESS THE CONTRACTOR SIGNS A RELEASE AGREEMENT PRIOR TO THE SHOP DRAWINGS BEING REVIEWED.

BASIS OF DESIGN

1. GOVERNING BUILDING CODE: 2012 INTERNATIONAL BUILDING CODE

2. ROOF SNOW LOAD . . . . . .51 PSF PLUS SNOW DRIFT
   ROOF COLLATERAL LOAD. . . . . .0 PSF
   ROOF DEAD LOAD. . . . . .10 PSF

3. SEISMIC LOADS
   SEISMIC DESIGN CATAGORY. . . . .D
   SOILS SITE CLASS. . . . . .D
   S_Di. 0.5168
   S_Ds. 0.7485
   Cs. 0.1361
   W. . . . . DEAD LOADS OF STRUCTURE PLUS 20% OF SNOW LOAD
   BASE SHEAR. . . . . .Vs = 0.7CsW = 0.0953 x W (ASD)
   IMPORTANCE FACTOR. . . . . .I = 1.00
   BUILDING TYPE. . . . . .R = 5.5

4. WIND LOADS LOADS
   BASIC WIND VELOCITY. . . . . .90 MPH (3 SEC. GUST)
   EXPOSURE TYPE. C
   IMPORTANCE FACTOR. 1.00

FOUNDATION

1. SOILS INVESTIGATION TEST PIT: SKYLINE A/E/S, INC.
2. SOIL BEARING PRESSURE: 1500 PSF ASSUMED
3. FROST PROTECTION: 30 INCHES MINIMUM
4. CLEAR EXCAVATIONS OF DEBRIS AND LOOSE SOIL PRIOR TO PLACING FOOTINGS. ALL FOOTINGS SHALL BEAR ON UNDISTURBED NATURAL SUB-GRADE OR ENGINEERED COMPACTED FILL AS NOTED IN THESE DRAWINGS.

EARTHWORK

1. CLEARING: THE ENTIRE BUILDING AREA SHALL BE SCRAPED TO REMOVE THE TOP 4 INCHES OF SOIL, INCLUDING ALL VEGETATION AND DEBRIS.
2. PROOF ROLLING: THE NATURAL UNDISTURBED SOIL BELOW ALL FOOTINGS SHALL BE PROOF ROLLED PRIOR TO PLACING CONCRETE. REMOVE ALL SOFT SPOTS AND REPLACE WITH COMPACTED STRUCTURAL FILL.
3. COMPACTED STRUCTURAL FILL: ALL FILL MATERIAL SHALL BE A WELL-GRADED GRANULAR MATERIAL WITH A MAXIMUM SIZE LESS THAN 4 INCHES AND WITH NOT MORE THAN 10 PERCENT PASSING A NO. 200 SIEVE. IT SHALL BE COMPACTED TO 95 PERCENT OF THE MAXIMUM LABORATORY DENSITY AS DETERMINED BY ASTM D 1557. ALL FILL SHALL BE TESTED.
4. CONSULT THE PROJECT SPECIFICATIONS FOR FURTHER EARTHWORK REQUIREMENTS.

CONCRETE

1. MATERIALS, UNLESS NOTED OTHERWISE:
   A. NORMAL WEIGHT AGGREGATES. . . . . ASTM C 33
   B. LIGHT WEIGHT AGGREGATES. . . . . ASTM C 330
      LIGHTWEIGHT CONCRETE SHALL NOT EXCEED 110 POUNDS PER CUBIC FOOT AND SHALL BE MADE OF LIGHTWEIGHT COURSE AGGREGATES AND A BLEND OF LIGHTWEIGHT AND NORMAL WEIGHT FINES.
   C. REINFORCING STEEL: ASTM 615 GRADE 60 (FY = 60 KSI), USE GRADE 40 (FY = 40 KSI) FOR FIELD BENT DOWELS WITH SPACINGS INDICATED REDUCED BY 1/3.
   D. DEFORMED BAR ANCHORS (DBA). . . . . ASTM A496
   E. HEADED STUD ANCHORS (HSA). . . . . ASTM A108
   F. ANCHOR BOLTS: ASTM A307 WITH ASTM A563 HEAVY HEX NUTS WITH HARDENED WASHERS
   G. ADMIXTURES: AIR-ENTRAINING ADMIXTURES, COMPLY WITH ASTM C 260 (WHEN USED).
      CALCIUM CHLORIDE SHALL NOT BE ADDED TO THE CONCRETE MIX.
   H. NO ALUMINUM CONDUIT OR PRODUCT CONTAINING ALUMINUM OR ANY OTHER MATERIAL INJURIOUS TO CONCRETE SHALL BE EMBEDDED IN CONCRETE.
2. COMPRESSIVE STRENGTHS OF CONCRETE AT 28 DAYS SHALL BE AS FOLLOWS:
   A. FOOTINGS. . . . . 3000 PSI
   B. INTERIOR SLABS ON GRADE. . . . . 3000 PSI
   C. FOUNDATION WALLS. . . . . 4000 PSI
   D. COLUMNS. . . . . 4000 PSI
   E. JOISTS, BEAMS AND SUSPENDED SLABS. . . . . 4000 PSI
   F. TILT UP WALL PANELS. . . . . 4000 PSI
   G. NORMAL HEIGHT CONCRETE OVER STEEL DECK. . . . . 3500 PSI
   H. ALL SITE CAST CONCRETE. . . . . 4500 PSI
3. 2-1/2" THICK (4" OVERALL) NORMAL HEIGHT CONCRETE SLAB SHALL BE POURED OVER THE STEEL DECK. REINFORCE SLAB WITH 6" X 6" - W4.0/W4.0 WELDED WIRE FABRIC MINIMUM, UNLESS NOTED OTHERWISE. WELDED WIRE FABRIC SHALL BE PLACED 1" TO 1-1/2" BELOW THE TOP OF THE SLAB
4. ONLY ONE GRADE OR TYPE OF CONCRETE SHALL BE POURED ON THE SITE AT ANY GIVEN TIME.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN, DETAILING, CARE, PLACEMENT AND REMOVAL OF ALL FORM WORK AND SHORES.
   A. SUPPORTING FORMS AND SHORING SHALL NOT BE REMOVED UNTIL STRUCTURAL MEMBERS HAVE ACQUIRED SUFFICIENT STRENGTH TO SAFELY SUPPORT THEIR OWN WEIGHT AND ANY CONSTRUCTION LOAD TO WHICH THEY MAY BE SUBJECTED. IN NO CASE, HOWEVER,SHALL FORMS AND SHORING BE REMOVED IN LESS THAN 24 HOURS AFTER CONCRETE PLACEMENT.
   B. SUSPENDED SLABS SHALL BE RESUPPORTED AFTER FORM REMOVAL UNTIL CONCRETE REACHES ITS 28 DAY SPECIFIED COMPRESSIVE STRENGTH.

CONCRETE CONTINUED

6. REINFORCEMENT SHALL HAVE THE FOLLOWING CONCRETE COVER:

	CLEAR COVER
CAST-IN-PLACE CONCRETE:	
A. CAST AGAINST AND PERMANENTLY EXPOSED TO EARTH.	3"
B. FORMED CONCRETE EXPOSED TO EARTH OR WEATHER:	
#6 THRU #18 BARS.	2"
#5 AND SMALLER BARS.	1-1/2"
C. CONCRETE NOT EXPOSED TO WEATHER OR IN CONTACT WITH GROUND:	
SLABS, WALLS, JOISTS, #11 BARS AND SMALLER.	3/4"
BEAMS, COLUMNS: PRIMARY REINF., TIES, STIRRUPS, SPIRALS.	1-1/2"
CONCRETE TILT-UP PANELS (MANUFACTURED UNDER PLANT CONTROLLED CONDITIONS)	
#6 BARS AND SMALLER.	1"
#8 THRU #18 BARS.	1-1/2"
PRE-CAST CONCRETE:	
A. CONCRETE EXPOSED TO EARTH OR WEATHER:	
WALL PANELS:	
#11 BARS AND SMALLER.	3/4"
#14 AND #18 BARS.	1-1/2"
OTHER MEMBERS:	
#11 BARS AND SMALLER.	1-1/2"
#14 AND #18 BARS.	2"
B. CONCRETE NOT EXPOSED TO WEATHER OR IN CONTACT WITH GROUND:	
SLABS, WALLS, JOISTS.	
#11 BARS AND SMALLER.	5/8"
#14 AND #18 BARS.	1-1/2"
BEAMS, COLUMNS:	
PRIMARY REINFORCEMENT.	1-1/2"
TIES, STIRRUPS, SPIRALS.	3/8"

7. CONSTRUCTION JOINTS AND CONTROL JOINTS:
   A. PROVIDE A KEYED AND BEVELED 2 X 4 X CONTINUOUS KEYWAY IN ALL HORIZONTAL AND VERTICAL CONSTRUCTION JOINTS INCLUDING BETWEEN TOP OF FOOTING AND FOUNDATION WALLS. IN ADDITION, ALL JOINTS SHALL BE INTENTIONALLY ROUGHENED TO A FULL AMPLITUDE OF APPROXIMATELY 1/4 INCH.
   B. CONTROL JOINTS SHALL BE INSTALLED IN SLABS ON GRADE SO THE LENGTH TO WIDTH RATIO OF THE SLAB IS NO MORE THAN 1.25:1. CONTROL JOINTS SHALL BE COMPLETED WITHIN 12 HOURS OF CONCRETE PLACEMENT. CONTROL JOINTS MAY BE INSTALLED BY: SAW CUT A DEPTH OF 1/4 THE THICKNESS OF THE SLAB TOOLED JOINTS A DEPTH OF 1/4 THE THICKNESS OF THE SLAB
   C. INSTALL CONSTRUCTION OR CONTROL JOINTS IN SLABS ON GRADE AT A SPACING NOT TO EXCEED 30 TIMES THE SLAB THICKNESS IN ANY DIRECTION FOR UNREINFORCED SLABS AND 75 TIMES THE SLAB THICKNESS IN ANY DIRECTION FOR REINFORCED SLABS, UNLESS NOTED OTHERWISE. CONSTRUCTION JOINTS SHALL NOT EXCEED A DISTANCE OF 125'-0" O.C. IN ANY DIRECTION.
8. CONSTRUCTION
   A. USE CHAIRS OR OTHER SUPPORT DEVICES RECOMMENDED BY THE CRSI TO SUPPORT AND TIE REINFORCEMENT BARS AND MAT PRIOR TO PLACING CONCRETE. MAT SHALL BE CONTINUOUSLY SUPPORTED AT 36" O.C. MAXIMUM. REINFORCING STEEL FOR SLABS ON GRADE SHALL BE ADEQUATELY SUPPORTED ON PRECAST CONCRETE UNITS. LIFTING THE REINFORCING OFF THE GRADE DURING PLACEMENT OF CONCRETE IS NOT PERMITTED
   B. CONTRACTOR SHALL COORDINATE PLACEMENT OF ALL OPENINGS, CURBS, DOWELS, SLEEVES, CONDUITS, BOLTS, INSERTS AND OTHER EMBEDDED ITEMS PRIOR TO CONCRETE PLACEMENT.
   C. ALL EMBEDS AND DOWELS SHALL BE SECURELY TIED TO FORM WORK OR TO ADJACENT REINFORCING PRIOR TO THE PLACEMENT OF CONCRETE.
   D. NO PIPES, DUCTS, SLEEVES, ETC SHALL BE PLACED IN STRUCTURAL CONCRETE UNLESS SPECIFICALLY DETAILED OR APPROVED BY THE STRUCTURAL ENGINEER. PENETRATIONS THROUGH WALLS, WHEN APPROVED, SHALL BE BUILT INTO THE WALL PRIOR TO CONCRETE PLACEMENT. PENETRATIONS WILL NOT BE ALLOWED IN FOOTINGS OR GRADE BEAMS UNLESS DETAILED. PIPING SHALL BE ROUTED AROUND THESE ELEMENTS AND FOOTINGS STEPPED TO AVOID PIPING.
   E. REINFORCING BARS SHALL NOT BE WELDED UNLESS SPECIFICALLY SHOWN ON DRAWINGS. IN SUCH CASES, USE ONLY AWS STANDARDS. DO NOT SUBSTITUTE REINFORCING BARS FOR D8AS OR W8AS.
9. DETAILING:
   A. LAP LENGTHS SHALL BE AS FOLLOWS:
      FOR FC = 3000 PSI
      #6 AND SMALLER 44 BD.
      #7 AND LARGER 55 BD.
      FOR FC = 4000 PSI
      #6 AND SMALLER 38 BD.
      #7 AND LARGER 47 BD.
   B. AT JOINTS PROVIDE REINFORCING DOWELS TO MATCH THE MEMBER REINFORCING, UNLESS NOTED OTHERWISE.
   C. AT ALL DISCONTINUOUS CONTROL OR CONSTRUCTION SLAB ON GRADE JOINTS, PROVIDE 2 - #4 X 48 INCHES.
   D. PROVIDE CORNER BARS AT INTERSECTING WALL CORNERS USING THE SAME BAR SIZE AND SPACING AS THE HORIZONTAL WALL REINFORCING.
   E. ALL VERTICAL REINFORCING SHALL BE DOWELED TO FOOTINGS, OR TO THE STRUCTURE BELOW WITH THE SAME SIZE AND SPACING AS THE VERTICAL REINFORCING FOR THE ELEMENT ABOVE. DOWELS EXTENDING INTO FOOTINGS SHALL TERMINATE WITH A 90 DEGREE STANDARD HOOK AND SHALL EXTEND TO WITHIN 4" OF THE BOTTOM OF THE FOOTING. FOOTING DOWELS (#8 BARS AND SMALLER) WITH HOOKS NEED NOT EXTEND MORE THAN 20" INTO FOOTINGS.
   F. HORIZONTAL WALL REINFORCING SHALL TERMINATE AT ENDS OF WALLS AND OPENINGS INTO THE FAR END OF THE JAMB CONFIN WITH A 90 DEGREE STANDARD HOOK PLUS A 6 BAR DIAMETER EXTENSION. . HORIZONTAL WALL REINFORCING SHALL BE CONTINUOUS THROUGH CONSTRUCTION AND CONTROL JOINTS. SPLICES IN HORIZONTAL REINFORCEMENT SHALL BE STAGGERED. SPLICES IN TWO CURTAINS WHERE USED SHALL NOT OCCUR IN THE SAME LOCATION.
   G. PROVIDE 2- #5 BARS AROUND ALL OPENINGS LARGER THAN 8 INCHES IN ANY DIRECTION AND SMALLER THAN 36 INCHES, UNLESS NOTED OTHERWISE. EXTEND REINFORCING BARS A MINIMUM OF 24" BEYOND THE CORNER OF THE OPENINGS. WHERE 24" IS NOT AVAILABLE, EXTEND BARS AS FAR BEYOND THE OPENING AS POSSIBLE AND TERMINATE THEM WITH A 90 STANDARD HOOK. FOR LARGER UNREINFORCED OPENINGS CONTACT THE ENGINEER.
   H. PROVIDE 2-#5 X 4'-0" DIAGONAL BARS (OR 1 - #7 X 4'-0" BAR IN 10" WALLS AND THINNER) AT THE CORNERS OF ALL OPENINGS. DIAGONAL BARS SHALL BE CENTERED ON THE CORNER OF THE OPENING. ALL RECESSES IN CONCRETE WALLS THAT INTERRUPT REINFORCING STEEL SHALL BE REINFORCED THE SAME AS AN OPENING.

MASONRY

1. MATERIALS, UNLESS NOTED OTHERWISE:
   A. CONCRETE MASONRY UNITS (CMU):
      LIGHTWEIGHT GRADE N, TYPE 1 (MINIMUM UNIT STRENGTH OF 2100 PSI). FM = 1500 PSI
   B. HOLLOW CLAY UNITS: HOLLOW BRICK, GRADE 1 (MINIMUM UNIT STRENGTH OF 3,000 PSI) FM = 1800 PSI
   C. SOLID UNITS: GRADE SW (MINIMUM UNIT STRENGTH OF 3000 PSI). FM = 1800 PSI
   D. MORTAR: USE TYPE "S" (1800 PSI MINIMUM COMPRESSIVE STRENGTH FOR FIELD SPECIMENS)
   E. GROUT SHALL ATTAIN A MINIMUM COMPRESSIVE STRENGTH OF 2000 PSI AT 28 DAYS.
   F. REINFORCING STEEL. . . . . ASTM 615 GRADE 60 (FY = 60 KSI)
   G. DEFORMED BAR ANCHORS (DBA). . . . . ASTM A496
   H. HEADED STUD ANCHORS (HSA). . . . . ASTM A108
   I. ANCHOR BOLTS. . . . . ASTM A307 WITH ASTM A563 HEAVY HEX NUTS HARDENED WASHERS
2. REINFORCEMENT SHALL HAVE THE FOLLOWING COVER:
   A. JOINT REINFORCEMENT SHALL HAVE NOT LESS THAN 5/8" MORTAR COVERAGE FROM THE EXPOSED FACE.
   B. OTHER REINFORCEMENT SHALL HAVE A MINIMUM COVERAGE OF ONE BAR DIAMETER OVER ALL THE BARS, BUT NOT LESS THAN 3/4". WHEN MASONRY IS EXPOSED TO SOIL, MINIMUM COVERAGE SHALL BE 1 1/2".
3. CONSTRUCTION REQUIREMENTS:
   A. ALL UNITS SHALL BE LAID WITH FULL MORTAR BEDS ON THE FACE SHELLS. ALL HEAD JOINTS SHALL BE FILLED SOLIDLY WITH MORTAR FOR A DISTANCE IN FROM THE FACE OF THE UNITS NOT LESS THAN THE THICKNESS OF THE LONGITUDINAL FACE SHELLS. CELLS WHICH ARE TO BE GROUTED SHALL HAVE FULL HEAD JOINTS.
   B. MASONRY WALLS, BEAMS AND COLUMNS SHALL BE CONSTRUCTED WITH RUNNING BOND, UNLESS NOTED OTHERWISE.
   C. ALL CELLS CONTAINING REINFORCEMENT, EMBEDS, ANCHOR BOLTS, ETC. SHALL BE FILLED SOLID WITH GROUT. GROUT SHALL BE PLACED BY MECHANICAL VIBRATION DURING PLACING AND REVIBRATED AFTER EXCESS MOISTURE HAS BEEN ABSORBED BUT BEFORE WORKABILITY IS LOST. PUDDLING OF GROUT IS NOT ALLOWED.
   D. WHERE WALLS ARE NOT GROUTED SOLID, EACH GROUT POUR SHALL TERMINATE FLUSH WITH THE TOP OF THE UPPERMOST UNIT EXCEPT AT CELLS WITH VERTICAL REINFORCING WHERE THE GROUT SHALL BE 1-1/2 INCHES BELOW TOP OF UNIT TO PROVIDE CONSTRUCTION KEY.
   E. GROUT POURS SHALL BE LIMITED TO 4'-0" UNLESS HIGH LIFT GROUTING PROCEDURES ARE FOLLOWED.
   F. VERTICAL CELLS TO BE FILLED WITH GROUT SHALL HAVE VERTICAL ALIGNMENT SUFFICIENT TO MAINTAIN A CLEAR, UNOBSTRUCTED VERTICAL CELL MEASURING NOT LESS THAN 2 INCHES BY 3 INCHES. ALL STEEL REINFORCEMENT SHALL BE SECURED AGAINST DISPLACEMENT PRIOR TO GROUTING BY WIRE POSITIONERS OR OTHER SUITABLE DEVICES AT INTERVALS NOT EXCEEDING 200 BAR DIAMETERS OR 10 FEET MAXIMUM, OR AT BAR SPLICE LOCATIONS. VERTICAL REINFORCING SHALL BE LOCATED AT THE CENTER OF THE WALL UNLESS NOTED OTHERWISE
   G. REINFORCING BARS SHALL NOT BE WELDED UNLESS SPECIFICALLY SHOWN ON DRAWINGS. IN SUCH CASES, USE ONLY AWS STANDARDS. DO NOT SUBSTITUTE REINFORCING BARS FOR D8AS OR W8AS.
   H. CONTROL JOINTS: SPACING SHALL NOT EXCEED 40'-0". SEE ARCHITECTURAL DRAWINGS FOR LOCATIONS.

MASONRY CONTINUED

   I. GROUT ALL BEAM AND JOIST POCKETS SOLID AFTER INSTALLATION OF BEAMS AND JOISTS.
   J. EMBED CHANNELS AND PLATES SHALL BE PLACED SO AS TO CREATE A FLUSH SURFACE WITH THE FACE OF THE WALL.
   K. ANCHOR BOLTS AND HEADED STUD ANCHORS SHALL BE SET IN A GROUTED CELL. ANCHOR BOLTS AND HEADED STUD ANCHORS SHALL HAVE 1" GROUT SURROUNDING THE SHANK AT ITS PENETRATION. GROUT SHALL BE FLUSH WITH THE FACE OR TOP OF THE MASONRY.
4. DETAILING REQUIREMENT
   A. LAP ALL MASONRY REINFORCING A MINIMUM OF 48 BAR DIAMETERS WITH A MINIMUM LAP OF 24". JOINT REINFORCEMENT SHALL LAP A MINIMUM OF 6".
   B. ALL VERTICAL REINFORCING SHALL BE DOWELED TO THE FOUNDATION WALL, FOOTING (STRUCTURE BELOW) AND TO THE STRUCTURE BELOW WITH THE SAME SIZE DOWEL, SPACING (AND IN THE SAME CORE) AS THE VERTICAL WALL REINFORCING ABOVE.
   C. CORNER BARS: HORIZONTAL REINFORCEMENT SHALL BE CONTINUOUS AT ALL CORNERS AND AT INTERSECTING HALLS. PROVIDE CORNER BARS WITH THE REQUIRED LAP SPLICE LENGTH.
   D. WALL OPENINGS 24" WIDE AND WIDER: PROVIDE REINFORCED MASONRY LINTELS PER MASONRY LINTEL SCHEDULE OVER THE TOP OF, AND 2-#5 BARS, IN GROUTED SPACES, ON ALL SIDES AND ADJACENT TO EVERY UNSCHEDULED OPENING, UNLESS NOTED OTHERWISE. BARS FOR ALL OPENINGS SHALL EXTEND A MINIMUM OF 48 BAR DIAMETERS BEYOND THE CORNERS OF THE OPENING. VERTICAL BARS SHALL EXTEND FROM FLOOR LEVEL BELOW TO THE FLOOR, OR ROOF, LEVEL ABOVE. WHERE A 48 BAR DIAMETER EXTENSION IS NOT POSSIBLE, EXTEND BARS AS FAR BEYOND THE OPENING AS POSSIBLE AND TERMINATE THEM WITH A 90 DEGREE STANDARD ACI HOOK.
   E. HORIZONTAL WALL REINFORCING SHALL BE CONTINUOUS THROUGH JOINING CONCRETE WALLS, MASONRY WALLS, COLUMNS, AND PILASTERS. PROVIDE A KEY BETWEEN THE HALL AND THE COLUMN OR PILASTER. HORIZONTAL WALL REINFORCING SHALL BE PLACED INSIDE THE COLUMN VERTICAL REINFORCING.
   F. HORIZONTAL WALL REINFORCING SHALL TERMINATE AT EACH SIDE OF CONTROL JOINTS EXCEPT AT FLOOR AND ROOF LEVEL BEAMS AND AT TOP OF PARAPETS.
   G. ALL MASONRY COLUMN TIES SHALL TERMINATE WITH 135 DEGREE HOOKS PLUS A 6 BAR DIAMETER EXTENSION (4" MINIMUM).
5. MASONRY STRENGTH VERIFICATION:
   A. MASONRY STRENGTH, FM SHALL BE VERIFIED USING THE "UNIT STRENGTH METHOD" PER ACI 530-99/ASCE 5-99/TMS 402-99 TABLE 1A,1B AND AS DESCRIBED BELOW.
      I. PRIOR TO CONSTRUCTION, A LETTER OF STRENGTH CERTIFICATION FROM THE SUPPLIERS OF THE MASONRY UNITS AND GROUT SHALL BE SUBMITTED.
      II DURING CONSTRUCTION, THE GROUT AND MORTAR SHALL BE TESTED FOR EVERY 5,000 SQUARE FEET OF MASONRY CONSTRUCTED.

WOOD

1. MATERIALS:
   A. GLU-LAM BEAMS SHALL BE DOUGLAS-FIR COMBINATION NUMBER 24F-V4 EXCEPT CANTILEVERED AND CONTINUOUS BEAMS SHALL BE COMBINATION NUMBER 24F-V8.
   B. FRAMING LUMBER SHALL BE # 2 DOUGLAS FIR-LARCH OR BETTER UNLESS NOTED OTHERWISE.
   C. WOOD SHEATHING SHALL BE APA STRUCTURAL 1 "2 OR OSB, INTERIOR GRADE WITH EXTERIOR GLUE, SPAN INDEX RATIO, UNLESS NOTED OTHERWISE:
      24/0 WALLS (7/16 INCH THICK)
      32/16 FLOORS (3/4 INCH THICK)
      48/24 ROOF (5/8 INCH THICK)
      PLACE FACE GRAIN OF SHEATHING PERPENDICULAR TO ROOF JOISTS AND STUDS. STAGGER 4'-0" SIDE JOINTS. BLOCK ALL EDGES WITH 2X4 MINIMUM FLAT.
   D. NAILS: STANDARD COMMON WITH THE FOLLOWING PROPERTIES:

NAIL SIZE	SHANK DIAMETER	MIN. PENETRATION INTO SUPPORT MEMBER
6d	0.113"	1.25"
8d	0.131"	1.50"
10d	0.148"	1.63"
12d	0.148"	1.63"
16d	0.162"	1.75"

      NAILING MACHINES OR FASTENERS OTHER THAN COMMON NAILS ARE NOT PERMITTED WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
   E. BOLTS SHALL BE ASTM A307 WITH ASTM A563 HEAVY HEX NUTS AND HARDENED WASHERS, GRADE A, UNLESS NOTED OTHERWISE.
   F. ALL LAMINATED VENEER LUMBER (LVL) SHALL BE FURNISHED BY TRUS-JOIST CORPORATION OR APPROVED EQUAL.
   G. ALL PREFABRICATED WOOD JOISTS SHALL BE TJI AS MANUFACTURED BY TRUS JOIST MACMILLAN CORP. OR BCI AS MANUFACTURED BY BOISE CASCADE CORP. ALL REQUIRED BLOCKING BRIDGING AND BRACING SHALL BE PROVIDED BY JOIST MANUFACTURER AND INSTALLED BY CONTRACTOR. ALL PENETRATIONS THROUGH THE JOISTS SHALL BE DONE PER MANUFACTURERS RECOMMENDATIONS AND REQUIREMENTS.
2. ALL WOOD IN CONTACT WITH CONCRETE, MASONRY OR SOIL SHALL BE PRESSURE TREATED OR REDWOOD.
3. GENERAL FRAMING AND CARPENTRY SHALL BE CONNECTED AS PER IBC TABLE 2304.9.1, "MINIMUM NAILING SCHEDULE", UNLESS NOTED OTHERWISE.
4. ALL FRAMING ANCHORS, POST CAPS, HOLD DOWNS, GULLWN BASES, ETC. SHALL BE PROVIDED BY SIMPSON STRONG-TIE OR APPROVED EQUAL.
5. PROVIDE SOLID SHAPED BLOCKING AT LEAST 2 IN(NOMINAL) THICK AND FULL DEPTH OF JOIST AT ENDS AND AT EACH SUPPORT OF JOIST. PROVIDE APPROVED BRIDGING AT A 8'-0" O.C. MAXIMUM BETWEEN JOIST END SUPPORTS. SOLID BLOCKING BETWEEN JOISTS SHALL BE NAILED TO THE WOOD PLATE AT THE TOP OF THE WALL WITH ONE SIMPSON "A35" FRAMING ANCHOR PER EACH PIECE OF BLOCKING. FILL ALL HOLES IN THE FRAMING ANCHORS WITH 8-D X 1-1/2" NAILS (12 NAILS PER A35).
6. BUILT-UP BEAMS OF 2X MEMBER (2 IN. OR LESS IN DEPTH SHALL BE SPIKED TOGETHER WITH NOT LESS THAN 16-D SPIKES AT TWELVE-INCH (12 IN) CENTERS, STAGGERED. IF THE DEPTH OF BEAM IS MORE THAN TWELVE INCHES (12 IN), THE MEMBERS SHALL BE CONNECTED TOGETHER WITH 1/2" DIAMETER BOLTS @ 24 IN. O.C. STAGGERED. BOLTS SHALL BE PLACED 1/4 THE DEPTH OF THE MEMBER FROM THE TOP AND BOTTOM OF THE MEMBER.
7. ALL WALLS SHALL HAVE A MINIMUM OF TWO TOP PLATES. SPLICES IN TOP PLATES SHALL BE STAGGERED A MINIMUM OF FOUR FEET FROM THE NEAREST SPLICE IN ADJOINING TOP PLATE.
8. PROVIDE A DOUBLE JOIST UNDER PARALLEL PARTITIONS.

SPECIAL INSPECTIONS

SPECIAL INSPECTION, AS REQUIRED BY TABLE 1704.4 OF THE IBC, SHALL BE PROVIDED BY AN INDEPENDENT AGENCY EMPLOYED BY THE OWNER UNLESS WAIVED BY THE BUILDING OFFICIAL. THE CONTRACTOR SHALL COORDINATE AND COOPERATE WITH THE REQUIRED INSPECTIONS. ITEMS REQUIRING SPECIAL INSPECTION ARE:

1. CONCRETE PLACEMENT
2. BOLTS INSTALLED IN CONCRETE
3. CONCRETE REINFORCING STEEL PLACEMENT
4. STRUCTURAL WELDING, INCLUDING STEEL DECK
5. HIGH STRENGTH BOLTED CONNECTIONS
6. STRUCTURAL MASONRY AS REQUIRED BY THE CONTRACT DOCUMENTS. SEE MASONRY SECTION OF THE GENERAL STRUCTURAL NOTES AND MASONRY SCHEDULES FOR ADDITIONAL INFORMATION. SPECIAL INSPECTION SHALL BE PROVIDED DURING PREPARATION AND TAKING OF ANY REQUIRED PRISMS OR TEST SPECIMENS, PLACING OF ALL MASONRY UNITS, PLACEMENT OF REINFORCING, INSPECTION OF GROUT SPACE, IMMEDIATELY PRIOR TO CLOSING OF CLEANOUTS AND DURING ALL GROUTING OPERATIONS.

REV#:	REVISION DESCRIPTION:	DATE:

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LICENSED PROFESSIONAL ENGINEER
GARY E. KNIGHTON
#170411
1-10-2014
STATE OF UTAH

Project Title:

CROCKET DAM CONTROL HOUSE

LOGAN CITY, UTAH

Sheet Title:

STRUCTURAL NOTES

Drawn By: T. EKINS	Project Number: 10-027	Drawing Type:
Designed By: G. KNIGHTON	Date: 1-10-14	Sheet Number: CHS01
Reviewed By: G. KNIGHTON	Sheet Scale: NONE	of

CONCRETE FOOTING SCHEDULE

FOOTING MARK	DIMENSIONS			TRANSVERSE REINF.				LENGTHWISE REINF.				COMMENTS
	WIDTH	LENGTH	THICK.	QTY.	SIZE	LENGTH	SPCG.	QTY.	SIZE	LENGTH	SPCG.	
FC1.6T	1'-8"	CONT.	10"	--	--	--	--	2	#4	CONT.	EQ.	

FOOTING SCHEDULE NOTES:
1. PLACE ALL FOOTING REINFORCING IN BOTTOM OF FOOTING WITH 3" CLEAR CONCRETE COVER, UNLESS NOTED OTHERWISE.
2. TOP REINFORCING, WHERE SPECIFIED, SHALL BE PLACED IN THE TOP OF THE FOOTING WITH 2" MINIMUM CONCRETE COVER.
3. IF FOOTINGS ARE EARTH FORMED, FOOTING WIDTH AND LENGTH SHALL BE 4" WIDER AND LONGER THAN SCHEDULED.
4. SEE GENERAL STRUCTURAL NOTES FOR ALL OTHER REQUIREMENTS.

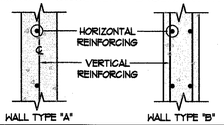
* REINFORCEMENT AT TOP AND BOTTOM OF FOOTING

CONCRETE FOUNDATION WALL SCHEDULE

WALL MARK	THICKNESS	REINFORCING			WALL TYPE	REMARKS
		VERTICAL	HORIZONTAL	TOP & BOTTOM		
CFW-1	8"	#4 BARS @ 18" O.C.	#5 BARS @ 18" O.C.	#5 BAR	A	

FOUNDATION SCHEDULE NOTES:
1. SEE GENERAL STRUCTURAL NOTES FOR ALL OTHER REQUIREMENTS NOT NOTED IN THE CONCRETE FOUNDATION WALL SCHEDULE.
2. PLACE STEEL IN THE CENTER OF THE WALL (EXCEPT CONCRETE RETAINING WALLS). WALLS THICKER THAN 10" SHALL HAVE TWO CURTAINS OF REINFORCEMENT (PLACED NEAR EACH FACE OF THE WALL, SEE GENERAL STRUCTURAL NOTES FOR CLEARANCE)
3. REFER TO RETAINING WALL DETAIL WHEN A RETAINING WALL OCCURS.

WALL REINFORCEMENT PLACEMENT TYPES

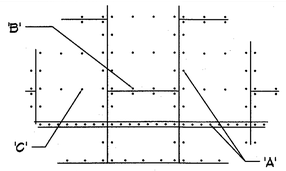


WOOD SHEATHING DIAPHRAGM SCHEDULE

DIAPHRAGM MARK	PANEL THICKNESS	PANEL EDGES	COMMON NAIL SPACING			COMMENTS
			'A'	'B'	'C'	
1	5/8"	UNBLOCKED	8d - 4"	8d - 6"	8d - 12"	ROOF

WOOD DIAPHRAGM NOTES:
1. ALL SHEATHING SHALL BE APA RATED EXPOSURE 1.
2. BLOCK ALL NOTED PANEL JOINTS W/ 2 X 4 MINIMUM (FLAT).
3. SEE GENERAL STRUCTURAL NOTES FOR ALL OTHER REQUIREMENTS.

COMMON NAIL SPACING LEGEND:
A = CONTINUOUS PANEL EDGES AND DIAPHRAGM BOUNDARIES.
B = ALL OTHER PANEL EDGES.
C = INTERMEDIATE PANEL SUPPORTS (IN FIELD NAILING).



DIAPHRAGM NAILING DIAGRAM

MASONRY WALL SCHEDULE

WALL MARK	THICKNESS	MATERIALS	REINFORCING			COMMENTS
			VERTICAL	HORIZONTAL	JOINTS	
MW-1	8"	8"x4"x16"	#5 BARS @ 24" O.C.	#5 BARS @ 48" O.C.	30'-0" MIN.	

MASONRY WALL NOTES:
1. COORDINATE WITH ARCHITECTURAL DRAWINGS, MASONRY WALL FINISHES, TYPES OF MATERIAL, COURSING, ETC.
2. DO NOT SOLID GROUT WALLS UNLESS NOTED OTHERWISE.
3. HORIZONTAL WALL REINFORCING SHALL BE PLACED BETWEEN VERTICAL MASONRY COLUMN REINFORCING BARS.
4. HORIZONTAL WALL REINFORCING SHALL CONTINUE THRU MASONRY LINTELS. WHERE BOTH HORIZONTAL WALL REINFORCING AND LINTEL REINFORCING OCCUR IN THE SAME COURSE, USE THE LARGER REINFORCING.
5. SEE GENERAL STRUCTURAL NOTES FOR ALL OTHER REQUIREMENTS.

MASONRY COLUMN SCHEDULE

COLUMN MARK	COLUMN SIZE	REINFORCING		COMMENTS
		VERTICAL	TIES	
MC-1	8"x8"	(2)- #5 BARS	#3 TIES @ 8" O.C.	

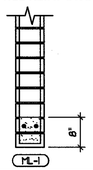
SCHEDULE NOTES:
1. THE CENTERLINE OF VERTICAL BARS SHALL BE LOCATED 2 1/2" FROM THE FACE OF THE MASONRY. HORIZONTAL WALL REINFORCEMENT SHALL BE LOCATED TO THE INSIDE OF VERTICAL BARS.
2. UNLESS NOTED OTHERWISE, VERTICAL REINFORCING AND TIES SHALL EXTEND TO FULL WALL HEIGHT.
3. VERTICAL MASONRY COLUMN REINFORCING SHALL EXTEND INTO THE FOOTING AND TERMINATE WITH A STANDARD 90° HOOK. FOR CONCRETE FOUNDATION WALLS OVER 5'-0" TALL, VERTICAL COLUMN REINFORCING REINFORCING SHALL DOWEL 4'-0" MINIMUM INTO THE FOUNDATION WALL.
4. IN CONCRETE FOUNDATION WALLS, VERTICAL MASONRY COLUMN REINFORCING SHALL BE TIED WITH #3 TIES @ 8" O.C.
5. SEE GENERAL STRUCTURAL NOTES FOR ALL OTHER REQUIREMENTS.

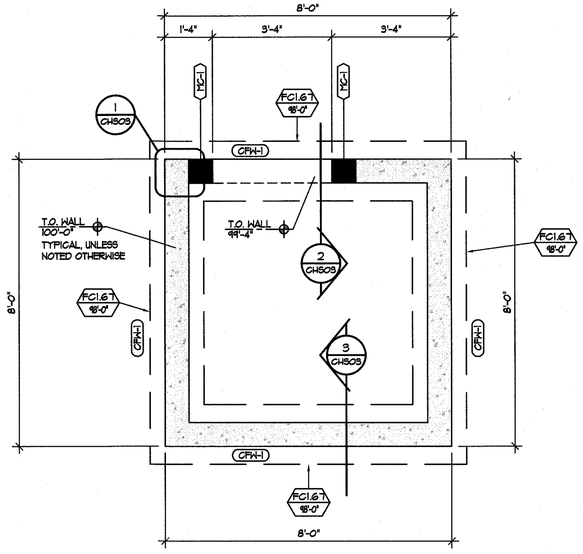
MASONRY LINTEL SCHEDULE

LINTEL MARK	LINTEL DEPTH	LINTEL SPAN MAXIMUM	REINFORCING		COMMENTS
			HORIZONTAL	STIRRUPS	
ML-1	8"	3'-4"	(2) #5 BAR CONT		

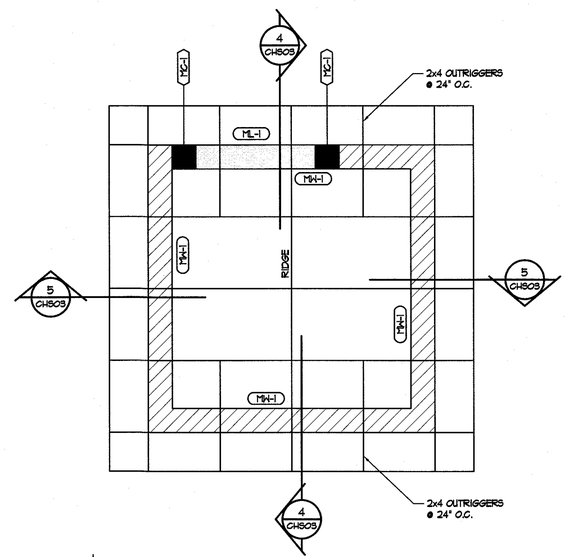
MASONRY LINTEL NOTES:
1. LINTEL WIDTH AND MATERIAL TYPE SHALL BE THE SAME AS THE WALL IN WHICH THE LINTEL IS CONSTRUCTED.
2. GROUT MASONRY LINTELS MONOLITHICALLY WITH THE SUPPORT WALL OR COLUMN AT EACH END.
3. MASONRY LINTELS ML-1 THRU ML-4 SHALL BE USED OVER OPENINGS IN MASONRY WALLS WHEN A SPECIFIC MASONRY LINTEL IS NOT OTHERWISE SPECIFIED. WHEN A LINTEL IS SPECIFIED ON THE PLANS, THE MAXIMUM SPAN AS NOTED IN THIS SCHEDULE SHALL NOT APPLY. CONSULT THE STRUCTURAL ENGINEER FOR LINTELS NOT SPECIFIED ON THE PLANS WHICH HAVE A SPAN GREATER THAN 10'-0".
4. MASONRY LINTELS ML-1 THRU ML-4 SHALL NOT BE LOCATED DIRECTLY BELOW FLOOR OR ROOF BEAMS OR GIRDERS UNLESS NOTED OTHERWISE ON THE PLANS. JOISTS SHALL NOT BEAR ON ANY LINTEL LESS THAN 16" DEEP. CONSULT THE STRUCTURAL ENGINEER FOR LINTELS NOT SHOWN ON THE PLANS WHICH ARE LOCATED DIRECTLY BELOW FLOOR OR ROOF BEAMS OR GIRDERS.
5. EXTEND ALL HORIZONTAL REINFORCING 48 BAR DIAMETERS MINIMUM BEYOND THE EDGE OF ALL OPENINGS. IF HORIZONTAL REINFORCING CANNOT EXTEND 48 BAR DIAMETERS BEYOND EDGE OF OPENING, PROVIDE 90° STANDARD HOOK.
6. SPLICE TOP BARS AT MIDSPAN OF LINTEL ONLY AND BOTTOM BARS OVER SUPPORTS ONLY.
7. HORIZONTAL WALL REINFORCING SHALL CONTINUE THRU MASONRY LINTELS. WHERE BOTH HORIZONTAL WALL REINFORCING AND LINTEL REINFORCING OCCUR IN THE SAME COURSE, USE THE LARGER REINFORCING.
8. DOWEL VERTICAL REINFORCING OF WALL ABOVE LINTEL INTO THE FULL DEPTH OF LINTEL OR 48 BAR DIAMETERS, WHICHEVER IS LESS.
9. SEE GENERAL STRUCTURAL NOTES FOR ALL OTHER REQUIREMENTS.

LINTEL REINFORCEMENT PLACEMENT TYPES





FOOTING AND FOUNDATION PLAN
SCALE: 1/2" = 1'-0"



ROOF FRAMING PLAN
SCALE: 1/2" = 1'-0"

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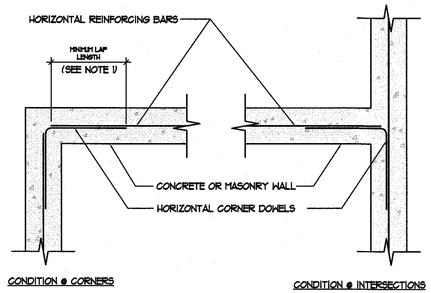
Professional Seal:

Project Title:
CROCKET DAM CONTROL HOUSE
LOGAN CITY, UTAH

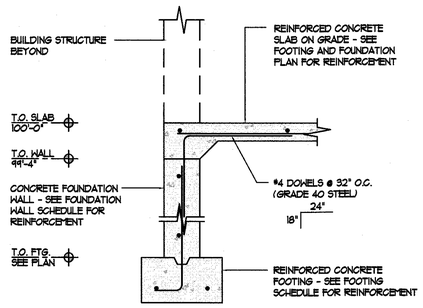
Sheet Title:
STRUCTURAL SCHEDULES AND STRUCTURAL PLANS

Drawn By: T. EKINS	Project Number: 10-027	Drawing Type:
Designed By: G. KNIGHTON	Date: 1-10-14	Sheet Number: CHS02
Reviewed By: G. KNIGHTON	Sheet Scale: AS NOTED	of

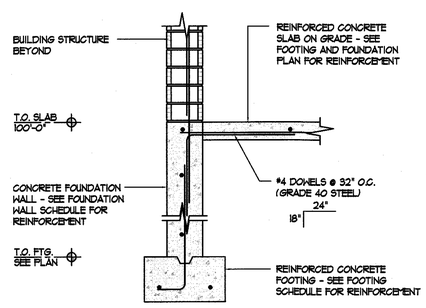
NOTES:
1. SEE GENERAL STRUCTURAL NOTES FOR MINIMUM BAR SPLICE LENGTHS.
2. CONDITION SIMILAR @ DOUBLE CURTAIN CONDITIONS.



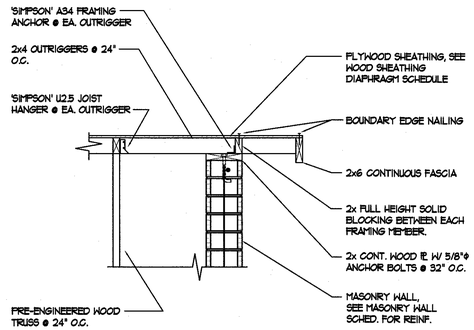
TYPICAL FOUNDATION WALL CORNER REINFORCING DETAIL — 1 / CHS03
SCALE: 3/4" = 1'-0"



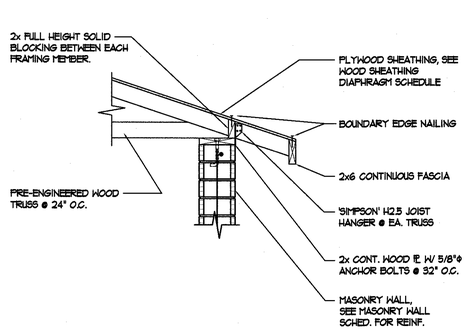
DETAIL — 2 / CHS03
SCALE: 3/4" = 1'-0"



DETAIL — 3 / CHS03
SCALE: 3/4" = 1'-0"



DETAIL — 4 / CHS03
SCALE: 3/4" = 1'-0"



DETAIL — 5 / CHS03
SCALE: 3/4" = 1'-0"

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LICENSED PROFESSIONAL ENGINEER — GARY D. KNIGHTON — #170411 — 1-16-2014 — STATE OF UTAH

Project Title:

CROCKET DAM CONTROL HOUSE

LOGAN CITY, UTAH

Sheet Title:

STRUCTURAL DETAILS

Drawn By: T. EKINS	Project Number: 10-027	Drawing Type:
Designed By: G. KNIGHTON	Date: 1-10-14	Sheet Number: CHS03
Reviewed By: G. KNIGHTON	Sheet Scale: AS NOTED	of

GENERAL PROJECT NOTES

1. THE ELECTRICAL CONTRACTOR SHALL HAVE A COORDINATION MEETING WITH THE MECHANICAL CONTRACTOR, CONSTRUCTION SUPERINTENDANT AND ANY OTHER TRADES AS REQUIRED WITHIN SEVEN DAYS OF THE START OF THE JOB TO REVIEW CODE CLEARANCE REQUIREMENTS FOR PANELS, SWITCHES, AND OTHER ELECTRICAL GEAR SPECIFICALLY FOR THIS JOB. RECORD THE MEETING IN THE SUPERINDENT'S LOG. REPORT UNRESOLVED CONFLICTS TO THE ARCHITECT IMMEDIATELY.
2. REFER TO MECHANICAL PLANS FOR EXACT LOCATION OF MECHANICAL EQUIPMENT.
3. ALL ELECTRICAL INSTALLATIONS TO CONFORM TO THE LATEST NEC AND LOCAL CODES.
4. CONTRACTOR SHALL VERIFY ALL SURFACE MOUNT FLUORESCENT FIXTURES CONFORM TO NEC 410.
5. ELECTRICAL CONTRACTOR SHALL FURNISH ALL MOTOR DISCONNECTS, STARTERS, AND CONTROL STATIONS FOR MECHANICAL EQUIPMENT UNLESS THE SAME IS FURNISHED AS AN INTEGRAL PART OF THE EQUIPMENT. VERIFY WITH MECHANICAL CONTRACTOR PRIOR TO BID.
6. EMT IS NOT ALLOWED.
7. MOUNTING HEIGHT OF GENERAL PURPOSE OUTLETS AND SWITCHES SHALL BE 16" TO BOTTOM AND 48" TO TOP RESPECTIVELY UNLESS OTHERWISE NOTED.
8. ALL FLUORESCENT LAMPS SHALL BE FROM THE SAME MANUFACTURER. ONLY STANDARD LAMPS BY GENERAL ELECTRIC, PHILIPS, OR SYLVANIA WILL BE ACCEPTED.
9. A GFI OUTLET SHALL BE INSTALLED AT EACH LOCATION DESIGNATED BY "GFI" ON THE DRAWINGS. DOWNSTREAM PROTECTION BY A GFI OUTLET UPSTREAM IS NOT ALLOWED.
10. PROVIDE SAFETY DISCONNECTS AS REQUIRED AT ALL CONNECTIONS TO MECHANICAL EQUIPMENT. PROVIDE FUSING AND RATINGS PER NAMEPLATE INFORMATION OF EQUIPMENT SERVED.
11. COORDINATE LOCATION OF LIGHT FIXTURES IN MECHANICAL ROOMS WITH MECHANICAL EQUIPMENT. DETERMINE FINAL FIXTURE LOCATIONS AFTER DUCTWORK INSTALLATION HAS BEEN COMPLETED. CHAIN SUSPEND FIXTURES UNDER DUCTWORK AND CONDUIT RACKS AS REQUIRED.
12. THE ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE TO FIELD VERIFY ALL PANEL CLEARANCES PER NEC 110.26 AND NOTIFY ALL OTHER TRADES ON THE JOB OF THESE CODE REQUIREMENTS.
13. DISCONNECT SWITCHES ARE SHOWN IN APPROXIMATE LOCATIONS ONLY. CONTRACTOR SHALL FIELD VERIFY LOCATION OF ALL ELECTRICAL SWITCHES AND MOTOR CONTROL FOR PROPER CODE CLEARANCES. NOTIFY ARCHITECT IMMEDIATELY OF ANY CONFLICTS WITH OTHER TRADES REGARDING PROPER EQUIPMENT CLEARANCES.
14. CONNECT EMERGENCY CIRCUIT OF EMERGENCY LIGHT BATTERY PACK TO UNSWITCHED LIGHTING CIRCUIT SERVING FIXTURES IN AREA. INSTALL EXTRA CONDUCTORS AS REQUIRED. WIRE SO LAMPS IN NORMAL MODE ARE CONTROLLED AS NOTED ON LIGHTING PLANS. PROVIDE ADDITIONAL BALLASTS AS REQUIRED.
15. ALL DISCONNECT SWITCHES FOR MOTORS SHALL BE RATED A MINIMUM OF 22000 AIC UNLESS OTHERWISE SHOWN.
16. CIRCUIT WIRE SIZES MUST MATCH BRANCH CIRCUIT BREAKERS PER NEC. VERIFY WITH PANEL SCHEDULES BEFORE PULLING WIRE.
17. PANEL INDEXES SHALL INCLUDE ALL PERTINENT INFORMATION ON THE PANEL SCHEDULES INCLUDING INFORMATION ON LIGHTS AND OUTLETS. DO NOT SIMPLY COPY THE CIRCUIT DESCRIPTION COLUMN. INDEXES TO BE TYPEWRITTEN.
18. PROVIDE NEUTRAL CONNECTION TO 208/240/480V, SINGLE-PHASE EQUIPMENT. RUN SEPARATE GROUND WIRE TO ALL OUTDOOR UNITS AND BOND TO THE EQUIPMENT GROUND LUG.
19. BEFORE RUNNING CONDUITS, PLACING OUTLETS OR ORDERING EQUIPMENT, THE CONTRACTOR SHALL REVIEW THE SPECIFICATIONS AND DESIGN AND SHOP DRAWINGS OF THE OTHER TRADES SERVED BY THE CONDUIT, OUTLETS, AND/OR EQUIPMENT.
20. FLUORESCENT EMERGENCY LIGHT BATTERY PACKS SHALL BE CONNECTED SO AS TO BE ABLE TO OPERATE IN THE TEST MODE WHEN THE NORMAL SWITCH LEG IS TURNED ON, AND SHALL ILLUMINATE ONE FIXTURE LAMP UNLESS OTHERWISE NOTED.
21. THE CLARITY OF RECORD DRAWING CHANGES MADE BY THE CONTRACTOR SHALL BE EQUAL TO THE ORIGINAL DRAWINGS AS JUDGED BY THE ARCHITECT OR THE RECORD SET WILL BE RETURNED TO THE CONTRACTOR FOR CLARIFICATION.
22. WHEN THE GENERAL CONTRACT CALLS FOR "RECORD" OR "AS-BUILT" DRAWINGS TO BE FURNISHED BY THE CONTRACTOR AT JOB COMPLETION, THE ELECTRICAL CONTRACTOR SHALL BE REQUIRED TO FURNISH A COMPLETE SET OF "BLUE-PRINT READY" AUTOCAD ELECTRICAL DRAWINGS FOR ALL CONTRACTOR GENERATED CHANGES FROM THE DRAWINGS OF A CLARITY EQUAL TO THE ORIGINAL DRAWINGS AS JUDGED BY THE ENGINEER. CONTACT ARCHITECT FOR DISKS OR REPRODUCIBLE ORIGINAL MEDIA. PROVIDE DRAWINGS ON CD IN AUTOCAD FORMAT.
23. ALL PATCH, REPAIR, REPAINT AND COVER UP REQUIRED AS A RESULT OF ELECTRICAL REMODEL IS TO BE THE RESPONSIBILITY OF THE ELECTRICAL CONTRACTOR, BUT ACTUAL WORK IS TO BE PERFORMED BY QUALIFIED PERSONNEL.
24. DO NOT SCALE ELECTRICAL FLOOR PLANS. SEE ARCHITECTURAL DRAWINGS FOR ACCURATE DIMENSIONS AND FLOOR PLANS.
25. ELECTRICAL CONTRACTOR SHALL CONTACT POWER COMPANY WITHIN THE FIRST WEEK OF THE START OF CONSTRUCTION AND NOTIFY THEM OF THE PROBABLE DATE WHEN THE NEW ELECTRICAL AND/OR TELPHONE SERVICE CONNECTION WILL BE NEEDED.
26. ALL CONVENIENCE OUTLETS MUST BE MOUNTED FLUSH WITH THE COVER PLATE AND SECURED FIRMLY TO THE OUTLET BOX.
27. THE ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE TO REVIEW ALL SWITCH LOCATIONS WITH THE GENERAL CONTRACTOR PRIOR TO ROUGH-IN TO PREVENT ANY SWITCHES FROM BEING LOCATED ON THE WRONG SIDE OF THE DOOR.
28. CONDUITS ENTERING MAIN PANEL FROM THE BOTTOM SHALL BE ARRANGED IN STRAIGHT ROWS FASTENED TO UNISTRUT. HOLES SHALL BE PUNCHED IN PANEL BOTTOM AND CONDUITS FASTENED BY TWO LOCKNUTS AND A CONDUIT BUSHING. CUTTING OUT THE BOTTOM OF THE PANEL IS NOT PERMITTED.
29. PROVIDE AN EQUIPMENT GROUNDING CONDUCTOR, PULLED INTO THE CONDUIT WITH THE PHASE CONDUCTOR, IN ALL SERVICE, FEEDER, AND BRANCH CIRCUITS.
30. PROVIDE A NEUTRAL CONDUCTOR FOR EACH BREAKER TRIP HANDLE. NEUTRALS SHALL NOT BE SHARED BETWEEN BRANCH CIRCUITS.
31. ALL CIRCUITS TO BE MINIMUM #12 CU IN MINIMUM 3/4" CONDUIT UNLESS OTHERWISE NOTED.
32. MC CABLE IS NOT AN APPROVED ALTERNATE TO CONDUCTORS IN CONDUIT.
33. WHERE THERE ARE CONFLICTS IN THE DRAWINGS AND/OR SPECIFICATIONS THE CONTRACTOR SHALL NOTIFY THE ARCHITECT/ENGINEER PRIOR TO BID. WHERE NO NOTIFICATION IS GIVEN THE MORE STRINGENT INTERPRETATION (GENERALLY INTERPRETED TO BE THE MORE COSTLY) WILL BE ENFORCED.

SHEET INDEX

● INDICATES PREVIOUSLY / CURRENTLY ISSUED SHEETS

PLANCHECK SUBMITTAL

SHEET	TITLE
E001	G.P.N., LEGEND, SHEET INDEX & SCHEDULES
E002	ELECTRICAL SPECIFICATIONS
E101	ELECTRICAL PLANS

ELECTRICAL LEGEND

ANNOTATIONS

Symbol	Description
X / XXX	DETAIL CALL-OUT; TOP "X" REFERS TO DETAIL NUMBER & BOTTOM "XXX" REFERS TO SHEET NUMBER

LIGHTING FIXTURES

Symbol	Description
	STRIP LIGHT
	FLUORESCENT FIXTURE
DL	LIGHT FIXTURE LOCATED IN IECC DAY-LIGHTING ZONE
	EMERGENCY FIXTURE

LIGHTING CONTROL

Symbol	Description
^{X}	SINGLE POLE SWITCH; "x" INDICATES SWITCH GROUP
$_{3}$	THREE WAY SWITCH
$_{4}$	FOUR WAY SWITCH
P	PHOTOCELL

BRANCH CIRCUITING

Symbol	Description
	DUPLEX OUTLET
	DUPLEX OUTLET: GROUND FAULT INTERRUPTER
WP	DUPLEX OUTLET: WEATHERPROOF
J	JUNCTION BOX
	MOTOR STARTER UNIT - FVNR
	OVERCURRENT PROTECTIVE DISCONNECT
$_{m}$	MOTOR PROTECTIVE THERMAL SWITCH
	QUANTITY OF CONDUCTORS: SHORT LINES = PHASE /SWITCH LONG LINES = NEUTRAL
	HOME-RUN

POWER AND DISTRIBUTION

Symbol	Description
	PANELBOARD
	METER/METER SOCKET

ONE-LINE

Symbol	Description
XA YP	BREAKER: "x" = BREAKER AMPERAGE "y" = QUANTITY OF POLES
	BRANCH PANEL
	BRANCH PANEL WITH MAIN BREAKER
	GROUND
M	DIRECT METER
hp	MOTOR; hp = MOTOR HORSEPOWER

SITE ELECTRICAL

Symbol	Description
----1ØOP---	1-PHASE OVERHEAD PRIMARY POWER
----1ØUP---	1-PHASE UNDERGOUND PRIMARY POWER
----1ØUS---	1-PHASE UNDERGOUND SECONDARY POWER
--(E)3ØOP--	EXISTING 3-PHASE OVERHEAD PRIMARY POWER
----3ØOP---	3-PHASE OVERHEAD PRIMARY POWER
----3ØOS---	3-PHASE OVERHEAD SECONDARY POWER
--(A)3ØUP--	ABANDONED 3-PHASE UNDERGROUND PRIMARY POWER
--(E)3ØUP--	EXISTING 3-PHASE UNDERGROUND PRIMARY POWER
----3ØUP---	3-PHASE UNDERGROUND PRIMARY POWER
----3ØUS---	3-PHASE UNDERGROUND SECONDARY POWER
----OT-----	OVERHEAD TELEPHONE
----OTV----	OVERHEAD TV
----(E)UT---	EXISTING UNDERGROUND TELEPHONE
----UT-----	UNDERGROUND TELEPHONE
----UTV----	UNDERGROUND TV
	POINT OF DISCONNECTION
	POINT OF CONNECTION
	UTILITY POLE

LIGHT FIXTURE SCHEDULE

TYPE	MANUFACTURER/CATALOG NO.	DESCRIPTION	MOUNTING	LAMPS
B	AS SPECIFIED	APPENDED TO FIXTURE TYPE; 1100 LUMEN EM BATTERY	AS SPECIFIED	PER FIXTURE TYPE
LW- 332 LW- 332B	LITHONIA DMW-332-MVOLT-GEB10PS-MS18-IP67-(EL) OR EQUIVALENT	WET LOCATION, SURFACE MOUNT FIXTURE; FIBERGLASS HOUSING; HIGH-IMPACT DIFFUSER; MULTI-VOLT, PROGRAM-START ELECTRONIC BALLAST; IP67 RATED; INTEGRAL OCCUPANCY SENSOR; EM BALLAST WHERE NOTED ON DRAWINGS	SURFACE OR CHAIN SUSPENDED	(2) FO32/841
OW3- L1K OW3- L1KB	LITHONIA DSXW1LED-10C/350/40K-T3M-MVOLT-DMG/PIR/(ELCW)-BSW-VG-DDBXD OR EQUIVALENT	EXTERIOR WALL PACK; TYPE 3 OPTICAL DISTRIBUTION; MULTI-VOLT DRIVER; INTEGRAL MOTION SENSOR; INTEGRAL PHOTOCELL; DIMMABLE; EM BACKUP WHERE NOTED ON DRAWINGS; BIRD SPIKES WHERE AVAILABLE FROM MANUFACTURER	WALL	LED 1000 LUMEN NOMINAL 4000K

MECHANICAL EQUIPMENT SCHEDULE

SYM	DESCRIPTION	LOAD	VOLTS	PHASE	FIRE ALARM SHUTDOWN	CONTROL CIRCUITS BY	* STARTER BY	SAFETY DISCONNECT BY	REMARKS
P- 1	PUMP	7.5 HP	240	1	NO	ELEC	ELEC	ELEC	
UH- 1	HEATER	3KW	240	1	NO	ELEC	EQUIP	EQUIP	PROVIDE HEATER WITH INTEGRAL OR REMOTE THRMOSTAT (QMARK MUH03-21 OR EQUIVALENT)

* ELECTRICAL CONTRACTOR VERIFY SINGLE SPEED OR TWO SPEED STARTERS WITH MECHANICAL DRAWINGS.

PANEL SCHEDULE

PANEL 1P1 — TYPE NQOB — 1 Ø 3 WIRE 120/240 VOLTS — LOCATION

[X] NEW
[ ] EXISTING

[ ] BOLT ON BREAKERS
[ ] ISOLATED GROUND BUS
[ ] SURGE PROTECT (SPD)

REMARKS: -NEMA 3R ENCLOSURE

MOUNTING: [ ] FLUSH [X] SURFACE

125 AMP MAIN: [X] LUGS [ ] BREAKER

No.	BRKR A	BRKR P	CIRCUIT DESCRIPTION	L	O	M	Wire	CIRC. LOAD	A	B	CIRC. LOAD	Wire	L	O	M	CIRCUIT DESCRIPTION	BRKR A	BRKR P	No.
1	70H	2	PUMP			1	6	4800	4980		180	12		1		PLUG	20	1	2
3	-	-	-			1	6	4800		4895	95	12		1		LIGHTING	20	1	4
5	20H	2	HEATER			1	12	1500	1500							SPARE	20	1	6
7	-	-				1	12	1500		1500						SPARE	20	1	8
9	20	1	SPACE						0							SPARE	20	1	10
11	20	1	SPACE							0						SPACE	20	1	12
13	20	1	SPACE						0							SPACE	20	1	14
15	20	1	SPACE							0						SPACE	20	1	16
17	20	1	SPACE						0							SPACE	20	1	18
19	20	1	SPACE							0						SPACE	20	1	20
21	20	1	SPACE						0							SPACE	20	1	22
23	20	1	SPACE							0						SPACE	20	1	24
								TOTALS	6480	6395									

AIC 10000

FEEDER SEE ONE-LINE — AMPS/PHASE 54 53 — PARALLEL RUNS SEE ONE-LINE

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Professional Seal: REGISTERED PROFESSIONAL ENGINEER — No. 294174 — SHANE D. SWENSON — 1/17/2014 — STATE OF UTAH

Project Title:

CONTROL HOUSE BUILDING
LOGAN CITY, UTAH

Sheet Title:

ABBREIVATIONS, LEGEND, G.P.N. & SHEET INDEX

Drawn By: D. PATTON	Project Number: SSE #2013051	Drawing Type:
Designed By: S. SWENSON	Date: 1-17-14	Sheet Number: E001 of
Reviewed By: S. SWENSON	Sheet Scale: AS NOTED	

ELECTRICAL SPECIFICATIONS

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL
1.1 COORDINATION
A. COORDINATE ARRANGEMENT, MOUNTING, AND SUPPORT OF ELECTRICAL EQUIPMENT:
1. TO ALLOW MAXIMUM POSSIBLE HEADROOM UNLESS SPECIFIC MOUNTING HEIGHTS THAT REDUCE HEADROOM ARE INDICATED.
2. TO PROVIDE FOR EASE OF DISCONNECTING THE EQUIPMENT WITH MINIMUM INTERFERENCE TO OTHER INSTALLATIONS.
3. TO ALLOW RIGHT OF WAY FOR PIPING AND CONDUIT INSTALLED AT REQUIRED SLOPE.
4. SO CONNECTING RACEWAYS, CABLES, WIREWAYS, CABLE TRAYS, AND BUSWAYS WILL BE CLEAR OF OBSTRUCTIONS AND OF THE WORKING AND ACCESS SPACE OF OTHER EQUIPMENT.
B. COORDINATE LOCATION OF ACCESS PANELS AND DOORS FOR ELECTRICAL ITEMS THAT ARE BEHIND FINISHED SURFACES OR OTHERWISE CONCEALED. ACCESS DOORS AND PANELS ARE SPECIFIED IN DIVISION 08 SECTION "ACCESS DOORS AND FRAMES."
1.2 GROUT
A. NONMETALLIC, SHRINKAGE-RESISTANT GROUT: ASTM C 1107, FACTORY-PACKAGED, NONMETALLIC AGGREGATE GROUT, NONCORROSIVE, NONSTAINING, MIXED WITH WATER TO CONSISTENCY SUITABLE FOR APPLICATION AND A 30-MINUTE WORKING TIME.
1.3 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION
A. COMPLY WITH NECA 1.
B. MEASURE INDICATED MOUNTING HEIGHTS TO BOTTOM OF UNIT FOR SUSPENDED ITEMS AND TO CENTER OF UNIT FOR WALL-MOUNTING ITEMS.
C. HEADROOM MAINTENANCE: IF MOUNTING HEIGHTS OR OTHER LOCATION CRITERIA ARE NOT INDICATED, ARRANGE AND INSTALL COMPONENTS AND EQUIPMENT TO PROVIDE MAXIMUM POSSIBLE HEADROOM CONSISTENT WITH THESE REQUIREMENTS.
D. EQUIPMENT: INSTALL TO FACILITATE SERVICE, MAINTENANCE, AND REPAIR OR REPLACEMENT OF COMPONENTS OF BOTH ELECTRICAL EQUIPMENT AND OTHER NEARBY INSTALLATIONS. CONNECT IN SUCH A WAY AS TO FACILITATE FUTURE DISCONNECTING WITH MINIMUM INTERFERENCE WITH OTHER ITEMS IN THE VICINITY.
E. RIGHT OF WAY: GIVE TO PIPING SYSTEMS INSTALLED AT A REQUIRED SLOPE.

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
1.1 QUALITY ASSURANCE
A. ELECTRICAL COMPONENTS, DEVICES, AND ACCESSORIES: LISTED AND LABELED AS DEFINED IN NFPA 70, ARTICLE 100, BY A TESTING AGENCY ACCEPTABLE TO AUTHORITIES HAVING JURISDICTION, AND MARKED FOR INTENDED USE.
B. COMPLY WITH NFPA 70.
1.2 CONDUCTORS AND CABLES
A. COPPER CONDUCTORS: COMPLY WITH NEMA WC 70.
B. CONDUCTOR INSULATION: COMPLY WITH NEMA WC 70 FOR TYPES THHN-THWN.
C. MULTICONDUCTOR CABLE: COMPLY WITH NEMA WC 70 FOR TYPE SOW WITH GROUND WIRE FOR CORD-AND-PLUG SETS.
1.3 CONNECTORS AND SPLICES
A. DESCRIPTION: FACTORY-FABRICATED CONNECTORS AND SPLICES OF SIZE, AMPACITY RATING, MATERIAL, TYPE, AND CLASS FOR APPLICATION AND SERVICE INDICATED.
1.4 CONDUCTOR MATERIAL APPLICATIONS
A. FEEDERS: COPPER. SOLID FOR NO. 10 AWG AND SMALLER; STRANDED FOR NO. 8 AWG AND LARGER.
B. BRANCH CIRCUITS: COPPER. SOLID OR STRANDED FOR NO. 10 AWG AND SMALLER; STRANDED FOR NO. 8 AWG AND LARGER.
1.5 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS
A. SERVICE ENTRANCE: TYPE THHN-THWN, SINGLE CONDUCTORS IN RACEWAY.
B. FEEDERS: TYPE THHN-THWN OR XHHW, SINGLE CONDUCTORS IN RACEWAY.
C. BRANCH CIRCUITS: TYPE THHN-THWN, SINGLE CONDUCTORS IN RACEWAY.
D. CORD DROPS AND PORTABLE APPLIANCE CONNECTIONS: TYPE SOW, HARD SERVICE CORD WITH STAINLESS-STEEL, WIRE-MESH, STRAIN RELIEF DEVICE AT TERMINATIONS TO SUIT APPLICATION.
E. CLASS 1 CONTROL CIRCUITS: TYPE THHN-THWN, IN RACEWAY.
F. CLASS 2 CONTROL CIRCUITS: TYPE THHN-THWN, IN RACEWAY.
1.6 INSTALLATION OF CONDUCTORS AND CABLES
A. CONCEAL CABLES IN FINISHED WALLS, CEILINGS, AND FLOORS, UNLESS OTHERWISE INDICATED.
B. USE MANUFACTURER-APPROVED PULLING COMPOUND OR LUBRICANT WHERE NECESSARY; COMPOUND USED MUST NOT DETERIORATE CONDUCTOR OR INSULATION. DO NOT EXCEED MANUFACTURER'S RECOMMENDED MAXIMUM PULLING TENSIONS AND SIDEWALL PRESSURE VALUES.
C. USE PULLING MEANS, INCLUDING FISH TAPE, CABLE, ROPE, AND BASKET-WEAVE WIRE/CABLE GRIPS, THAT WILL NOT DAMAGE CABLES OR RACEWAY.
D. INSTALL EXPOSED CABLES PARALLEL AND PERPENDICULAR TO SURFACES OF EXPOSED STRUCTURAL MEMBERS, AND FOLLOW SURFACE CONTOURS WHERE POSSIBLE.
E. SUPPORT CABLES ACCORDING TO DIVISION 26 SECTION "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS."
F. IDENTIFY AND COLOR-CODE CONDUCTORS AND CABLES ACCORDING TO DIVISION 26 SECTION "IDENTIFICATION FOR ELECTRICAL SYSTEMS."
1.7 CONNECTIONS
A. TIGHTEN ELECTRICAL CONNECTORS AND TERMINALS ACCORDING TO MANUFACTURER'S PUBLISHED TORQUE-TIGHTENING VALUES. IF MANUFACTURER'S TORQUE VALUES ARE NOT INDICATED, USE THOSE SPECIFIED IN UL 486A AND UL 486B.
B. MAKE SPLICES AND TAPS THAT ARE COMPATIBLE WITH CONDUCTOR MATERIAL AND THAT POSSESS EQUIVALENT OR BETTER MECHANICAL STRENGTH AND INSULATION RATINGS THAN UNSPLICED CONDUCTORS.
C. WIRING AT OUTLETS: INSTALL CONDUCTOR AT EACH OUTLET, WITH AT LEAST 12 INCHES (300 MM) OF SLACK.

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
1.1 QUALITY ASSURANCE
A. ELECTRICAL COMPONENTS, DEVICES, AND ACCESSORIES: LISTED AND LABELED AS DEFINED IN NFPA 70, ARTICLE 100, BY A TESTING AGENCY ACCEPTABLE TO AUTHORITIES HAVING JURISDICTION, AND MARKED FOR INTENDED USE.
B. COMPLY WITH UL 467 FOR GROUNDING AND BONDING MATERIALS AND EQUIPMENT.
1.2 CONDUCTORS
A. INSULATED CONDUCTORS: COPPER WIRE OR CABLE INSULATED FOR 600 V UNLESS OTHERWISE REQUIRED BY APPLICABLE CODE OR AUTHORITIES HAVING JURISDICTION.
B. BARE COPPER CONDUCTORS:
1. SOLID CONDUCTORS: ASTM B 3.
2. STRANDED CONDUCTORS: ASTM B 8.
3. BONDING CONDUCTOR: NO. 4 OR NO. 6 AWG, STRANDED CONDUCTOR.
4. BONDING JUMPER: COPPER TAPE, BRAIDED CONDUCTORS, TERMINATED WITH COPPER FERRULES; 1-5/8 INCHES (41 MM) WIDE AND 1/16 INCH (1.6 MM) THICK.
1.3 CONNECTORS
A. LISTED AND LABELED BY A NATIONALLY RECOGNIZED TESTING LABORATORY ACCEPTABLE TO AUTHORITIES HAVING JURISDICTION FOR APPLICATIONS IN WHICH USED, AND FOR SPECIFIC TYPES, SIZES, AND COMBINATIONS OF CONDUCTORS AND OTHER ITEMS CONNECTED.
B. BOLTED CONNECTORS FOR CONDUCTORS AND PIPES: COPPER OR COPPER ALLOY, BOLTED PRESSURE-TYPE, WITH AT LEAST TWO BOLTS.
1. PIPE CONNECTORS: CLAMP TYPE, SIZED FOR PIPE.
C. WELDED CONNECTORS: EXOTHERMIC-WELDING KITS OF TYPES RECOMMENDED BY KIT MANUFACTURER FOR MATERIALS BEING JOINED AND INSTALLATION CONDITIONS.
1.4 GROUNDING ELECTRODES
A. GROUND RODS: COPPER-CLAD STEEL; 3/4 INCH BY10 FEET (19 MM BY 3 M) IN DIAMETER.
1.5 APPLICATIONS
A. CONDUCTORS: INSTALL SOLID CONDUCTOR FOR NO. 8 AWG AND SMALLER, AND STRANDED CONDUCTORS FOR NO. 6 AWG AND LARGER, UNLESS OTHERWISE INDICATED.
B. CONDUCTOR TERMINATIONS AND CONNECTIONS:
1. PIPE, ROD AND EQUIPMENT GROUNDING CONDUCTOR TERMINATIONS: BOLTED CONNECTORS.
2. UNDERGROUND CONNECTIONS: WELDED CONNECTORS, EXCEPT AT GROUND RODS AND AS OTHERWISE INDICATED.
3. CONNECTIONS TO STRUCTURAL STEEL: WELDED CONNECTORS.
1.6 EQUIPMENT GROUNDING
A. INSTALL INSULATED EQUIPMENT GROUNDING CONDUCTORS WITH ALL FEEDERS AND BRANCH CIRCUITS.
B. METAL POLES SUPPORTING OUTDOOR LIGHTING FIXTURES: INSTALL GROUNDING ELECTRODE AND A SEPARATE INSULATED EQUIPMENT GROUNDING CONDUCTOR IN ADDITION TO GROUNDING CONDUCTOR INSTALLED WITH BRANCH-CIRCUIT CONDUCTORS.
1.7 INSTALLATION
A. GROUNDING CONDUCTORS: ROUTE ALONG SHORTEST AND STRAIGHTEST PATHS POSSIBLE, UNLESS OTHERWISE INDICATED OR REQUIRED BY CODE. AVOID OBSTRUCTING ACCESS OR PLACING CONDUCTORS WHERE THEY MAY BE SUBJECTED TO STRAIN, IMPACT, OR DAMAGE.
B. GROUND RODS: DRIVE RODS UNTIL TOPS ARE 2 INCHES (50 MM) BELOW FINISHED FLOOR OR FINAL GRADE, UNLESS OTHERWISE INDICATED.
1. INTERCONNECT GROUND RODS WITH GROUNDING ELECTRODE CONDUCTOR BELOW GRADE AND AS OTHERWISE INDICATED. MAKE CONNECTIONS WITHOUT EXPOSING STEEL OR DAMAGING COATING, IF ANY.
C. UFER GROUND (CONCRETE-ENCASED GROUNDING ELECTRODE): FABRICATE ACCORDING TO NFPA 70, USING A MINIMUM OF 20 FEET (6 M) OF BARE COPPER CONDUCTOR NOT SMALLER THAN NO. 4 AWG.
1. IF CONCRETE FOUNDATION IS LESS THAN 20 FEET (6 M) LONG, COIL EXCESS CONDUCTOR WITHIN BASE OF FOUNDATION.
2. BOND GROUNDING CONDUCTOR TO REINFORCING STEEL IN AT LEAST FOUR LOCATIONS AND TO ANCHOR BOLTS. EXTEND GROUNDING CONDUCTOR BELOW GRADE AND CONNECT TO GROUNDING ELECTRODE EXTERNAL TO CONCRETE.

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
1.1 PERFORMANCE REQUIREMENTS
A. RATED STRENGTH: ADEQUATE IN TENSION, SHEAR, AND PULLOUT FORCE TO RESIST MAXIMUM LOADS CALCULATED OR IMPOSED FOR THIS PROJECT, WITH A MINIMUM STRUCTURAL SAFETY FACTOR OF FIVE TIMES THE APPLIED FORCE.
1.2 QUALITY ASSURANCE
A. WELDING: QUALIFY PROCEDURES AND PERSONNEL ACCORDING TO AWS D1.1/D1.1M, "STRUCTURAL WELDING CODE - STEEL."
B. COMPLY WITH NFPA 70.
1.3 COORDINATION
A. COORDINATE SIZE AND LOCATION OF CONCRETE BASES. CAST ANCHOR-BOLT INSERTS INTO BASES.
1.4 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS
A. RACEWAY AND CABLE SUPPORTS: AS DESCRIBED IN NECA 1 AND NECA 101.
B. CONDUIT AND CABLE SUPPORT DEVICES: STEEL HANGERS, CLAMPS, AND ASSOCIATED FITTINGS, DESIGNED FOR TYPES AND SIZES OF RACEWAY OR CABLE TO BE SUPPORTED.
C. MOUNTING, ANCHORING, AND ATTACHMENT COMPONENTS: ITEMS FOR FASTENING ELECTRICAL ITEMS OR THEIR SUPPORTS TO BUILDING SURFACES INCLUDE THE FOLLOWING:
1. POWDER-ACTUATED FASTENERS: THREADED-STEEL STUD, FOR USE IN HARDENED PORTLAND CEMENT CONCRETE, STEEL, OR WOOD, WITH TENSION, SHEAR, AND PULLOUT CAPACITIES APPROPRIATE FOR SUPPORTED LOADS AND BUILDING MATERIALS WHERE USED.
2. MECHANICAL-EXPANSION ANCHORS: INSERT-WEDGE-TYPE, ZINC-COATED OR STAINLESS STEEL, FOR USE IN HARDENED PORTLAND CEMENT CONCRETE WITH TENSION, SHEAR, AND PULLOUT CAPACITIES APPROPRIATE FOR SUPPORTED LOADS AND BUILDING MATERIALS IN WHICH USED.
3. CONCRETE INSERTS: STEEL OR MALLEABLE-IRON, SLOTTED SUPPORT SYSTEM UNITS SIMILAR TO MSS TYPE 18; COMPLYING WITH MFMA-4 OR MSS SP-58.
4. CLAMPS FOR ATTACHMENT TO STEEL STRUCTURAL ELEMENTS: MSS SP-58, TYPE SUITABLE FOR ATTACHED STRUCTURAL ELEMENT.
5. THROUGH BOLTS: STRUCTURAL TYPE, HEX HEAD, AND HIGH STRENGTH. COMPLY WITH ASTM A 325.
6. TOGGLE BOLTS: ALL-STEEL SPRINGHEAD TYPE.
1.5 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES
A. DESCRIPTION: WELDED OR BOLTED, STRUCTURAL-STEEL SHAPES, SHOP OR FIELD FABRICATED TO FIT DIMENSIONS OF SUPPORTED EQUIPMENT.
1.6 APPLICATION
A. COMPLY WITH NECA 1 AND NECA 101 FOR APPLICATION OF HANGERS AND SUPPORTS FOR ELECTRICAL EQUIPMENT AND SYSTEMS EXCEPT IF REQUIREMENTS IN THIS SECTION ARE STRICTER.
B. MAXIMUM SUPPORT SPACING AND MINIMUM HANGER ROD SIZE FOR RACEWAY: SPACE SUPPORTS FOR EMT, IMC, AND RMC AS REQUIRED BY NFPA 70. MINIMUM ROD SIZE SHALL BE 1/4 INCH (6 MM) IN DIAMETER.
C. SPRING-STEEL CLAMPS DESIGNED FOR SUPPORTING SINGLE CONDUITS WITHOUT BOLTS MAY BE USED FOR 1-1/2-INCH (38-MM) AND SMALLER RACEWAYS SERVING BRANCH CIRCUITS AND COMMUNICATION SYSTEMS ABOVE SUSPENDED CEILINGS AND FOR FASTENING RACEWAYS TO TRAPEZE SUPPORTS.
1.7 SUPPORT INSTALLATION
A. COMPLY WITH NECA 1 AND NECA 101 FOR INSTALLATION REQUIREMENTS EXCEPT AS SPECIFIED IN THIS ARTICLE.
B. RACEWAY SUPPORT METHODS: IN ADDITION TO METHODS DESCRIBED IN NECA 1, EMT, IMC, AND RMC MAY BE SUPPORTED BY OPENINGS THROUGH STRUCTURE MEMBERS, AS PERMITTED IN NFPA 70.
C. STRENGTH OF SUPPORT ASSEMBLIES: WHERE NOT INDICATED, SELECT SIZES OF COMPONENTS SO STRENGTH WILL BE ADEQUATE TO CARRY PRESENT AND FUTURE STATIC LOADS WITHIN SPECIFIED LOADING LIMITS. MINIMUM STATIC DESIGN LOAD USED FOR STRENGTH DETERMINATION SHALL BE WEIGHT OF SUPPORTED COMPONENTS PLUS 200 LB (90 KG).
D. MOUNTING AND ANCHORAGE OF SURFACE-MOUNTED EQUIPMENT AND COMPONENTS: ANCHOR AND FASTEN ELECTRICAL ITEMS AND THEIR SUPPORTS TO BUILDING STRUCTURAL ELEMENTS BY THE FOLLOWING METHODS UNLESS OTHERWISE INDICATED BY CODE:
1. TO WOOD: FASTEN WITH LAG SCREWS OR THROUGH BOLTS.
2. TO NEW CONCRETE: BOLT TO CONCRETE INSERTS.
3. TO MASONRY: APPROVED TOGGLE-TYPE BOLTS ON HOLLOW MASONRY UNITS AND EXPANSION ANCHOR FASTENERS ON SOLID MASONRY UNITS.
4. TO EXISTING CONCRETE: EXPANSION ANCHOR FASTENERS.
5. INSTEAD OF EXPANSION ANCHORS, POWDER-ACTUATED DRIVEN THREADED STUDS PROVIDED WITH LOCK WASHERS AND NUTS MAY BE USED IN EXISTING STANDARD-WEIGHT CONCRETE 4 INCHES (100 MM) THICK OR GREATER. DO NOT USE FOR ANCHORAGE TO LIGHTWEIGHT-AGGREGATE CONCRETE OR FOR SLABS LESS THAN 4 INCHES (100 MM) THICK.
6. TO STEEL: WELDED THREADED STUDS COMPLYING WITH AWS D1.1/D1.1M, WITH LOCK WASHERS AND NUTS.
7. TO LIGHT STEEL: SHEET METAL SCREWS.
8. ITEMS MOUNTED ON HOLLOW WALLS AND NONSTRUCTURAL BUILDING SURFACES: MOUNT CABINETS, PANELBOARDS, DISCONNECT SWITCHES, CONTROL ENCLOSURES, PULL AND JUNCTION BOXES, TRANSFORMERS, AND OTHER DEVICES ON SLOTTED-CHANNEL RACKS ATTACHED TO SUBSTRATE.
E. DRILL HOLES FOR EXPANSION ANCHORS IN CONCRETE AT LOCATIONS AND TO DEPTHS THAT AVOID REINFORCING BARS.
1.8 PAINTING
A. TOUCHUP: CLEAN FIELD WELDS AND ABRADED AREAS OF SHOP PAINT. PAINT EXPOSED AREAS IMMEDIATELY AFTER ERECTING HANGERS AND SUPPORTS. USE SAME MATERIALS AS USED FOR SHOP PAINTING. COMPLY WITH SSPC-PA 1 REQUIREMENTS FOR TOUCHING UP FIELD-PAINTED SURFACES.
1. APPLY PAINT BY BRUSH OR SPRAY TO PROVIDE MINIMUM DRY FILM THICKNESS OF 2.0 MILS (0.05 MM).
B. GALVANIZED SURFACES: CLEAN WELDS, BOLTED CONNECTIONS, AND ABRADED AREAS AND APPLY GALVANIZING-REPAIR PAINT TO COMPLY WITH ASTM A 780.

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS
1.1 QUALITY ASSURANCE
A. ELECTRICAL COMPONENTS, DEVICES, AND ACCESSORIES: LISTED AND LABELED AS DEFINED IN NFPA 70, ARTICLE 100, BY A TESTING AGENCY ACCEPTABLE TO AUTHORITIES HAVING JURISDICTION, AND MARKED FOR INTENDED USE.
B. COMPLY WITH NFPA 70.
1.2 METAL CONDUIT AND TUBING
A. RIGID STEEL CONDUIT: ANSI C80.1.
B. PVC-COATED STEEL CONDUIT: PVC-COATED RIGID STEEL CONDUIT.
1. COMPLY WITH NEMA RN 1.
2. COATING THICKNESS: 0.040 INCH (1 MM), MINIMUM.
C. FMC: ZINC-COATED STEEL.
D. LFMC: FLEXIBLE STEEL CONDUIT WITH PVC JACKET.
E. FITTINGS FOR CONDUIT (INCLUDING ALL TYPES AND FLEXIBLE AND LIQUIDTIGHT), EMT, AND CABLE: NEMA FB 1; LISTED FOR TYPE AND SIZE RACEWAY WITH WHICH USED, AND FOR APPLICATION AND ENVIRONMENT IN WHICH INSTALLED.
1. COATING FOR FITTINGS FOR PVC-COATED CONDUIT: MINIMUM THICKNESS, 0.040 INCH (1 MM), WITH OVERLAPPING SLEEVES PROTECTING THREADED JOINTS.
F. JOINT COMPOUND FOR RIGID STEEL CONDUIT OR IMC: LISTED FOR USE IN CABLE CONNECTOR ASSEMBLIES, AND COMPOUNDED FOR USE TO LUBRICATE AND PROTECT THREADED RACEWAY JOINTS FROM CORROSION AND ENHANCE THEIR CONDUCTIVITY.
1.3 NONMETALLIC CONDUIT AND TUBING
A. RNC: NEMA TC 2, TYPE EPC-40-PVC, UNLESS OTHERWISE INDICATED.
B. FITTINGS FOR RNC: NEMA TC 3; MATCH TO CONDUIT OR TUBING TYPE AND MATERIAL.
1.4 BOXES, ENCLOSURES, AND CABINETS
A. SHEET METAL OUTLET, DEVICE, PULL, AND JUCTION BOXES: NEMA OS 1.
B. CAST-METAL OUTLET, DEVICE, PULL, AND JUNCTION: NEMA FB 1, FERROUS ALLOY, TYPE FD, WITH GASKETED COVER.
C. HINGED-COVER ENCLOSURES: COMPLY WITH UL 50 AND NEMA 250, WITH CONTINUOUS-HINGE COVER WITH FLUSH LATCH UNLESS OTHERWISE INDICATED.
1.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING
A. DESCRIPTION: COMPLY WITH SCTE 77.
1. COLOR OF FRAME AND COVER: GREEN.
2. CONFIGURATION: UNITS SHALL BE DESIGNED FOR FLUSH BURIAL AND HAVE OPEN BOTTOM, UNLESS OTHERWISE INDICATED.
3. COVER: WEATHERPROOF, SECURED BY TAMPER-RESISTANT LOCKING DEVICES AND HAVING STRUCTURAL LOAD RATING CONSISTENT WITH ENCLOSURE.
4. COVER FINISH: NONSKID FINISH SHALL HAVE A MINIMUM COEFFICIENT OF FRICTION OF 0.50.
5. COVER LEGEND: MOLDED LETTERING, "ELECTRIC" OR AS OTHERWISE INDICATED FOR EACH SERVICE.
6. CONDUIT ENTRANCE PROVISIONS: CONDUIT-TERMINATING FITTINGS SHALL MATE WITH ENTERING DUCTS FOR SECURE, FIXED INSTALLATION IN ENCLOSURE WALL.
7. HANDHOLES 12 INCHES WIDE BY 24 INCHES LONG (300 MM WIDE BY 600 MM LONG) AND LARGER SHALL HAVE INSERTS FOR CABLE RACKS AND PULLING-IN IRONS INSTALLED BEFORE CONCRETE IS POURED.
B. POLYMER-CONCRETE HANDHOLES AND BOXES WITH POLYMER-CONCRETE COVER: MOLDED OF SAND AND AGGREGATE, BOUND TOGETHER WITH POLYMER RESIN, AND REINFORCED WITH STEEL OR FIBERGLASS OR A COMBINATION OF THE TWO.
1.6 RACEWAY APPLICATION
A. ABOVEGROUND: RIGID STEEL CONDUIT.
B. UNDERGROUND CONDUIT: RNC, TYPE EPC-40-PVC, DIRECT BURIED.
C. CONNECTION TO VIBRATING EQUIPMENT (INCLUDING TRANSFORMERS AND HYDRAULIC, PNEUMATIC, ELECTRIC SOLENOID, OR MOTOR-DRIVEN EQUIPMENT): LFMC.
D. BOXES AND ENCLOSURES, ABOVEGROUND: NEMA 250, TYPE 3R
E. APPLICATION OF HANDHOLES AND BOXES FOR UNDERGROUND WIRING:
1. HANDHOLES AND PULL BOXES IN DRIVEWAY, PARKING LOT, AND OFF-ROADWAY LOCATIONS, SUBJECT TO OCCASIONAL, NONDELIBERATE LOADING BY HEAVY VEHICLES: POLYMER CONCRETE, SCTE 77, TIER 15 STRUCTURAL LOAD RATING.
2. HANDHOLES AND PULL BOXES IN SIDEWALK AND SIMILAR APPLICATIONS WITH A SAFETY FACTOR FOR NONDELIBERATE LOADING BY VEHICLES: POLYMER-CONCRETE UNITS, SCTE 77, TIER 8 STRUCTURAL LOAD RATING.
F. MINIMUM RACEWAY SIZE: 3/4-INCH (21-MM) TRADE SIZE.
G. RACEWAY FITTINGS: COMPATIBLE WITH RACEWAYS AND SUITABLE FOR USE AND LOCATION.
1. RIGID STEEL CONDUIT: USE THREADED RIGID STEEL CONDUIT FITTINGS, UNLESS OTHERWISE INDICATED.
2. PVC EXTERNALLY COATED, RIGID STEEL CONDUITS: USE ONLY FITTINGS LISTED FOR USE WITH THAT MATERIAL. PATCH AND SEAL ALL JOINTS, NICKS, AND SCRAPES IN PVC COATING AFTER INSTALLING CONDUITS AND FITTINGS. USE SEALANT RECOMMENDED BY FITTING MANUFACTURER.
H. INSTALL NONFERROUS CONDUIT OR TUBING FOR CIRCUITS OPERATING ABOVE 60 HZ. WHERE ALUMINUM RACEWAYS ARE INSTALLED FOR SUCH CIRCUITS AND PASS THROUGH CONCRETE, INSTALL IN NONMETALLIC SLEEVE.
I. DO NOT INSTALL ALUMINUM CONDUITS IN CONTACT WITH CONCRETE.
1.7 INSTALLATION
A. COMPLY WITH NECA 1 FOR INSTALLATION REQUIREMENTS APPLICABLE TO PRODUCTS SPECIFIED IN PART 2 EXCEPT WHERE REQUIREMENTS ON DRAWINGS OR IN THIS ARTICLE ARE STRICTER.
B. KEEP RACEWAYS AT LEAST 6 INCHES (150 MM) AWAY FROM PARALLEL RUNS OF FLUES AND STEAM OR HOT-WATER PIPES. INSTALL HORIZONTAL RACEWAY RUNS ABOVE WATER AND STEAM PIPING.
C. COMPLETE RACEWAY INSTALLATION BEFORE STARTING CONDUCTOR INSTALLATION.
D. SUPPORT RACEWAYS AS SPECIFIED IN DIVISION 26 SECTION "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS."
E. ARRANGE STUB-UPS SO CURVED PORTIONS OF BENDS ARE NOT VISIBLE ABOVE THE FINISHED SLAB.
F. INSTALL NO MORE THAN THE EQUIVALENT OF THREE 90-DEGREE BENDS IN ANY CONDUIT RUN EXCEPT FOR COMMUNICATIONS CONDUITS, FOR WHICH FEWER BENDS ARE ALLOWED.
G. CONCEAL CONDUIT AND EMT WITHIN FINISHED WALLS, CEILINGS, AND FLOORS, UNLESS OTHERWISE INDICATED.
H. RACEWAYS EMBEDDED IN SLABS:
1. RUN CONDUIT LARGER THAN 1-INCH (27-MM) TRADE SIZE, PARALLEL OR AT RIGHT ANGLES TO MAIN REINFORCEMENT. WHERE AT RIGHT ANGLES TO REINFORCEMENT, PLACE CONDUIT CLOSE TO SLAB SUPPORT.
2. ARRANGE RACEWAYS TO CROSS BUILDING EXPANSION JOINTS AT RIGHT ANGLES WITH EXPANSION FITTINGS.
3. CHANGE FROM TYPE EPC-40-PVC TO WRAPPED RIGID STEEL CONDUIT BEFORE RISING ABOVE GRADE.
I. THREADED CONDUIT JOINTS, EXPOSED TO WET, DAMP, CORROSIVE, OR OUTDOOR CONDITIONS: APPLY LISTED COMPOUND TO THREADS OF RACEWAY AND FITTINGS BEFORE MAKING UP JOINTS. FOLLOW COMPOUND MANUFACTURER'S WRITTEN INSTRUCTIONS.
J. RACEWAY TERMINATIONS AT LOCATIONS SUBJECT TO MOISTURE OR VIBRATION: USE INSULATING BUSHINGS TO PROTECT CONDUCTORS, INCLUDING CONDUCTORS SMALLER THAN NO. 4 AWG.
K. INSTALL PULL WIRES IN EMPTY RACEWAYS. USE POLYPROPYLENE OR MONOFILAMENT PLASTIC LINE WITH NOT LESS THAN 200-LB (90-KG) TENSILE STRENGTH. LEAVE AT LEAST 12 INCHES (300 MM) OF SLACK AT EACH END OF PULL WIRE.
L. INSTALL RACEWAY SEALING FITTINGS AT SUITABLE, APPROVED, AND ACCESSIBLE LOCATIONS AND FILL THEM WITH LISTED SEALING COMPOUND. FOR CONCEALED RACEWAYS, INSTALL EACH FITTING IN A FLUSH STEEL BOX WITH A BLANK COVER PLATE HAVING A FINISH SIMILAR TO THAT OF ADJACENT PLATES OR SURFACES. INSTALL RACEWAY SEALING FITTINGS WHERE REQUIRED BY NFPA 70.
M. EXPANSION-JOINT FITTINGS FOR RNC: INSTALL IN EACH RUN OF ABOVEGROUND CONDUIT THAT IS LOCATED WHERE ENVIRONMENTAL TEMPERATURE CHANGE MAY EXCEED 30 DEG F (17 DEG C), AND THAT HAS STRAIGHT-RUN LENGTH THAT EXCEEDS 25 FEET (7.6 M).
1.8 INSTALLATION OF UNDERGROUND CONDUIT
A. DIRECT-BURIED CONDUIT:
1. EXCAVATE TRENCH BOTTOM TO PROVIDE FIRM AND UNIFORM SUPPORT FOR CONDUIT. PREPARE TRENCH BOTTOM FOR PIPE LESS THAN 6 INCHES (150 MM) IN NOMINAL DIAMETER.
2. INSTALL BACKFILL.
3. AFTER INSTALLING CONDUIT, BACKFILL AND COMPACT. START AT TIE-IN POINT, AND WORK TOWARD END OF CONDUIT RUN, LEAVING CONDUIT AT END OF RUN FREE TO MOVE WITH EXPANSION AND CONTRACTION AS TEMPERATURE CHANGES DURING THIS PROCESS. FIRMLY HAND TAMP BACKFILL AROUND CONDUIT TO PROVIDE MAXIMUM SUPPORTING STRENGTH. AFTER PLACING CONTROLLED BACKFILL TO WITHIN 12 INCHES (300 MM) OF FINISHED GRADE, MAKE FINAL CONDUIT CONNECTION AT END OF RUN AND COMPLETE BACKFILLING WITH NORMAL.
4. INSTALL MANUFACTURED DUCT ELBOWS FOR STUB-UPS AT POLES AND EQUIPMENT AND AT BUILDING ENTRANCES THROUGH THE FLOOR, UNLESS OTHERWISE INDICATED. ENCASE ELBOWS FOR STUB-UP DUCTS THROUGHOUT THE LENGTH OF THE ELBOW.
5. INSTALL MANUFACTURED RIGID STEEL CONDUIT ELBOWS FOR STUB-UPS AT POLES AND EQUIPMENT AND AT BUILDING ENTRANCES THROUGH THE FLOOR.
a. COUPLE STEEL CONDUITS TO DUCTS WITH ADAPTERS DESIGNED FOR THIS PURPOSE, AND ENCASE COUPLING WITH 3 INCHES (75 MM) OF CONCRETE.
b. FOR STUB-UPS AT EQUIPMENT MOUNTED ON OUTDOOR CONCRETE BASES, EXTEND STEEL CONDUIT HORIZONTALLY A MINIMUM OF 60 INCHES (1500 MM) FROM EDGE OF EQUIPMENT PAD OR FOUNDATION. INSTALL INSULATED GROUNDING BUSHINGS ON TERMINATIONS AT EQUIPMENT.
1.9 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES
A. INSTALL HANDHOLES AND BOXES LEVEL AND PLUMB AND WITH ORIENTATION AND DEPTH COORDINATED WITH CONNECTING CONDUITS TO MINIMIZE BENDS AND DEFLECTIONS REQUIRED FOR PROPER ENTRANCES.
B. UNLESS OTHERWISE INDICATED, SUPPORT UNITS ON A LEVEL BED OF CRUSHED STONE OR GRAVEL, GRADED FROM 1/2-INCH (12.5-MM) SIEVE TO NO. 4 (4.75-MM) SIEVE AND COMPACTED TO SAME DENSITY AS ADJACENT UNDISTURBED EARTH.
C. ELEVATION: IN PAVED AREAS, SET SO COVER SURFACE WILL BE FLUSH WITH FINISHED GRADE. SET COVERS OF OTHER ENCLOSURES 1 INCH (25 MM) ABOVE FINISHED GRADE.
D. INSTALL REMOVABLE HARDWARE, INCLUDING PULLING EYES, CABLE STANCHIONS, CABLE ARMS, AND INSULATORS, AS REQUIRED FOR INSTALLATION AND SUPPORT OF CABLES AND CONDUCTORS AND AS INDICATED. SELECT ARM LENGTHS TO BE LONG ENOUGH TO PROVIDE SPARE SPACE FOR FUTURE CABLES, BUT SHORT ENOUGH TO PRESERVE ADEQUATE WORKING CLEARANCES IN THE ENCLOSURE.
E. FIELD-CUT OPENINGS FOR CONDUITS ACCORDING TO ENCLOSURE MANUFACTURER'S WRITTEN INSTRUCTIONS. CUT WALL OF ENCLOSURE WITH A TOOL DESIGNED FOR MATERIAL TO BE CUT. SIZE HOLES FOR TERMINATING FITTINGS TO BE USED, AND SEAL AROUND PENETRATIONS AFTER FITTINGS ARE INSTALLED.
1.10 PROTECTION
A. PROVIDE FINAL PROTECTION AND MAINTAIN CONDITIONS THAT ENSURE COATINGS, FINISHES, AND CABINETS ARE WITHOUT DAMAGE OR DETERIORATION AT TIME OF SUBSTANTIAL COMPLETION.
1. REPAIR DAMAGE TO GALVANIZED FINISHES WITH ZINC-RICH PAINT RECOMMENDED BY MANUFACTURER.
2. REPAIR DAMAGE TO PVC OR PAINT FINISHES WITH MATCHING TOUCHUP COATING RECOMMENDED BY MANUFACTURER.

SECTION 262416 - PANELBOARDS
1.1 SUBMITTALS
A. PRODUCT DATA: FOR EACH TYPE OF PRODUCT.
B. FIELD QUALITY-CONTROL REPORTS.
C. OPERATION AND MAINTENANCE DATA
1.2 QUALITY ASSURANCE
A. ELECTRICAL COMPONENTS, DEVICES, AND ACCESSORIES: LISTED AND LABELED AS DEFINED IN NFPA 70, BY A QUALIFIED TESTING AGENCY, AND MARKED FOR INTENDED LOCATION AND APPLICATION.
B. COMPLY WITH NEMA PB 1.
C. COMPLY WITH NFPA 70.
1.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES
A. MANUFACTURERS: COMPATIBLE WITH OWNER FURNISHED EQUIPMENT.
B. MOLDED-CASE CIRCUIT BREAKER (MCCB): COMPLY WITH UL 489, WITH INTERRUPTING CAPACITY TO MEET AVAILABLE FAULT CURRENTS.
1. THERMAL-MAGNETIC CIRCUIT BREAKERS: INVERSE TIME-CURRENT ELEMENT FOR LOW-LEVEL OVERLOADS, AND INSTANTANEOUS MAGNETIC TRIP ELEMENT FOR SHORT CIRCUITS. ADJUSTABLE MAGNETIC TRIP SETTING FOR CIRCUIT-BREAKER FRAME SIZES 250 A AND LARGER.
2. GFCI CIRCUIT BREAKERS: SINGLE- AND TWO-POLE CONFIGURATIONS WITH CLASS A GROUND-FAULT PROTECTION (6-MA TRIP).
3. MOLDED-CASE CIRCUIT-BREAKER (MCCB) FEATURES AND ACCESSORIES:
a. STANDARD FRAME SIZES, TRIP RATINGS, AND NUMBER OF POLES.
b. LUGS: MECHANICAL STYLE, SUITABLE FOR NUMBER, SIZE, TRIP RATINGS, AND CONDUCTOR MATERIALS.
c. APPLICATION LISTING: APPROPRIATE FOR APPLICATION; TYPE SWD FOR SWITCHING FLUORESCENT LIGHTING LOADS; TYPE HID FOR FEEDING FLUORESCENT AND HIGH-INTENSITY DISCHARGE (HID) LIGHTING CIRCUITS.
d. MULTIPOLE UNITS ENCLOSED IN A SINGLE HOUSING OR FACTORY ASSEMBLED TO OPERATE AS A SINGLE UNIT.
1.4 EXAMINATION
A. RECEIVE, INSPECT, HANDLE, AND STORE PANELBOARDS ACCORDING TO NEMA PB 1.1.
B. EXAMINE PANELBOARDS BEFORE INSTALLATION. REJECT PANELBOARDS THAT ARE DAMAGED OR RUSTED OR HAVE BEEN SUBJECTED TO WATER SATURATION.
C. EXAMINE ELEMENTS AND SURFACES TO RECEIVE PANELBOARDS FOR COMPLIANCE WITH INSTALLATION TOLERANCES AND OTHER CONDITIONS AFFECTING PERFORMANCE OF THE WORK.
D. PROCEED WITH INSTALLATION ONLY AFTER UNSATISFACTORY CONDITIONS HAVE BEEN CORRECTED.
1.5 INSTALLATION
A. INSTALL PANELBOARDS AND ACCESSORIES ACCORDING TO NEMA PB 1.1.
B. MOUNT PANELBOARD CABINET PLUMB AND RIGID WITHOUT DISTORTION OF BOX. MOUNT RECESSED PANELBOARDS WITH FRONTS UNIFORMLY FLUSH WITH WALL FINISH AND MATING WITH BACK BOX.
C. INSTALL OVERCURRENT PROTECTIVE DEVICES AND CONTROLLERS NOT ALREADY FACTORY INSTALLED.
D. INSTALL FILLER PLATES IN UNUSED SPACES.
E. ARRANGE CONDUCTORS IN GUTTERS INTO GROUPS AND BUNDLE AND WRAP WITH WIRE TIES.
F. COMPLY WITH NECA 1.
1.6 IDENTIFICATION
A. IDENTIFY FIELD-INSTALLED CONDUCTORS, INTERCONNECTING WIRING, AND COMPONENTS; PROVIDE WARNING SIGNS COMPLYING WITH DIVISION 26 SECTION "IDENTIFICATION FOR ELECTRICAL SYSTEMS."
B. CREATE A DIRECTORY TO INDICATE INSTALLED CIRCUIT LOADS; INCORPORATE OWNER'S FINAL ROOM DESIGNATIONS. OBTAIN APPROVAL BEFORE INSTALLING. USE A COMPUTER OR TYPEWRITER TO CREATE DIRECTORY; HANDWRITTEN DIRECTORIES ARE NOT ACCEPTABLE.
C. PANELBOARD NAMEPLATES: LABEL EACH PANELBOARD WITH A NAMEPLATE COMPLYING WITH REQUIREMENTS FOR IDENTIFICATION SPECIFIED IN DIVISION 26 SECTION "IDENTIFICATION FOR ELECTRICAL SYSTEMS."

SECTION 262713 - ELECTRICITY METERING
1.1 SUMMARY
A. SECTION INCLUDES EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY.
1.2 SUBMITTALS
A. PRODUCT DATA: FOR EACH TYPE OF PRODUCT INDICATED.
B. SHOP DRAWINGS: DIMENSIONED PLANS AND SECTIONS OR ELEVATION LAYOUTS AND WIRING DIAGRAMS.
C. FIELD QUALITY-CONTROL REPORTS.
D. OPERATION AND MAINTENANCE DATA. IN ADDITION TO ITEMS SPECIFIED IN DIVISION 01 SECTION "OPERATION AND MAINTENANCE DATA," INCLUDE THE FOLLOWING:
1. APPLICATION AND OPERATING SOFTWARE DOCUMENTATION.
2. SOFTWARE LICENSES.
3. SOFTWARE SERVICE AGREEMENT.
4. HARD COPIES OF MANUFACTURER'S OPERATING SPECIFICATIONS, DESIGN USER'S GUIDES FOR SOFTWARE AND HARDWARE, AND PDF FILES ON CD-ROM OF THE HARD-COPY SUBMITTAL.
1.3 QUALITY ASSURANCE
A. ELECTRICAL COMPONENTS, DEVICES, AND ACCESSORIES: LISTED AND LABELED AS DEFINED IN NFPA 70, BY A QUALIFIED TESTING AGENCY, AND MARKED FOR INTENDED LOCATION AND APPLICATION.
1.4 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY
A. METERS WILL BE FURNISHED BY UTILITY COMPANY.
B. CURRENT-TRANSFORMER CABINETS: COMPLY WITH REQUIREMENTS OF ELECTRICAL-POWER UTILITY COMPANY.
C. METER SOCKETS: COMPLY WITH REQUIREMENTS OF ELECTRICAL-POWER UTILITY COMPANY.
1.5 INSTALLATION
A. COMPLY WITH EQUIPMENT INSTALLATION REQUIREMENTS IN NECA 1.
B. INSTALL METERS FURNISHED BY UTILITY COMPANY. INSTALL RACEWAYS AND EQUIPMENT ACCORDING TO UTILITY COMPANY'S WRITTEN REQUIREMENTS. PROVIDE EMPTY CONDUITS FOR METERING LEADS AND EXTEND GROUNDING CONNECTIONS AS REQUIRED BY UTILITY COMPANY.
C. COMPLY WITH REQUIREMENTS FOR IDENTIFICATION SPECIFIED IN DIVISION 26 SECTION "IDENTIFICATION FOR ELECTRICAL SYSTEMS."
1. SERIES COMBINATION WARNING LABEL: SELF-ADHESIVE TYPE, WITH TEXT AS REQUIRED BY NFPA 70.

SECTION 262726 - WIRING DEVICES
1.1 QUALITY ASSURANCE
A. SOURCE LIMITATIONS: OBTAIN EACH TYPE OF WIRING DEVICE AND ASSOCIATED WALL PLATE THROUGH ONE SOURCE FROM A SINGLE MANUFACTURER. INSOFAR AS THEY ARE AVAILABLE, OBTAIN ALL WIRING DEVICES AND ASSOCIATED WALL PLATES FROM A SINGLE MANUFACTURER AND ONE SOURCE.
B. ELECTRICAL COMPONENTS, DEVICES, AND ACCESSORIES: LISTED AND LABELED AS DEFINED IN NFPA 70, ARTICLE 100, BY A TESTING AGENCY ACCEPTABLE TO AUTHORITIES HAVING JURISDICTION, AND MARKED FOR INTENDED USE.
C. COMPLY WITH NFPA 70.
1.2 GFCI RECEPTACLES
A. GENERAL DESCRIPTION: STRAIGHT BLADE, FEED-THROUGH TYPE. COMPLY WITH NEMA WD 1, NEMA WD 6, UL 498, AND UL 943, CLASS A, AND INCLUDE INDICATOR LIGHT THAT IS LIGHTED WHEN DEVICE IS TRIPPED.
B. DUPLEX GFCI CONVENIENCE RECEPTACLES, 125 V, 20 A:
1.3 WALL PLATES
A. WET-LOCATION, WEATHERPROOF COVER PLATES: NEMA 250, COMPLYING WITH TYPE 3R WEATHER-RESISTANT, DIE-CAST ALUMINUM OR THERMOPLASTIC WITH LOCKABLE COVER.
1.4 INSTALLATION
A. COMPLY WITH NECA 1, INCLUDING THE MOUNTING HEIGHTS LISTED IN THAT STANDARD, UNLESS OTHERWISE NOTED.
B. COORDINATE WITH OTHER TRADES TO PROTECT BOXES AND KEEP DEVICE BOXES CLEAR OF DEBRIS. INSTALL DEVICES ONLY AFTER ALL SURFACE PREPARATION IS COMPLETED.
C. CONDUCTORS:
1. DO NOT STRIP INSULATION FROM CONDUCTORS UNTIL JUST BEFORE THEY ARE SPLICED OR TERMINATED ON DEVICES.
2. STRIP INSULATION EVENLY AROUND THE CONDUCTOR USING TOOLS DESIGNED FOR THE PURPOSE. AVOID SCORING OR NICKING OF SOLID WIRE OR CUTTING STRANDS FROM STRANDED WIRE.
3. THE LENGTH OF FREE CONDUCTORS AT OUTLETS FOR DEVICES SHALL MEET PROVISIONS OF NFPA 70, ARTICLE 300, WITHOUT PIGTAILS.
D. DEVICE INSTALLATION:
1. CONNECT DEVICES TO BRANCH CIRCUITS USING PIGTAILS THAT ARE NOT LESS THAN 12 INCHES (300 MM) IN LENGTH.
2. WHEN CONDUCTORS LARGER THAN NO. 12 AWG ARE INSTALLED ON 15- OR 20-A CIRCUITS, SPLICE NO. 12 AWG PIGTAILS FOR DEVICE CONNECTIONS.
3. WHEN MOUNTING INTO METAL BOXES, REMOVE THE FIBER OR PLASTIC WASHERS USED TO HOLD DEVICE MOUNTING SCREWS IN YOKES, ALLOWING METAL-TO-METAL CONTACT.
1.5 IDENTIFICATION
A. COMPLY WITH DIVISION 26 SECTION "IDENTIFICATION FOR ELECTRICAL SYSTEMS."
1.6 FIELD QUALITY CONTROL
A. TESTS FOR CONVENIENCE RECEPTACLES:
1. LINE VOLTAGE: ACCEPTABLE RANGE IS 105 TO 132 V.
2. PERCENT VOLTAGE DROP UNDER 15-A LOAD: A VALUE OF 6 PERCENT OR HIGHER IS NOT ACCEPTABLE.
3. GROUND IMPEDANCE: VALUES OF UP TO 2 OHMS ARE ACCEPTABLE.
4. GFCI TRIP: TEST FOR TRIPPING VALUES SPECIFIED IN UL 1436 AND UL 943.
5. USING THE TEST PLUG, VERIFY THAT THE DEVICE AND ITS OUTLET BOX ARE SECURELY MOUNTED.
6. THE TESTS SHALL BE DIAGNOSTIC, INDICATING DAMAGED CONDUCTORS, HIGH RESISTANCE AT THE CIRCUIT BREAKER, POOR CONNECTIONS, INADEQUATE FAULT CURRENT PATH, DEFECTIVE DEVICES, OR SIMILAR PROBLEMS. CORRECT CIRCUIT CONDITIONS, REMOVE MALFUNCTIONING UNITS AND REPLACE WITH NEW ONES, AND RETEST AS SPECIFIED ABOVE.

SECTION 265100 - INTERIOR LIGHTING
1.1 ACTION SUBMITTALS
A. PRODUCT DATA: FOR EACH TYPE OF LIGHTING FIXTURE, ARRANGED IN ORDER OF FIXTURE DESIGNATION. INCLUDE DATA ON FEATURES, ACCESSORIES, AND FINISHES.
1.2 QUALITY ASSURANCE
A. ELECTRICAL COMPONENTS, DEVICES, AND ACCESSORIES: LISTED AND LABELED AS DEFINED IN NFPA 70, BY A QUALIFIED TESTING AGENCY, AND MARKED FOR INTENDED LOCATION AND APPLICATION.
B. COMPLY WITH NFPA 70.
1.3 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS
A. FLUORESCENT FIXTURES: COMPLY WITH UL 1598. WHERE LER IS SPECIFIED, TEST ACCORDING TO NEMA LE 5 AND NEMA LE 5A AS APPLICABLE.
B. METAL PARTS: FREE OF BURRS AND SHARP CORNERS AND EDGES.
C. DIFFUSERS AND GLOBES:
1. ACRYLIC LIGHTING DIFFUSERS: 100 PERCENT VIRGIN ACRYLIC PLASTIC. HIGH RESISTANCE TO YELLOWING AND OTHER CHANGES DUE TO AGING, EXPOSURE TO HEAT, AND UV RADIATION.
a. LENS THICKNESS: AT LEAST 0.125 INCH MINIMUM UNLESS OTHERWISE INDICATED.
b. UV STABILIZED.
1.4 BALLASTS FOR LINEAR FLUORESCENT LAMPS
A. GENERAL REQUIREMENTS FOR ELECTRONIC BALLASTS:
1. COMPLY WITH UL 935 AND WITH ANSI C82.11.
2. DESIGNED FOR TYPE AND QUANTITY OF LAMPS SERVED.
3. PROGRAM-START
1.5 LED LUMINAIRES
A. SOLID STATE DRIVERS AND LED: COMPLY WITH DOE LM 79
1. TOTAL HARMONIC DISTORTION RATING: LESS THAN 10 PERCENT
2. TRANSIENT VOLTAGE PROTECTION
3. POWER FACTOR: 0.90 OR HIGHER
4. TEMPERATURES: MINUS 40 DEG F (MINUS 40 DEG C) AND HIGHER
5. HEAT SINK TO REMOVE HEAT FROM CIRCUITS
6. L70 COMPLIANT TO 70,000 HOURS MINIMUM
7. DIMMABLE
a. DIMMING RANGE: 100 TO 1 PERCENT OF RATED LAMP LUMENS
b. INPUT WATTS: CAN BE REDUCED TO 20 PERCENT OF NORMAL
1.6 EMERGENCY POWER UNIT
A. INTERNAL TYPE: SELF-CONTAINED, MODULAR, BATTERY-INVERTER UNIT, FACTORY MOUNTED WITHIN LIGHTING FIXTURE BODY AND COMPATIBLE WITH BALLAST OR DRIVER. COMPLY WITH UL 924.
1. EMERGENCY CONNECTION: OPERATE ONE LAMP(S) CONTINUOUSLY AT AN OUTPUT OF 1100 LUMENS EACH. CONNECT UNSWITCHED CIRCUIT TO BATTERY-INVERTER UNIT AND SWITCHED CIRCUIT TO FIXTURE POWER SUPPLY OR BALLAST.
2. TEST PUSH BUTTON AND INDICATOR LIGHT: VISIBLE AND ACCESSIBLE WITHOUT OPENING FIXTURE OR ENTERING CEILING SPACE.
a. PUSH BUTTON: PUSH-TO-TEST TYPE, IN UNIT HOUSING, SIMULATES LOSS OF NORMAL POWER AND DEMONSTRATES UNIT OPERABILITY.
b. INDICATOR LIGHT: LED INDICATES NORMAL POWER ON. NORMAL GLOW INDICATES TRICKLE CHARGE; BRIGHT GLOW INDICATES CHARGING AT END OF DISCHARGE CYCLE.
3. BATTERY: SEALED, MAINTENANCE-FREE, NICKEL-CADMIUM TYPE.
4. CHARGER: FULLY AUTOMATIC, SOLID-STATE, CONSTANT-CURRENT TYPE WITH SEALED POWER TRANSFER RELAY.
5. INTEGRAL SELF-TEST: FACTORY-INSTALLED ELECTRONIC DEVICE AUTOMATICALLY INITIATES CODE-REQUIRED TEST OF UNIT EMERGENCY OPERATION AT REQUIRED INTERVALS. TEST FAILURE IS ANNUNCIATED BY AN INTEGRAL AUDIBLE ALARM AND A FLASHING RED LED.
1.7 FLUORESCENT LAMPS
A. T8 RAPID-START LAMPS CRI 85 (MINIMUM), COLOR TEMPERATURE 3500 K, AND AVERAGE RATED LIFE 20,000 HOURS UNLESS OTHERWISE INDICATED.
1.8 LIGHTING FIXTURE SUPPORT COMPONENTS
A. WIRES: ASTM A 641/A 641M, CLASS 3, SOFT TEMPER, ZINC-COATED STEEL, 12 GAGE.
B. WIRES FOR HUMID SPACES: ASTM A 580/A 580M, COMPOSITION 302 OR 304, ANNEALED STAINLESS STEEL, 12 GAGE.
1.9 INSTALLATION
A. LIGHTING FIXTURES: SET LEVEL, PLUMB, AND SQUARE WITH CEILINGS AND WALLS. INSTALL LAMPS IN EACH FIXTURE.
B. COMPLY WITH NFPA 70 FOR MINIMUM FIXTURE SUPPORTS.
1.10 FIELD QUALITY CONTROL
A. TEST FOR EMERGENCY LIGHTING: INTERRUPT POWER SUPPLY TO DEMONSTRATE PROPER OPERATION. VERIFY TRANSFER FROM NORMAL POWER TO BATTERY AND RETRANSFER TO NORMAL.

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Project Title:
CONTROL HOUSE BUILDING
LOGAN CITY, UTAH

Sheet Title:
ELECTRICAL SPECIFICATIONS

Drawn By: D. PATTON	Project Number: SSE #2013051	Drawing Type:
Designed By: S. SWENSON	Date: 1-17-14	Sheet Number: E002 of
Reviewed By: S. SWENSON	Sheet Scale: AS NOTED	

SHEET KEYED NOTES

1. APPROXIMATE LOCATION OF EXISTING POLE WITH POLE-MOUNT UTILITY TRANSFORMER.
2. PROVIDE NEW UNDERGROUND SERVICE LATERAL TO NEW CONTROL HOUSE.

GENERAL SHEET NOTES

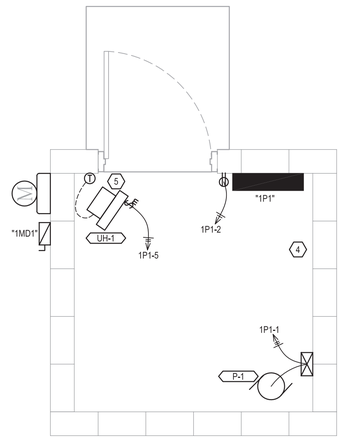
1. CIRCUIT & FEEDER ROUTING IS SCHEMATIC. VERIFY ROUTES WITH CONDITIONS PRIOR TO BID.

1 ELECTRICAL SITE PLAN

Scale: 1"=20'-0"

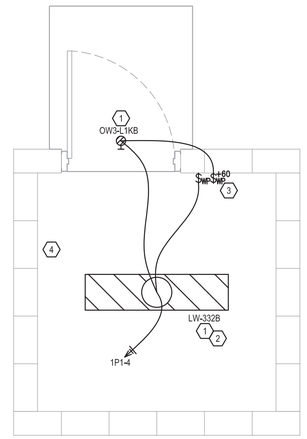
KEYED NOTES

1. PROVIDE EM BATTERY BALLAST FOR FIXTURES NOTED. CONNECT BATTERY TO UNSWITCHED CONDUCTOR OF CIRCUIT SERVING FIXTURE. CONNECT LAMPS TO OPERATE WITH SWITCHES IN NORMAL MODE.
2. CHAIN SUSPEND FIXTURE IN SPACE AS NEEDED TO ACCOMMODATE PIPING.
3. PROVIDE OFF OVERRIDE SWITCH FOR EXTERIOR FIXTURE.
4. ALL INSTALLATIONS IN SPACE TO BE NEMA 3R RATED.
5. PROVIDE HEATER. VERIFY MOUNTING LOCATION WITH FIELD CONDITIONS. SEE MECHANICAL EQUIPMENT SCHEDULE FOR ADDITIONAL INFORMATION.



2 POWER PLAN

Scale: 1/2"=1'-0"

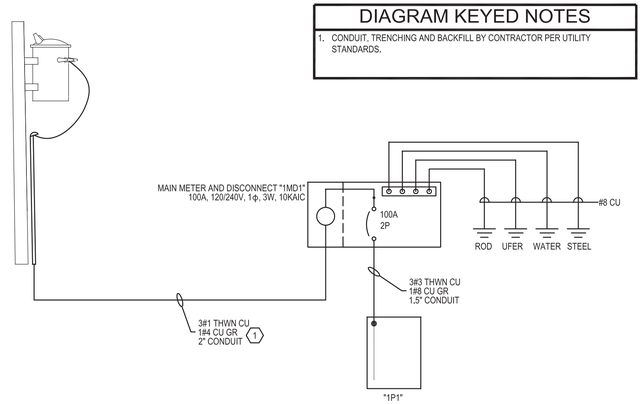


3 LIGHTING PLAN

Scale: 1/2"=1'-0"

DIAGRAM KEYED NOTES

1. CONDUIT, TRENCHING AND BACKFILL BY CONTRACTOR PER UTILITY STANDARDS.



4 ELECTRICAL ONE-LINE DIAGRAM

SCALE: NTS

REV#:	REVISION DESCRIPTION:	DATE:

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SHANE D. SWENSON
11/11/2014
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Project Title:

CONTROL HOUSE BUILDING

LOGAN CITY, UTAH

Sheet Title:

ELECTRICAL PLANS

Drawn By: D. PATTON	Project Number: SSE #2013051	Drawing Type:
Designed By: S. SWENSON	Date: 1-17-14	Sheet Number: E101
Reviewed By: S. SWENSON	Sheet Scale: AS NOTED	of

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BID TAB SHEETS

Expanded Table

No Federal Action Alternative

Project Measure	Description	Units	Qty	Unit Cost	Total Cost	HCC UNIT COST	HCC TOTAL COST
Reconstruct Crockett Dam	Remove concrete bridge and fencing	ls	1	$ 20,000	$ 20,000.00	16500	16,500.00
	Dewatering/flow management	ls	1	$ 100,000	$ 100,000.00		
	Remove concrete wall and grouted rip-rap	ls	1	$ 35,000	$ 35,000.00	16500	16,500.00
	Remove steel superstructure at dam: railings, braces, bridge, etc.	ls	1	$ 15,000	$ 15,000.00	15000	15,000.00
	Channel excavation	cy	350	$ 15	$ 5,250.00	125	43,750.00
	Construction of Proposed dam and concrete walls	ls	1	$ 250,000	$ 250,000.00	125000	125,000.00
	Installation of overshot gates and appurtenances	ls	1	$ 250,000	$ 250,000.00	250000	0.00
	Install canal gate	ls	1	$ 25,000	$ 25,000.00	5000	5,000.00
	Construction of control house	ls	1	$ 25,000	$ 25,000.00	30000	30,000.00
	Electrical wiring for site	ls	1	$ 15,000	$ 15,000.00	70000	70,000.00
	Install rip-rap upstream of dam	ls	1	$ 10,000	$ 10,000.00	141.15	141.15
	Revegetation/stabiliation	sy	1000	$ 10	$ 10,000.00	9.25	9,250.00
	Install chain-link fence	ls	1	$ 15,000	$ 15,000.00	20000	20,000.00
			Reconstruct Crockett Dam Subtotal		$ 990,000	R.C.D.STOTAL	$ 351,141
Initial Canal Enclosure	Line Canal on Hill (4x6 box culvert)	ft	2,500	$ 1,200	$ 3,000,000	360	$ 900,000
			Line Canal Section Subtotal		$ 3,000,000		$ 900,000
	Initial Project Measures Subtotal				$ 3,990,000		$ 1,251,141
Contractor Overhead	Mobilization	Percent	5%	$ 180,000	$ 180,000	$ 13,000	$ 13,000
	Survey		1%	$ 40,000	$ 40,000	$ 13,000	$ 13,000
			Contractor Overhead Section Subtotal		$ 220,000		$ 26,000
	Total Initial Cost				**$ 4,210,000**		**$ 1,277,141**

Summary Table

No Federal Action Alternative

Description	Total Cost
Reconstruct Crockett Dam	$ 990,000
Line Canal Section	$ 3,000,000
Contractor Overhead	$ 220,000
Total Cost	**$ 4,210,000**

						Materials	Labor	
Future Canal Enclosure	Crockett Remaining north branch (4x6 box culvert)	lf	2640	$ 1,200	$ 3,168,000			
	Twins new headgate structure	ea	1	$ 25,000	$ 25,000			
	Twins 200N to 1000 N (48" N-12)	lf	6864	$ 329	$ 2,258,256	129	200	1.5504
	Twins 200N to 1000 N 72" Manholes	ea	14	$ 10,000	$ 140,000			
	Twins 1000N to 1800 N (48" N-12)	lf	5808	$ 329	$ 1,910,832	129	200	
	Twins 1000N to 1800 N 72" Manholes	ea	12	$ 10,000	$ 120,000			
	Twins 1800 N to 2500 N (48" N-12)	lf	4752	$ 329	$ 1,563,408	129	200	
	Twins 1800 N to 2500 N 72" Manholes	ea	10	$ 10,000	$ 100,000			
	Isolation Valve for HPIC	ea	1	$ 15,000	$ 15,000			
	Twins 2500 N to 3100 N (36" N-12)	lf	4224	$ 158	$ 667,392	61	97	1.5902
	Twins 2500 N to 3100 N 48" Manholes	ea	8	$ 7,700	$ 61,600			
	Twins 3100 N to 200 S (HP) crossing (36" N12)	lf	2640	$ 158	$ 417,120	61	97	
	Twins 3100 N to 200 S (HP) crossing 48" Manholes	ea	5	$ 7,700	$ 38,500			
	Twins 200 S Crossing to 100 W Crossing (36" N-12)	lf	4752	$ 158	$ 750,816	61	97	
	Twins 200 S Crossing to 100 W 48" Manholes	ea	10	$ 7,700	$ 77,000			
	LNWF Concrete Headgate structure and gate	ea	1	$ 25,000	$ 25,000			
	LNWF Diversion to 400 N (42" N-12)	lf	4752	$ 231	$ 1,097,712	88	143	1.625
	LNWF Diversion to 400 N 60" Manholes	ea	10	$ 9,200	$ 92,000			
	LNWF 400 N to 1400 N (42" N-12)	lf	4752	$ 231	$ 1,097,712	88	143	
	LNWF 400 N to 1400 N 60" Manholes	ea	10	$ 9,200	$ 92,000			
	LNWF 1400 N to 2500 N (42" N-12)	lf	7920	$ 231	$ 1,829,520	88	143	
	LNWF 1400 N to 2500 N 60" Manholes	ea	16	$ 9,200	$ 147,200			
	Benson Isolation Valve	ea	1	$ 12,000	$ 12,000			
	Benson (30" N-12)	lf	9504	$ 139	$ 1,321,056	50	89	1.78
	Benson 48" Manholes	ea	19	$ 7,700	$ 146,300			
	Logan Northfield 1 Isolation Valve	ea	1	$ 12,000	$ 12,000			
	Logan Northfield 1 (36" N-12)	lf	5280	$ 158	$ 834,240	61	97	
	Logan Northfield 1 48" Manholes	ea	11	$ 7,700	$ 84,700			
	Logan Northfield 2 Isolation Valve	ea	1	$ 10,000	$ 10,000			
	Logan Northfield 2 (30" N-12)	lf	2640	$ 139	$ 366,960	50	89	
	Logan Northfield 2 48" Manholes	ea	5	$ 7,700	$ 38,500			
	Cow Pasture Valve	ea	1	$ 10,000	$ 10,000			
	Cow Pasture Delivery (24" N-12)	lf	2640	$ 115	$ 303,600	34	81	2.3824
	Cow Pasture Delivery 48" Manholes	ea	5	$ 7,700	$ 38,500			
			Future Canal Enclosure Subtotal		$ 18,871,924			
Contractor Overhead	Mobilization	Percent	5%	$ 849,000	$ 849,000	2/2024	SupplieCub River estimate (Hess CC labor cost)	
	Survey		1%	$ 189,000	$ 189,000			
			Contractor Overhead Section Subtotal		$ 1,038,000			
	Total Initial Cost[1]				**$ 19,909,924**			

[1]Includes CWA Section 404 mitigation measures.

Expanded Table

First Dam Alternative

Project Measure	Line Item	Units	Qty		Unit Cost	Total Cost	HCC UNIT COST	HCC TOTAL COST
First Dam Intake	Sediment Removal at First Dam	cy	80000		$ 85	$ 6,800,000	12	960,000.00
	60" Welded Steel pipe	lf	325		$ 1,855	$ 602,875	1850	601,250.00
	60" x 54" steel Reducer	ea	2		$ 19,000	$ 38,000	18965.25	37,930.50
	60" steel elbow	ea	3		$ 36,800	$ 110,400	36765	110,295.00
	60" x 24" steel tee	ea	1		$ 33,600	$ 33,600	33575.25	33,575.25
	60" steel wye	ea	1		$ 29,400	$ 29,400	29375.55	29,375.55
	60" flow meter	ea	1		$ 38,900	$ 38,900	38875	38,875.00
	Vault/box for 60" meter	ea	1		$ 90,750	$ 90,750	90750	90,750.00
	24" flow meter	ea	1		$ 20,000	$ 20,000	21500	21,500.00
	24" gate valve	ea	1		$ 21,700	$ 21,700	21500	21,500.00
	Concrete pipe supports/thrust blocks	ls	8		$ 1,900	$ 15,200	1895.35	15,162.80
	Supply pipeline: 60" C-900 PVC DR 27.5 pipe	lf	8300		$ 570	$ 4,731,000	570	4,731,000.00
	60" pipeline installation road repair	lf	600	13177	$ 4.5	$ 59,298	4.5	2,700.00
	Canyon Road Crossing	ls	1		$ 300,000.0			
	Hillside stabilization	ls	1		$ 5,000,000.0	$ 5,000,000		
		First Dam Intake Subtotal				$ 17,591,123		$ 6,693,914
Pressurized Irrigation System	60" C-900 PVC DR 27.5 Pipe	lf	450		$ 570	$ 256,500	567.38	255,321.00
	60" Pipe installation road repair	lf	1055	23170	$ 4.5	$ 104,265	4.50	104,265.00
	54" C-900 PVC DR 27.5 Pipe	lf	1820		$ 440	$ 800,800	437.63	796,486.60
	48" C-900 PVC DR 27.5 Pipe	lf	15170		$ 375	$ 5,688,750	372.75	5,654,617.50
	48" Pipe installation road repair	lf	9570	114840	$ 4.5	$ 516,780	4.50	516,780.00
	42" C-900 PVC DR 27.5 Pipe	lf	20300		$ 315	$ 6,394,500	312.29	6,339,487.00
	42" Pipe installation road repair	lf	20300	233450	$ 4.5	$ 1,050,525	4.50	1,050,525.00
	36" C-900 PVC DR 27.5 Pipe	lf	8000		$ 255	$ 2,040,000	252.34	2,018,720.00
	36" Pipe installation road repair	lf	2790	27900	$ 4.5	$ 125,550	4.50	125,550.00
	30" C-900 PVC DR 27.5 Pipe	lf	9910		$ 225	$ 2,229,750	222.95	2,209,434.50
	30" Pipe installation road repair	lf	9910	94145	$ 4.5	$ 423,653	4.50	423,652.50
	27" PIP 125 PSI Pipe	lf	3010		$ 195	$ 586,950	193.56	582,615.60
	27" Pipe installation road repair	lf	3010	27843	$ 4.5	$ 125,294	4.50	125,293.50
	24" PIP 125 PSI Pipe	lf	8770		$ 170	$ 1,490,900	165.91	1,455,030.70
	24" Pipe installation road repair	lf	8770	74545	$ 4.5	$ 335,453	4.50	335,452.50
	21" PIP 125 PSI Pipe	lf	23270		$ 142	$ 3,304,340	140.18	3,261,988.60
	21" Pipe installation road repair	lf	23270	180343	$ 4.5	$ 811,544	4.50	811,543.50
	18" PIP 125 PSI Pipe	lf	25850		$ 115	$ 2,972,750	114.46	2,958,791.00
	18" Pipe installation road repair	lf	22685	170138	$ 4.5	$ 765,621	4.50	765,621.00
	15" PIP 125 PSI Pipe	lf	14450		$ 95	$ 1,372,750	94.13	1,360,178.50
	15" Pipe installation road repair	lf	14450	104763	$ 4.5	$ 471,434	4.50	471,433.50
	12" PIP 125 PSI Pipe	lf	51550		$ 80	$ 4,124,000	78.84	4,064,202.00
	12" Pipe installation road repair	lf	13320	93240	$ 4.5	$ 419,580	4.50	419,580.00
	10" PIP 125 PSI Pipe	lf	4970		$ 71	$ 352,870	70.52	350,484.40
	10" Pipe installation road repair	lf	4970	34790	$ 4.5	$ 156,555	4.50	156,555.00
	8" PIP 125 PSI Pipe	lf	28520		$ 63	$ 1,796,760	62.35	1,778,222.00
	8" Pipe installation road repair	lf	27509	185686	$ 4.5	$ 835,587	4.50	835,587.00
	6" PIP 125 PSI Pipe	lf	3180		$ 55	$ 174,900	54.16	172,228.80
	6" Pipe installation road repair	lf	3180	17490	$ 4.5	$ 78,705	4.50	78,705.00
	4" PIP 125 PSI Pipe	lf	380880		$ 47	$ 17,901,360	46.65	17,768,052.00
	4" Pipe installation road repair	lf	379650	2088075	$ 4.5	$ 9,396,338	4.50	9,396,337.50
	24" PIP 80 PSI Pipe	lf	10850		$ 155	$ 1,681,750	152.64	1,656,144.00
	24" Pipe installation road repair	lf	520	4420	$ 4.5	$ 19,890	4.50	19,890.00
	18" PIP 80 PSI Pipe	lf	9010		$ 107	$ 964,070	105.31	948,843.10
	18" Pipe installation road repair	lf	9010	67575	$ 4.5	$ 304,088	4.50	304,087.50
	15" PIP 80 PSI Pipe	lf	8180		$ 90	$ 736,200	86.60	708,388.00
	15" Pipe installation road repair	lf	8180	59305	$ 4.5	$ 266,873	4.50	266,872.50
	12" PIP 80 PSI Pipe	lf	20360		$ 75	$ 1,527,000	72.54	1,476,914.40
	12" Pipe installation road repair	lf	20360	142520	$ 4.5	$ 641,340	4.50	641,340.00
	4" PIP 80 PSI Pipe	lf	11510		$ 45	$ 517,950	42.46	488,714.60
	4" Pipe installation road repair	lf	11510	63305	$ 4.5	$ 284,873	4.50	284,872.50
	1" Turnouts (connection to main, ultrasonic mea		10,200		$ 1,630	$ 16,626,000	1626.35	16,588,770.00
	2" Turnouts (connection to main, ultrasonic mea		90		$ 2,570	$ 231,300	2568.18	231,136.20
	4" Turnouts (connection to main, ultrasonic mea		110		$ 3,800	$ 418,000	3789.45	416,839.50
	6" Turnouts (connection to main, ultrasonic mea		25		$ 4,220	$ 105,500	4219.35	105,483.75
	8" Turnouts (connection to main, ultrasonic mea		5		$ 4,890	$ 24,450	4885.26	24,426.30
	27" PRV	ea	1		$ 29,347	$ 29,347	29347.83	29,347.83
	24" PRV	ea	1		$ 16,300	$ 16,300	26085.00	26,085.00
	21" PRV	ea	1		$ 13,050	$ 13,050	22825.00	22,825.00
	15" PRV	ea	1		$ 10,000	$ 10,000	16304.38	16,304.38
	12" PRV	ea	1		$ 7,500	$ 7,500	13043.48	13,043.48
	8" PRV	ea	2		$ 6,000	$ 12,000	9250.00	18,500.00
	Appurtenances and Valves	% tota	10%		$9,154,224.05	$ 9,154,224	$ 9,093,156.92	9,093,156.92
	Meter Reading infrastructure	ea	1		$ 150,000	$ 150,000	150000	150000
	SCADA	ea	1		$ 300,000	$ 300,000	250000	250000
	Billing software	ea	1		$ 120,000	$ 120,000	120000	120000
	Office/garage space	ea	1		$ 1,200,000	$ 1,200,000		1200000
		Pressurized Irrigation System Subtotal				$ 102,466,465		$ 101,744,726
West River Pump Station	Screening Structure	ea	1		$ 75,000	$ 75,000.00	75000	75,000.00
	Intake Structure	ea	1		$ 92,500	$ 92,500.00	92500	92,500.00
	Isolation gates	ea	4		$ 5,000	$ 20,000.00	5000	20,000.00
	36" ID N-12 pipe	ea	20		$ 175	$ 3,500.00	175	3,500.00
	Manholes	ea	4		$ 7,700	$ 30,800.00	7685.25	30,741.00
	18" steel Pipe	lf	18		$ 200	$ 3,600.00	200	3,600.00
	Pumps and Controls	ea	4		$ 50,000	$ 200,000.00	50000	200000
	18" flow meter	ea	4		$ 16,250	$ 65,000.00	16250	65,000.00
	18" Butterfly valves	ea	4		$ 8,750	$ 35,000.00	8750	35,000.00
	54" steel manifold	ea	1		$ 90,000	$ 90,000.00	90000	90,000.00
	6" air-vac	ea	1		$ 7,700	$ 7,700.00	7685	7,685.00
	150 kVa Transformer and Power	ls	1		$ 25,000	$ 25,000.00	25000	25,000.00
	42" PVC C900 Transmission line	lf	5600		$ 315	$ 1,764,000.00	312.29	1,748,824.00
		West River Pump Station Subtotal				$ 2,412,100		$ 2,396,850
West Lagoon Pump & Station	1.25" Helical Piers	ea	22		$ 10,000	$ 220,000.00	3500	77000
	Steel beams	lb	15200		$ 5	$ 76,000.00	5	76000
	Columns	lb	9200		$ 5	$ 46,000.00	5	46000
	Steel trusses	lb	2700		$ 5	$ 13,500.00	5	13500
	Z girts	lb	1900		$ 5	$ 9,500.00	5	9500
	Metal Roofing	sf	2940		$ 12	$ 35,280.00	12	35280
	Pump platform structural steel	lb	4000		$ 5	$ 20,000.00	5	20,000.00
	Pump platform metal grating for deck	ea	1		$ 8,500	$ 8,500.00	8500	8,500.00
	Reinforced concrete	cy	31		$ 1,650	$ 51,150.00	1650	51,150.00
	Guardrails	lf	160		$ 75	$ 12,000.00	75	12,000.00
	Power and control box	ea	1		$ 25,000	$ 25,000.00	25000	25000
	Low Head Pumps and controls	ea	3		$ 50,000	$ 150,000.00	50000	150000
	18" flow meter	ea	3		$ 16,250	$ 48,750.00	16125	48375
	18" Butterfly valves	ea	3		$ 8,750	$ 26,250.00	8750	26,250.00
	18" steel pipe	lf	45		$ 200	$ 9,000.00	200	9,000.00
	36" Steel pump manifold	ea	1		$ 37,000	$ 37,000.00	36950	36,950.00
	6" air-vac	ea	1		$ 7,685	$ 7,685.00	7685	7,685.00
	30" Steel pipe	lf	30		$ 365	$ 10,950.00	365	10,950.00
	30" Steel 90 degree bend	ea	1		$ 10,250	$ 10,250.00	10250	10,250.00
	High Head Pumps and Controls	ea	6		$ 75,000	$ 450,000.00	75000	450000
	24" steel pipe	lf	85		$ 275	$ 23,375.00	275	23,375.00
	24" Flow meter	ea	4		$ 21,500	$ 86,000.00	21500	86,000.00
	24" butterfly valve	ea	4		$ 21,500	$ 86,000.00	21500	86,000.00
	72" steel manifold	ea	1		$ 120,000	$ 120,000.00	120000	120,000.00

Summary Table

First Dam Alternative

Description	Total Cost
First Dam Intake	$ 17,591,123
Pressurized Irrigation System	$ 102,466,465
West River Pump Station	$ 2,412,100
West Lagoon Pump Station	$ 1,821,680
Storage Facility	$ 7,908,800
Hydropower Equipment	$ 1,355,265
Cow Pasture Pump station	$ 2,308,100
Removal of Crockett Diversion Dam	$ 1,281,900
Removal of Providence Pioneer Diversion dam	$ 194,300
Flood Control Actions	$ 13,238
Project Measures Subtotal	**$ 137,352,970**
Contractor Overhead	$ 9,614,708
Total Cost	**$146,967,677.56**

	6" Air-vac	ea	1	$ 7,690	$ 7,690.00	7685	7,685.00
	60" steel pipe	lf	60	$ 750	$ 45,000.00	750	45,000.00
	60" steel 90 degree Tee	ea	1	$ 36,800	$ 36,800.00	36765	36,765.00
	3000 kVa Transformer and Power	ls	1	$ 150,000	$ 150,000.00	150000	150,000.00
	24" Cone Valve	ea	1	$ 75,000	$ 75,000.00	26750	26750
	24" Steel pipe	lf	50	$ 275	$ 13,750.00	275	13,750.00
	24" Steel elbow	ea	1	$ 8,250	$ 8,250.00	8250	8,250.00
	24" Butterfly valve	ea	1	$ 21,500	$ 21,500.00	21500	21,500.00
	60" x 24" steel reducer	ea	1	$ 15,250	$ 15,250.00	15250	15,250.00
		West Lagoon Pump Station Subtotal			$ 1,821,680		$ 1,678,215
Storage Facility	Excavate dried sludge and transport to Cell	cy	352000	$ 12	$ 4,224,000.00	12	4,224,000.00
	Inside Berm Removal and disposal of mater	cy	283000	$ 12	$ 3,396,000.00	12	3,396,000.00
	Exterior Berm rehabilitation	cy	7400	$ 12	$ 88,800.00	12	88,800.00
	Construction of concrete overflow spillway	ls	1	$ 200,000	$ 200,000.00	200000	200000
		Storage Facility Subtotal			$ 7,908,800		$ 7,908,800
Hydropower Station	510 kW Francis Turbine, generator, switch gear, and appurtenances	ea	1	$ 1,100,000	$ 1,100,000.00	1100000	1100000
	500 kVa Transformer and Power	ea	1	$ 65,000	$ 65,000.00	65000	65000
	30" Steel elbow	ea	2	$ 10,250	$ 20,500.00	10250	20,500.00
	30" steel pipe	lf	40	$ 365	$ 14,600.00	365	14,600.00
	48" x 30" steel reducer	lf	1	$ 11,665	$ 11,665.00	11665	11,665.00
	48" steel Tee	ea	1	$ 31,600	$ 31,600.00	31575	31,575.00
	48" Steel pipe	lf	10	$ 525	$ 5,250.00	525	5,250.00
	48" butterfly valve	ea	1	$ 53,350	$ 53,350.00	53350	53,350.00
	60" x 48" steel reducer	ea	1	$ 16,500	$ 16,500.00	16454	16,454.00
	60" Steel Tee	ea	1	$ 36,800	$ 36,800.00	36765	36,765.00
		Hydropower Station Subtotal			$ 1,355,265		$ 1,355,159
Cow Pasture Pump station	Canal Diversion Gates	ea	2	$ 10,000	$ 20,000.00	10000	20,000.00
	Canal connection to wet wells	lf	220	$ 40	$ 8,800.00	40	8800
	Pond isolation gates	ea	2	$ 10,000	$ 20,000.00	10000	20,000.00
	Pumping pond	ea	1	$ 8,800	$ 8,800.00	8800	8,800.00
	Screening Structure	ea	1	$ 75,000	$ 75,000.00	75000	75,000.00
	Intake Structure	ea	1	$ 92,500	$ 92,500.00	92500	92,500.00
	Gates	ea	4	$ 5,000	$ 20,000.00	5000	20,000.00
	36" ID N-12 pipe	ea	20	$ 200	$ 4,000.00	200	4,000.00
	Manholes	ea	4	$ 7,500	$ 30,000.00	7500	30,000.00
	Pumps and Controls	ea	4	$ 40,000	$ 160,000.00	40000	160,000.00
	18" flow meter	ea	4	$ 16,250	$ 65,000.00	16125	64,500.00
	18" Butterfly valves	ea	4	$ 8,500	$ 34,000.00	8475	33,900.00
	54" steel manifold	ea	1	$ 90,000	$ 90,000.00	90000	90,000.00
	150 kVa Transformer and Power	ls	1	$ 55,000	$ 55,000.00	55000	55,000.00
	36" Transmission line	lf	250	$ 6,500	$ 1,625,000.00	6500	1,625,000.00
		Cow Pasture Pump Station Subtotal			$ 2,308,100		$ 2,307,500
Removal of Crockett Diversion Dam	Removal of footbridge and catwalk	ls	1	$ 6,900	$ 6,900.00	6875.25	6,875.25
	Removal of existing dam	ls	1	$ 150,000	$ 150,000.00	55000	55,000.00
	Channel excavation	cy	5200	$ 50	$ 260,000.00	12	62,400.00
	Rip-rap	tons	3000	$ 180	$ 540,000.00	141.15	423,450.00
	Place rock weirs	tons	1200	$ 200	$ 240,000.00	141.15	169,380.00
	Revegetation/stabilization	sy	3500	$ 10	$ 35,000.00	9.25	32,375.00
	Water flow and quality management	ls	1	$ 50,000	$ 50,000.00	50000	50,000.00
		Crockett Dam Removal Subtotal			$ 1,281,900		787,980.25
Removal of Providence Pioneer Diversion dam	Remove and dispose of 4' concrete structure	ls	1	$ 25,000	$ 25,000.00	16300.55	16,300.55
	Channel excavation	cy	430	$ 50	$ 21,500.00	12	5,160.00
	Channel stabilization (rip-rap)	tons	810	$ 180	$ 145,800.00	141.15	114,331.50
	Revegetation/stabilization	sy	200	$ 10	$ 2,000.00	9.25	1,850.00
		Providence Pioneer Dam Removal Subtotal			$ 194,300		128,654.00
Flood Control Actions	Landscaping fill material	cy	200	$ 27	$ 5,400.00	26.75	5,350.00
	Revegetation/stabilization	sy	825	$ 10	$ 7,837.50	9.25	7,631.25
		Flood Control Subtotal			$ 13,238		12,981.25
	Project Measures Subtotal				$ 137,352,970		$111,742,777
Contractor Overhead	Mobilization	Percen	5%	$ 6,867,648	$ 6,867,648	$1,117,428	55,871.40
	Survey	Percen	2%	$ 2,747,059	$ 2,747,059	$1,117,428	22,348.56
		Contractor Overhead Section Subtotal			$ 9,614,708		$2,234,856
Total Cost[1]					**$ 146,967,677.56**		**$113,977,632.82**

[1]Includes CWA Section 404 mitigation costs.

Expanded Table

Crockett Diversion Alternative

Same as FD Alt?	Project Measure	Line Item	Units	Qty	Unit Cost	Total Cost	Hess Unit Cost	
Same as NFA Alternative	Crockett Dam Reconstruction	Remove concrete bridge and fencing	ls	1	$ 20,000.00	$ 20,000.00		
		Remove concrete wall and grouted rip-rap	ls	1	$ 35,000.00	$ 35,000.00		
		Remove steel superstructure at dam: railings, braces, bridge, etc.	ls	1	$ 15,000.00	$ 15,000.00		
		Channel excavation	cy	350	$ 15.00	$ 5,250.00		
		Construction of Proposed dam and concrete walls	ls	1	$ 250,000.00	$ 250,000.00		
		Installation of overshot gates and appurtenances	ls	1	$ 250,000.00	$ 250,000.00		
		Install canal gate	ls	1	$ 25,000.00	$ 25,000.00		
		Construction of control house	ls	1	$ 25,000.00	$ 25,000.00		
		Electrical wiring for site	ls	1	$ 15,000.00	$ 15,000.00		
		Install rip-rap upstream of dam	ls	1	$ 10,000.00	$ 10,000.00		
		Revegetation/stabiliation	sy	1000	$ 10.00	$ 10,000.00		
		Install chain-link fence	ls	1	$ 15,000.00	$ 15,000.00		
				Crockett Dam Reconstruction		$ 675,250		
No	Crockett pump Station	Screening Structure	ea	1	$ 100,000	$ 100,000	75000	75000
		Intake Structure	ea	1	$ 15,000	$ 15,000	92500	92500
		Isolation gates	ea	6	$ 10,000	$ 60,000	5000	30000
		48" N-12 pipe	lf	60	$ 200	$ 12,000	405	24300
		72" Manholes	ea	6	$ 10,000	$ 60,000	10000	60000
		30" steel Pipe	lf	40	$ 220	$ 8,800	365	14600
		Pump House	ea	1	$ 25,000	$ 25,000		
		Pumps and Controls	ea	6	$ 75,000	$ 450,000	75000	450000
		30" flow meter	ea	6	$ 25,000	$ 150,000	27650	165900
		30" Butterfly valves	ea	6	$ 8,500	$ 51,000	28250	169500
		72" steel manifold	ea	1	$ 64,700	$ 64,700	120000	120000
		6" air-vac	ea	1	$ 7,700	$ 7,700	7485	7485
		2000 kVa Transformer and Power	ls	1	$ 165,000	$ 165,000	165000	165000
		60" Transmission line	lf	10	$ 570	$ 5,700	1245	12450
		60" Butterfly valve	ls	1	$ 35,000	$ 35,000	66665	66665
				Crockett Pump Station		$ 1,209,900		
Yes	Pressurized Irrigation System	60" C-900 PVC DR 27.5 Pipe	lf	450	$ 570	$ 256,500		
		60" Pipe installation road repair	lf	1055	$ 5	$ 104,265		
		54" C-900 PVC DR 27.5 Pipe	lf	1820	$ 440	$ 800,800		
		48" C-900 PVC DR 27.5 Pipe	lf	15170	$ 375	$ 5,688,750		
		48" Pipe installation road repair	lf	9570	$ 5	$ 516,780		
		42" C-900 PVC DR 27.5 Pipe	lf	20300	$ 315	$ 6,394,500		
		42" Pipe installation road repair	lf	20300	$ 5	$ 1,050,525		
		36" C-900 PVC DR 27.5 Pipe	lf	8000	$ 255	$ 2,040,000		
		36" Pipe installation road repair	lf	2790	$ 5	$ 125,550		
		30" C-900 PVC DR 27.5 Pipe	lf	9910	$ 225	$ 2,229,750		
		30" Pipe installation road repair	lf	9910	$ 5	$ 423,653		
		27" PIP 125 PSI Pipe	lf	3010	$ 195	$ 586,950		
		27" Pipe installation road repair	lf	3010	$ 5	$ 125,294		
		24" PIP 125 PSI Pipe	lf	8770	$ 170	$ 1,490,900		
		24" Pipe installation road repair	lf	8770	$ 5	$ 335,453		
		21" PIP 125 PSI Pipe	lf	23270	$ 142	$ 3,304,340		
		21" Pipe installation road repair	lf	23270	$ 5	$ 811,544		
		18" PIP 125 PSI Pipe	lf	25850	$ 115	$ 2,972,750		
		18" Pipe installation road repair	lf	22685	$ 5	$ 765,621		
		15" PIP 125 PSI Pipe	lf	14450	$ 95	$ 1,372,750		
		15" Pipe installation road repair	lf	14450	$ 5	$ 471,434		
		12" PIP 125 PSI Pipe	lf	51550	$ 80	$ 4,124,000		
		12" Pipe installation road repair	lf	13320	$ 5	$ 419,580		
		10" PIP 125 PSI Pipe	lf	4970	$ 71	$ 352,870		
		10" Pipe installation road repair	lf	4970	$ 5	$ 156,555		
		8" PIP 125 PSI Pipe	lf	28520	$ 63	$ 1,796,760		
		8" Pipe installation road repair	lf	27509	$ 5	$ 835,587		
		6" PIP 125 PSI Pipe	lf	3180	$ 55	$ 174,900		
		6" Pipe installation road repair	lf	3180	$ 5	$ 78,705		
		4" PIP 125 PSI Pipe	lf	380880	$ 47	$ 17,901,360		
		4" Pipe installation road repair	lf	379650	$ 5	$ 9,396,338		
		24" PIP 80 PSI Pipe	lf	10850	$ 155	$ 1,681,750		
		24" Pipe installation road repair	lf	520	$ 5	$ 19,890		
		18" PIP 80 PSI Pipe	lf	9010	$ 107	$ 964,070		
		18" Pipe installation road repair	lf	9010	$ 5	$ 304,088		
		15" PIP 80 PSI Pipe	lf	8180	$ 90	$ 736,200		
		15" Pipe installation road repair	lf	8180	$ 5	$ 266,873		
		12" PIP 80 PSI Pipe	lf	20360	$ 75	$ 1,527,000		
		12" Pipe installation road repair	lf	20360	$ 5	$ 641,340		
		4" PIP 80 PSI Pipe	lf	11510	$ 45	$ 517,950		
		4" Pipe installation road repair	lf	11510	$ 5	$ 284,873		
		1" Turnouts (connection to main, ultrasonic meter, valve)	ea	10200	$ 1,630	$ 16,626,000		
		2" Turnouts (connection to main, ultrasonic meter, valve)	ea	90	$ 2,570	$ 231,300		
		4" Turnouts (connection to main, ultrasonic meter, valve)	ea	110	$ 3,800	$ 418,000		
		6" Turnouts (connection to main, ultrasonic meter, valve)	ea	25	$ 4,220	$ 105,500		
		8" Turnouts (connection to main, ultrasonic meter, valve)	ea	5	$ 4,890	$ 24,450		
		27" PRV	ea	1	$ 29,347	$ 29,347		
		24" PRV	ea	1	$ 16,300	$ 16,300		
		21" PRV	ea	1	$ 13,050	$ 13,050		
		15" PRV	ea	1	$ 10,000	$ 10,000		
		12" PRV	ea	1	$ 7,500	$ 7,500		
		8" PRV	ea	2	$ 6,000	$ 12,000		
		Appurtenances and Valves	% total	0.1	$ 9,154,224	$ 9,154,224		
		Meter Reading infrastructure	ea	1	$ 150,000	$ 150,000		
		SCADA	ea	1	$ 300,000	$ 300,000		
		Billing software	ea	1	$ 120,000	$ 120,000		
		Office/garage space	ea	1	$ 1,200,000	$ 1,200,000.00		
				Pressurized Irrigation System Subtotal		$ 102,466,465		
Yes	West River Pump Station	Screening Structure	ea	1	$ 75,000	$ 75,000.00		
		Intake Structure	ea	1	$ 92,500	$ 92,500.00		
		Isolation gates	ea	4	$ 5,000	$ 20,000.00		
		36" ID N-12 pipe	ea	20	$ 175	$ 3,500.00		
		Manholes	ea	4	$ 7,700	$ 30,800.00		
		18" steel Pipe	lf	18	$ 200	$ 3,600.00		
		Pumps and Controls	ea	4	$ 50,000	$ 200,000.00		
		18" flow meter	ea	4	$ 16,250	$ 65,000.00		
		18" Butterfly valves	ea	4	$ 8,750	$ 35,000.00		
		54" steel manifold	ea	1	$ 90,000	$ 90,000.00		
		6" air-vac	ea	1	$ 7,700	$ 7,700.00		
		150 kVa Transformer and Power	ls	1	$ 25,000	$ 25,000.00		
		42" PVC C900 Transmission line	lf	5600	$ 315	$ 1,764,000.00		
				West River Pump Station Subtotal		$ 2,412,100		
	West Lagoon	1.25" Helical Piers	ea	22	$ 10,000	$ 220,000.00		
		Steel beams	lb	15200	$ 5	$ 76,000.00		
		Columns	lb	9200	$ 5	$ 46,000.00		
		Steel trusses	lb	2700	$ 5	$ 13,500.00		
		Z girts	lb	1900	$ 5	$ 9,500.00		
		Metal Roofing	sf	2940	$ 12	$ 35,280.00		
		Pump platform structural steel	lb	4000	$ 5	$ 20,000.00		
		Pump platform metal grating for deck	ea	1	$ 8,500	$ 8,500.00		
		Reinforced concrete	cy	31	$ 1,650	$ 51,150.00		
		Guardrails	lf	160	$ 75	$ 12,000.00		
		Power and control box	ea	1	$ 25,000	$ 25,000.00		
		Low Head Pumps and controls	ea	3	$ 50,000	$ 150,000.00		
		18" flow meter	ea	3	$ 16,250	$ 48,750.00		
		18" Butterfly valves	ea	3	$ 8,750	$ 26,250.00		

Summary Table

Crockett Diversion Alternative

Description	Total Cost
Crockett Dam Reconstruction	$ 675,250
Crockett Pump Station	$ 1,209,900
Pressurized Irrigation System	$ 102,466,465
West River Pump Station	$ 2,412,100
West Lagoon Pump Station	$ 1,821,680
Storage Facility	$ 7,908,800
Cow Pasture Pump station	$ 2,308,100
Removal of Providence Pioneer Diversion dam	$ 194,300
Flood Control Actions	$ 17,288
Project Measures Subtotal	**$ 119,013,882**
Contractor Overhead	$ 8,331,000
Total Cost	############

Yes	Pump Station	18" steel pipe	lf	45	$ 200	$ 9,000.00		
		36" Steel pump manifold	ea	1	$ 37,000	$ 37,000.00		
		6" air-vac	ea	1	$ 7,685	$ 7,685.00		
		30" Steel pipe	lf	30	$ 365	$ 10,950.00		
		30" Steel 90 degree bend	ea	1	$ 10,250	$ 10,250.00		
		High Head Pumps and Controls	ea	6	$ 75,000	$ 450,000.00		
		24" steel pipe	lf	85	$ 275	$ 23,375.00		
		24" Flow meter	ea	4	$ 21,500	$ 86,000.00		
		24" butterfly valve	ea	4	$ 21,500	$ 86,000.00		
		72" steel manifold	ea	1	$ 120,000	$ 120,000.00		
		6" Air-vac	ea	1	$ 7,690	$ 7,690.00		
		60" steel pipe	lf	60	$ 750	$ 45,000.00		
		60" steel 90 degree Tee	ea	1	$ 36,800	$ 36,800.00		
		3000 kVa Transformer and Power	ls	1	$ 150,000	$ 150,000.00		
		24" Cone Valve	ea	1	$ 75,000	$ 75,000.00		
		24" Steel pipe	lf	50	$ 275	$ 13,750.00		
		24" Steel elbow	ea	1	$ 8,250	$ 8,250.00		
		24" Butterfly valve	ea	1	$ 21,500	$ 21,500.00		
		60" x 24" steel reducer	ea	1	$ 15,250	$ 15,250.00		
				West Lagoon Pump Station Subtotal		$ 1,821,680		
Yes	Storage Facility	Excavate dried sludge and transport to Cell B1	cy	352000	$ 12	$ 4,224,000.00		
		Inside Berm Removal and disposal of material	cy	283000	$ 12	$ 3,396,000.00		
		Exterior Berm rehabilitation	cy	7400	$ 12	$ 88,800.00		
		Construction of concrete overflow spillway	ls	1	$ 200,000	$ 200,000.00		
				Storage Facility Subtotal		$ 7,908,800		
Yes	Cow Pasture Pump Station	Canal Diversion Gates	ea	2	$ 10,000	$ 20,000.00		
		Canal connection to wet wells	lf	220	$ 40	$ 8,800.00		
		Pond isolation gates	ea	2	$ 10,000	$ 20,000.00		
		Pumping pond	ea	1	$ 8,800	$ 8,800.00		
		Screening Structure	ea	1	$ 75,000	$ 75,000.00		
		Intake Structure	ea	1	$ 92,500	$ 92,500.00		
		Gates	ea	4	$ 5,000	$ 20,000.00		
		36" ID N-12 pipe	ea	20	$ 200	$ 4,000.00		
		Manholes	ea	4	$ 7,500	$ 30,000.00		
		Pumps and Controls	ea	4	$ 40,000	$ 160,000.00		
		18" flow meter	ea	4	$ 16,250	$ 65,000.00		
		18" Butterfly valves	ea	4	$ 8,500	$ 34,000.00		
		54" steel manifold	ea	1	$ 90,000	$ 90,000.00		
		150 kVa Transformer and Power	ls	1	$ 55,000	$ 55,000.00		
		36" Transmission line	lf	250	$ 6,500	$ 1,625,000.00		
				Cow Pasture Pump Station Subtotal		$ 2,308,100		
Yes	Removal of Providence Pioneer Diversion dam	Remove and dispose of 4' concrete structure	ls	1	$ 25,000	$ 25,000.00	16300.55	16300.55
		Channel excavation	cy	430	$ 50	$ 21,500.00		
		Channel stabilization (rip-rap)	tons	810	$ 180	$ 145,800.00	12	9720
		Revegetation/stabilization	sy	200	$ 10	$ 2,000.00	141.15	28230
				rovidence Pioneer Dam Removal Subtota		$ 194,300		$ 54,251
Yes	Flood Control Actions	Landscaping fill material	cy	350	$ 27	$ 9,450.00		0
		Revegetation/stabilization	sy	1050	$ 10	$ 7,837.50	26.75	28087.5
				Flood Control Subtotal		$ 17,288		$ 28,088
No		Project Measures Subtotal				$ 119,013,882		$ 82,338
No	Contractor Overhead	Mobilization	Percent	5%	$ 5,951,000	$ 5,951,000	0.05	$5,950,694.10
		Permitting and Survey	Percent	2%	$ 2,380,000	$ 2,380,000	0.02	$2,380,277.64
				Contractor Overhead Section Subtotal		$ 8,331,000	1117428	$ 8,330,972
	Total Cost[1]					############		**$8,413,309.79**

[1]Includes CWA Section 404 mitigation costs.

$ 20,745.00

TM 017 Operation and Maintenance (O&M) Costs

TECHNICAL MEMORANDUM 017

Date:	July 2024
To:	NRCS-Utah
Cc:	
From:	Kyler Olsen, EIT Lance Houser, PE Eric Franson, PE Franson Civil Engineers, Inc.
Project:	Logan River Watershed Plan-EIS
Subject:	

1.0 Introduction

In addition to debt service for capital cost repayment, operation and maintenance costs under each alternative are necessary to gain a full understanding of project lifetime costs. This tech memo discusses the methods used to estimate annual operation and maintenance (O&M) costs under each of the proposed alternatives.

2.0 Estimated Project O&M Costs

Operation and maintenance requirements vary between the proposed alternatives from very little change to substantial changes. The No Federal Action alternative simplifies and increases safety of operations at the diversion dam, with no significant change to the remainder of the system. However, action alternatives, with the construction of a pressurized irrigation system, would need additional resources to operate appropriately. Through discussions with the stakeholder communities, personnel and equipment needs were identified. The following sections identify the resource requirements for operation under each alternative.

2.1 Existing Condition and No Federal Action Alternative

The No Federal Action Alternative includes rehabilitation of existing structures, and very little change operationally. It is estimated that O&M costs would remain the same as under the existing conditions. The current operation and maintenance budget for CIC was estimated based on input from Crockett Irrigation board members. Hyde Park Irrigation company budget amounts were used as a conservative representation of all irrigation companies due to their mixed agricultural and residential use, longest lengths of canal needing maintenance, and due to data availability. Based on their use of 11 cfs over 180 days, and an annual operation budget of $30,000 (including Crockett assessments), this translates to a diversion of 3920 acre-feet and about $8 per acre-foot of diverted water.

A large number of shareholders pressurize their water using single phase, low-efficiency pumps, which can cost around $80 per acre-foot as estimated by Crockett Irrigation board members. These pumping costs have been excluded due to insufficient data to be able to accurately

quantify individual power usage. Benson's annual O&M budget included pumping costs ($30/acre-foot of water based on their reported power bill increase trends and the average amount of water pumped from 2020 to 2022).

Table-1 shows the estimate for the current annual O&M budget by company based on the cost per acre-foot included above and the average annual diversion from 2019 to 2022.

Table 2-1 No Federal Action O&M Cost Estimate

Irrigation Company	Average Annual Diversion (acre feet)	Estimated Annual O&M Budget
Sunday Water Users	18	$200
Logan Island	1,620	$13,000
Seventh Ward	328	$3,000
Hyde Park &Logan Northfield	5,392	$40,000
Thatcher	248	$500
Logan Northwest Field	7,817	$60,000
Benson	7,006	$175,000
Logan Southwest Field	3,025	$24,000
Cow Pasture	Not recorded	$8,000
Total	18,705+	$325,000

2.2 First Dam and Crockett Diversion Alternatives

The First Dam and Crockett Diversion Alternatives include construction of a pressurized irrigation system and multiple pump stations. The First Dam alternative includes a gravity flow intake structure and hydropower facility, while the Crockett Diversion alternative includes one additional pump station in the place of the intake and hydropower facilities. Due to the similarity of O&M needs from each alternative, costs for both alternatives are described together.

While the system will be automated to the extent practical, equipment and pipelines require monitoring and maintenance to remain in good operating condition. Discussions with stakeholder communities, especially Logan City due to system similarities, helped to identify O&M resource allocation needed for successful operations, as well as providing current market values for each resource, position, and overhead. The office/garage space and equipment total costs were divided by the anticipated lifetime: 7 years for heavy equipment, 10 years for crew trucks, and 100 years for the office space. Overhead of 60% on all salaries was included on all

personnel positions to cover benefit packages, which is similar to Logan City budgetary numbers.

Pumping costs were estimated using the energy consumption calculated at each pump station (see TM013 for details on how energy consumption was calculated; pumping costs were identified in the TM0006 calculations spreadsheet) and the 2023 power rates as listed on the Logan Light and Power website. These included a tiered rate, with $0.12 per kW-hr for the first 1500 kW-hr and $0.091 per kW-hr afterward, as well as an additional peak usage rate of $11/kW-hr.

Because system revenue is dependent on the number of individuals within the service area that connect to the secondary system, revenue was excluded from the O&M analysis. It is assumed that the entity that runs the secondary system would set user connection rates in coordination with the municipalities to offer competitive pricing while offsetting the outstanding operations and maintenance costs throughout the project lifetime.

The operating entity would take care of the pressurized distribution systems and the pump stations. O&M costs identified for the project measures under these alternatives can be seen below in Table 2-2 and Table 2-3.

Table 2-2 First Dam Alternative O&M Cost Estimate

Type	Resource	Quantity	Annual Cost
Management	Manager	1	$168,000
	Administrative Assistant/Secretary	1	$104,000
Billing	Billing Rep	2	$128,000
	Software	1	$10,000
System Maintenance	Crew Chief	1	$112,000
	Back-Hoe Operator	1	$104,000
	Dump Truck Driver	1	$96,000
Bluestaking	Bluestaker	2	$176,000
Equipment	Back-Hoe	1	$42,000
	Dump Truck	1	$51,000
	Crew Trucks	3	$17,000
	Vehicle Maintenance	5	$8,000
	Fuel	1	$15,000
System Parts & Service	Customer appurtenances	1	$40,000
	Pipe & valves	1	$80,000
	Intake stations (pumps, screens, etc)	1	$20,000
	Professional and Technical	1	$10,000
Pumping Costs	West River Pump Station	1	$180,000
Pumping Costs	West Lagoon Pump Station	1	$130,000
	Cow Pasture Pump Station	1	$215,000
	USU Hydropower Impact Payment	1	$55,000
Pumping Consumables	West River Pump Station	4	$10,000
	West Lagoon Pump Station	9	$30,000
	Cow Pasture Pump Station	4	$8,000
Total	Total		$1,910,000

Table 2-3 First Dam Alternative O&M Revenue Estimate

Type	Resource	Quantity	Annual Revenue
Hydropower	West Lagoon Hydropower Station	1	$190,000
Total	Total		$190,000

Table 2-4 Crockett Diversion Alternative O&M Cost Estimate

Type	Resource	Quantity	Annual Cost
Management	Manager	1	$168,000
	Administrative Assistant	1	$104,000
Billing	Billing Rep	2	$128,000
	Software	1	$10,000
System Maintenance	Crew Chief	1	$112,000
	Back-Hoe Operator	1	$104,000
	Dump Truck Driver	1	$96,000
Bluestaking	Bluestaker	2	$176,000
Equipment	Back-Hoe	1	$42,000
	Dump Truck	1	$51,000
	Crew Trucks	3	$17,000
	Vehicle Maintenance	5	$8,000
	Fuel	1	$15,000
System Parts & Service	Customer appurtenances	1	$40,000
	Pipe & valves	1	$80,000
	Intake stations (pumps, screens, etc)	1	$20,000
	Professional and Technical	1	$15,000
Pumping Costs	Crockett Pump Station	1	$525,000
	West River Pump Station	1	$180,000
	West Lagoon Pump Station	1	$130,000
	Cow Pasture Pump Station	1	$215,000
Pumping Consumables	Crockett Pump Station	6	$22,500
	West River Pump Station	4	$10,000
	West Lagoon Pump Station	9	$30,000
	Cow Pasture Pump Station	4	$8,000
Total	Total		$2,320,000

Attachment A: O&M Calculations for the No Federal Action, First Dam, and Crockett Diversion Alternatives

$/ac-ft from Ben Clegg: 8

Irrigation Company	Average Annual Diversion (2019-2022; acre-feet)	Irrigated Acres	Estimated Annual Operating budget	Actual Operating Expenses 2021	Actual Operating Expenses 2022	Actual Operating Expenses 2023	Average Operating expenses 2021-2023	Expenses for O&M Memo	Notes
Sunday Water Users	18	0	$ 200					$ 200	
Logan Island	1620	61	$ 13,000					$ 13,000	
Seventh Ward	328	115	$ 2,700					$ 2,700	
Hyde Park & Logan Northfield	5392	1347	$ 43,200	$ 33,318	$ 35,569	$ 49,908	$ 39,598	$ 40,000	
Thatcher	248	87	$ 500				$ 500	$ 500	
Logan Northwest Field	7817	830	$ 62,600		$ 46,203	$ 71,022	$ 58,613	$ 60,000	
Benson	7006	2544	$ 121,100	$ 171,362	$ 174,175	$ 167,055	$ 170,864	$ 175,000	
Logan Southwest Field	3025	608	$ 24,200					$ 24,200	
Cow Pasture	not recorded	1412	$ 8,000					$ 8,000	
Total	**18705**	**7004**	**$ 275,500**					**$ 323,600**	

2019	2020	2021	2022	average
10	26	19	18	18.25
1609	1884	1516	1470	1619.75
345	400	324	243	328
4660	5969	4983	5955	5391.75
148	459	191	192	247.5
7390	9202	7276	7398	7816.5
7365	7958	5277	7423	7005.75
2461	3794	2814	3030	3024.75
17937	22422	16995	17467	18705.25
23988	29692	22400	25729	25452.25
34%	32%	32%	47%	36%

2019	1533.32	29581	19.3	$/acre-ft
2020	2198.89	45481	20.7	$/acre-ft
2021	2257.98	51319	22.7	$/acre-ft
2022	2260.67	61159	27.1	$/acre-ft
	2239.18	60457.86		

Type	Position/Item	Number	Base Salary/Cost	With Overhead (60% manpower, 5% Equipment)	Total Cost	Years/cost	Total Annual Costs	Frequency
Management	Manager	1	$ 105,000.00	$ 63,000.00	$ 168,000.00	1	$ (168,000.00)	Annually
	Administrative Assistant/Secretary	1	$ 65,000.00	$ 39,000.00	$ 104,000.00	1	$ (104,000.00)	Annually
Billing	Billing Rep	2	$ 40,000.00	$ 24,000.00	$ 128,000.00	1	$ (128,000.00)	Annually
	IT infrastructure	1	$ 10,000.00		$ 10,000.00	1	$ (10,000.00)	Computers, GIS Software, billing software updates, Office suite
Operations	Operator	1	$ 30,000.00	$ 18,000.00	$ 48,000.00	1	$ (48,000.00)	Annually- Full time through irrigation season, part time (hydro) during off season. This line item only covers PI system ops
Maintenance	Crew Chief	1	$ 70,000.00	$ 42,000.00	$ 112,000.00	1	$ (112,000.00)	Annually
	Back-Hoe Operator	1	$ 65,000.00	$ 39,000.00	$ 104,000.00	1	$ (104,000.00)	Annually
	Dump Truck Driver	1	$ 60,000.00	$ 36,000.00	$ 96,000.00	1	$ (96,000.00)	Annually
Bluestaking	FT Bluestaker	2	$ 55,000.00	$ 33,000.00	$ 176,000.00	1	$ (176,000.00)	Annually
Equipment	Back-Hoe	1	$ 185,000.00	$ 111,000.00	$ 296,000.00	7	$ (42,285.71)	Probably 7 year life cycle
	Dump Truck	1	$ 225,000.00	$ 135,000.00	$ 360,000.00	7	$ (51,428.57)	Probably 7 year life cycle
	Crew Trucks	3	$ 55,000.00	$ 2,750.00	$ 173,250.00	10	$ (17,325.00)	Probably 10 year life cycle
	Vehicle Maintenance	5	$ 1,500.00	$ -	$ 7,500.00	1	$ (7,500.00)	
	Fuel	1	$ 15,000.00		$ 15,000.00	1	$ (15,000.00)	
System Service	Connection appurtenances	1	$ 40,000.00		$ 40,000.00	1	$ (40,000.00)	
	Pipe & valves	1	$ 80,000.00		$ 80,000.00	1	$ (80,000.00)	
	Intake stations (pumps, screens, etc)	1	$ 20,000.00		$ 20,000.00	1	$ (20,000.00)	
	Public education and outreach	1	$ 15,000.00		$ 15,000.00	1	$ (15,000.00)	
	Professional and Technical	1	$ 10,000.00		$ 10,000.00	1	$ (10,000.00)	
Pumping Costs	West River Pump Station	1	$ 180,000.00		$ 180,000.00	1	$ (180,000.00)	
	West Lagoon Pump Station	1	$ 130,000.00		$ 130,000.00	1	$ (130,000.00)	
	Cow Pasture Pump Station	1	$ 215,000.00		$ 215,000.00	1	$ (215,000.00)	
	USU hydropower impact payment	1	$ 55,000.00		$ 55,000.00	1	$ (55,000.00)	
Pumping Consumables	West River Pump Station	4	$ 50,000.00		$ 200,000.00	20	$ (10,000.00)	
	West Lagoon Pump Station	9	$ 66,666.67		$ 600,000.00	20	$ (30,000.00)	
	Cow Pasture Pump Station	4	$ 40,000.00		$ 160,000.00	20	$ (8,000.00)	
Hydropower Station	Equipment/Parts	1	$ 40,000.00		$ 40,000.00	1	$ (40,000.00)	
	Operator labor (280 hrs per year)	1	$ 20,000.00	$ 12,000.00	$ 32,000.00	1	$ (32,000.00)	
	Capital Improvements	1	$ 15,000.00		$ 15,000.00	1	$ (15,000.00)	
Total							$ (1,912,539.29)	100 Yr Life Probably

Type	Position/Item	Number	Base Salary/Cost	With Overhead (60% manpower, 5% Equipment)	Total Cost	Years/cost	Total Annual Costs	Frequency
Management	Manager	1	$ 105,000.00	$ 63,000.00	$ 168,000.00	1	$ (168,000.00)	Annually
	Administrative Assistant/Secretary	1	$ 65,000.00	$ 39,000.00	$ 104,000.00	1	$ (104,000.00)	Annually
Billing	Billing Rep	2	$ 40,000.00	$ 24,000.00	$ 128,000.00	1	$ (128,000.00)	Annually
	IT infrastructure	1	$ 10,000.00		$ 10,000.00	1	$ (10,000.00)	Computers, GIS Software, billing software updates, Office suite
Maintenance	Crew Chief	1	$ 70,000.00	$ 42,000.00	$ 112,000.00	1	$ (112,000.00)	Annually
	Back-Hoe Operator	1	$ 65,000.00	$ 39,000.00	$ 104,000.00	1	$ (104,000.00)	Annually
	Dump Truck Driver	1	$ 60,000.00	$ 36,000.00	$ 96,000.00	1	$ (96,000.00)	Annually
Bluestaking	FT Bluestaker	2	$ 55,000.00	$ 33,000.00	$ 176,000.00	1	$ (176,000.00)	Annually
Equipment	Back-Hoe	1	$ 185,000.00	$ 111,000.00	$ 296,000.00	7	$ (42,285.71)	Probably 7 year life cycle
	Dump Truck	1	$ 225,000.00	$ 135,000.00	$ 360,000.00	7	$ (51,428.57)	Probably 7 year life cycle
	Crew Trucks	3	$ 55,000.00	$ 2,750.00	$ 173,250.00	10	$ (17,325.00)	Probably 10 year life cycle
	Vehicle Maintenance	5	$ 1,500.00	$ -	$ 7,500.00	1	$ (7,500.00)	
	Fuel	1	$ 15,000.00		$ 15,000.00	1	$ (15,000.00)	
System Service	Connection appurtenances	1	$ 40,000.00		$ 40,000.00	1	$ (40,000.00)	
	Pipe & valves	1	$ 80,000.00		$ 80,000.00	1	$ (80,000.00)	
	Intake stations (pumps, screens, etc)	1	$ 20,000.00		$ 20,000.00	1	$ (20,000.00)	
	Public education and outreach	1	$ 15,000.00		$ 15,000.00	1	$ (15,000.00)	
	Professional and Technical	1	$ 10,000.00		$ 10,000.00	1	$ (10,000.00)	
Pumping Costs	Crockett Pump Station	1	$ 525,000.00		$ 525,000.00	1	$ (525,000.00)	
	West River Pump Station	1	$ 180,000.00		$ 180,000.00	1	$ (180,000.00)	
	West Lagoon Pump Station	1	$ 130,000.00		$ 130,000.00	1	$ (130,000.00)	
	Cow Pasture Pump Station	1	$ 215,000.00		$ 215,000.00	1	$ (215,000.00)	
Pump Station Consumables	Crockett Pump Station	6	$ 75,000.00		$ 450,000.00	20	$ (22,500.00)	20 year life for pumps
	West River Pump Station	4	$ 50,000.00		$ 200,000.00	20	$ (10,000.00)	20 year life for pumps
	West Lagoon Pump Station	9	$ 66,666.67		$ 600,000.00	20	$ (30,000.00)	20 year life for pumps
	Cow Pasture Pump Station	4	$ 40,000.00		$ 160,000.00	20	$ (8,000.00)	20 year life for pumps
Total							$ (2,317,039.29)	100 Yr Life Probably

TM 018 Project Benefits and Cost Share

TECHNICAL MEMORANDUM 018

Date:	June 30, 2024
To:	NRCS-Utah
Cc:	
From:	Eric Franson, PE Kyler Olsen, Franson Civil Engineers, Inc.
Project:	Logan River Watershed Plan-EIS
Subject:	Agricultural Water Management Project Benefits and Cost Share

1.0 Introduction

The Logan River Watershed Project outlined in TM006 provides benefits to many individuals and groups in Cache Valley. Several groups are involved in the project as co-sponsors, including Crockett Irrigation Company and the ten subsidiary companies, and Logan City, North Logan City, and Hyde Park City. Other groups that could see benefit from the project, depending on the selected alternative include Cache County, Utah State University, the Utah Water Research Laboratory, Trout Unlimited, and Benson Culinary Water District.

The project comes with significant cost. Project construction costs for the agricultural water improvements for each alternative are outlined in TM016 and project O&M costs are outlined in TM017. During discussions between the sponsors and co-sponsors, an idea of the cost-share between the financially responsible co-sponsors was required to provide assurance that the project could move forward.

This technical memo describes the culmination of years of discussion on financial cost-share for the project. It includes a description of the anticipated additional annual financial burden to Crockett Irrigation companies under the No Federal Action alternative and the action alternatives.

2.0 No Federal Action Alternative

Under this alternative, the only formal beneficiaries would be the Crockett Irrigation Company. All construction costs would be borne by shareholders of the individual companies that rely on the Crockett system for water diversion and distribution. The anticipated benefits under this alternative include a reduction in seepage losses as the canal system is enclosed, improvements in operational safety at the Crockett Diversion, reduction in flooding due to a lowered crest elevation and overshot gates, and a reduced risk of canal failure in the area along the hillside. See TM006 for a full description of the project measures.

It was assumed that the initial capital costs would be paid for through a loan with the Utah Division of Water Resources. The Division has a revolving funds program set up for water

projects with a 2% interest rate. This interest rate over a 30-year repayment period with additional ongoing capital project costs being paid for through assessment increases was used to bring the total project costs to an annual value. These quantified benefits are all included in the benefit-cost ratio for this alternative and, since there are no other formal entities receiving benefit, the full cost would be borne by Crockett Irrigation Company.

The total initial installation costs are included in TM016, and after including engineering, construction management, permitting, and administration, the total comes to $6,300,000. Based on discussions with Crockett board members, in lieu of accounting for future enclosure costs, a 10% savings for future capital replacements was included. The estimated annual payment and savings for future capital expenses comes to $340,000. This cost would be in addition to the current $325,000 spent on O&M throughout the canal companies. Table 2-2 below includes a cost-breakdown of each individual irrigation company by percent ownership. Individual shareholder assessments would be defined by each company. The Additional Annual Cost outlined in the table below would be divided between shareholders in each company and added to the current share assessments.

Table 2-1 Crockett Irrigation Additional Annual Cost Breakdown

Company	% Ownership	Additional Annual Cost
HPIC	18.4%	$63,000
LNFIC	17.0%	$58,000
LNWFIC	24.8%	$85,000
BIC	12.3%	$42,000
LII	16.5%	$56,000
SWIC	1.6%	$5,000
TIC	0.7%	$2,000
LSWFIC	8.6%	$29,000
LCPIC	0.2%	$800
SWUIC	0.1%	$300

3.0 Action Alternatives

Through many discussions with all project co-sponsors, all expressed that the system would ideally be a self-sustaining one that could repay a loan for initial capital costs not covered by the NRCS as well as the annual operation and maintenance expenses. The sentiment arose that irrigators should be expected to pay more than they currently do, as they would be receiving an improved product (pressurized water with less distribution losses and potentially less timing restrictions). However, since their collaboration in the project would be to the benefit of the other co-sponsors, the irrigators alone should not shoulder the full cost of system improvements. The project team proposed a cost share formula that would cover loan repayment and operation and

maintenance costs through additional shareholder assessments and new shareholder connections.

The municipalities expressed interest in collaborating on project cost share through methods such as reevaluating culinary water rates to reflect the true cost of water (which would increase the number of potential future connections contributing payment toward the system) and potentially even placing requirements for landowners to connect to a secondary system when it becomes available to them. They also discussed potentially providing some one-time capital funds to pay down the debt incurred as part of the sponsor cost-share to help bring secondary water costs into a feasible range. The number of future secondary connections was found to be the single most impactful piece to creating a self-sustaining system.

At this point in the project, a full, detailed cost share was not required by the NRCS, and the co-sponsors agreed that if the project were to continue through to its full development, legally binding agreements would need to be created. For the time being, the project team recommended that the irrigators cover approximately 15% of the anticipated annual cost (including loan repayment and annual operation and maintenance costs), with 80% being covered by secondary connections, and 5% covered by additional non-federal funding sources. This concept cost share is shown below in Figure 1.

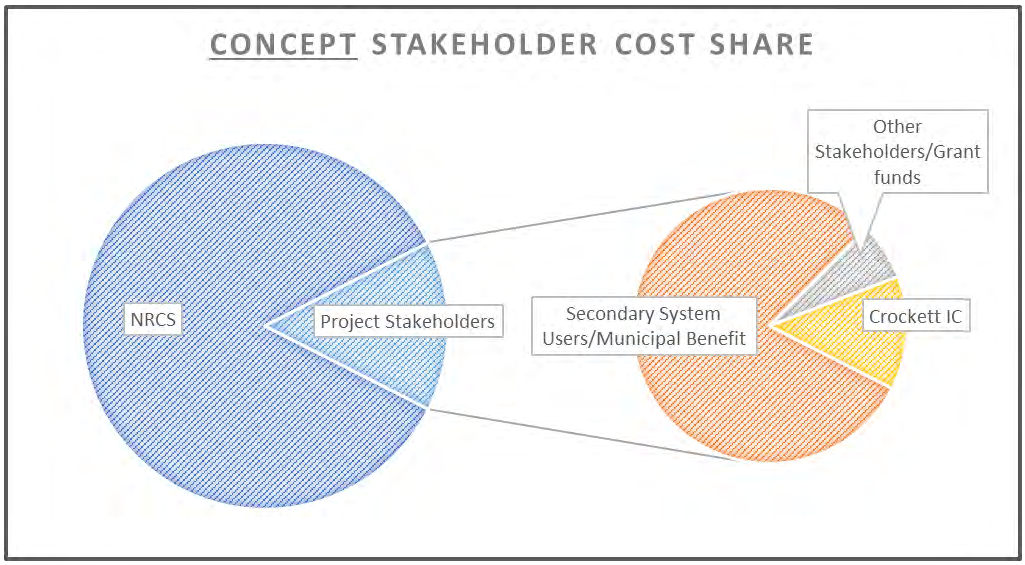


Figure 1 Concept Stakeholder Cost Share

Although the cost to canal company shareholders would be raised, costs would be approximately 90% (in the First Dam alternative) and 95% (in the Crockett Diversion alternative) of the anticipated financial burden under the FWOFI. The values in Table 2-2 above can be multiplied by these percentages to approximate the additional annual cost incurred by each canal company under the Action Alternatives, as shown in Table 2-3 below. Irrigators would be receiving an improved product for less than what they would experience under the FWOFI, as

well as contributing to the establishment of a much more efficient water distribution system in the community and restoring the beneficial use of their water right.

New secondary connections would be available to landowners whose land had historically been irrigated by the Crockett Irrigation companies. Although the secondary connections would come at a monthly or annual cost to the landowners, the use of secondary water for outdoor irrigation would reduce the costs incurred for culinary water and would reduce the magnitude and frequency of future culinary water rate increases that would be experienced under the FWOFI. This concept is shown in Figure 2 below.

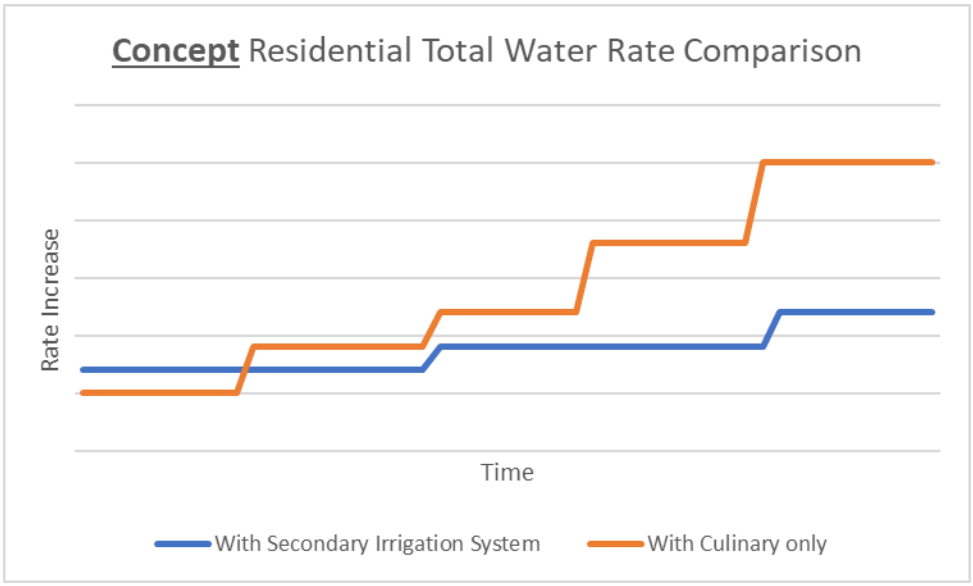


Figure 2 Concept Residential Total Water Rate Comparison

The anticipated cost for new connections was approximated based on three scenarios of total connections to potential connections based on current parcel and zoning information. These values, especially under the higher connection rate percentages were in line with other secondary system costs along the Wasatch Front and were supported by the municipal co-sponsors. Table 3-1 below shows the anticipated cost ranges based on connection rate under the previously described cost-share.

Table 3-1 Estimated Secondary User Rates with NRCS funding

Estimated Secondary User Rates with NRCS Funding			
Connection Rate	50%	75%	100%
Estimated Secondary Rate* (monthly for 12 months)	$60-70	$40-45	$30-35

The remainder of the annual balance would be covered through a combination of additional non-federal funding, one-time contributions of the municipalities, or contributions by other local stakeholders.

The project sponsors agreed to move forward with the understanding that the remaining project costs not covered by the NRCS would be their responsibility. They felt confident after many discussions and financial analysis that the remaining project funds needed to complete the project, based on the funding percentages outlined in the EIS, could be covered through other non-federal funding opportunities, local community stakeholder contributions, shareholder assessment increases, and municipal contributions to encourage secondary connections. The signature of each co-sponsor on the Watershed Plan-EIS indicates a willingness to collaborate toward financial requirements of the project as outlined in the Watershed Plan-EIS.

TM 019 Flood Prevention

J-U-B ENGINEERS, INC.

TECHNICAL MEMORANDUM 019

Date:	November 26, 2024
To:	Shawn Stanley, Watershed Engineer Derek Hamilton, Water Resources Coordinator
Cc:	
From:	Zan Murray, PE – J-U-B ENGINEERS, Inc. Chris Slater, PE – J-U-B ENGINEERS, Inc. Colton Smith, PE – J-U-B ENGINEERS, Inc.
Project:	Logan River Watershed Plan-EIS
Subject:	Flood Control
Note:	

1.0 Introduction

Cache Water District contracted with J-U-B Engineers, Inc. (J-U-B) to complete a Watershed Plan-Environmental Impact Statement (Plan-EIS) of the Logan River Watershed Project. Part of the Scope of Work includes analysis of the hydraulics and hydrology for the flood water that is discharged to the Logan and Northern Canal, Twins Canal, and Northwest Field Canal. These canals flow south to north beginning in Logan City and ending in Smithfield. North Logan and Hyde Park and experience flooding during large rainfall events. These canals are not located in FEMA floodplains.

Hydraulics is the study of water movement within a specific conduit. Conduits can be natural, such as a stream channels, or manmade such as box culverts or pipes. Using equations developed from mathematical derivations and laboratory testing data, hydraulics can be used to predict the capacity of a specific conduit and the behavior of flow through it.

Hydrology is the study of the movement of water on earth in a large scale, such as water movement through a watershed. Hydrologic analysis utilizes historical data and statistical analysis to predict the volume and flow rates of water in a watershed for a specific storm event.

This technical memorandum examines the hydrology and hydraulics of the canals and the contributing areas and their effects on the proposed floodwater prevention system.

1.1 Purpose and Need

The purpose of this technical memorandum (TM019) is to present the Hydraulics and Hydrology Analysis and the Flood Protection Design conducted for the Logan River Watershed Plan-EIS. The Technical Memorandum is provided in **Appendix E**.

A hydrologic study of the contributing areas to the canals is needed to determine the anticipated peak runoff and volume of water that will be discharged during a specific storm event and how this peak flow moves through the watershed over time. A hydraulic study is needed to determine the appropriate conduits to convey the predicted peak runoff. The size, shape, slope, and material properties of the conduits within the study area are evaluated to determine runoff carrying capacity.

1.2 Historic Conditions & Flooding

The Logan and Northern Canal, Twins Canal, and Northwest Field Canal start at the Logan River and meander north through Logan, North Logan, and Hyde Park Cities generally between 600 East and 1200 East, 200 East and 600 East, and 200 West, respectively. Irrigation water is diverted from the Logan River and the canals flow north and deliver irrigation water to users within these cities and unincoporated areas of Cache County.

The canals are currently used for both irrigation delivery and floodwater conveyance throughout Cache Valley. During storm events flood water enters the canals at roadway crossings causing flows to increase along the canal alignments while conveying irrigation flows to canal shareholders. As development has continued to occur within Logan, North Logan, and Hyde Park it has become more challenging for the canal companies to manage these flood water flows in the canals as they flow through North Logan and Hyde Park. This is largely due to encroachment of development on the canals that has limited or eliminated access for canal maintenance.

Historically, during a storm event, the irrigation water diversions were closed at the Logan River to increase the conveyance flood water capacity by removing the irrigation flows from the canals. Headgates along the canals were opened to convey flood waters through existing ditches that ultimately discharge to the open fields and wetlands west of 1200 West in Logan City. Even with these efforts, the canals were monitored for possible overtopping during large events for flooding concerns north of 400 North in Logan and along each canal in North Logan and Hyde Park.

1.3 Floodwater Protection Policies

The cities within Cache County have adopted the storm water design requirements outlined in the Cache County Storm Water Design Standard Manual. Design standards outlined in the manual will be followed. Also, design requirements are identified in NRCS Practice Standards Codes 378, 587, 580, and 638.

1.4 Previous Studies

Historically, the canal companies allowed flood waters from the surrounding areas to be discharged into the canals. Development has occurred throughout the Cache Valley that has converted permeable farm ground into residential and commercial, increasing the impervious area. This has caused flows in the canals to increase beyond the conveyance capacity of the canals. In the Logan 2012 Storm Drain Master Plan, three alternatives were evaluated to address the flooding impacts within Logan City limits. The alternatives that were evaluated were Do Nothing, Canal Bypass, and Utilizing the Canals. Do Nothing would be a costly option as maintenance costs continue to rise for both Logan City and the canal companies and it perpetuates the problem of potential flooding in the future. The Canal Bypass alternative would remove the flood water from the canals but would require large regional detention and large pipes and other infrastructure to be installed. With the majority of Logan City being built out, this alternative would be difficult and costly for the city to implement. The Utilizing the Canals alternative was identified then as the preferred alternative moving forward and included making improvements to the canals that would improve and increase the conveyance capacity of the canals. This alternative would still have a high initial capital cost and would require ongoing coordination with the canal companies.

A 2015 Canal Drainage Study was performed as a joint study done by Logan City, North Logan, and Hyde Park. The study extended the area of study of the canals going north into the neighboring cities of North Logan and Hyde Park. The study evaluated potential spill locations along the canal alignments that would remove flood waters from the canals to help in reducing the potential of overtopping flooding. The study recommended a bypass in North Logan in the area of 1800 North or 2200 North.

2.0 Flood Water Analysis

As stated above, the canals were analyzed as part of the Logan City 2012 Storm Water Master Plan and in the 2015 Canal Drainage Study. Refer to the Storm Water Master Plan and Canal Drainage Study that were completed by J-U-B Engineers, Inc. in for a more detailed report on the flood water modeling and analysis.

J-U-B analyzed the existing canal flows starting at 400 N in Logan and flows were added at roadway crossings into Hyde Park to determine flooding limits during various storm events. The system was then analyzed with the proposed canal and piping improvements with the same storm events.

The flood water analysis was performed using Innovyze software package InfoSWMM. InfoSWMM uses EPASWMM for hydrologic and hydraulic routing. The InfoSWMM model was utilized for this evaluation to determine the inflow hydrographs of the canals for the 500-, 100-, 50-, 25-, 10-, 5-, and 2-year storm events.

2.1 Canal Systems Overview

The three canals that are the focus of this project are the Logan and Northern, Hyde Park and Logan North Field (Twins), and Logan Northwest Field. The natural slope of Cache Valley slopes from east to west. The canals intercept and convey flood water as it drains naturally to the west. The subcatchment delineation includes the area between the canals as shown in Figure 1.

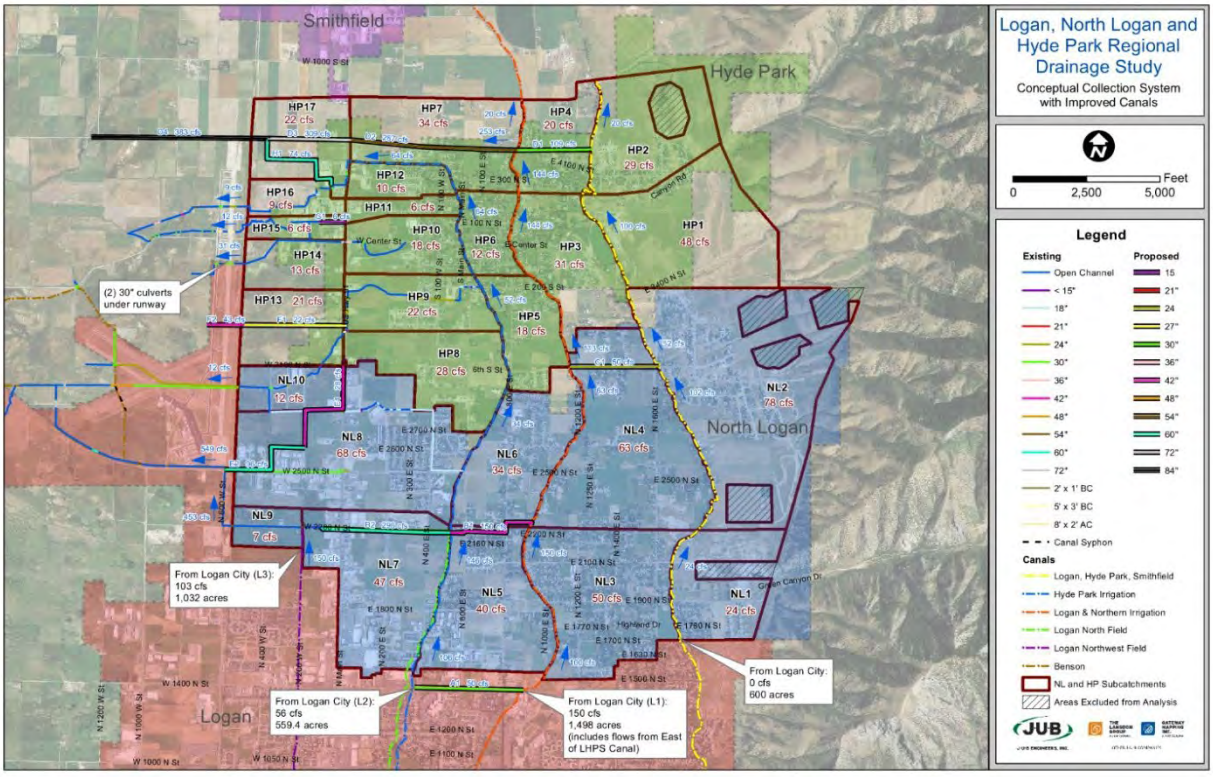


Figure 1: Canals Flood Control and Storm Drain Service Area

2.2 Canal System Model

The canals were modeled as part of the 2012 Storm Drain Master Plan and 2015 Canal Drainage

Study. The selected model for the hydraulic routing within the canals was performed in Innovyze's software package InfoSWMM and a list of the input parameters can be found in those studies. The parameters include soil conditions, rainfall loss methods, storm event, rainfall distribution, and time of concentration. Reported runoff flows from the reference studies varied widely based on methodology and the temporal distribution. The required temporal distribution for Logan City for new developments is the SCS Type II distribution. This temporal distribution is highly conservative and for the size of the subcatchments, it resulted in unreasonably high peak runoff flood flows in the canals. For this reason, the NOAA temporal distribution, 2nd Quartile, 50% probability for the Semiarid Southwest was selected as the design temporal distribution. Canal and pipe proposed improvements were sized to convey the 25-year storm event.

2.3 Alternatives

Several alternatives were evaluated during this analysis. The first alternative evaluated a flood overflow pipe to remove the flood water from the canals before they reach North Logan. The pipe would have been constructed along 1400 North and return to open flow on the west side of 1200 West. An existing channel would have allowed for the water to drain to the Swift Slough. After a preliminary economic analysis was completed, it was determined that a benefit-cost ratio of 1 or greater was not feasible under this scenario. During the 1400 North alternative evaluation, it was determined that the a large amount of the flooding occurred in North Logan City near 1800 North and 2200 North. To more efficiently reduce the amount of flooding occurring in this area, three additional alternatives were developed and evaluated, they are described below:

Alternative 1 – 1800 North (Preferred) – Divert flood flows from the canals into a pipe along 1800 north with an overflow at the Logan and Northern Canal that would flow west through a 48-inch pipe, an overflow at the Twins Canal that would flow into the pipeline and be upsized to a 54-inch pipe, and an overflow at the Northwest Field Canal that would flow into the pipeline and be upsized to a 72-inch pipe. The 72-inch pipe would outlet in the open channel on the west side of 2400 West and be conveyed north to the Swift Slough. A 24" pipe would be constructed between the Logan Northern Canal and Twins Canal along 2200 North to convey flood flows from the Logan Northern Canal to the Twin Canal which would convey those flows to 1800 North. It also includes lining the Logan and Northern canal from 1400 North to 1800 North and enclosing the Twin Canal in a box pipe starting at 400 north along the alignment of the canal to 1800 North.

Alternative 2 – 2200 North (1800 North) – Divert flood flows from the canals to a pipe that would run along 2200 north with an overflow at the Logan and Northern Canal that would flow into a 48-inch pipe, an overflow at the Twins Canal that would flow into the pipeline and be upsized to a 54-inch pipe, and an overflow at the Northwest Field Canal that would flow into the pipeline and be upsized to a 72-inch pipe. The 72-inch pipe would follow 2200 North until 1200 west where it would follow 1200 West to 1800 North and outlet similar to Alternative 1 in the open channel on the west side of 2400 West and be conveyed north to the Swift Slough.

Alternative 3 – 2200 North (Northwest Field Canal) – divert flood flows from the canals to a pipe that would run along 2200 north with an overflow at the Logan and Northern Canal that would flow into a 48-inch pipe, an overflow at the Twins Canal that would flow into the pipeline and be upsized to a 54-inch pipe and outlet the Northwest Field Canal. The Northwest Field Canal would be improved and upsized along the canal to the start of Swift Slough.

Alternative 1 has the least amount of wetland impacts and has fewer potential utility impacts and for these reasons it is the preferred alternative, see Figure 2.

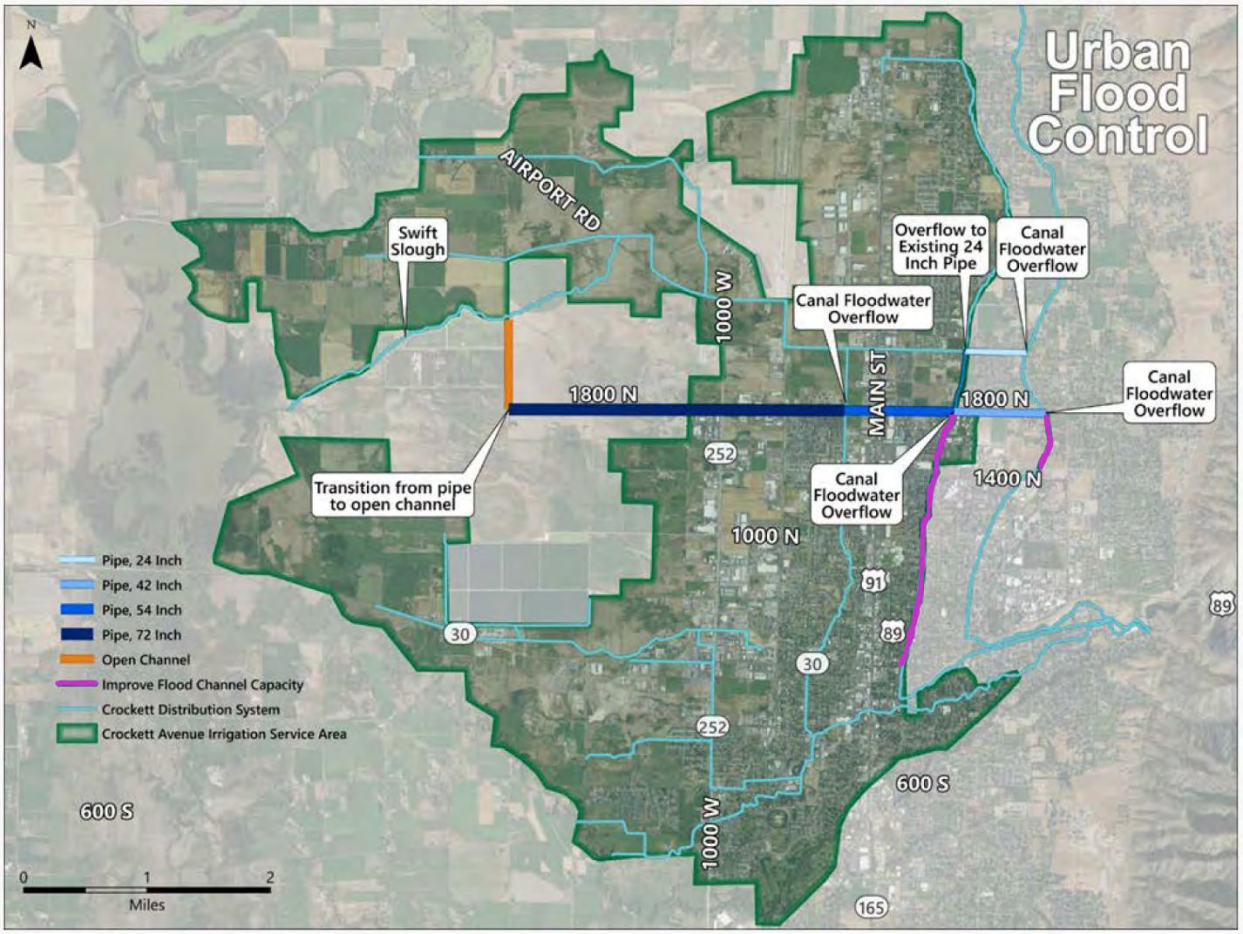


Figure 2: Urban Flood Control Alternative 1

2.3.1 No Action Alternative (Existing Condition)

Outflow hydrographs from the InfoSWMM model were loaded into HEC-RAS 2D model. Overtopping in the roadways and at structures varies, see Table 2 for flooding impacts.

Table 1 – No Action Totalized Flooding

Storm Event	Peak Flooding Flow (cfs)	Flooding Volume (ac-ft)	Peak Time (hrs)[a]	Flooding Duration (hrs)
2-Year	0	0	0	0
5-Year	0	0	0	0
10-Year	193	69	0.75	86.9
25-Year	285	101	0.75	90.8
50-Year	345	127	0.92	90.8
100-Year	371	146	1.00	99.2
200-Year	381	162	1.25	115.4
500-Year	415	182	1.92	126.6

[a]Hours after storm event began.

Table 2 – No Action Summary of Flooding Impacts - Structures

Scenario	Depth	Residential	Mobile Home	Commercial	Garage/Shed	Other
500-Year	0-1 ft	446	56	98	160	8
	1-2 ft	32	0	18	9	2
	2-3 ft	3	0	2	4	0
	3-4 ft	4	0	0	1	0
	4-5 ft	2	0	0	0	0
	5-6 ft	2	0	0	0	0
200-Year	0-1 ft	432	56	92	134	8
	1-2 ft	32	0	16	6	2
	2-3 ft	3	0	2	4	0
	3-4 ft	4	0	0	1	0
	4-5 ft	3	0	0	0	0
	5-6 ft	1	0	0	0	0
100-Year	0-1 ft	426	56	93	119	8
	1-2 ft	32	0	12	6	2
	2-3 ft	3	0	2	4	0
	3-4 ft	4	0	0	1	0
	4-5 ft	3	0	0	0	0
	5-6 ft	1	0	0	0	0
50-Year	0-1 ft	413	55	90	117	6
	1-2 ft	29	0	8	6	2
	2-3 ft	3	0	2	4	0
	3-4 ft	4	0	0	1	0
	4-5 ft	4	0	0	0	0
25-Year	0-1 ft	376	49	75	108	6
	1-2 ft	23	0	8	5	2
	2-3 ft	5	0	1	4	0
	3-4 ft	5	0	0	1	0
	4-5 ft	3	0	0	0	0
10-Year	0-1 ft	329	44	56	88	3
	1-2 ft	20	0	6	4	2
	2-3 ft	4	0	0	3	0
	3-4 ft	6	0	0	1	0
	4-5 ft	2	0	0	0	0

See **Attachment 1** for flood inundation maps of the No Action Alternative.

2.3.2 Preferred Alternative (Proposed Condition)

The following projects are included in the Preferred Alternative:

1. Concrete canal lining on Logan and Northen Canal from 1400 North to 1800 North
2. Installation of a 24-inch pipe along 2200 North from the Logan and Northern Canal to the Twin Canal
3. Divider removal and concrete lining on Twins Canal from 1800 North to 2200 North
4. 48-inch, 54-inch, and 72-inch piping along 1800 North
5. Box pipe on Twin Canal from 400 North to 1800 North

See tables below for a summary of results from the Preferred Alternative system model.

Table 3 –Preferred Alternative Totalized Flooding

Storm Event	Peak Flooding Flow (cfs)	Flooding Volume (ac-ft)	Peak Time (hrs)[a]	Flooding Duration (hrs)
2-Year	0	0	0	0
5-Year	0	0	0	0
10-Year	33	6	0.33	43.3
25-Year	96	19	0.25	54.2
50-Year	157	31	0.17	54.5
100-Year	192	41	0.25	55.6
200-Year	208	50	0.42	57.5
500-Year	226	60	0.50	60.6

[a] Hours after storm event began.

Table 4 –Preferred Alternative Summary of Flooding Impacts - Structures

Scenario	Depth	Residential	Mobile Home	Commercial	Garage/Shed	Other
500-Year	0-1 ft	333	49	52	91	2
	1-2 ft	27	0	7	5	2
	2-3 ft	3	0	0	3	0
	3-4 ft	4	0	0	1	0
	4-5 ft	4	0	0	0	0
200-Year	0-1 ft	327	46	49	83	1
	1-2 ft	25	0	6	5	2
	2-3 ft	3	0	0	3	0
	3-4 ft	5	0	0	1	0
	4-5 ft	3	0	0	0	0
100-Year	0-1 ft	302	43	48	78	1
	1-2 ft	23	0	3	5	2
	2-3 ft	3	0	0	3	0
	3-4 ft	5	0	0	1	0
	4-5 ft	3	0	0	0	0
50-Year	0-1 ft	277	33	32	65	0
	1-2 ft	21	0	3	4	2
	2-3 ft	3	0	0	3	0
	3-4 ft	7	0	0	1	0
	4-5 ft	1	0	0	0	0
25-Year	0-1 ft	223	19	15	62	1
	1-2 ft	21	0	1	3	1
	2-3 ft	3	0	0	3	0
	3-4 ft	7	0	0	1	0
10-Year	0-1 ft	137	0	4	38	1
	1-2 ft	10	0	0	4	0
	2-3 ft	5	0	0	3	0
	3-4 ft	4	0	0	0	0

3.0 Statement of Limitations

This document represents J-U-B Engineers, Inc.'s professional judgement based on the information available at the time of its completion and as appropriate for the project Scope of Work. Services performed in developing the content of this document have been conducted in a manner consistent

with that level and skill ordinarily exercised by members of the engineering profession currently practicing under similar conditions. No warranty, express or implied, is made.

4.0 References

Innovyze. 2019. Innovyze Help File Updated April 12, 2019, InfoSWMM v14.7.

J-U-B Engineers, Inc. 2012. Logan City Storm Drain Master Plan.

J-U-B Engineers, Inc. 2015. Canal Drainage Study.

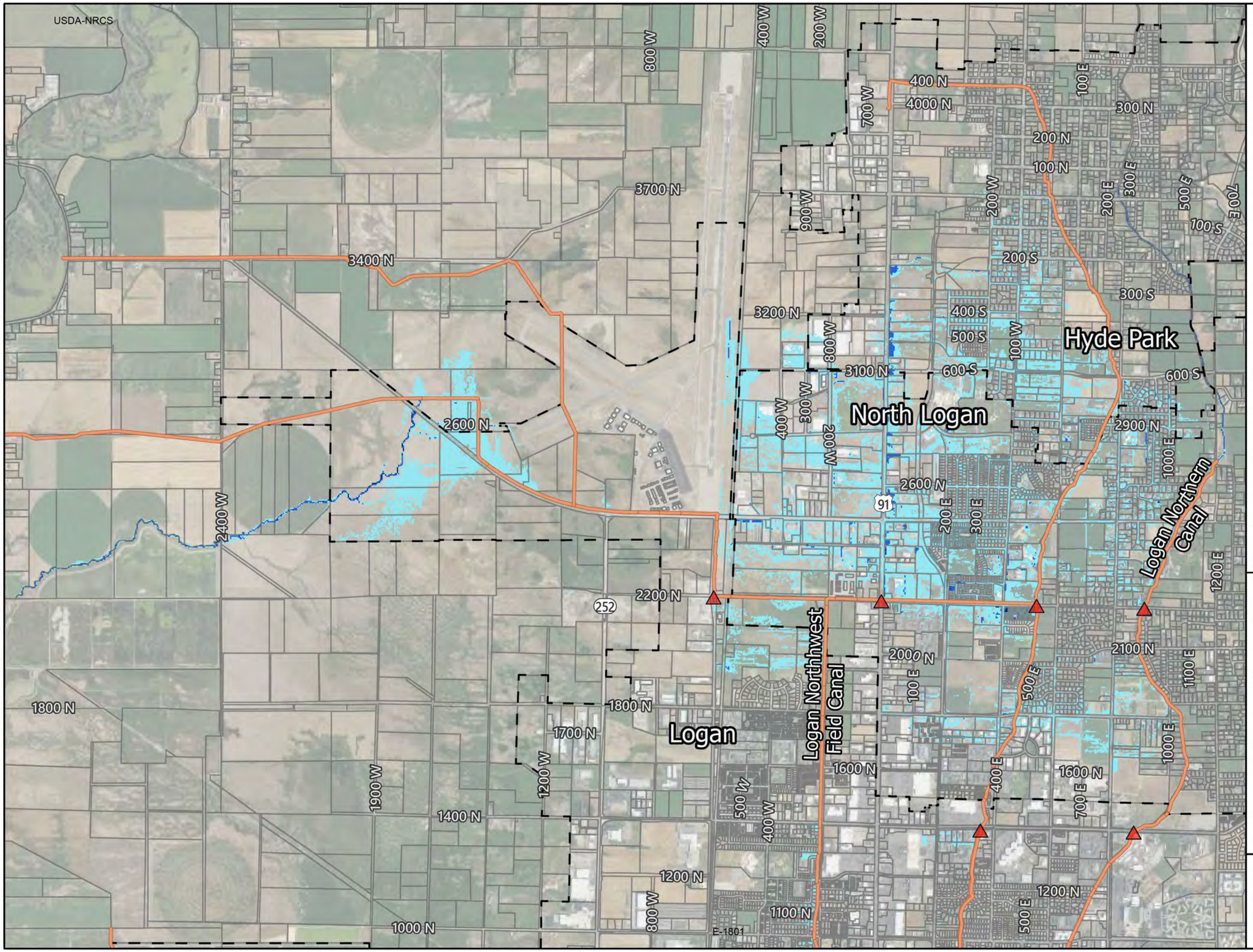
Attachment 1 – Flood Inundation Maps

Logan River Watershed Project

EXISTING FLOOD INUNDATION

10 YEAR STORM

Logan Plan-EA



N

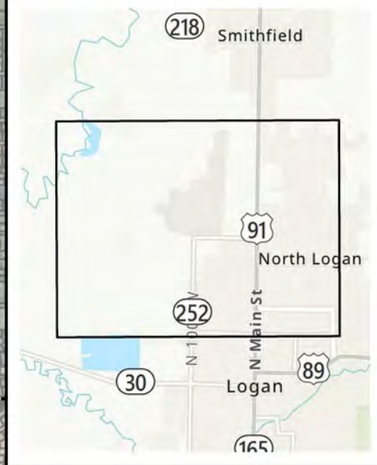
0 1,500 3,000

Feet

- Storm Drain Outlet To Canal
- Canal
- Parcels
- Municipalities

Flood Inundation

- <1 Feet
- 1-3 Feet
- >3 Feet



5/16/2024

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USDA-NRCS

Logan River Watershed Project

PROPOSED FLOOD INUNDATION

10 YEAR STORM

Logan Plan-EA

N

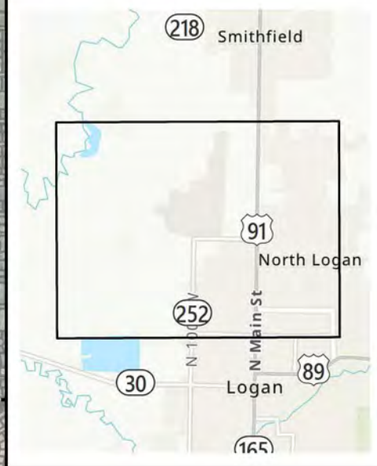
0 1,500 3,000

Feet

- Storm Drain Outlet To Canal
- Canal
- Parcels
- Municipalities

Flood Inundation

- <1 Feet
- 1-3 Feet
- >3 Feet



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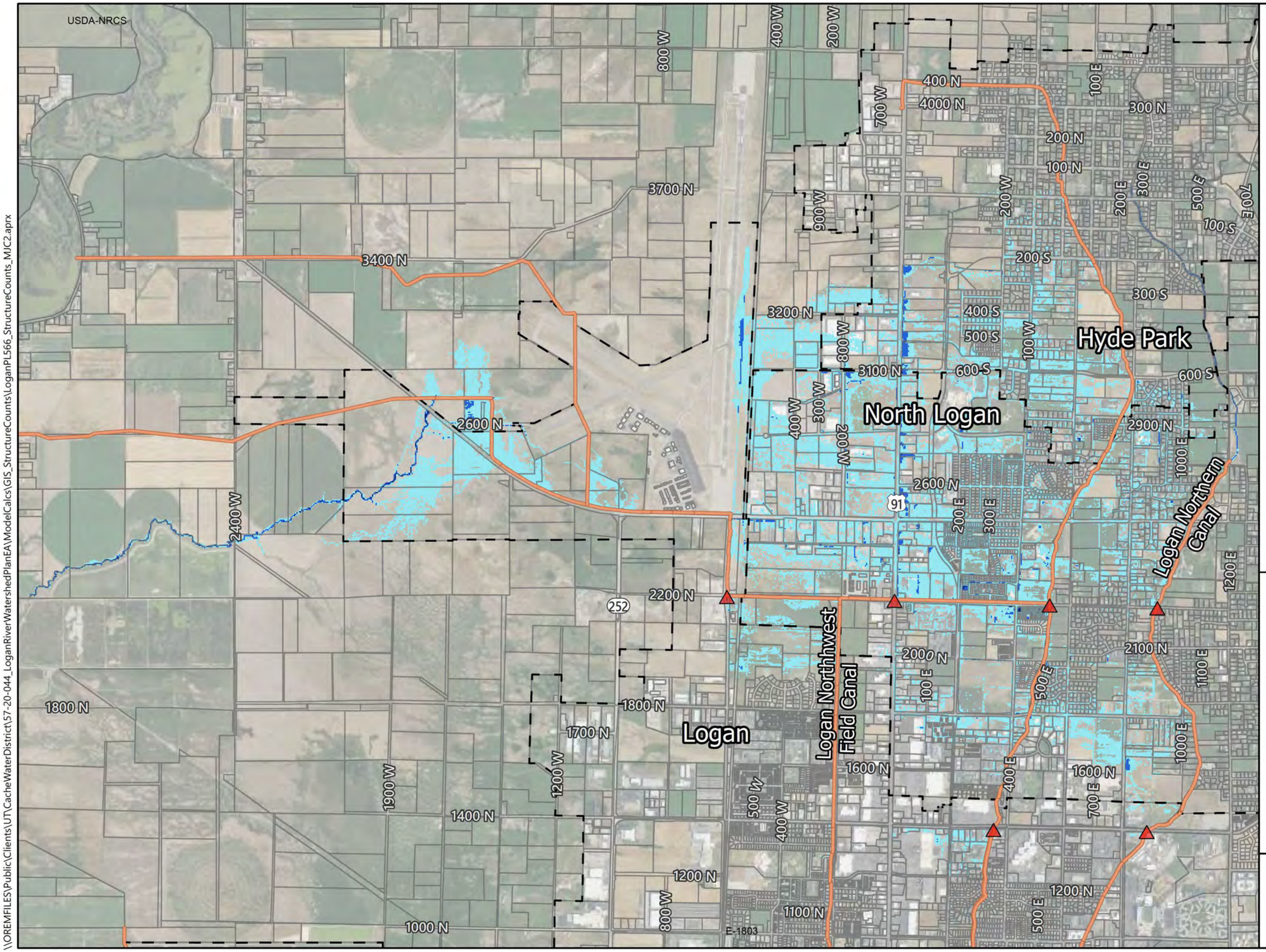
Logan River Watershed Project

EXISTING FLOOD INUNDATION

25 YEAR STORM

Logan Plan-EA



N

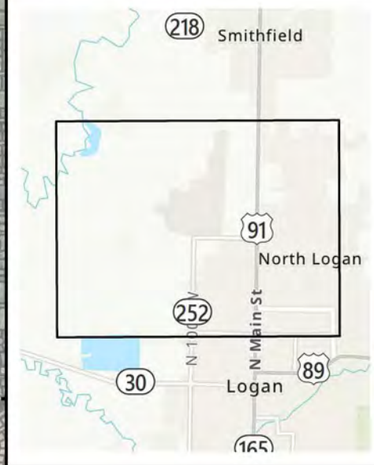
0 1,500 3,000

Feet

- Storm Drain Outlet To Canal
- Canal
- Parcels
- Municipalities

Flood Inundation

- <1 Feet
- 1-3 Feet
- >3 Feet



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USDA-NRCS

Logan River Watershed Project

PROPOSED FLOOD INUNDATION

25 YEAR STORM

Logan Plan-EA

N

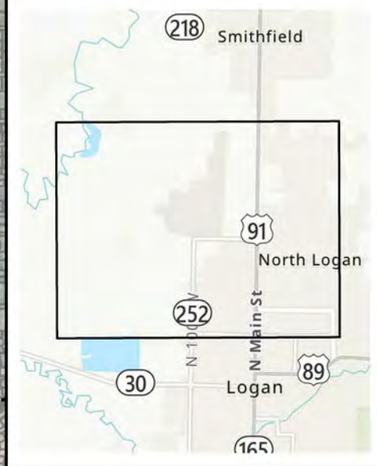
0 1,500 3,000

Feet

- Storm Drain Outlet To Canal
- Canal
- Parcels
- Municipalities

Flood Inundation

- <1 Feet
- 1-3 Feet
- >3 Feet



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USDA-NRCS

Logan River Watershed Project

EXISTING FLOOD INUNDATION

50 YEAR STORM

Logan Plan-EA

N

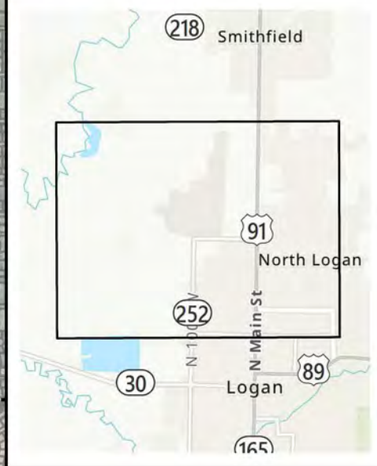
0 1,500 3,000

Feet

- Storm Drain Outlet To Canal
- Canal
- Parcels
- Municipalities

Flood Inundation

- <1 Feet
- 1-3 Feet
- >3 Feet



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USDA-NRCS

Logan River Watershed Project

PROPOSED FLOOD INUNDATION

50 YEAR STORM

Logan Plan-EA

N

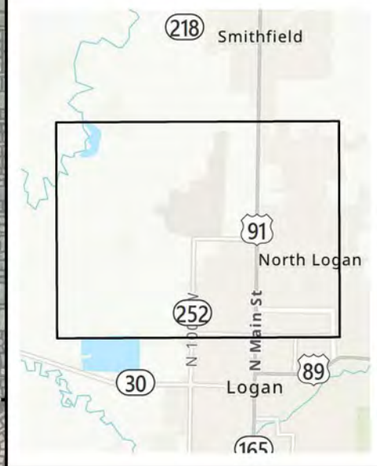
0 1,500 3,000

Feet

- Storm Drain Outlet To Canal
- Canal
- Parcels
- Municipalities

Flood Inundation

- <1 Feet
- 1-3 Feet
- >3 Feet



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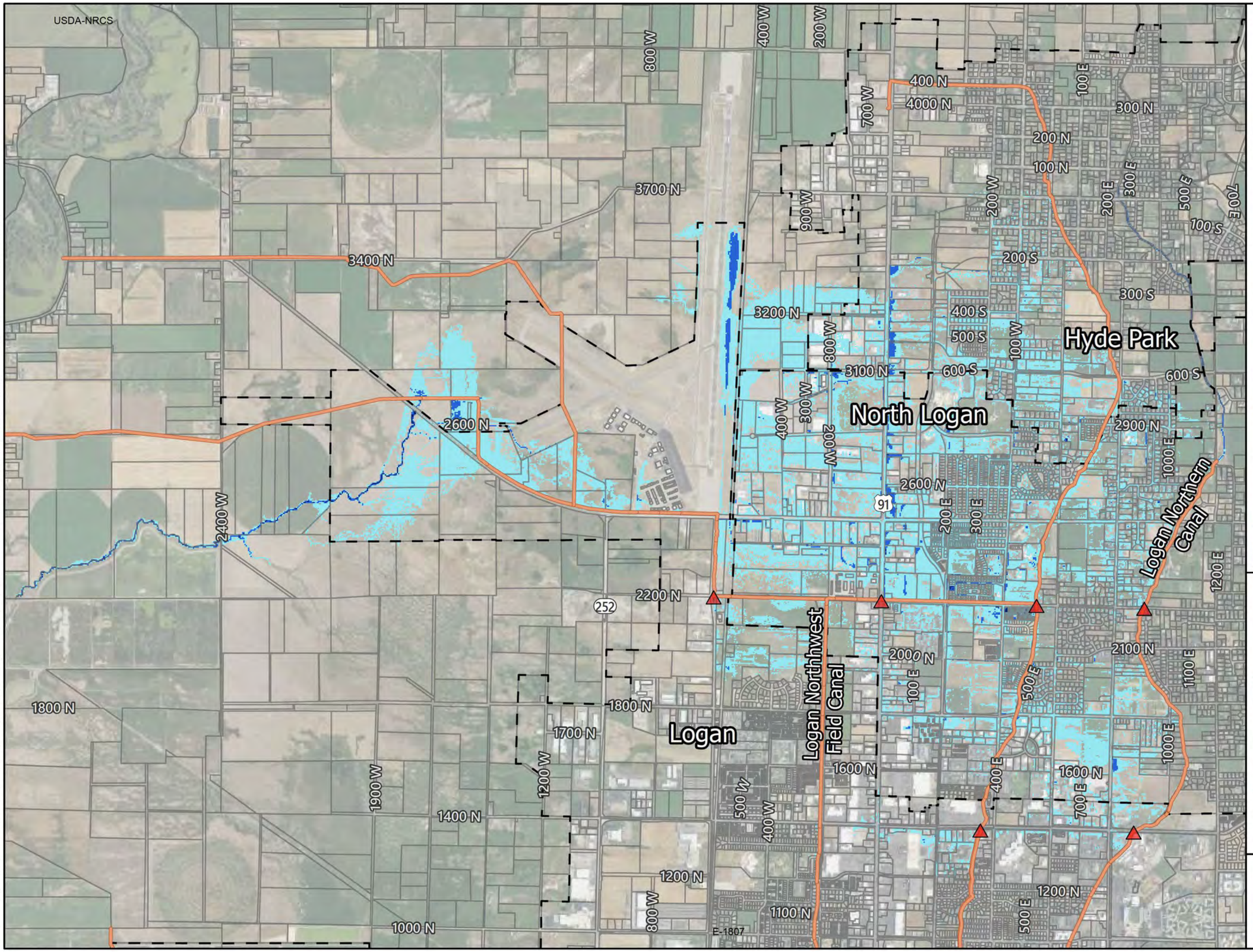
E-1806

Logan River Watershed Project

EXISTING FLOOD INUNDATION

100 YEAR STORM

Logan Plan-EA



N

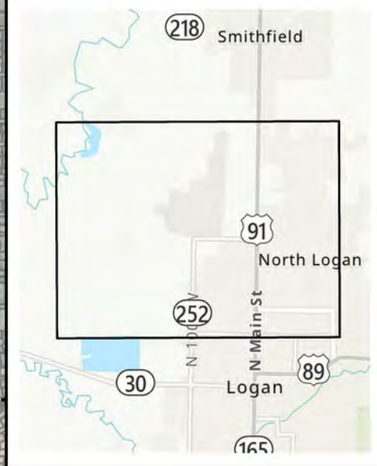
0 1,500 3,000

Feet

- Storm Drain Outlet To Canal
- Canal
- Parcels
- Municipalities

Flood Inundation

- <1 Feet
- 1-3 Feet
- >3 Feet



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USDA-NRCS

Logan River Watershed Project

PROPOSED FLOOD INUNDATION

100 YEAR STORM

Logan Plan-EA

N

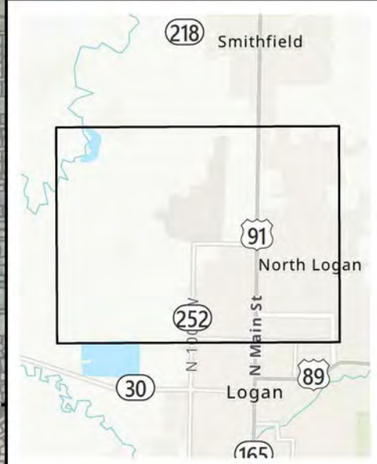
0 1,500 3,000

Feet

- Storm Drain Outlet To Canal
- Canal
- Parcels
- Municipalities

Flood Inundation

- <1 Feet
- 1-3 Feet
- >3 Feet



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USDA-NRCS

Logan River Watershed Project

EXISTING FLOOD INUNDATION

200 YEAR STORM

Logan Plan-EA

N

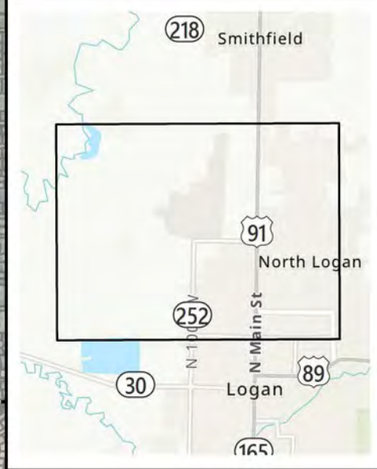
0 1,500 3,000

Feet

- Storm Drain Outlet To Canal
- Canal
- Parcels
- Municipalities

Flood Inundation

- <1 Feet
- 1-3 Feet
- >3 Feet



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USDA-NRCS

Logan River Watershed Project

PROPOSED FLOOD INUNDATION

200 YEAR STORM

Logan Plan-EA

N

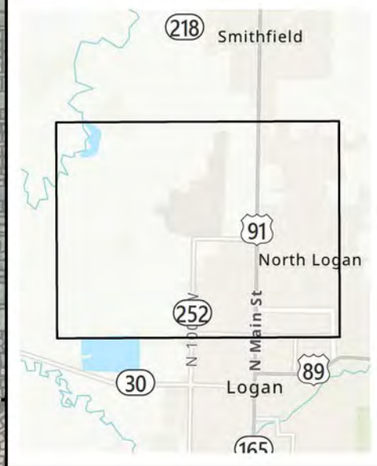
0 1,500 3,000

Feet

- Storm Drain Outlet To Canal
- Canal
- Parcels
- Municipalities

Flood Inundation

- <1 Feet
- 1-3 Feet
- >3 Feet



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USDA-NRCS

Logan River Watershed Project

EXISTING FLOOD INUNDATION

500 YEAR STORM

Logan
Plan-EA

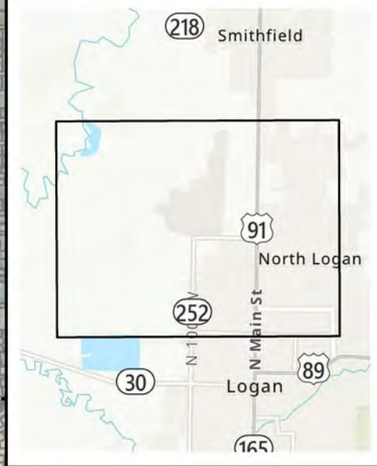
N

0 1,500 3,000
Feet

- Storm Drain Outlet To Canal
- Canal
- Parcels
- Municipalities

Flood Inundation

- <1 Feet
- 1-3 Feet
- >3 Feet



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USDA-NRCS

Logan River Watershed Project

PROPOSED FLOOD INUNDATION

500 YEAR STORM

Logan Plan-EA

N

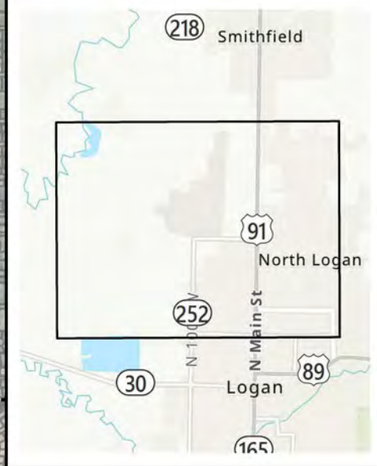
0 1,500 3,000

Feet

- Storm Drain Outlet To Canal
- Canal
- Parcels
- Municipalities

Flood Inundation

- <1 Feet
- 1-3 Feet
- >3 Feet



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TM 020 Recreation

J·U·B ENGINEERS, INC.

TECHNICAL MEMORANDUM 020

Date:	5/17/2024
To:	Derek Hamilton, Water Resources Coordinator Shawn Stanley, Watershed Engineer
Cc:	
From:	Jonny Budge, P.E. – J-U-B ENGINEERS, Inc.
Project:	Cache Water District: Logan River Watershed Plan
Subject:	Recreation Design Summary

1.0 Introduction

The recreation component (the Recreation project) of the Logan River Watershed Plan-EIS consists of completing two American Disabilities Act (ADA) compliant shared use paths located within Logan City (City).

Canyon Road Trail: The first shared use path is along the north side of Canyon Road between 200 East and 600 East.

River Hollow Trail: The second path provides access to River Hollow Park from three locations:

- Pedestrian routes along Sumac Drive
- Riverside Drive
- Lauralin Drive

These proposed trails are shown in Figure 1.

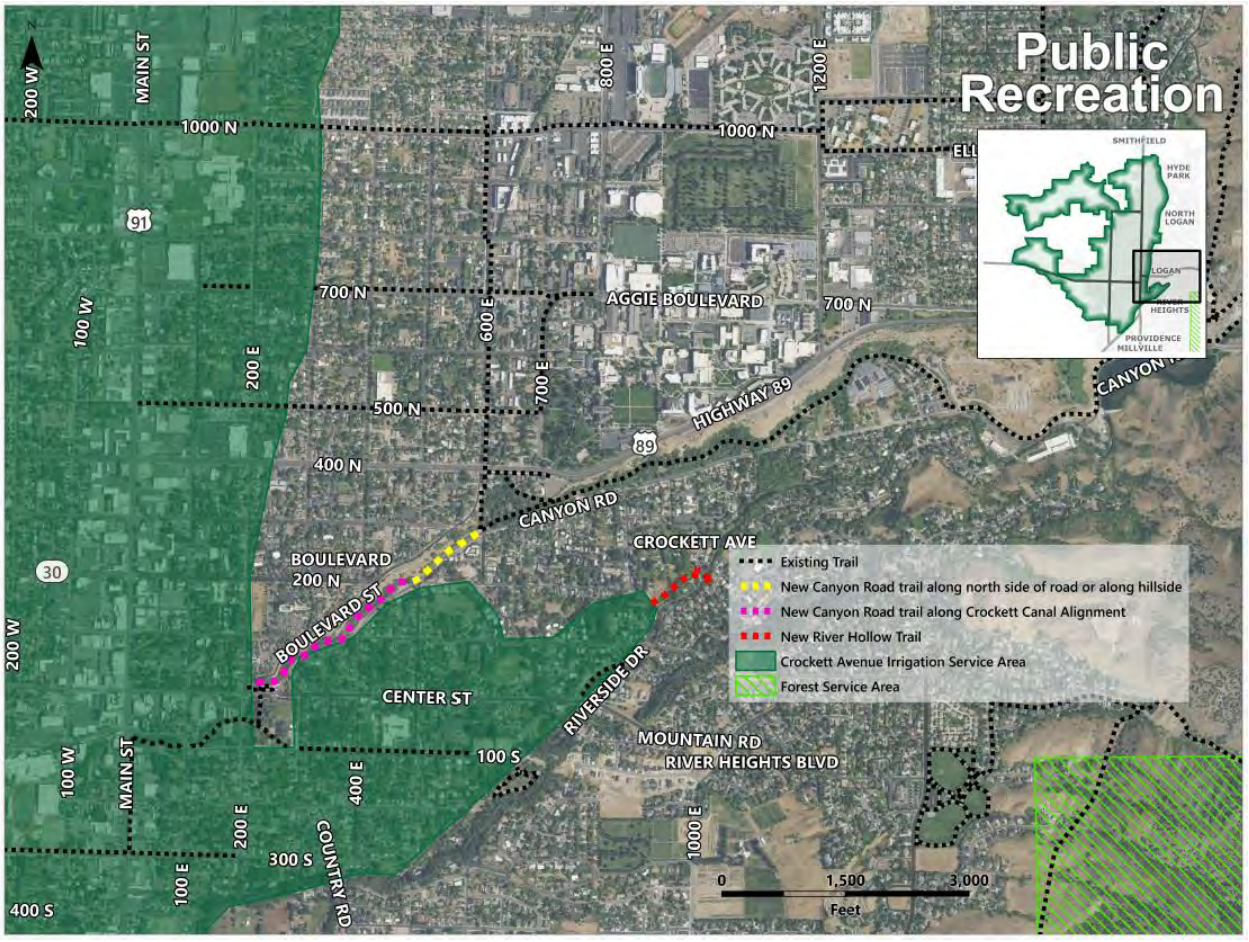


Figure 1. Proposed Trails

1.1 Purpose and Need

The primary proposes of this project are to improve agricultural water management in the Crockett Avenue Irrigation distribution service area and to provide flood control to the cities of Logan, North Logan, Hyde Park, and portions of Cache County. The two trails described in Section 1.0 enhance the improvements being completed for the agricultural water management improvements.

Most of the Canyon Road Trail will be constructed in place of the Crockett Canal along a section of the canal that will no longer be used for irrigation delivery if one of the evaluated pressure irrigation alternatives is constructed. The canal could be modified to allow a trail from about 500 East to 200 East.

River Hollow Park Trail improvements will complement and enhance the agricultural water management improvements that will be made near River Hollow Park if one of the evaluated pressure irrigation alternatives is constructed. These trails will provide access to maintain key components of the pressure irrigation system as well as provide recreational opportunities for residents.

2.0 Existing System

Logan City has an existing city-wide network of shared use paths which connect recreational facilities inside and outside of City limits. These shared use paths are typically concrete paths 5 to 10 feet wide. There are also other isolated shared use path routes within the City. Many of the existing trails are shown in Figure 1.

There is an existing shared use path along Boulevard Street from 200 East at Merlin Olsen Park to 600 East at the foot of the Utah State University Campus. This existing shared use path is non-compliant with ADA accessibility requirements, featuring steep grades. There is currently no walkable connection between 200 East and 600 East along Canyon Road.

The existing bridge from Sumac Park to River Hollow Park is currently the only walkable connection east of Crockett Avenue across the Logan River. The bridge connects Sumac Park to River Hollow Park. This route connects neighborhoods north and south of the Logan River. A portion of the existing pedestrian bridge is located on private property, with the property owner expressing a desire to remove the bridge from said property.

3.0 Improved System

3.1 Canyon Road Trail

A closer view of the Canyon Road trail is provided in Figure 2.

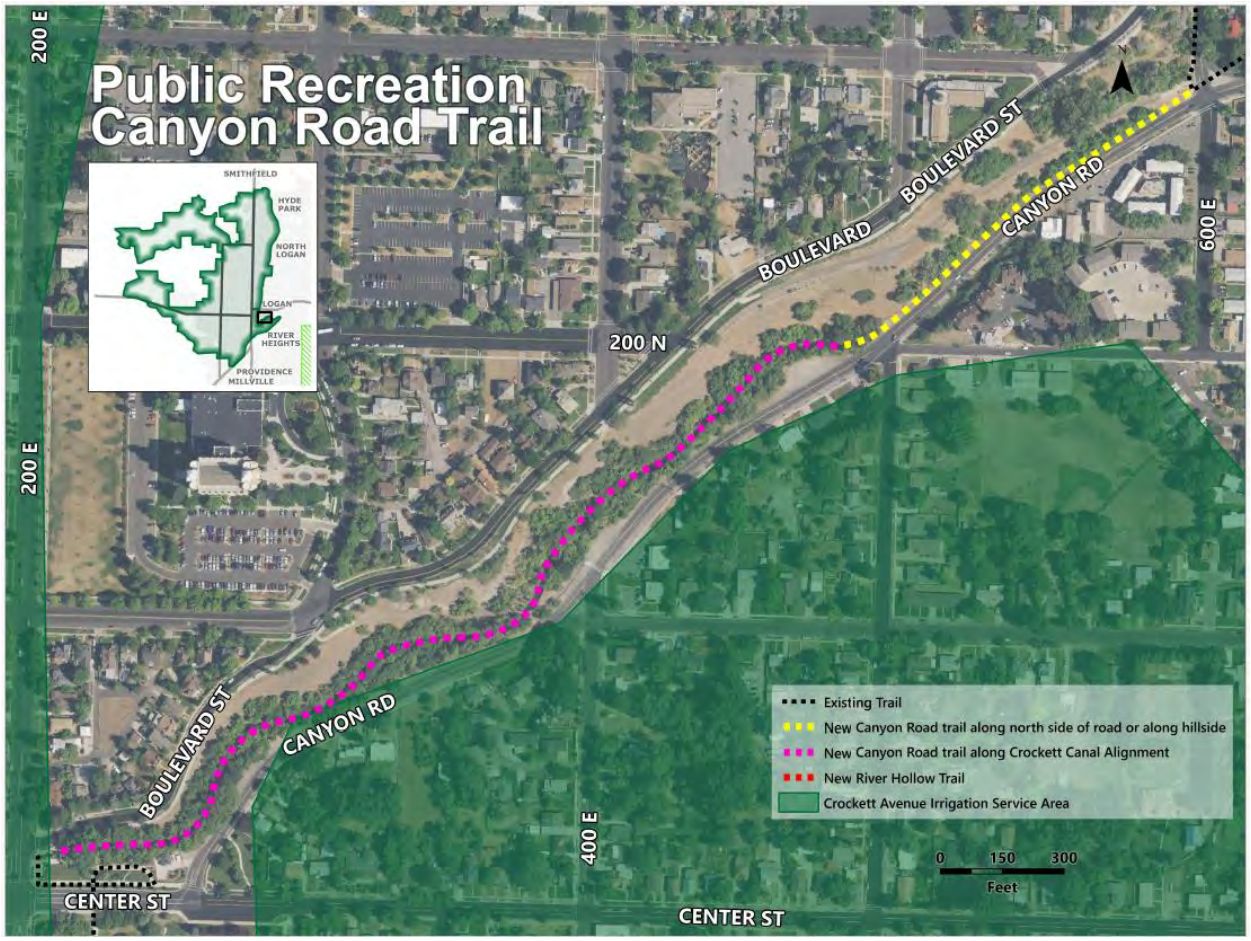


Figure 2. Proposed Canyon Road Trail

The eastern part of the trail from 600 East to approximately 500 East will run adjacent to Canyon Road in a southwesterly direction. Once the trail intersects the Crockett Canal near 500 East the trail will run over the top of the canal. Figure 3 shows the trail alignment and cross section for the trail that will run adjacent to Canyon Road and a cross section for the trail that will run along the Crockett Canal. The canal between 500 East and 200 East will no longer carry irrigation water, but a pipe is planned under the trail along this alignment to drain water that will run off of the canal and adjacent areas, as well as some periodic pump-to-waste flows from the city well house that is located on Center Street between 200 East and Canyon Road.

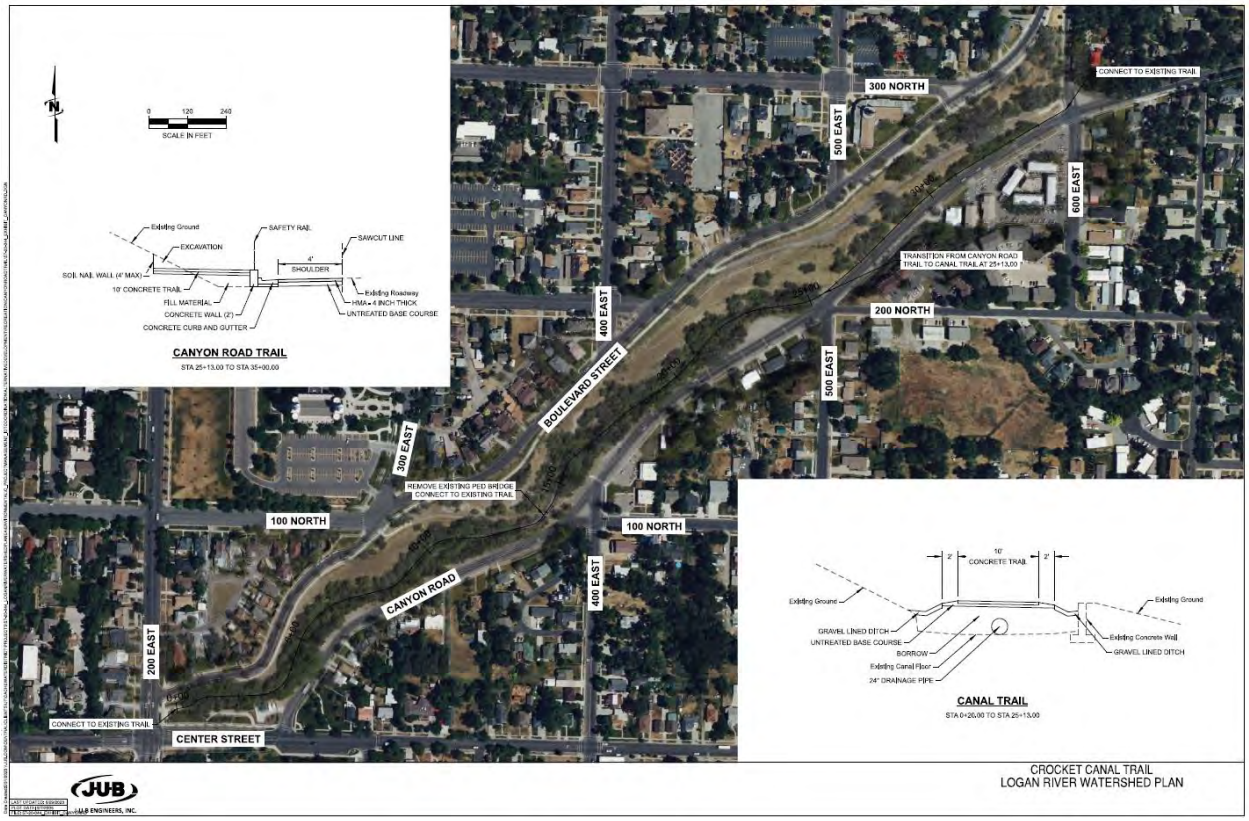


Figure 3. Proposed Canyon Road Trail Cross Sections

3.2 River Hollow Park Trail

A closer view of the River Hollow Park trail is provided in Figure 4.

Figure 4. Proposed River Hollow Park Trail

This trail would provide three points of access to River Hollow Park. The access from Sumac Drive would include a new shift to the east to allow for a new pedestrian bridge to cross the Logan River just upstream of the existing Crockett Diversion. The trail would go to the west toward Riverside Drive just north of the Little Logan to the western edge of River Hollow Park. At that point the trail would shift a little to the south to allow for the trail to fit next to the Little Logan. A retaining wall will likely be needed along the south side of the trail to keep it from sloughing off into the open Little Logan channel. Figure 5 is a conceptual sketch of the trail section from River Hollow Park to Riverside Drive.

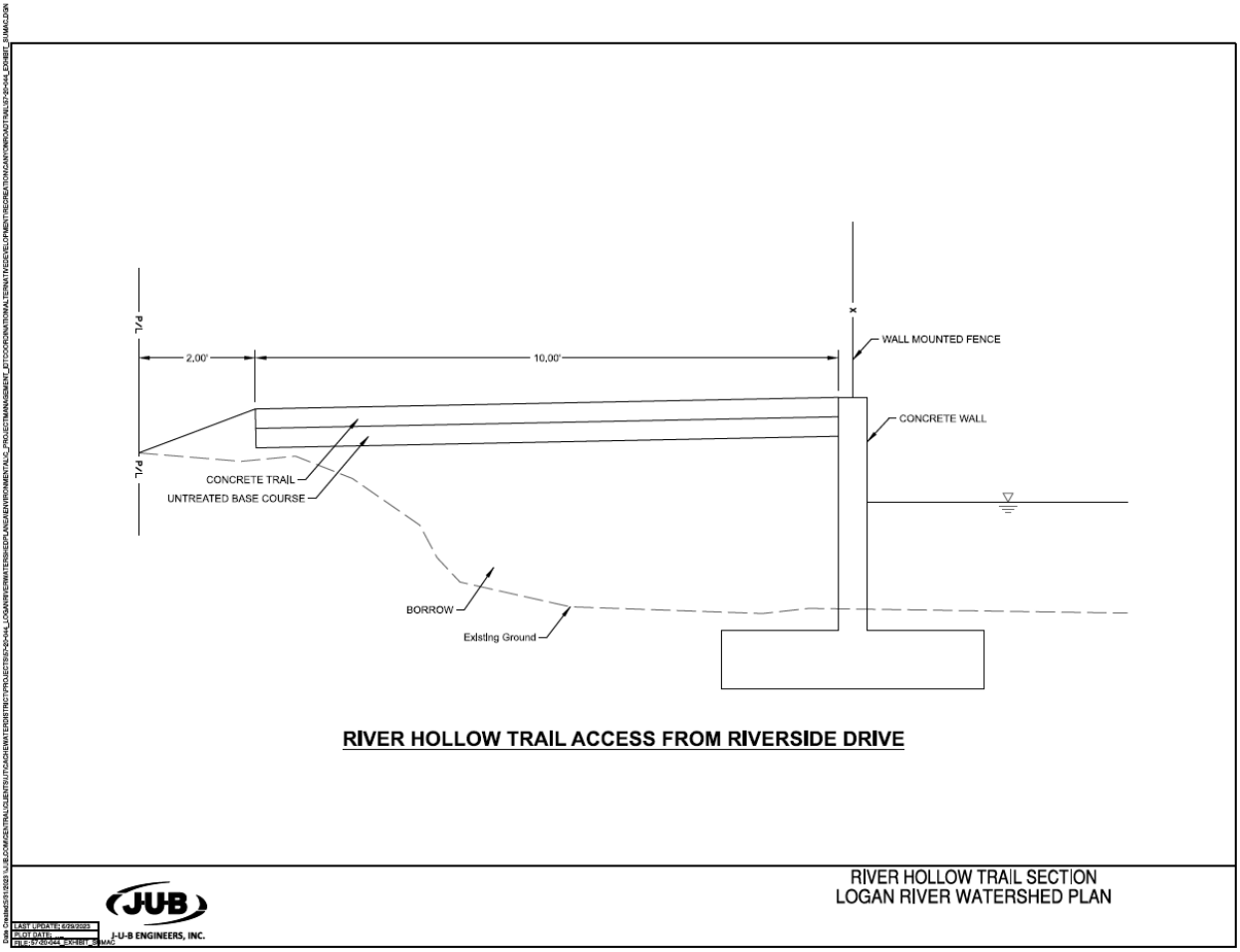


Figure 5. Proposed River Hollow Park Trail Cross Section

4.0 Design Criteria

4.1 American Disabilities Act (ADA)

ADA guidelines will be used in the final design of the recreation infrastructure. Cross slopes will be less than 2%, ADA ramps will be less than 8.3%, and minimum four-foot square landings will be required at the end of each ramp.

4.2 American Association of State Highway and Transportation Officials

American Association of State Highway and Transportation Officials (AASHTO) Guide for the Development of Bicycle Facilities recommends a width of 10 feet for a shared use path. A minimum clearance of 2 feet graded to a maximum of 16.67% is recommended for either side of the trail. The 2-feet of clearance provides space between the trail and lateral obstructions such as bushes, trees and rocks. Following AASHTO guidance the newly constructed shared use path will have a width of 10 feet to allow for two-directional travel by a variety of path users. The recommended maximum grade for a shared use path is 5% per AASHTO Guide for the Development of Bicycle Facilities.

AASHTO recommends a design speed of 18 mph for shared use paths with generally flat grades. Curves for a shared use path depend upon the leaning angle of bicycles while turning. Based on an 18-mph design speed and the recommended 20 degree leaning angle, the minimum horizontal turn radius is 60 feet. At the recommended design speed, the stopping sight distance is 141 feet.

The existing canal along the north side of Canyon Road has a large quantity of overhead tree cover. AASHTO recommends an overhead clearance of 10 feet for shared use paths. The project would remove or trim existing trees to meet vertical clearance requirements.

4.3 NRCS Code 575—Trails and Walkways Conservation Practice Standard

NRCS Code 575 refers to the Trails and Walkways Conservation Practice Standard. This standard is used to design and construct paths with various surfaces (vegetated, earthen, gravel, paved, etc.) to facilitate the movement of animals, people, or off-road vehicles12.

The primary purposes of this practice include:

- Improving animal access to forage, water, or shelter.
- Protecting ecologically sensitive or erosive sites.
- Providing pedestrian or off-road vehicle access for agricultural, construction, or maintenance operations.
- Creating trails or walkways for recreational activities.

4.4 Use Projections

The proposed Canyon Road and the River Hollow Park trails will provide ADA compliant connectivity between existing shared used path routes. These paths will service a variety of active transportation devices, including bicycles, pedestrians, wheelchairs, electric scooters and others. Motor vehicles and equestrian usage would not be permitted along the recreation projects. The portion of the recreation project along Canyon Road will connect recreation facilities west of 200 E to recreation facilities in Logan Canyon to the east. The portion of the recreation project to River Hollow Park will provide walkable neighborhood connectivity.

5.0 Statement of Limitations

It is important to emphasize the intent of the alignments. The alignments are a planning tool to guide recreation improvements. Alignments in the model may be affected by several factors, including the accuracy of base mapping, utility conflicts, physical features, and other assumptions made throughout this study.

The economic analysis was conducted using sound engineering judgement and information gathered from creditable sources, however prices of materials, labor, and supplies fluctuate regularly, making project costs highly variable.

TM 021 Logan River Conservation Action Plan (CAP) Analysis

Logan River Conservation Action Plan-EIS
Evaluation of Alternatives for the Logan River Watershed Plan-
11 March 2025 - BIO-WEST, Inc.

Introduction

The Logan River originates within the Bear River Mountains in the headwaters of Logan Canyon and terminates at its confluence with the Little Bear River in Cutler Reservoir. The river is an asset to residents of Logan City and Cache County and supports many beneficial uses. Cache Valley citizens are attracted to the river and enjoy the aesthetics, recreational values, and wildlife resources in this high-quality riverine ecosystem. The river supports fish, wildlife, and many plant species unique to riparian habitats and floodplains, is an integral part of the greater Bear River ecosystem, and an asset to Cache Valley residents.

The purpose of this technical memorandum is to provide a summary of anticipated effects to the Logan River and its floodplain and riparian ecosystem from the two action alternatives that increase summer base flows considered in the Logan River Watershed Plan Environmental Impact Statement (Plan-EIS) being conducted by J-U-B Engineers and Franson Civil Engineers for the Natural Resources Conservation Service (NRCS), Cache Water District, and partners. An evaluation of anticipated improvements to the river and riparian ecosystem associated with increased summer base flows was conducted by BIO-WEST using Logan River Conservation Action Plan (CAP) evaluation criteria developed in 2016. Attachment 1 of this report is a recently developed spreadsheet that utilizes the 2016 CAP (Attachment 2) to determine anticipated changes to 21 indicators of ecological, recreational, and social conditions of the Logan River and riparian corridor with higher summer base flows compared to existing conditions as described in TM-002 and TM-011.

Summer base flows are very important to aquatic life and were considered poor in the 2016 CAP (under 10 cubic feet per second [cfs]) with a desired rating of good (over 30 cfs) below Crockett Diversion to Cutler Reservoir. Strategic Actions were identified in the CAP to increase summer base flows to improve water quality and connect aquatic habitats during critical times of the year by supporting the following actions; “1) help secure and manage instream flows recognizing existing water rights, 2) participate with governmental and non-governmental organizations that would find and manage water for instream flows, and 3) evaluate the instream flow initiatives and potentially support the formation of a water conservancy district.” The Logan River Watershed Project and the recently formed water district provide the water rights and ability to secure and manage higher instream flows and improve water quality, and aquatic and terrestrial habitats for 14 miles of the

lower Logan River, previously nearly completely dewatered during droughts for the past several decades.

Logan River Conservation Action Plan Background

In 2014, a group of citizens, Utah State University professors, state and local government officials, and interest group representatives organized the Logan River Task Force (Task Force) to develop a plan for conserving and improving the Logan River and its floodplain, which is particularly important as development expands in Cache Valley. The Task Force and Logan City worked with BIO-WEST, a local environmental consulting firm, to develop and implement a CAP to evaluate existing conditions of the Logan River and to inform and prioritize conservation and restoration efforts, improve access and make additional trails and trail connections, with long term goals to improve conditions of all 21 CAP indicators, including the new Blue Trail indicator for floating the river. The development of a short- and long-range vision for the river was needed to coordinate and prioritize conservation efforts and ensure a sustainable river system for future generations. Stakeholder groups representing residential, commercial, recreational, and agricultural interests participated in the development of the Logan River CAP. The CAP is a dynamic set of objectives and strategies that can be revised as needed when new conservation solutions and restoration opportunities, or threats are identified along the river corridor.

The Logan River CAP evaluates indicators for three distinct river reaches: First Dam to 100 East (Upper Reach), 100 East to 1000 West (Middle Reach), and 1000 West to Cutler Reservoir (Lower Reach) as shown below.

The CAP has been utilized by the Task Force previously to evaluate the benefits of various river restoration opportunities, and to make recommendations to Logan City and State agencies regarding specific projects and strategic actions for improving conditions and functions of the river, floodplain, and riparian ecosystem. Existing and future conditions for each indicator are rated on the color-coded, four-point scale: Poor, Fair, Good, and Very Good based on criteria established by Task Force committees using all available data at the time.

Each indicator rationale is explained and strategic actions to achieve or maintain the anticipated conditions are shown in Attachments 1 and 2. To monitor conditions of the Logan River and its riparian corridor and track change over time, data has been collected and analyzed for various indicators by a wide group of partners as per the 2020 Logan River Conservation Action Plan (CAP) Monitoring Protocol (Attachment 3).

Fortunately, there is very good data collected and reported consistently for indicators such as hydrology and water quality at many locations along the Logan River to quantify existing and future conditions for all reaches under various instream flow scenarios as detailed in TM-002 and TM-011. Unfortunately, consistent monitoring data is not currently being reported for indicators such as fisheries, macroinvertebrates, riparian vegetation conditions and terrestrial biology, making tracking trends more convoluted for those indicators. Some data has been collected on all indicators, however. Qualitative criteria and less certain best professional judgements considering all available information are made for indicators with limited data.

Evaluation of Logan River Watershed Plan-EIS Alternatives

Flows, water temperature, and dissolved oxygen have been measured regularly by the Utah Water Research Lab Logan River Observatory (UWRL) for the past decade, and modeled for existing conditions and the two action alternatives described in the Plan-EIS. Relationships between flow and water temperature and dissolved oxygen during summer base flows have been developed by UWRL. A detailed description of existing and modeled hydrology and water quality conditions in various reaches of the Logan River during an extreme drought of 2022 can be found in TM-011.

BIO-WEST first revisited the existing condition of each indicator as of 2024, and then assessed the likely effects of each of the two alternatives being evaluated in the Logan

River Watershed Plan-EIS, considering whether the additional flow associated with Plan-EIS alternatives has potential to improve conditions and change the indicator rating for 15 river miles from First Dam to the downstream diversion near the old sewer ponds where a lower point of diversion and pump station would be constructed and increased flows associated with the Plan-EIS would be stored and pumped back for lower elevation irrigation needs. Because the Plan-EIS alternatives would involve changes to the structure and operation of the Crockett Diversion, the Upper Reach was divided in two—above and below Crockett Diversion. The Crockett Canal below Crockett Diversion is also called the Little Logan.

An instream flow of up to 10 cfs would be provided to the Little Logan using Logan City water rights during the irrigation season under either action alternative to maintain flow in City Parks. For purposes of this Plan-EIS evaluation, 6 cfs is added to extreme drought base flows shown in Figure 7 of TM-011 (Summer Base Flow Existing Conditions Calibrated Model and Alternatives 1 and 2 for Low Water Year 2022). The lower number is used since all diversions are proportionately lowered according to the Kimball Decree during extreme drought conditions. An additional 10–20 cfs of non-consumptive water use for Water Lab operations is also added to dry water year flows shown in TM-011. The lower number (10 cfs) was added to all reaches and 15 river miles according to the First Dam Alternative, whereas the added 10 cfs terminates at Crockett Diversion for the 1-mile upper reach under the Crockett Diversion Alternative.

Summary of Results

Certainty of the anticipated effects and recommendations are made for each indicator in the Plan-EIS CAP evaluation spreadsheet (Attachment 1). Result summaries of a few pertinent Logan River CAP indicator evaluations are provided below. The full CAP evaluation spreadsheet and monitoring protocol for all 21 indicators are available as attachments to this memorandum.

Summer Base Flow

Summer base flows are critical for maintaining good water quality and a functional aquatic ecosystem with connected aquatic habitats. Upstream and within reach diversions significantly reduce summer base flows in the Logan River. In 2016, summer base flow was evaluated by the Task Force as having Poor Condition during dry water years for all reaches but noted that the condition from First Dam to Crockett Diversion was Very Good or near natural relative to the lower reaches, using CAP criteria shown below.

CAP Summer Base Flow Indicator Condition Criteria

Poor	Fair	Good	Very Good
< 10 cfs	10-30 cfs	30-60 cfs	> 60 cfs

The Logan River HydroCouple modeling application described in TM-011 for the Plan-EIS indicates a summer baseflow below First Dam during an extreme dry water year of approximately 65 cfs. Within-reach diversions currently reduce summer base flows below Crockett Diversion late July through September to approximately 9 cfs. The Providence-Pioneer diversion below Denzil Stewart Nature Park and upstream of Main Street has water rights for 6 cfs but currently only diverts <1.5 cfs because the diversion and canal are in disrepair.

BIO-WEST evaluated 2024 conditions as mostly unchanged from the 2016 Task Force ratings. Existing conditions of the Upper Reach from First Dam to Crockett Diversion has a Very Good summer base flow for 1 river mile, while below Crockett Diversion the summer base flow is currently in Poor Condition in all lower reaches for 14 river miles during extremely dry years. Recent flow monitoring shows the middle reach as currently in Fair Condition (>10cfs), but it probably should be a Poor Rating since more than 25% of the flow consists of warm irrigation return flows upstream of 100 East, raising temperatures and disconnecting habitats.

During low and average water years it is common for the Logan-Blacksmith Diversion just upstream of Trapper Park to divert all remaining streamflow, leaving a significant portion of the lower reach dry some years. The zero flow conditions known to occur August and September downstream of Logan-Blacksmith Diversion are considered in this evaluation but are not captured in monitoring data used for TM-011.

The First Dam Alternative reduces summer base flows by approximately one-third between First Dam and Crockett Diversion during an extreme dry year, reducing the rating from Very Good Condition to Good Condition for 1 river mile. Below Crockett Diversion, the First Dam Alternative increases summer base flows by 2-3 times during extreme droughts and increases CAP ratings from Poor Condition to Good Condition for 14 river miles. The First Dam Alternative provides a significant improvement to summer base flows below Crockett Diversion in the Logan River.

The Crockett Diversion Alternative maintains summer base flows between First Dam and Crockett Diversion in Very Good Condition, and increases summer base flows from Poor Condition to Fair Condition for the below Crockett portion of upper reach and middle reach, and increases the lower reach to Good Condition during extreme dry years, assuming flows remain at this level (40 cfs) or higher below the Logan-Blacksmith

Diversion. The Crockett Diversion Alternative would maintain summer base flows in Good Condition most of the time in the middle reach, but not in the driest years, which is also a significant improvement over existing condition, and without impacting flows in the upper reach above Crockett Diversion.

Water Quality (water temperatures and dissolved oxygen)

Existing and anticipated conditions of water temperatures and dissolved oxygen concentrations are determined quantitatively using data collected by the Logan River Observatory over the past ten years and modeling results for existing conditions and the two action alternatives as described in TM-011. Graphs showing flow-temperature relationships for 15 monitoring stations and flow-dissolved oxygen concentration for 3 monitoring stations were also provided by the Logan River Observatory (Figure 1). This data shows a strong relationship between streamflow, water temperature, and dissolved oxygen in Logan River during low flow conditions, and indicates that Utah State Water Quality Standards for Cold Water Fishery are currently not being met some of the time, especially when flows drop below 25 cfs in the middle reach and below 40 cfs in the lower reach. The following CAP criteria were used to evaluate water quality in the Logan River.

CAP Water Quality Indicator Condition Criteria

Poor	Fair	Good	Very Good
State Standards Exceeded more than 50% of time	State Standards Exceeded 10-50% of time	State Standards Exceeded less than 10% of time	State Standards Rarely Exceeded

Water quality is currently in Good Condition upstream of Crockett Diversion, Fair Condition between Crockett Diversion and 1000 West, and Poor Condition in the lower reach.

According to the model created by the Logan River Observatory, the proposed increased dry-year summer base flows described above will reduce water temperatures by approximately 2 degrees upstream of Blacksmith Fork confluence, and approximately 1 degree below Blacksmith Fork confluence. The instream flows also increase dissolved oxygen concentrations. The State Water Quality Standards for Cold Water Fishery will be met for water temperature and dissolved oxygen more than 90% of the time with the proposed instream flows for either action alternative, and possibly rarely exceeded based strictly on flow/temperature and flow/dissolved oxygen relationships. Other pollutant loads and water quality violations not related to the Plan-EIS flow scenarios are not included in this analysis.

The First Dam and Crockett Diversion Alternatives maintains water quality as Good between First Dam and Crockett Diversion, increases water quality from Fair Condition to Good Condition in the middle reach, and from Poor Condition to Good Condition in the lower reach.

Figure 1. Graphs provided by Logan River Observatory showing flow-temperature and flow-dissolved oxygen relationships for 15 monitoring stations on the Logan River between First Dam and Mendon Road with data collected between 2014-2021.

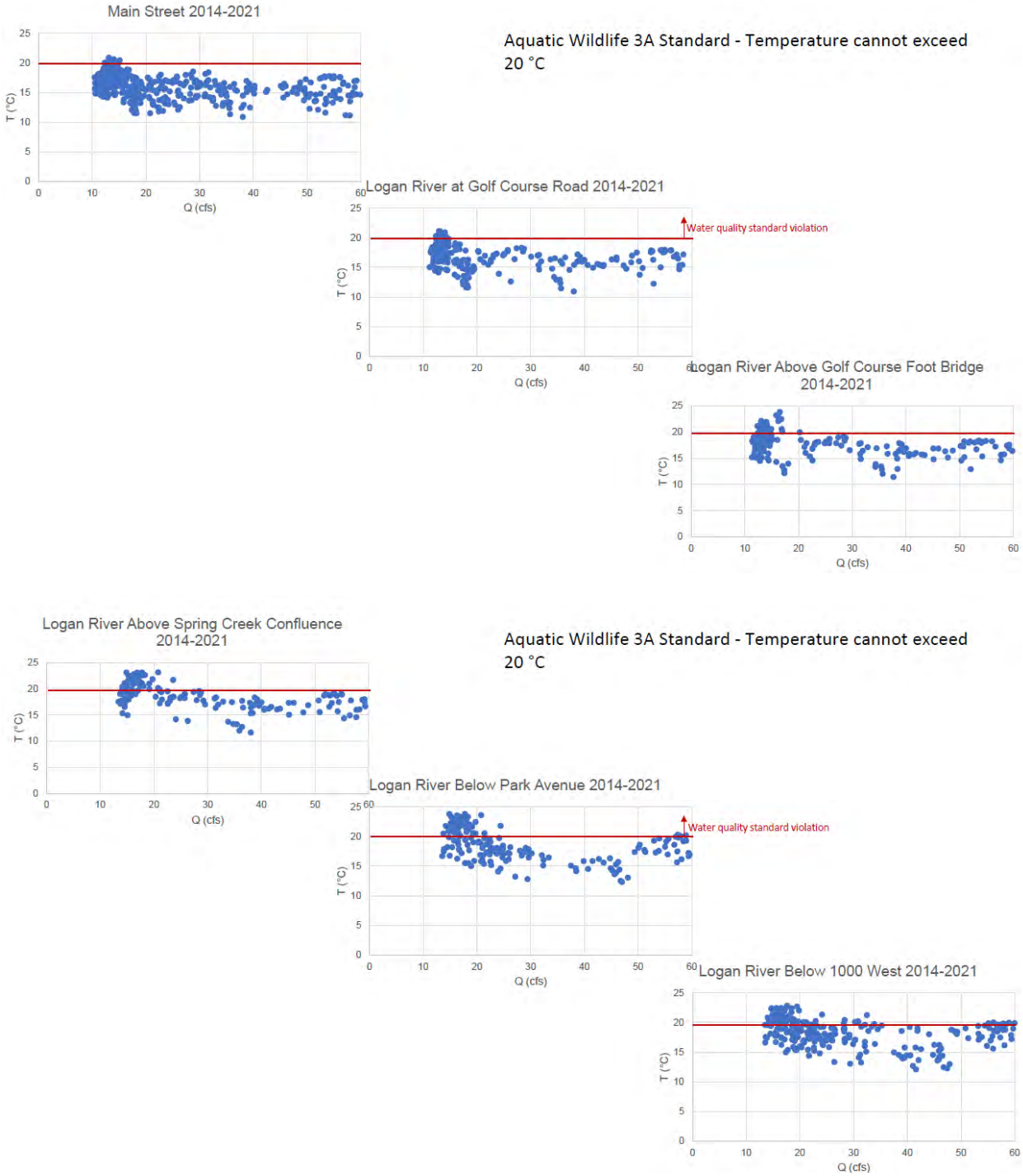


Figure 1 (continued). Graphs provided by Logan River Observatory showing flow-temperature and flow-dissolved oxygen relationships for 15 monitoring stations on the Logan River between First Dam and Mendon Road with data collected between 2014-2021.

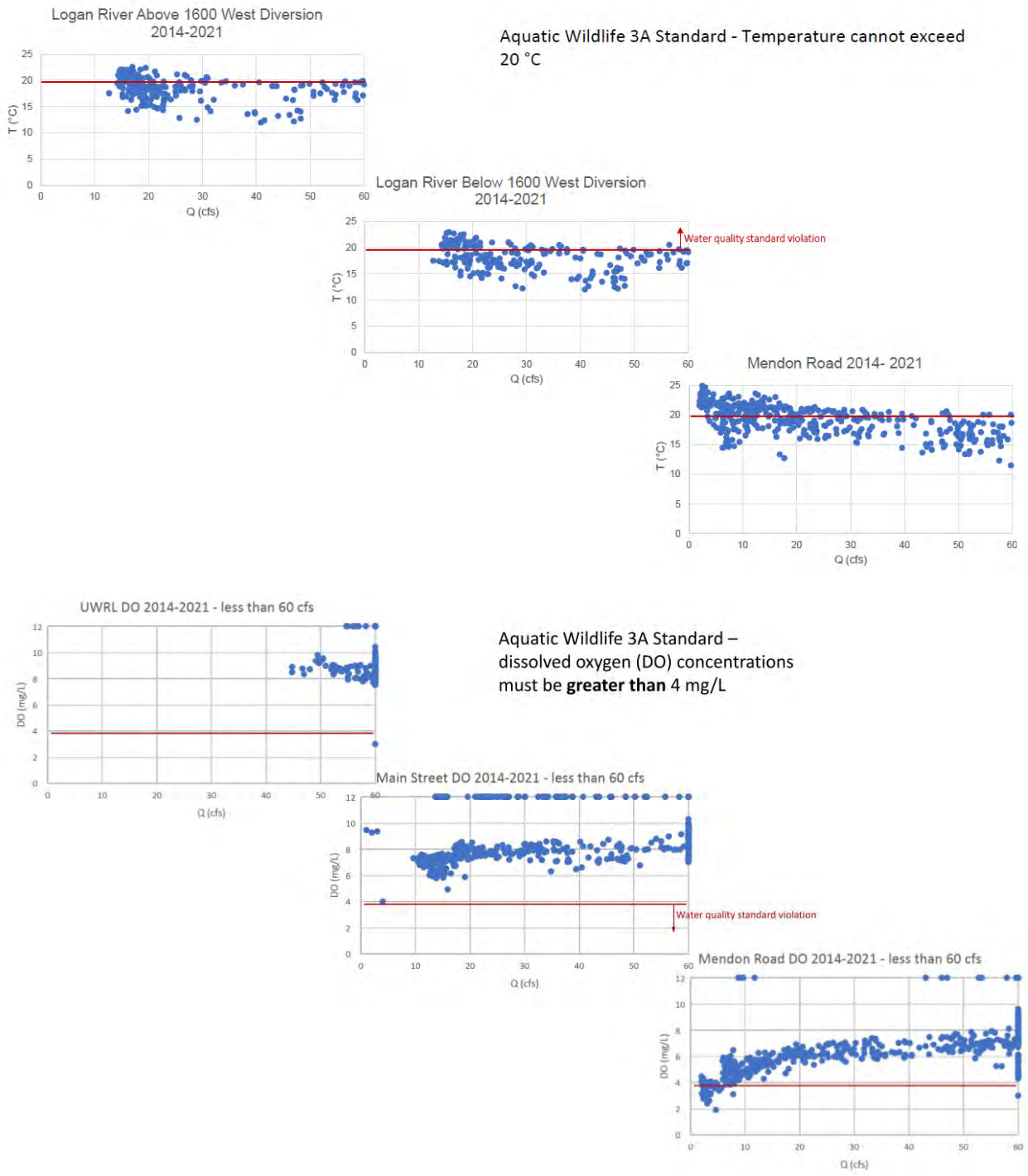


Figure 1 (continued). Graphs provided by Logan River Observatory showing flow-temperature and flow-dissolved oxygen relationships for 15 monitoring stations on the Logan River between First Dam and Mendon Road with data collected between 2014-2021.

Instream Habitat

This indicator includes hydraulic complexity and habitat diversity, including a natural sequence of pools and riffles, a variety of pool sizes and depths, stable woody materials in the bed and banks, and includes upstream and downstream connectivity for migrating species. Instream habitat is important aesthetically and critical for all aquatic species living in the river. Diversion dams impact sediment transport for hundreds of feet upstream and thousands of feet downstream of the structure, disrupting the natural sequence of pools and riffles. In 2016, instream habitat was evaluated by the Task Force as having Fair Condition for all reaches for various reasons using CAP criteria shown below.

CAP Instream Habitat Indicator Condition Criteria

Poor	Fair	Good	Very Good
> 66% departure from natural	34-66% departure from natural	10-33% departure from natural	<10% departure from natural

According to the Logan River HydroCouple flow model, the increased summer base flows associated with the two action alternatives would increase water depths between 5-8 inches during extreme dry years, depending on alternative and reach, compared to existing conditions (Figure 2). The proposed instream flows also increases the wetted perimeter and wetted area for 14 river miles, improving instream habitat and conditions for fisheries, macroinvertebrates, riparian and wetland vegetation along the river, and birds and other terrestrial wildlife. There is an approximately 1-inch difference in water depths between the two action alternatives during extreme dry years. The additional instream flows better connect pools and other instream habitats that otherwise became isolated during extreme low flows when the river is traditionally dried up in specific reaches. The two action alternatives may also include reconstruction or removal of the Crockett and Pioneer-Providence Diversions, which are currently barriers to fish and kayakers in Logan River.

The 2024 existing condition of instream habitat is still considered to be in Fair Condition in all reaches. The upper reach is currently impacted by sediments periodically being sluiced from First Dam, and two diversion dam fish barriers (Crockett and Pioneer-Providence Diversions). The First Dam Alternative maintains instream habitat in Fair Condition between First Dam and Crockett Diversion even with lower flows. The reduced flows will reduce water depths by approximately 7 inches for 1 river mile during extremely dry years. Currently, sluicing at First Dam releases tons of high sediment oxygen demand (SOD) silt periodically that can cover the streambed and significantly impact instream habitat and water quality, until it gets washed downstream to Cutler Reservoir. Dredging and removing the silt out of First Dam mechanically instead of sluicing it downstream, as is proposed under the First Dam Alternative, would improve instream habitat, water quality, and

improve conditions for aquatic species in all three reaches, but especially the upper reach immediately below First Dam. Below Crockett Diversion, the First Dam Alternative increases instream habitat from Fair Condition to Good Condition for 14 river miles.

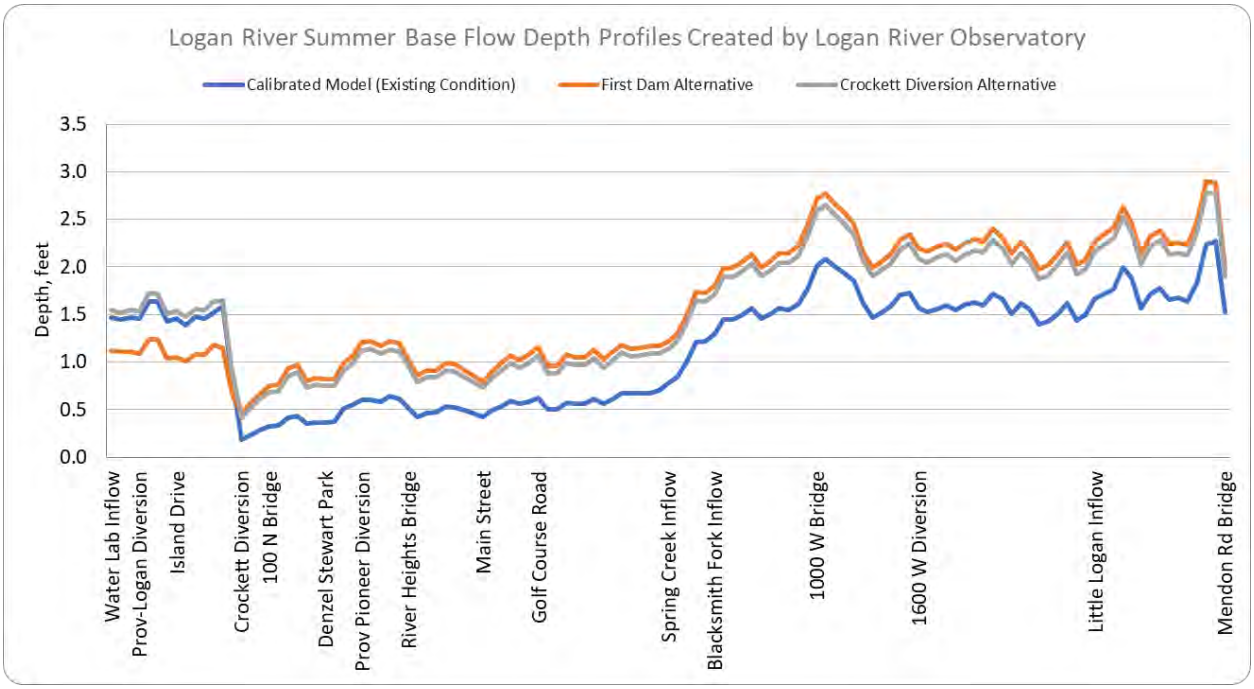


Figure 2. Graph of Water Depths for Existing Conditions and Alternatives. Calibrated Model for low water year (2022), (Graph data provided by Logan River Observatory).

Attachments

Attachment 1. Logan River CAP Evaluation Worksheets for Logan River Watershed Plan-EIS March 2025

Attachment 2. Logan River CAP Summary Report May 2016

Attachment 3. Logan River CAP Monitoring Protocol June 2020

Key Attribute	Indicator	Methods of Assessment and Available Data	Reach	2016 Rating	Existing Condition Ratings for EIS	First Dam Alternative	Crockett Diversion Alternative	Certainty of Effects	Recommendations
Flow Regime	Spring Peak Flow	USGS Gauging Station at First Dam (inflow to upper reach) and Logan River Observatory gauges operated by Utah State University Water Research Lab streamflow data available for each reach.	First Dam to Crockett	Good (minimally altered peak flow hydrograph)	Good (minimally altered peak flow hydrograph)	Good (the alternatives would not affect spring peak flows for any reach)	Good (the alternatives would not affect spring peak flows for any reach)	High certainty for both alternatives because Logan River has natural peak flows and the project does not involve upstream watershed storage nor any changes to spring runoff peak flows.	It would be beneficial for the USU Logan River Observatory to continue monitoring peak flows in the Logan River at the existing montoring locations to determine trends.
			Crockett to 100 E	Good					
			Middle	Good					
			Lower	Good					
Flow Regime	Summer Base Flow	Summer base flows are critical for maintaining good water quality and a functional aquatic ecosystem. The Logan River Observatory has measured flow at numerous locations from First Dam to Cutler Reservoir during summer base flows to model anticipated water quality effects of the additional instream flows associated with the two action alternatives. The 2022 water-year modeled for TM011 was an extreme drought and represents the worse case scenario low flow conditions. Under the First Dam Alternative, non-consumptive water rights owned by USU for the Water Lab adds 10-20 cfs for all reaches (15 river miles). Under the Crockett Diversion Alternative, the additional non-consumptive water from USU will be diverted at Crockett Diversion, only improving flows for 1 mile. An additional 6-10 cfs will be added to the upper reach above Crockett Diversion to provide flow for the Little Logan River under either action alternative.	First Dam to Crockett	Very good	Very good (61 cfs)	Good (25+10+6=41 cfs)	Very Good (60+10+6=76 cfs)	HIgh certainty. The Logan River Observatory modeled existing conditions and action alternatives based on extreme drought conditions experienced in 2022 (TM011), which were approximately 10 cfs lower than the 25% exceedence flow for low water years shown in TM002. Summer base flows may dip towards the bottom range of Good in the driest water years, but summer base flows raise toward the higher end of the Good range during average and wet water years, with either action alternative. The additional 10-20 cfs from USU Water Lab keeps the First Dam Alternative well within the Good range even during the driest years.	It would be beneficial for the USU Logan River Observatory to continue monitoring flows, water temperature, and dissolved oxygen in the Logan River at the existing monitoring locations to validate anticipated summer base flow increases and quantify water quality improvements (less water quality violations) with the additional summer base flows. It would also be beneficial to quantify changes in wetted area and habitat connectivity by reach with the additional summer base flows.
			Crockett to 100 E	Poor	Poor (9 cfs)	Good (31+10=41 cfs)	Fair (25 cfs) Good most of the time but can drop to Fair during dry water years.		
			Middle	Poor	Fair (14 cfs) Probably should be Poor rating given that over 27% of the total flow consists of very warm irrigation return flows upstream of 100 East.	Good (33+10=43 cfs)	Fair (27 cfs) Good most of the time but can drop to Fair during dry water years.		
			Lower	Poor	Poor (27 cfs upstream of Trapper Park, 0 cfs below) All flow is diverted above Trapper Park totally disconnecting aquatic habitats during low water years.	Good (44+10=54 cfs)	Good (40 cfs)		
Hydrology	Flood Conveyance Through Reach	Review of existing conditions and potential effects to flood conveyance within the Logan River floodplain.	First Dam to Crockett	Fair	Fair	Fair (reduced base flows could promote vegetation encroachment and reduce flood conveyance)	No change.	Moderate Certainty. Floodplain are extremely dynamic and can be unpredictable during floods. Currently, large woody debris (LWD) is very high from the aging crack willow forest on the floodplain of Logan River within the middle and lower reaches. Super-elevated quantities of LWD in the Logan River is a relatively recent phenomenon. Many of the invasive crack willow came in following the floods in the 1950s and 1980s, and are now dying and creating at least 7 times more LWD annually clogging the floodway, than a natural cottonwood dominated floodplain. Some of the most hazardous LWD accumulations have been reduced in recent years, with plans in progress to continue improving flood conveyance and floodplain functions as funding and property access allows. It's important to note that LWD falls in the river unpredictably, and occasionally gets caught under bridges during floods, which can dam the river temporarilly, possibly increasing water levels upstream and/or downstream of the log jam well above designated 100-year flood elevations, until it's removed.	Continue updating floodplain surveys and hydraulic modeling as needed, and continue removing hazardous crack willow LWD accumulations from the floodplain, and transitioning the dominant riparian vegetation in manageable patches (5 acres or less per year) from invasive crack willow back to native willows shrubs and cottonwood trees similar to the Rendezvous Park Restoration project, recognising the need to maintain as much river shading as possible.
			Crockett to 100 E	Fair	Fair	Good (lowering the elevation of the Crocket Diversion crest and increasing the land elevation slightly at the empty lot on Fox Farm Road above the 100-Year flood elevation will improve flood conveyance)	Good (lowering the elevation of the Crocket Diversion crest and increasing the land elevation slightly at the empty lot on Fox Farm Road above the 100-Year flood elevation will improve flood conveyance)		
			Middle	Fair (flood conveyance partially impacted by sand/gravel deposition and woody debris accumulation on a fairly infrequent >25-yr flood event)	Good (flood conveyance partially impacted by sand/gravel deposition and woody debris accumulation during >50-yr flood events) Flood conveyance improvements have been made between 100 East and Main Street and between Golf Cart Bridge and 1000 West.	Good (increased base flows could reduce vegetation encrouchment in channel and improve flood conveyance) Floodplain conveyance was improved from 100 East to Main Street and from Golf Cart Bridge to 1000 West from recent restoration and maintenance projects.	Good (increased base flows could reduce vegetation encrouchment in channel and improve flood conveyance) Floodplain conveyance was improved from 100 East to Main Street and from Golf Cart Bridge to 1000 West from recent restoration and maintenance projects.		
			Lower	Fair	Fair	Fair (increased base flows could reduce vegetation encroachment in channel and improve flood conveyance)	Fair (increased base flows could reduce vegetation encroachment in channel and improve flood conveyance)		
Hydrology	Floodplain Function	Review of existing conditions and potential effects to floodplain functions of the Logan River.	First Dam to Crockett	Poor	Poor	Poor (reduced base flows would not affect floodplain functions)	No change.	Moderate Certainty. Same as above.	Same as above.
			Crockett to 100 E	Poor	Poor	Poor (increased base flows would not affect floodplain functions)	Poor (increased base flows would not affect floodplain functions)		
			Middle	Poor	Fair (Improvements made at restoration sites)	Fair (increased base flows would not affect floodplain functions)	Fair (increased base flows would not affect floodplain functions)		

			Lower	Poor	Fair (Improvements made)	Fair (increased base flows would not affect floodplain functions)	Fair (increased base flows would not affect floodplain functions)		
Hydrology	Instream Habitat	According to cross sections surveys during flow measurements and modeling provided by the Logan River Observatory, the additional instream flows associated with the two action alternatives increases water depths by approximately 5 to 8 inches, depending on reach and alternative for approximately 14 river miles below Crockett Diversion to the bottom of the lower reach. There is approximately 1 inch difference in water depths between alternatives. The additional instream flows increase the wetted perimeter and wetted area improving aquatic habitat, better connecting pools and other instream habitats that otherwise became isolated during extreme low flows when the river has been traditionally dry dammed just upstream of Trapper Park during dry	First Dam to Crockett	Fair (Crockett Diversion barrier and First Dam sluicing impacting instream habitat)	Fair (Crockett Diversion barrier and First Dam sluicing impacting instream habitat)	Fair (improving fish passage at Crockett Diversion and reducing sediment impacts from First Dam sluicing improves conditions, but reducing water depths by 5 inches degrades conditions)	Fair (Crockett Diversion barrier and First Dam sluicing impacting instream habitat)	High Certainty. Increases in water depths, wetted perimeter and wetted area combined with diversion dam removals will certainly improve instream habitat and habitat connectivity, especially in the lower reach where the river is completely dewatered at and below Trapper Park in dry and average years. Sluicing at First Dam releases tons of high sediment oxygen demand (SOD) silt periodically that can cover the streambed and significantly impact instream habitat and water quality, until it gets washed downstream to Cutler Reservoir. Dredging the silt out of First Dam instead of sluicing would likely improve instream habitat, water quality, and provide better conditions for aquatic species in all three reaches associated with the First Dam Alternative.	Reduce the need to sluice at First Dam by dredging and removing the silt above the impoundement and not releasing it downstream would improve instream habitat and water quality compared to the current practice of sluicing.
			Crockett to 100 E	Fair	Fair	Good (potentially remove Providence Pioneer Diversion structure and increase water depths between 6-7 inches)	Good (potentially remove Providence-Pioneer Diversion structure and increase water depths between 5-6 inches)		
			Middle	Fair	Fair	Good (increase water depths between 6-7 inches)	Good (increase water depths between 5-6 inches)		
			Lower	Fair	Fair	Good (increase water depths between 7-8 inches)	Good (increase water depths between 6-7 inches)		
Water Quality	State Water Quality Standards for All UDEQ Beneficial Uses	Flow, temperature, and dissolved oxygen concentration relationships and modeling results provided by the Logan River Observatory for each reach.	First Dam to Crockett	Good (standards exceeded <10% of the time, however this reach is impacted by First Dam sluicing)	Good (standards exceeded <10% of the time, however this reach is impacted by First Dam sluicing	Good (41 cfs maintains water temperatures <20 degree C and First Dam sluicing impacts reduced)	Good (76 cfs maintains water temperatures <20 degree C	High Certainty. The Logan River Observatory has developed excellent flow/temperature and flow/dissolved oxygen relationships at numerous locations from First Dam to Cutler Reservoir during summer base flows. This data and model provides a relatively high degree of certainty for existing conditions and probable water quality effects of the alternatives.	It would be beneficial for the USU Logan River Observatory to continue monitoring flows, water temperature, and dissolved oxygen in the Logan River at the existing monitoring locations to validate anticipated flow increases and quantify water quality improvements in terms of percent of time State Standards are exceeded.
			Crockett to 100 E	Good (most of the time)	Fair (standards exceeded >10% of the time in 2021 and 2022)	Good (41 cfs maintains water temperatures <20 degree C and First Dam sluicing impacts reduced)	Good (25 cfs maintains water temperatures <20 degree C)		
			Middle	Good (most of the time)	Fair (standards exceeded >10% of the time in 2021 and 2022)	Good (43 cfs maintains water temperatures <20 degree C and First Dam sluicing impacts reduced)	Good (27 cfs maintains water temperatures <20 degree C)		
			Lower	Fair (standards exceeded 10% - 50% of the time, water quality impacts from cattle and polluted runoff)	Poor (low summer base flows causes water temperatures to >20 degrees C often, plus chronic water quality impacts from cattle and polluted runoff)	Good (54 cfs maintains water temperatures <20 degree C. Improved base flows maintain temperature and dissolved oxygen standards, but cronic water quality impacts from cattle operations and polluted runoff from the old landfill are anticipated to continue)	Good (40 cfs maintains water temperatures <20 degree C. Improved base flows maintain temperature and dissolved oxygen standards, but cronic water quality impacts from cattle operations and polluted runoff from the old landfill are anticipated to continue)		
Aquatic Biology	Trout Density & Size	Literature review of all available fisheries data for applicable reaches of the Logan River and professional judgement.	First Dam to Crockett	Poor (density < 500/mile)	Good (density 1,000 - 1,499)	Fair (density 500 - 999, reduction of wetted area/perimeter)	Good, no change.	Moderate Certainty. Improvement from poor to good will be somewhat uncertain since routine and repeated fish monitoring is absent in this portion of the Logan River system. However, removing fish passage barriers at Crockett and Providence-Pioneer Diversions would improve fish migration and aquatic biology.	Standardized and routine fisheries surveys at consistent, standardized, long-term monitoring locations before and after project implementation to validate improvements from instream flows, track system health, and provide feedback to management of the fishery on a routine basis. Monitoring is recommended to repeat every 2-3 years, using consistent methods and locations to track trends in fish populations.
			Crockett to 100 E	Poor	Poor	Good (increased wetted area/perimeter, contributing toward improved trout density and size)	Good (increased wetted area/perimeter, contributing toward improved trout density and size)		
			Middle	Poor	Poor	Good (increased wetted area/perimeter, contributing toward improved trout density and size)	Good (increased wetted area/perimeter, contributing toward improved trout density and size)		
			Lower	Poor	Poor	Good (increased wetted area/perimeter, contributing toward improved trout density and size)	Good (increased wetted area/perimeter, contributing toward improved trout density and size)		
Aquatic Biology	Benthic Invertebrates Observed/ Expected (UTDEQ Predictive Model from USU Buglab)	USU Buglab data from 2021 and anectotal observations.	First Dam to Crockett	Fair (70 -75% of expected taxa)	Good (76 - 85% expected taxa with new data)	Fair (reduced wetted area/perimeter negatively impacts available habitat, however reduced sluicing improves habitat conditions)	Good, no change.	Moderate Certainty. Some macroinvertebrate data is available from 2021 and there are anecdotal observations of macroinvertebrates at restoration projects in upper and middle reaches indicating good benthic conditions.	Standardized, additional, and consistent monitoring in all reaches is recommended to validate macroinvertebrate conditions before and after project implementation, and trends with increased base flows. This could be conducted similarly to, and simultaneous with, the standardized fish monitoring recommendations, outlined above.
			Crockett to 100 E	Fair	Fair	Good (increased wetted area/perimeter and reduced sluicing contributes toward improved conditions for macroinvertebrates)	Good (increased wetted area/perimeter contributes toward improved conditions for macroinvertebrates)		
			Middle	Fair	Very good (>85% of expected taxa)	Very good (increased wetted area/perimeter and reduced sluicing contributes toward improved conditions for macroinvertebrates)	Very good (increased wetted area/perimeter contributes toward improved conditions for macroinvertebrates)		
			Lower	Poor (<70% of expected taxa)	Poor	Fair (increased wetted area/perimeter and decreased warm irrigation returns, contributing toward improved conditions for macroinvertebrates)	Fair (increased wetted area/perimeter and decreased warm irrigation returns, contributing toward improved conditions for macroinvertebrates)		

Riparian Ecology	Riparian Vegetation Condition	General observations and review of river photo points showing dominant vegetation by reaches	First Dam to Crockett	Poor (>66% departure from natural)	Poor (mostly developed and landscaped with some native species)	Poor, no change.	Poor, no change.	Moderate Certainty. Increasing base flows to a more natural condition increases the wetted perimeter, reduces depth to groundwater on the floodplain, improves conditions for cottonwood recruitment, and is reasonably expected to improve riparian vegetation conditions. The potential area of improved condition and/or expansion of the native riparian plant community must be available for vegetation and not farmed, developed or allowed to become dominated by invasive species such as crack willow.	Develop a riparian vegetation condition baseline map and monitor change every five years to validate anticipated improvements. Continue removing hazardous LWD accumulations from the floodplain and transitioning the dominant riparian vegetation from crack willow back to the native willows and cottonwoods. Establishing some limited riparian vegetation monitoring along with dry season hydrology monitoring in the same areas would allow for documentation of predicted effects. Preserving and restoring additional areas of floodplain adjacent to the river would allow for improved condition of riparian habitat in the future and would also prevent loss due to development and floodplain filling and conversion.
			Crockett to 100 E	Poor	Poor (mostly developed and landscaped with some native vegetation at Denzil Stewart Nature Park)	Poor (increased wetted perimeter during base flows provides improved conditions for native riparian vegetation recruitment, however currently dominated with non-native species)	Poor (increased wetted perimeter during base flows provides improved conditions for native riparian vegetation recruitment, however currently dominated with non-native species)		
			Middle	Poor	Fair (33-66% departure from natural, native riparian vegetation restoration at 100 East to Main St., Rendezvous, and UDOT mitigation projects)	Good (10-32% departure from natural with increased flow to suport restored native vegetation communities) Increased wetted perimeter during base flows provides improved conditions for native riparian vegetation recruitment and	Good (10-32% departure from natural with increased flow to suport restored native vegetation communities) Increased wetted perimeter during base flows provides improved conditions for native riparian vegetation recruitment and		
			Lower	Poor	Poor	Poor (increased wetted perimeter during base flows provides improved conditions for native riparian vegetation recruitment, however currently dominated with invasive Crack Willow)	Poor (increased wetted perimeter during base flows provides improved conditions for native riparian vegetation recruitment, however currently dominated with invasive Crack Willow)		
Riparian Ecology	Cache County Noxious Weeds	General observations and review of river photo points showing dominant vegetation by reach.	First Dam to Crockett	Good (noxious weeds minimally present)	Good	Good	Good	Moderate Certainty. The increased base flows will provide a higher and more stable water table necessary for phreatophytic vegetation. This makes near river wetlands wetter and less succeseptable to phragmites invasion. Increased soil moisture availability during summer months would improve native seedling survivorship needed for natural recruitment, further shifting the competitive balance away from invasives. The majority of species on the Cache County Noxious Weeds List are wetland facultative to upland species that are less competitive under more hydric	Monitor and prevent the spread of noxious weeds by properly treating infested areas. Continued nonnative crack willow removal and native species revegetation efforts would benefit native vegetation competiveness.
			Crockett to 100 E	Good	Good	Good	Good		
			Middle	Poor (widespread invasion of noxious weeds)	Poor	Poor	Poor		
			Lower	Poor	Poor	Poor	Poor		
Terrestrial Biology	Bird Species Richness and Diversity	Avian surveys conducted by Frank Howe and others. Species richness and species diversity calculated using Shannon-Wiener Index. The overall rating is the lesser of the two ratings; for example, a site with good diversity but fair richness would be rated fair.	First Dam to Crockett	Fair (diversity 2.685-2.941, richness 26.5-37.4)	Fair	Fair (potential habitat deterioration with lower base flows)	Fair, no change.	Moderate Certainty.	Continue monitoring.
			Crockett to 100 E	Fair	Fair	Fair (potential habitat improvements with higher base flows)	Fair (potential habitat improvements with higher base flows)		
			Middle	Fair	Fair	Fair (potential habitat improvements with higher base flows)	Fair (potential habitat improvements with higher base flows)		
			Lower	Fair	Fair	Fair (potential habitat improvements with higher base flows)	Fair (potential habitat improvements with higher base flows)		
Terrestrial Biology	Amphibians and Reptiles	Review of existing conditions and proposed actions. Native species include two snakes (Wandering Gartersnake and Common Gartersnake), three frogs (Northern Leopard Frog, Boreal Chorus Frog, and Woodhouse's Toads), and one salamander (Tiger Salamander). All of these species except for the toad and the salamander occur in all reaches; the toad and the salamander likely occur only in the lower reach	First Dam to Crockett	Fair (native herps present with limited breeding locations)	Fair	Fair (potential habitat deterioration with lower base flows)	Fair, no change.	Moderate Certainty.	Monitor.
			Crockett to 100 E	Fair	Good (native herps present with multiple breeding locations with numerous frog ponds restored at Rendezvous Park and 600-1000 West)	Good (potential habitat improvements with higher base flows)	Good (potential habitat improvements with higher base flows)		
			Middle	Fair	Fair	Fair (potential habitat improvements with higher base flows)	Fair (potential habitat improvements with higher base flows)		
			Lower	Poor	Poor	Poor (potential improvements with higher base flows)	Poor (potential improvements with higher base flows)		
			First Dam to Crockett	Poor	Poor (there are more than 2 trail breaks along river giving it a poor rating, however the Canal Trail from First Dam to 600 East provides walking and biking opportunities away from traffic, but there are no connections back to the river away from traffic)	Poor	Poor		

Recreation	Trail Continuity	Review of Cache County GIS recreation map and proposed actions	Crockett to 100 E	Poor	Fair (new trail connections at 100 North to Center Street along river, and at Denzil Stewart Nature Park to 1000 East though Johnson Cove)	Fair (new trail connections along Little Logan River from River Hollow Park to Crockett Ave. and another new trail between 200 E and 600 E on the canal alignment). Trails along the river are not possible in this reach but new trails within canal easements are possible and provide walking and biking opportunities away from traffic.	Fair (new trail connections along Little Logan River from River Hollow Park to Crockett Ave. and another new trail between 200 E and 600 E on the canal alignment). Trails along the river are not possible in this reach but new trails within canal easements are possible and provide walking and biking opportunities away from traffic.	High Certainty.	Better connections between the existing Canal Trail, which currently terminates at 600 E, back to the river through the Island would significantly improve trail connections in the upper reach. The new bridge between Sumac Park/River Hollow Park and the trail to Crockett Ave along the Little Logan River will connect with the new.
			Middle	Poor	Good (new trails and trail connections between 100 East and Main Street and at Rendezvous Park)	Good (one remaining break in reach at Main Street but the a tunnel is currently being built under Main to provide that connection, no change associated with the alternative)	Good (one remaining break in reach at Main Street but the a tunnel is currently being built under Main to provide that connection, no change associated with the alternative)		
			Lower	Poor	Poor (plans for future bridge at Trapper Park and trails associated with the McAllister Conservation Easement on the north side of the Logan River will likely raise this indicator to Good when it's finished and open to the public)	Poor (plans for future trails, no change associated with the alternative)	Poor (plans for future trails, no change associated with the alternative)		
Recreation	Blue Recreation (tubing, kayaking, canoeing, paddle boarding)	Review of Blue Trail Plans and proposed actions	First Dam to Crockett	Poor (many unavaidable hazards)	Poor (hazards in channel are unavoidable, especially Crockett Diversion)	Fair (flows and water depths are reduced. Crockett Diversion, new crossing, and Little Logan River designed to facilitate passage by fish and floatable by kayak, other identified hazards remain in channel)	Fair (Crockett Diversion, new crossing, and Little Logan River designed to facilitate passage by fish and floatable by kayak, other identified hazards remain in channel)	Moderate Certainty. Additional flows will certainly improve Blue Recreation from Poor to Fair generally, but even the additional 25 cfs might not always be enough to create floatable conditions for the entire river. There is an opportunity to further improve Blue Recreation from Fair to Good in the Upper Reach if the redesign of the streambanks and floodplain near Crocket Diversion (Logan River and Little Logan River) includes better access to the river with fewer fences, and improved native riparian vegetation conditions.	Support Logan City Blue Trail Hazard Removal Projects and enhance river access at River Hollow Park and other launch/take-out locations.
			Crockett to 100 E	Poor (many unavaidable hazards)	Poor (shallow water depths and hazards in channel, espicially Providence-Pioneer Diversion)	Fair (Increased water depths for floating, Providence-Pioneer Diversion potentially removed but other identified hazards remain in channel)	Fair (Increased water depths for floating, Providence-Pioneer Diversion potentially removed but other identified hazards remain in channel)		
			Middle	Good (very few unavaidable hazards)	Good, when flows are adequate (new launch at 100 East, and hazard removal between 100 East-Main Street, Rendezvous, and 600-1000 West)	Good (increased water depths during low flow improves conditions for floating, plans for future hazard removal)	Good (increased water depths during low flow improves conditions for floating, plans for future hazard removal)		
			Lower	Poor (many unavoidable hazards)	Poor (plans for future hazard removal)	Fair (Increased water depths for floating, plans for future hazard removal)	Fair (Increased water depths for floating, plans for future hazard removal)		
Recreation	Legal Access To River Bed (wading)	Review of existing conditions and proposed actions. Public ownership of the Logan River bed allows for public wading and standing in channel not just floating through, though landowners may not be aware of ownership and river users may wander onto banks or trespass to exit river corridor.	First Dam to Crockett	Very Good (>75% of reach length)	Very Good	Very Good	Very Good	High Certainty. Reflects legal ability to access and utilize riverbed. It assumes riverbed is public, so surface access is in place for wading and floating.	
			Crockett to 100 E	Very Good	Very Good	Very Good	Very Good		
			Middle	Very Good	Very Good	Very Good	Very Good		
			Lower	Very Good	Very Good	Very Good	Very Good		
Recreation	Legal Access To River Bank (above high-water line)	Review of existing conditions and proposed actions. Reflects legal access to river bank using public property, not private property. Park and other public space expansions and trails along the river would increase the accessible river bank.	First Dam to Crockett	Poor (<25% of reach length)	Poor	Poor (Not affected/changed by the Alternative)	Poor (Not affected/changed by the Alternative)	High Certainty. This CAP indicator is intended to improve access to the river banks using public property, not private property. Trail and park expansions at River Hollow Park would increase the accessibility of river banks on Logan River and Little Logan.	Plant native trees and shrubs along the north side of new Little Logan trail, especialy between River Hollow Park and Crockett Ave, to buffer the trail from nearby homes and private property.
			Crockett to 100 E	Poor	Poor (River Hollow Park, 100 N-Center St, and Denzil Stewart Nature Park)	Fair (lowering Crockett Diversion, improving the bridge between Sumac and River Hollow Parks, and creating a trail along Little Logan River connecting River Hollow Park to Crockett Ave will improve legal access	Fair (redesign of Crockett Diversion, improving the bridge between Sumac and River Hollow Parks, and creating a trail along Little Logan River connecting River Hollow Park to Crockett Ave will improve legal access to river banks)		
			Middle	Poor	Good (50-75% of reach length, including 100 E-Main St, River Trail extension to Main St, Rendezvous Park trails, and 600-1000 W Projects)	Good, no change.	Good, no change.		
			Lower	Poor	Fair (25-50% of reach length with trail to Trapper Park)	Fair (future trail plans will improve legal access to river banks, no change associated with the alternative)	Fair (future trail plans will improve legal access to river banks, no change associated with the alternative)		
			First Dam to Crockett	Poor	Poor	Poor (no change associated with the alternative)	Poor (no change associated with the alternative)		

Recreation	Access facilities (pedestrian/ADA access points, parking, boat launches, desirable river features for kayaking, tubing, canoeing)	Review of existing conditions of public spaces and facilities along river and within river channel and proposed actions.	Crockett to 100 E	Poor	Poor	Fair (modification of Crockett Diversion and Little Logan River to be fish and kayak passable, and creating a trail along Little Logan connected to the new Crockett Avenue trail will improve access points and desirable river features for kayaking, tubing, canoeing adjacent to and connecting existing trails, parks, and facilities)	Fair (modification of Crockett Diversion and Little Logan River to be fish and kayak passable, and creating a trail along Little Logan connected to the new Crockett Avenue trail will improve access points and desirable river features for kayaking, tubing, canoeing adjacent to and connecting existing trails, parks, and facilities)	High Certainty. Access facilities are anticipated to be much improved over current conditions with the removal or redesign of Crockett Diversion and connections with Little Logan and future trail. The certainty is based on the anticipated ability of the project river and park designers to significantly improve accessibility and floatability of the rivers at this park.	Expand the width for public access along Little Logan from River Hollow Park to Crockett Ave to enhance stream and trail for fish and recreation.
			Middle	Fair (adequate on 1-2 facilities)	Good (adequate)	Good, no change.	Good, no change.		
			Lower	Poor	Poor	Poor (no change associated with the alternative)	Poor (no change associated with the alternative)		
Recreation	Fishing success/catch rate of Salmonids (Brown Trout and Whitefish)	Review of existing conditions and proposed actions. Coleman et al. observed a overall catch rate of 0.7 fish per hour (fph), 100 E to Trapper Park (good), but varying seasonally, ranging from 1.7 fph in June (very good) to 0.4 fph (fair) in September. They found a positive correlation between flow rates and angler catch rate and a negative correlation between water temperature and catch rate, but state that the correlations are not statistically significant (this may be due to small data set).	First Dam to Crockett	Fair	Fair	Fair (reduction of wetted area/perimeter)	Fair, no change.	Moderate Certainty. One creel survey was performed recently in the middle reach indicating high usage and good fishing success, but more data is needed in other reaches. It is reasonable to expect improvement in fishing success with improved base flows and the associated benefits to the aquatic ecosystem, including removal/improvement of fish passage barriers.	Additional creel surveys are recommended to validate improvements. Angling success and interest (frequency of fishing, number of persons fishing, and catch rates) could be observed over time indirectly through website data (iNaturalist) or by angler surveys.
			Crockett to 100 E	Fair	Fair	Good (increased wetted area/perimeter, contributing toward improved trout density and size, and improved fishing success rates)	Good (increased wetted area/perimeter, contributing toward improved trout density and size, and improved fishing success rates)		
			Middle	Fair	Good	Good (increased wetted area/perimeter, contributing toward improved trout density and size, and improved fishing success rates)	Good (increased wetted area/perimeter, contributing toward improved trout density and size, and improved fishing success rates)		
			Lower	Poor	Poor	Good (increased wetted area/perimeter, contributing toward improved trout density and size, and improved fishing success rates)	Good (increased wetted area/perimeter, contributing toward improved trout density and size, and improved fishing success rates)		
Recreation	Blue Ribbon Fishery (BRF) Status	Review of existing conditions and proposed actions. Numbers for each alternative show number of BRF criteria out of 5 and associated CAP rating. BRT Criteria: 1) sufficient water quality and quantity to sustain a viable fishery; 2) accessible to the public; 3) possess a natural capacity to produce and maintain a sustainable recreational fishery with management strategies that consistently produce fish of significant size and/or numbers to provide a quality angling experience; 4) water must be able to withstand angling pressure; and 5) selection may be based on a specific species.	First Dam to Crockett	Fair	Fair	2	2	Moderate Certainty. Logan River did not meet BRT criteria in 2016 for the following reasons: 1) Lack of public space for river access, 2) Lack of diverse habitat for desired species, 3) Low summer flows, and 4) Poor water quality. However, with improved public access to significant portions of the middle and lower reaches from new easements, parks and trails, and improved habitat diversity and public river access at completed river restoration areas, removal of fish barriers, and improvements to water quality, aquatic habitats, natural reproduction capacity, and ability to withstand angling pressures from the instream flows proposed herein, the middle and lower reaches may be able to achieve all 5 critera for Blue Ribbon Trout fishery designation with additional instream flows.	Continue making improvements to all five BRF criteria. The lack of public space for river access is being addressed by additional trails and boat launch sites being developed by Logan City. The low summer flows and poor water quality issues are being addressed in the Logan River Watershed Project by increasing summer base flows, which improves water quality.
			Crockett to 100 E	Fair	Fair	4	4		
			Middle	Good	Good	5	5		
			Lower	Poor	Poor	4	4		
Private Property	Adverse Impacts to Private Property from Public Recreation	Review of existing conditions and proposed actions. Would not expect direct effects from the proposed actions, but may see changes indirectly from additional uses of the river, especially at River Hollow and Sumac Parks.	First Dam to Crockett	Fair	Fair	Fair (additional public use of river, parks and trails could impact nearby residents with some additional noise and trash)	Fair (additional public use of river, parks and trails could impact nearby residents with some additional noise and trash)	Moderate Certainty.	With river access and trail improvements, consider design elements (fencing, signage, garbage disposal/collection sites) adjacent to private properties to avoid possible issues/future conflicts from increased public access and use of the river and parks.
			Crockett to 100 E	Fair	Fair	Fair (additional public use of river, parks and trails could impact nearby residents with some additional noise and trash)	Fair (additional public use of river, parks and trails could impact nearby residents with some additional noise and trash)		
			Middle	Fair	Fair	Fair (additional public use of river, parks and trails could impact nearby residents with some additional noise and trash)	Fair (additional public use of river, parks and trails could impact nearby residents with some additional noise and trash)		
			Lower	Fair	Fair	Fair (additional public use of river, parks and trails could impact nearby residents with some additional noise and trash)	Fair (additional public use of river, parks and trails could impact nearby residents with some additional noise and trash)		
Private Property	Adverse Impacts to Private Property from River Restoration Actions	Review of existing conditions and proposed actions.	First Dam to Crockett	Fair	Fair	Fair (construction noise and changes in river water elevations near Crockett Diversion would affect nearby residence and landscapes)	Fair (construction noise and changes in river water elevations near Crockett Diversion would affect nearby residence and landscapes)	Moderate Certainty. The project design and implementation will determine adverse impacts to private property from river restoration actions.	Involve nearby property owners and the public when developing design and implementation plans for Crockett Diversion improvements.
			Crockett to 100 E	Fair	Fair	Fair (construction noise and changes in river water elevations near Crockett and potentially Providence Pioneer Diversions would affect nearby residence and landscapes)	Fair (construction noise and changes in river water elevations near Crockett and potentially Providence Pioneer Diversions would affect nearby residence and landscapes)		
			Middle	Fair	Good	No change	No change		
			Lower	Fair	Fair	No change	No change		

Key Attribute	Indicator	Reach	Current Rating	Desired Rating	Trend	Poor	Fair	Good	Very Good	Notes:	Attribute Rationale	Objectives	Issues/Concerns/Threats	Strategic Actions
Flow Regime	Flow Regime (Spring Peak Flows)	Upper	Good	Good	Static	Heavily altered flow regime. Hydrograph does not resemble the natural/historical hydrograph	Moderately altered flow regime, non-natural hydrograph	Minimally altered flow regime	Natural flow regime, no alteration of hydrograph in terms of magnitude, duration, and timing of peak flows	There are several diversion dams currently on the Logan River which affect summertime base flows much more than spring runoff. These are run-of-the-river dams with no significant storage and therefore this indicator is rated as good under current conditions.	Natural flow regime is important for maintaining channel capacity and habitat conditions	Maintain natural/historical hydrograph for channel maintenance purposes	1) New water development project diverting or storing spring snowmelt 2) Climate change (transition from snow to rain dominate precipitation)	1) Evaluate water development projects which would significantly affect peak flows 2) Evaluate the cumulative effects of any future water development projects with respect to climate change
		Middle	Good	Good	Static									
		Lower	Good	Good	Static									
Flow Regime	Flow Regime (Summer Base Flow)	Upper	Very good above Crockett Diversion Poor below	Good	Static	Minimum flows throughout most of the reach marginally sufficient in terms of water temperature and dissolved oxygen to support cold water fishery, and mostly disconnects aquatic habitats (< 10 cfs)	Minimum flows throughout most of the reach insufficient in terms of water temperature and dissolved oxygen to support cold water fishery, and partially disconnects aquatic habitats (10-30 cfs)	Minimum flows throughout most of the reach sufficient in terms of water temperature and dissolved oxygen to support cold water fishery, and mostly connects aquatic habitats (30-60 cfs)	Minimum flows near natural throughout the entire reach sufficient in terms of water temperature and dissolved oxygen to fully support cold water fishery, and fully connects aquatic habitats (>60 cfs)	Upstream and within reach water diversions significantly reduce summer base flows. The iUTAH gage at the Water Lab indicates a base flow of approximately 90 cfs. Within reach diversions reduce base flows within the lower end of the reach (below Crockett and Providence Diversions) late July through end of September to approximately 15 cfs, with times of reduced flows to <3 cfs as indicated at the iUTAH gage at Main Street. Base flows outside of the irrigation season (October-March) are approximately 90 cfs at the Main Street gage.	Summer base flows are critical for maintaining good water quality and a functional aquatic ecosystem	1) Decrease summertime water temperatures lethal to cold water species 2) Increase dissolved oxygen concentrations 3) Connect aquatic habitats throughout reach	Low summer flows	1) Help secure and manage instream flows recognizing existing water rights 2) Participate with governmental and non-governmental organizations that would find and manage water for instream flows 3) Evaluate the instream flow initiatives and potentially support the formation of a water conservancy district
		Middle	Poor	Good	Static									
		Lower	Poor	Good	Static									
Hydrology	Flood Conveyance Through Reach	Upper	Fair	Good	Static	Flood conveyance through reach significantly impacted by sand/gravel deposition and woody debris accumulation on a relatively frequent runoff event (<10-yr flood event)	Flood conveyance through reach partially impacted by sand/gravel deposition and woody debris accumulation on a fairly infrequent runoff event (>25-yr flood event)	Flood conveyance through reach partially impacted by sand/gravel deposition and woody debris accumulation only during a rare runoff event (>50-yr flood event)	Flood conveyance through reach not impacted by sand/gravel deposition and woody debris accumulation except during extremely rare runoff event (>100-yr flood event)	Upper Reach: Sand/gravel is effectively transported through this steep and confined upper reach with limited locations of bedload deposition (i.e., bar development). Sand bagging was necessary in the upper reach during the last 25-yr runoff event in 2011. Most woody debris has been cleared from the channel in the upper reach but the potential for large trees to fall into the channel and block flow is a concern.	Flooding risk to private and public property is assessed using this indicator	Reduce frequency of flooding events affecting private property	Upper Reach: 1) Encroachment of floodway by development and channel alterations 2) Encroachment onto public property 3) Lack of connection with floodplains 4) Lack of space for channel migration when accumulations of sand/gravel occur 5) Backwater and flooding impacts caused by Crockett Diversion 6) Materials used for bank stabilization (I.e. concrete, boulders, etc.) fail and accumulate in channel	Use an adaptive approach to improve flood conveyance through a combination of the following actions: 1) Determine existing sand, gravel, and woody debris transport and/or accumulation rates 2) Provide space for sand/gravel accumulations within the active floodplain such that channel capacity is maintained through natural bar development/meander migration processes. Methods for providing space include removal of floodplain encroachment and levees as well as through purchasing floodway easements or land acquisitions 3) Remove channel constrictions and over-accumulations of downed woody debris within floodplain 4) Design pressure relief points for sediment accumulation 5) Inform public of necessity of obtaining a state stream alteration permit before taking actions 6) Conduct municipal or county review of state stream alteration applications (Logan City Engineer to coordinate with DWQ Watershed Coordinator and DWR Habitat Manager to request that stream alteration permit applications be forwarded to local governments for comments related to goals and objectives from the CAP)
		Middle	Fair	Good	Static					Middle Reach: Current condition is Good from 100 East to Golf Course Road and Poor from Golf Course Road to 1000 West. Evidence of historic dredging indicates sand and gravel deposition has occurred historically in the middle reach. Recent dredging following the 2011 (25-yr event) shows that sand and gravel accumulation continues to impact flood conveyance. Also, excessive woody debris accumulation of crack willow branches (dams) including large fallen trees spanning the channel significantly impact flood conveyance throughout the lower portions of the middle reach.			Middle Reach: 1) Encroachment of floodway by development and channel alterations 2) Encroachment onto public property 3) Lack of connection with floodplains 4) Lack of space for channel migration when accumulations of sand/gravel occur 5) Accumulation of sand/gravel and woody debris 6) Materials used for bank stabilization (I.e. concrete, boulders, etc.) fail and accumulate in channel	
		Lower	Fair	Good	Static					Lower Reach: Evidence of historic dredging indicates sand and gravel deposition has occurred historically in upper portion of the lower reach. Also, excessive woody debris accumulation of crack willow branches (dams) including large fallen trees spanning the channel significantly impact flood conveyance throughout the lower reach.			Lower Reach: 1) Accumulation of sand/gravel and woody debris 2) Materials used for bank stabilization (I.e. concrete, old cars, etc.) fail and accumulate in channel 3) Lack of space for channel migration when accumulations of sand/gravel occur	
Hydrology	Floodplain Function	Upper	Poor	Fair	Static	Floodplain functions severely limited within reach with widespread portions of floodplain non-existent on one or both sides of channel. Floodplain is highly manipulated and/or disconnected from channel due to anthropogenic factors such as channelization, bank manipulation, filling and/or levee development.	Floodplain functions partially limited within reach with portions of floodplain impaired on one or both sides of channel. Floodplain is partially manipulated and/or disconnected from channel due to anthropogenic factors such as channelization, bank manipulation, filling and/or levee development.	Floodplain mostly functioning within natural variability of the current setting.	Floodplain fully functioning within natural variability of the current setting.	Floodplain functions severely limited in upper portions of middle reach due to channelization, bank manipulation, fill, structures and levee development. Due to existing development constraints, "fair" is likely the best condition that can be achieved in the upper reach and in the middle reach from 100 East to Golf Course Road. Below Golf Course Road, improvement to "good" condition is a realistic objective.	Functioning floodplains provide a variety of services including flood control, water quality/filtration, and wildlife habitat	Improve floodplain function	Upper Reach: 1) Encroachment of floodway by development and channel alterations 2) Channelization and unnatural bank stabilization practices	Use an adaptive approach to improve floodplain function through a combination of the following actions: 1) Provide stream channel and floodplain guidance (best management practices) for property owners and municipalities 2) Support public riparian planting and bank treatment workshop 3) Remove/pull back fill and levees that disconnect the channel from the floodplain wherever possible 4) Restore banks wherever possible that are lined with unnatural materials (concrete rubble, cars, walls, etc.) 5) Increase public awareness and enforcement of Logan City floodplain and riparian vegetation ordinances 6) Enable floodplain function through ordinance, easements, or acquisition
		Middle	Poor	Fair	Static								Middle Reach: 1) Encroachment of floodway by development and channel alterations 2) Channelization and unnatural bank stabilization practices 3) Lack of connection with floodplains	
		Lower	Poor	Good	Static								Lower Reach: 1) Encroachment of floodway by development and channel alterations 2) Channelization and unnatural bank stabilization practices 3) Lack of connection with floodplains	
Hydrology	Instream Habitat	Upper	Fair	Good	Static	>66% departure from natural	34-66% departure from natural	10-33% departure from natural	<10% departure from natural	This indicator includes hydraulic complexity and habitat diversity, including a natural sequence of pools and riffles, a variety of pool sizes and depths, and stable woody materials in the bed and banks.	Instream habitat is important aesthetically and critical for all aquatic species living in the river	Restore instream habitats in the Logan River	1) Channelization and unnatural bank stabilization practices 2) Low summer flows 3) Poor water quality 4) Fish migration barriers 5) Lack of local oversight of state stream alteration permits 6) Lack of Logan City floodplain ordinance enforcement	1) Provide stream channel guidance (best management practices) for property owners and municipalities 2) Promote "net-gain" habitat improvement philosophy into any future channel projects 3) Construct and maintain diverse instream habitat, including stable woody materials 4) Conduct municipal or county review of state stream alteration applications (Logan City Engineer to coordinate with DWQ Watershed Coordinator and DWR Habitat Manager to request that stream alteration permit applications be forwarded to local governments for comments related to goals and objectives from the CAP) 5) Educate citizens regarding best management practices within floodplain (for example, by distributing the Riparian Planting Guide and workshops)
		Middle	Fair	Good	Static									
		Lower	Fair	Good	Static									

Water Quality	State Water Quality Standards for All UDEQ Beneficial Uses	Upper	Good	Very Good	Static	Standards exceeded more than 50% of time	Standards exceeded 10% - 50% of time	Standards exceeded less than 10% of time	Standards rarely exceeded	Upper Reach: Logan River is not considered impaired by the UDWQ according to the 2014 303d list. UDWQ determines a waterbody is impaired when state water quality standards are exceeded more than 10% of samples over a 10-yr period. Water temperatures and dissolved oxygen concentrations are well within State 3A Standards at the Water Lab and Main St iUTAH gages.	Clean water is aesthetically pleasing and critical for all aquatic species living in the river	Maintain high water quality year round	1) Low summer flows 2) Poor water quality 3) Sediment releases from First Dam 4) Loss and fragmentation of native, multi-layered riparian vegetation	1) Help secure and manage instream flows recognizing existing water rights 2) Promote native vegetation planting program on all properties to transition vegetation towards native species 3) Oppose damaging sediment releases from First Dam maintenance operations
		Middle	Good	Very Good	Static					Middle Reach: Logan River is not considered impaired by the UDWQ according to the 2014 303d list. Water temperatures and dissolved oxygen concentrations are within State 3A Standards at the Main St iUTAH gage (above middle reach) but exceedances of both water temperatures >20 degrees C and <6mg/l of dissolved oxygen have occurred the past two years at the Mendon iUTAH gage (below middle reach).				
		Lower	Fair	Good	Static					Lower Reach: Logan River is not considered impaired by the UDWQ according to the 2014 303d list. Water temperatures >20 degrees C and dissolved oxygen concentrations <6mg/l have occurred the past two years at the Mendon iUTAH gage.				
Aquatic Biology	Trout Density & Size	Upper	Poor	Very Good	Static	Density < 500/mile Size <0.10	Density 500 - 999 Size 0.10 - 0.19	Density 1,000 - 1,499 Size 0.20 - 0.29	Density >1,500 Size > 0.30	Density is measured in fish > 4 inches per mile. Size structure is measured in Proportional Stock Density (PSD) which is the ratio of big fish (> 15 inches) to stock size fish (> 9 inches). The overall rating is the lesser of the two ratings; for example a site with fair density but poor size receives an overall rating of poor. Current ratings of poor condition for all three reaches are based on past size structure data and it is this metric that is going to predominantly determine the future rating. Native Fish Species: Improvements in instream habitat, water quality, and summertime flows would also benefit native fish species such as whitefish and sculpin (both common in lower Logan River, but with less population information than brown trout) and possibly cutthroat trout (absent to rare below First Dam).	Brown trout are the existing, dominant game fish in the river and the primary draw for anglers. Larger trout are important to high-quality fishing experiences to residents and visitors	Increase proportional stock density of salmonids	1) Lack of diverse habitat for desired species 2) Simplification of habitat by dredging 3) Poor water quality 4) Low summer flows 5) Sediment releases from First Dam	1) Construct and maintain diverse instream habitat, including stable woody materials 2) Ensure sufficient summer base flow for fish survival 3) Ensure water quality is sufficient for fish survival 4) Oppose damaging sediment releases from First Dam maintenance operations
		Middle	Poor	Very Good	Static									
		Lower	Poor	Very Good	Static									
Aquatic Biology	Benthic Invertebrates Observed/Expected (UTDEQ Predictive Model)	Upper	Very Good	Very Good	Static	Less than 70% of expected taxa	70 -75% of expected taxa	76 - 85% expected taxa	Greater than 85% of expected taxa	Condition based on composition of observed invertebrate species compared to expected invertebrate species within unaltered river conditions.	Diverse invertebrate species composition is indicative of a healthy riverine system	Increase diversity of benthic invertebrates	1) Lack of diverse habitat for desired species 2) Low summer flows 3) Poor water quality 4) Sediment releases from First Dam 5) Effects of First Dam on daily temperature variations (upper reach)	1) Construct and maintain diverse instream habitat, including stable woody materials 2) Ensure sufficient summer base flow for desired species survival 3) Oppose damaging sediment releases from First Dam maintenance operations 4) Work with State and academic experts to determine other strategic actions
		Middle	Fair	Very Good	Static									
		Lower	Poor	Good	Static									
Riparian Ecology	Riparian Vegetation Condition	Upper	Poor	Fair	Static	>66% departure from natural	33-66% departure from natural	10-32% departure from natural	<10% departure from natural	This indicator includes a combination of the percent of floodplain area that is riparian habitat, structure, and percent native vegetation.	Natural riparian vegetation provides a variety of important riverine functions	Move floodplain riparian vegetation toward a more natural condition	1) Channelization and unnatural bank stabilization practices 2) Loss and fragmentation of native, multi-layered riparian vegetation	1) Educate citizens regarding best management practices within floodplain (for example, by distributing the Riparian Planting Guide and workshops) 2) Promote native vegetation planting program on all properties to transition vegetation towards native species 3) Provide stream channel and floodplain guidance (best management practices) for property owners and municipalities 4) Increase public awareness and enforcement of Logan City floodplain and riparian vegetation ordinances 5) Control undesirable and non-native vegetation (beyond official noxious weeds list)
		Middle	Poor	Good	Static									
		Lower	Poor	Good	Static									
Riparian Ecology	Cache County Noxious Weeds	Upper	Good	Very Good	Static	Widespread invasion of noxious weeds	Noxious weeds common	Noxious weeds minimally present	No noxious weeds	Noxious weeds determined by State and County weed list.	Noxious weeds compete with native vegetation and reduce habitat for native animals	Reduce prevalence of weeds and prevent new infestations	1) Upstream and within watershed noxious weed seed sources 2) Lack of funding	1) Promote weed control within river corridor and watershed 2) Encourage native vegetation planting along river corridor 3) Education citizens regarding noxious weeds and treatment (distribute Riparian Planting Guide, workshops) 4) Provide environmental education along river trails
		Middle	Poor	Very Good	Static									
		Lower	Poor	Very Good	Static									
Terrestrial Biology	Bird Species Richness and Diversity	Upper	Fair	Good	Static	Diversity < 2.685 Richness < 26.5	Diversity 2.685-2.941 Richness 26.5-37.4	Diversity 2.942-3.197 Richness 37.5-48.3	Diversity >3.197 Richness >48.3	Species richness and species diversity calculated using Shannon-Wiener Index. The overall rating is the lesser of the two ratings; for example, a site with fair diversity but poor richness would be rated poor.	Birds are an important aesthetic component of the Logan River and indicator of ecosystem health. Birders contribute to local economies by feeding birds, buying equipment, and purchasing travel-related items.	Increase avian diversity	1) Loss and fragmentation of native, multi-layered riparian vegetation 2) Lack of invertebrate food source	1) Promote native vegetation planting program on all properties to transition vegetation towards native species 2) Construct and maintain diverse instream habitat, including stable woody materials 3) Conserve important nesting/foraging features of diverse riparian habitat (e.g. snags) 4) Develop diversity/richness monitoring strategy
		Middle	Fair	Very Good	Static									
		Lower	Fair	Very Good	Static									
Terrestrial Biology	Amphibians and Reptiles	Upper	Fair	Very Good	Static	No native amphibians and reptiles present; non-native amphibians established	Native amphibians and reptiles present with limited breeding locations; non-native amphibians established	Native amphibians and reptiles present with multiple breeding locations identified; non-native amphibians may be present but not well established	Native amphibians and reptiles present, multiple breeding locations identified and protected; non-native amphibians not present	Native species include two snakes (Wandering Gartersnake and Common Gartersnake), three frogs (Northern Leopard Frog, Boreal Chorus Frog, and Woodhouse's Toads), and one salamander (Tiger Salamander). All of these species except for the toad and the salamander occur in all three reaches; the toad and the salamander likely occur only in the lower reach	Amphibians and reptiles are an important aesthetic component of the Logan River and indicator of ecosystem health.	Maintain or increase native amphibian and reptile density	1) Destruction of hibernation sites 2) Erosion and sedimentation 3) Loss of riparian habitat to development and river channelization 4) Poor water quality 5) Predation by bullfrogs	1) Maintain or improve riparian habitat and wetlands 2) Encourage homeowners to create habitat, such as fishless ponds with native vegetation 3) Encourage homeowners to tolerate snakes on their property
		Middle	Fair	Very Good	Static									
		Lower	Poor	Fair	Static									
Recreation	Trail Continuity	Upper	Poor	Very Good	Static	More that two breaks within reach	Two breaks	One break	No breaks	This attribute is designed to capture trail continuity; breaks include, for example, at-grade road crossings without pedestrian crossings, signals. The CAP project is not promoting trail development through property of unwilling landowners. Therefore, trail continuity would be achieved by routes that connect existing and future parks, trails, and access points without necessarily paralleling the river throughout the entire river corridor. Possibly property	Even small breaks in trail systems can prevent widespread trail use and/or have potential for injury to trail users and to cause trespass	Expand trail system to connect existing and planned trails, parks, and river access locations	1) Lack of public space for river access 2) Lack of funding	1)Work with Logan Parks and Recreation Advisory Board 2) Identify gaps in existing trail system 3) Determine best opportunity to connect existing trail system 4) Enable trail connectivity through ordinance, easements, or acquisition 5) Construct new trail segments 6) Remove barriers to existing trails connectivity 7) Determine and provide a Main Street crossing (pedestrian crossing light, bridge
		Middle	Poor	Very Good	Static									

		Lower	Poor	Very Good	Static					throughout the entire river corridor. Possibly property could be acquired for river access or park development/expansion.				7) Determine and provide a Main Street crossing (pedestrian crossing light, bridge, underpass, etc.)
Recreation	Blue Recreation (tubing, kayaking, canoeing, paddle boarding)	Upper	Poor	Very Good	Static	Many unavoidable hazards within reach	Few unavoidable hazards within reach	Very few unavoidable hazards within reach	No unavoidable hazards within reach			Expand navigablility of Logan River by addressing hazards that exist on the bed, banks, and accross the river	1) Legal authority and accessibility to remove hazards 2) Lack of funding	1 incorporate eval of hazards into annual street dept. evaluation of river hazards…. (Lance to complete the thought)
		Middle	Good	Very Good	Static									
		Lower	Poor	Very Good	Static									
Recreation	Legal Access To River Bed (wading)	Upper	Very Good	Very Good	Static	<25% of reach length.	25-50% of reach length.	50-75% of reach length.	>75% of reach length.	Reflects legal ability to access and utilize riverbed. A park expansion would increase the accessible river bank through public property.	1) River access is important for public uses of river 2) Help prevent private property impacts such as trespass	Enable public river access at appropriate locations	1) Legal riverbed access may change with state law changes 2) Poor etiquette (noise, trash, trespass, etc.) 3) Future urban development and enclosure of riverway	1) Develop appropriate facilities (parking especially) to support public access 2) Acquire property or easements for access 3) Provide public education, such as legal access map and appropriate river behavior
		Middle	Very Good	Very Good	Static									
		Lower	Very Good	Very Good	Static									
Recreation	Legal Access To River Bank (above high-water line)	Upper	Poor	Fair	Static	<25% of reach length.	25-50% of reach length.	50-75% of reach length.	>75% of reach length.	Reflects legal access to river bank using public property, not private property. A park expansion would increase the accessible river bank.	1) River access is important for public uses of river 2) Help prevent private property impacts such as trespass	Enable public river access at appropriate locations	1) Lack of public space for river access 2) Poor etiquette (noise, trash, trespass, etc.) 3) Future urban development and enclosure of riverway	1) Work with city and county to build or improve facilities to enable public use of the river 2) Enable river access through ordinance, easements, or acquisition 3) Provide public education, such as legal access map and appropriate river etiquette
		Middle	Poor	Fair	Static									
		Lower	Poor	Fair	Static									
Recreation	Access facilities (pedestrian/ADA access points, parking, boat launches, desirable river features for kayaking, tubing, canoeing)	Upper	Poor	Good	Static	Adequate on no facility types.	Adequate on 1-2 facility types.	Adequate on 2-3 facility types.	Adequate on all 4 facility types.	This indicator reflects public facilities used to access river or support use. Determination of adequacy based on specific reach.	Logan River is a public amenity and should have appropriate facilities to enable access and use	Expand and maintain public spaces and facilities along river and within river channel	1) Lack of public space for river access 2) Landowner opposition to new public facilities 3) Potential for recreation user conflicts to arise as accessibility and use increases 4) Safety hazards to river users, including concrete and metal debris (addressed under the Blue Trails indicator)	1) Work with city and county to build or improve facilities to enable public use of river 2) Create appropriate access points and exits for kayaking and tubing. Identify these on signage and maps including information about rules and regulations, river ratings (whitewater classifications), etc. 3) In designing river restoration projects, incorporate water features that enhance boating access and experience, particularly for kayaking. 4) Maintain and improve the navigability of the river for kayaking and tubing, including access/exit locations, river features that enhance the boating experience (kayak waves), and that address safety concerns 5) Address private property concerns (see strategic actions for adverse impacts to private property from public recreation)
		Middle	Fair	Very Good	Static									
		Lower	Poor	Good	Static									
Recreation	Fishing success/catch rate of Salmonids (Brown Trout and Whitefish)	Upper	Fair	Very Good	Static	Catch rate les than or equal to 0.25 Salmonids/hour	Catch rate of 0.26 to 0.50 Salmonids/hour.	Catch rate of 0.51 to 0.75 Salmonids/hour.	Catch rate greater than or equal to 0.76 Salmonids/hour	From Paul Thompson, UDWR Northern Region Fisheries Manager: In general, we set statewide objectives for catch rates at Utah flowing waters to meet or exceed 0.5 fish/angler hour. We do not break it out further than that. For perspective, the latest creel surveys for the lower Provo River and middle Provo River indicated catch rates of 0.75 and 0.88 fish/angler/hour. The Provo is one of the top two destination waters in the state. The latest creel survey for the Weber River from the town of Uinta upstream to Lost Creek was 1.28 fish/angler/hour. The Weber is the 3rd most visited flowing water in Utah. So your break out of catch rates seem reasonable.	Fishing success/catch rates are important for the angler experience	Sufficiently high catch rates to satisfy anglers	1) Lack of diverse habitat for desired species 2) Low summer flows 3) Poor water quality	1) Construct and maintain diverse instream habitat, including stable woody materials 2) Ensure sufficient summer base flow for desired species survival 3) Ensure water quality is sufficient for fish survival 4) Oppose damaging sediment releases from First Dam maintenance operations
		Middle	Fair	Very Good	Static									
		Lower	Poor	Good	Static									
Recreation	Blue Ribbon Fishery (BRF) Status	Upper	Fair	Very Good	Static	The reach meets none of the five BRF criteria	The reach meets 1-2 BRF criteria.	The reach meets 3 - 4 BRF criteria.	The reach meets all five BRF criteria and is designated.	BRF criteria: 1) Water quality and quantity: a body of water, warm or cold, flowing or flat, will be considered for BRF status if it has sufficient water quality and quantity to sustain a viable fishery; 2) Water accessibility: the water must be accessible to the public; 3) Natural reproduction capacity: the body of water should possess a natural capacity to produce and maintain a sustainable recreational fishery. There must be management strategies that will consistently produce fish of significant size and/or numbers to provide a quality angling experience; 4) Angling pressure: the water must be able to withstand angling pressure; and 5) Specific species: selection may be based on a specific species.	High-quality fishing experiences are important to residents and visitors	Obtain BRF status	1) Lack of public space for river access 2) Lack of diverse habitat for desired species 3) Low summer flows 4) Poor water quality	1) Construct and maintain diverse instream habitat, including stable woody materials 2) Ensure sufficient summer base flow for desired species survival 3) Ensure water quality is sufficient for fish survival 4) Work with city and county to build or improve facilities to enable public use of the river 5) Enable river access through ordinance, easements, or acquisition
		Middle	Good	Very Good	Static									
		Lower	Poor	Good	Static									
Private Property	Adverse Impacts to Private Property from Public Recreation	Upper	Fair	Very Good	Static	Heavy littering and vegetation trampling. Fences damaged repeatedly. Gates frequently left open. Trespass on private property is common. Issues are not sufficiently addressed by local government.	Moderate littering and vegetation trampling. Fences occasionally damaged and/or gates left open. Trespass on private property noted. Issues are not addressed by local government in a timely manner.	Few problems with litter, vegetation damage, and fence damage infrequent. Gates rarely left open. Trespass infrequent. Issues are addressed by local government.	Littering uncommon and regularly cleaned-up. Vegetation damage and fence damage infrequent. Gates rarely left open. Trespass infrequent. Issues are promptly addressed by local government.	Upper Reach: In the CAP residents' survey (Nov. 2015), some upper reach residents complained about recreationist parking and problems with trespass. Thirty-six percent indicated some level of negative impact from public use of the river. Middle Reach: Increased trespass apparent between Main and Golf Course Rd (Fair). Golf Course Rd. to 600 West (Very Good); 600 W. to 1000 West increased trespass on bank right no change on bank left (Fair). Lower Reach: stakeholder meeting with agricultural community representatives (11/30/15) supported a current condition of Fair. Existing public access is limited and there is little or no public information about where the public can (and should not) access the river. Landowners see evidence of boating groups taking out at various locations and crossing from ground. Gates are occasionally	Acknowledging private property along river channel is a top priority	Avoid and mitigate public recreation impacts on private property	1) Lack of public space for river access 2) Poor etiquette (noise, trash, trespass, etc.)	1) Include facilities (i.e. designated access locations, parking, signage, fences, law enforcement) which reduce incidence of property trespass 2) Provide and maintain trash collection facilities and public education to reduce litter 3) Local government to work with landowners and state agencies to implement a coordinated walk-in access program 4) Provide public education, such as legal access map and appropriate river etiquette
		Middle	Fair	Very Good	Static									

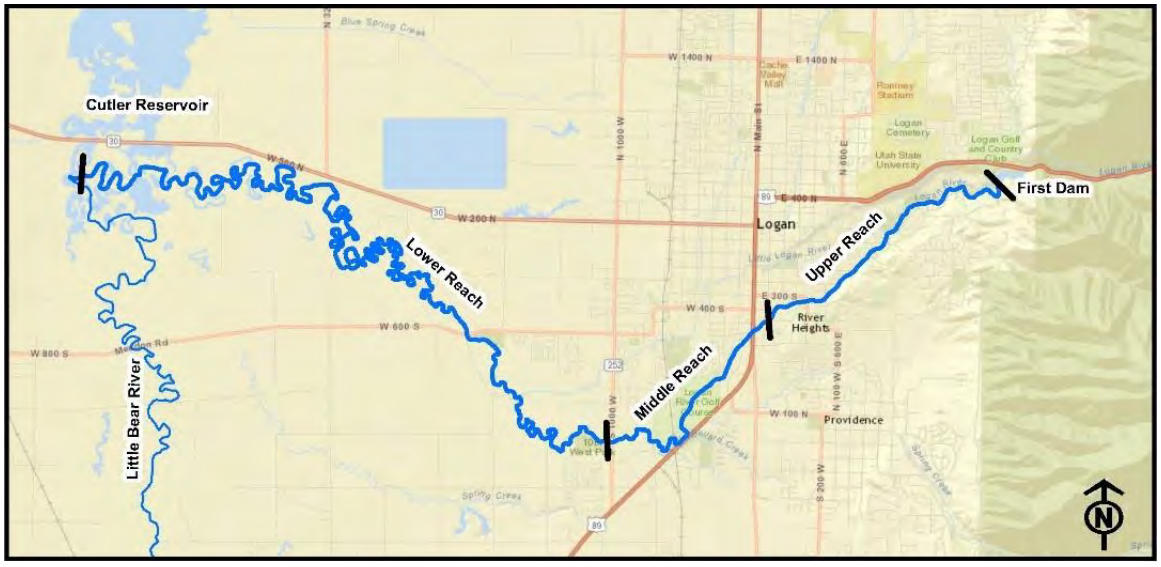
		Lower	Fair	Very Good	Static					locations and crossing farm ground. Gates are occasionally left open and/or fences damaged. Littering was noted to occur. Condition could quickly become poor if river access (debris clearing, trail extension) is improved in the absence of actions to better direct the public and address trespass issues.				
Private Property	Adverse Impacts to Private Property from River Restoration Actions	Upper	Fair	Very Good	Static	Changes to Logan River for hydrologic or biological improvement result in significant damages (flooding, erosion, reduced agricultural productivity, etc.)	Changes to Logan River for hydrologic or biological improvement result in minor damages (flooding, erosion, reduced agricultural productivity, etc.)	Changes to Logan River for hydrologic or biological improvement result in minor benefits to private property (reduced flooding or easement for floodzone, reduced bank erosion, sustained or improved agricultural productivity, etc.)	Changes to Logan River for hydrologic or biological improvement result in significant benefits to private property (reduced flooding or easement for floodzone, reduced bank erosion, sustained or improved agricultural productivity, etc.)	Anticipated effects to private property should be considered in design and discussed with property owners. Unanticipated effects should be monitored, discussed with landowners, and mitigated to the extent practicable. Landowners also need to be aware of how their actions, such as bank stabilization, may affect others downstream.	Changes to flood conveyance and the riparian corridor could have anticipated or unanticipated consequences for adjacent private properties	Avoid and mitigate impacts from CAP on private property	1) Unintended consequences from actions 2) Lack of funding	1) Facilitate early public involvement in river restoration projects 2) Implement well-designed river restoration projects based on the CAP 3) Conduct follow-up public involvement to evaluate project success, identify issues that warrant resolution, and improve future projects
		Middle	Fair	Very Good	Static									
		Lower	Fair	Good	Static									

LOGAN RIVER RESTORATION
Conservation Action Plan
May 2016

The Logan River, an integral part of the greater Bear River ecosystem, originates within the Bear River Mountains in the headwaters of Logan Canyon and terminates at its confluence with the Little Bear River in Cutler Reservoir. The river is an asset to residents of Logan City and Cache County and has historically supported many beneficial uses. The Logan River was an important resource for Native Americans and pioneers, and it remains valuable today. Cache Valley citizens are attracted to the river and enjoy the aesthetics, recreational values, and wildlife resources associated with this high-quality river, which supports fish, wildlife, and many plant species unique to riparian and wetland habitats. The Logan River also provides water for irrigation, municipal water supply, and hydroelectricity.

To protect the Logan River from degradation and the growing threats of floodplain development, a Conservation Action Plan (CAP) has been developed for the portions of the Logan River from First Dam (at the mouth of Logan Canyon) through Cache Valley to the confluence with the Little Bear River at Cutler Reservoir (Figure 1). The development of a short- and long-range vision for the river is needed to coordinate and prioritize conservation efforts and ensure a sustainable river system for future generations. Stakeholder groups representing residential, commercial, recreational, and agricultural interests have participated in the development of this CAP. The CAP is a dynamic set of objectives that can be revised as needed when new threats or conservation solutions are identified.

The Logan River CAP uses The Nature Conservancy's science-based planning framework (further described at https://www.conservationgateway.org/Files/Pages/action-planning-cap-handb.aspx) to create a system-wide assessment and plan for the river. The CAP's purpose is to address the most important conservation, protection, and restoration priorities for the Logan River.



Planning Process and Methods

The CAP approach was adapted for the Logan River to include recreational and public values as well as ecological indicators of river health. To that end, the Task Force used a broad range of river health indicators and public uses to develop the CAP. The CAP addresses property protection associated with flooding and various recreational activities. It incorporates traditional values such as irrigation, concerns associated with channel erosion and flooding, and ecological conservation. The CAP provides the foundation for prioritizing river restoration projects, as well as evaluation criteria for monitoring long-term success of the various implemented conservation practices.

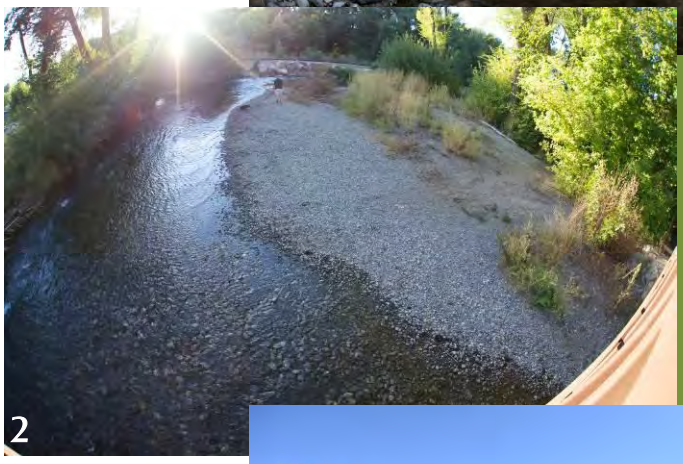
River Reaches

For planning purposes the Logan River was delineated into three reaches, as described below.

Upper Reach – First Dam to 100 East is dominated by residential development and associated land uses. The total length of the Upper Reach is 3.0 miles, and the reach is relatively high gradient (channel slope ranging from 1.00 to 0.75 percent), straight, and confined.


1

Middle Reach – 100 East to 1000 West is dominated by commercial and recreational development and associated land uses. The total length of the Middle Reach is 2.5 miles, the reach transitions from relatively high to moderately gradient (channel slope transitioning from 0.75 to 0.25 percent), and it becomes meandering and unconfined.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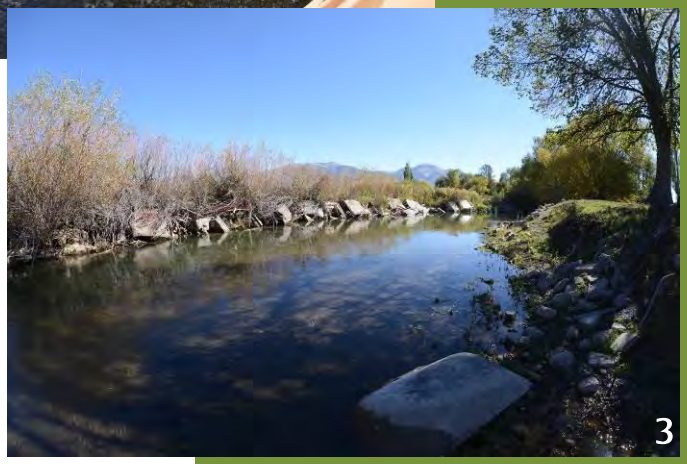
Sand and gravel sediments erode from the bed and banks in the Upper Reach and are transported during floods to the lower Middle Reach where they drop out of transport, creating large gravel bars and a meandering channel in this reach. Woody debris accumulation is very high in the channel, and consequently the potential for large branches to clog the river at bridges and other river constrictions is also very high in this reach. Much of the woody debris comes from crack willow, an invasive, nonnative tree that has overtaken the more desirable diverse native riparian vegetation that should exist here. Many native trees, shrubs, and grasses that protect streambanks cannot survive in the shaded understory of crack willow.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Lower Reach – 1000 West to the confluence with the Little Bear River in Cutler Reservoir is dominated by agricultural development and associated land uses. The total length of the Lower Reach is 14.5 miles, and it is relatively low-gradient (channel slope less than 0.25 percent), meandering, and unconfined.

Logan River Task Force Background

In 2014 a group of Utah State University professors, state and local government officials, and interest group representatives organized the Logan River Task Force (Task Force) to develop a method for improving areas along the Logan River.

The Task Force and Logan City are working with BIO WEST, a local environmental consulting firm, to develop and implement the CAP and design restoration concepts for the river. More Task Force information can be found on page 8.

Existing and Desired Condition Indicators

The CAP identifies existing and desired conditions for each indicator (e.g., water quality), identifies threats to the conditions, and provides strategic actions to overcome the threats. Many indicators and strategic actions apply to the entire river, but the CAP separates existing and desired conditions for specific reaches where it was appropriate to do so. Existing and desired conditions for each indicator are rated on the color-coded, four-point scale below.

Poor	Fair	Good	Very Good

Results

Table 1 summarizes example indicators, conditions as assessed by the Task Force, and recommended strategic actions. Attachment A provides more details about all of the CAP indicators, existing and desired conditions, and strategic actions for improving conditions.

Indicators currently considered to be in **poor** condition include summer base flows (low flows during the hot summer months), floodplain functions, trout density, and riparian vegetation.

Strategic Action Example

Summer base flows, for example, are critical for maintaining good water quality, healthy fish populations, and a functional aquatic ecosystem, as well as aesthetics and preventing vegetation encroachment into the streambed. Summer base flows are currently considered **very good** above Crockett Diversion but **poor** from Crockett Diversion to Cutler Reservoir. The following strategic actions have been identified to improve summer base flows from **poor** (less than 10 cubic feet per second) to good (greater than 30 cubic feet per second):

- Help secure and manage instream flows recognizing existing water rights.
- Participate with governmental and nongovernmental organizations that can find and manage water for instream flows.
- Evaluate instream flow initiatives and potentially support the formation of a water conservancy district.

Table 1. A summary list of Logan River CAP indicators, existing conditions, and examples of strategic actions.

INDICATOR	RATIONALE	EXAMPLES OF STRATEGIC ACTIONS TO ACHIEVE OR MAINTAIN DESIRED CONDITION	CURRENT CONDITION	DESIRED CONDITION
Spring Peak Flow	A natural flow regime is important for maintaining channel capacity and habitat conditions.	• Evaluate projects (dams) that might adversely alter flow patterns. • Evaluate cumulative effects of any future water-development projects with respect to climate change.	Good	Good
Summer Base Flow	Summer flows are critical for maintaining good water quality and a functional aquatic ecosystem.	• Help secure and manage instream flows while recognizing existing water rights. • Participate with governmental and nongovernmental organizations that can find and manage water for instream flows. • Evaluate the instream flow initiatives and potentially support the formation of a water conservancy district.	Poor	Good
Flood Conveyance	Maintain the river channel's ability to convey flood waters reduces the flood risk to private and public property.	• Widen the floodplain where feasible. • Reduce or eliminate backwater and flooding impacts caused by Crockett Diversion • Design pressure-relief points for sediment accumulation. • Identify and address over accumulation of debris.	Fair	Good
Floodplain Functions	Functioning floodplains provide a variety of services including flood control, water quality and filtration, and wildlife habitat.	• Remove/pull back levees and restore banks wherever possible. • Provide homeowners and agricultural operators with guidance (best management practices). • Improve compliance with state stream alteration permitting. • Improve compliance with existing city floodplain and riparian ordinances. • Consider ordinance additions, easements, and acquisition.	Poor	Good
Water Quality	Clean water is aesthetically pleasing and critical for all aquatic species living in the river.	• Secure and manage instream flows. • Promote native vegetation planting. • Prevent damaging sediment releases.	Good	Very Good
Trout Density and Size	High catch rates and large fish size are important for quality fishing experiences.	• Increase diversity of instream habitat. • Ensure that water quality and quantity are sufficient for fish and food base survival. • Obtain Blue Ribbon Fishery designation.	Poor	Very Good
Bird Species Richness and Diversity	Birds are an important aesthetic component of the Logan River and indicator of ecosystem health.	• Restore multilayered vegetation. • Improve instream habitat. • Conserve nesting/foraging features. • Initiate monitoring program.	Fair	Very Good
Riparian Vegetation	Natural riparian vegetation provides important riverine functions.	• Promote native vegetation planting. • Control noxious weeds.	Poor	Good
Frogs, Salamanders, and Snakes	Amphibians and reptiles are an important aesthetic component of the Logan River and an indicator of ecosystem health.	• Restore riparian habitat including wetlands. • Improve habitat (fishless ponds, native vegetation). • Monitor/prevent invasive species (bullfrogs).	Poor	Very Good
Recreation Access	The Logan River is a public amenity and should have facilities that enable appropriate access and use.	• Connect/expand trails and parks. • Easement/acquisition. • Designated public river access locations. • Address barriers to trail connectivity, such as Main Street.	Fair	Very Good
Private Property Recreation Impacts	Public impacts on private properties should be addressed and prevented.	• Designate river access locations. • Provide trash collection, signage. • Expand walk-in access program. • Provide access map and appropriate river etiquette information.	Fair	Very Good
Private Property River Restoration Impacts	Project-related changes to flood conveyance and the riparian corridor could have anticipated or unanticipated impacts on adjacent private properties.	• Facilitate early public involvement in river restoration projects. • Implement well-designed river restoration projects based on the CAP. • Conduct follow-up public involvement to evaluate project success, identify issues that warrant resolution, and improve future projects.	Fair	Very Good

Logan River Task Force Vision

Make the Logan River system a showcase of ecologically viable, socially beneficial river restoration.

Indicators currently considered to be in **poor** to **fair** condition include flood conveyance, bird diversity and abundance, recreational access, and private property impacts from recreation and restoration activities. Recent channel alterations conducted by Logan City and Cache County throughout the Logan River and Blacksmith Fork addressed various bed- and bank-erosion issues and had a net effect of improving flood conveyance from **poor** to **fair** at several locations in the Upper and Middle Reaches.

Issues, Concerns, and Threats Example

The following flood-conveyance issues, concerns, and threats are identified in the Logan River CAP for the Upper Reach:

- encroachment of the floodway by development and channel alterations,
- encroachment of public property by development and channel alterations,
- lack of connection between the river and its floodplains,
- lack of space for channel migration when accumulations of sand/gravel occur,
- backwater and flooding impacts caused by Crockett Diversion, and
- materials used for bank stabilization (e.g., concrete, boulders) fail and accumulate in channel.

Each threat identified in the CAP is of concern. For example, the combination of floodway encroachments, unregulated channel alterations, development encroachments onto public properties, and backwater and flooding impacts resulting from Crockett Diversion cause many homes and Riverside Elementary to be more susceptible to flooding. Addressing the issues and threats in this area will enhance public safety and result in better flood protection for up to 40 homes that are currently within the Federal Emergency Management Agency's 100-year floodplain designation in the vicinity of Crockett Diversion to the 100 North bridge. Many other opportunities exist to restore the Logan River's flood-conveyance capacities, as well as other indicators that are currently rated as **poor** or **fair**.

Some indicators are rated as good. Water quality, for example, is considered in good condition throughout the Upper and Middle Reaches, but it degrades into fair condition in the Lower Reach, especially in portions of the reach affected by Cutler Reservoir. Clean water is aesthetically pleasing and critical for all aquatic species living in the river, as well as those terrestrial species like birds and bats that forage on aquatic species. One objective of the Logan River CAP is to maintain high water quality year-round by reducing the threats posed by lower summer base flows, sediment releases from First Dam, and the loss and fragmentation of native, multilayered riparian vegetation.


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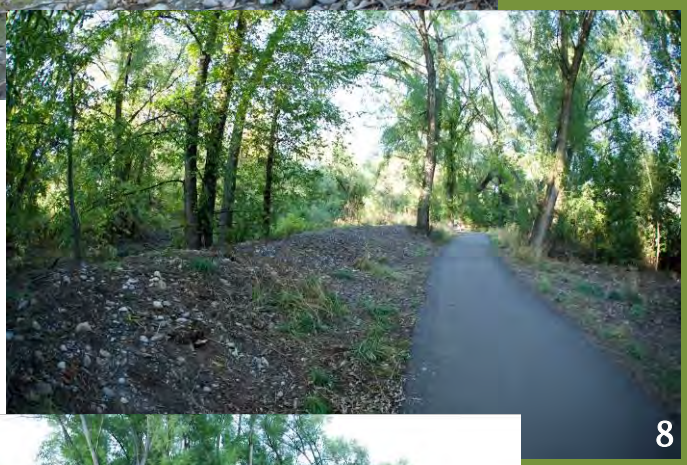
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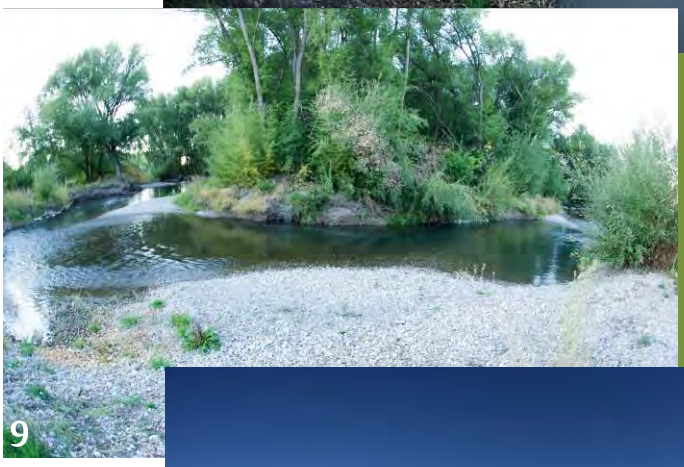
Improvements through Strategic Actions

The good news is that many of the indicators of river health and desired conditions are interrelated, so improvement in one area will help improve other areas. For example, riparian vegetation improvements will not only support more diverse bird species but also provide better water quality and fish habitat, as well as help prevent noxious weed invasions.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More good news is that actions can be taken by individual landowners, not just the City, to improve the Logan River. These incremental actions will make a big difference if they are conducted in a manner that minimizes downstream or cross-river effects and enhances instream and riparian habitats. For instance, Utah State University Forestry Extension's planting guide, *Taking Care of Streams and Rivers in Cache Valley*, provides a list of suggested plants—such as golden current, water birch, and redosier dogwood (to name a few) —that can help property owners protect streambanks and improve the riparian habitat on their lands.


10

The Task Force has helped Logan City obtain grants to be used for restoration work on the Logan River in 2016-2018 at Denzil Stewart Nature Park and Rendezvous Park. The Task Force and BIO-WEST want these projects to serve as a river restoration showcase that will inspire subsequent Logan River improvements.

Agriculture is an important land use along the Middle and Lower Reaches of the Logan River.

All Logan River reaches are used by boaters and anglers.

Great horned owls are among the bird species that inhabit the Logan River s riparian corridor.

Photo Information

Front page: Residential development impacting the banks, floodplain, and riparian area of the Upper Reach.

Photo 1. Eroding side hills and streambanks are common in the Upper Reach and a source of downstream sediment deposition.

Photo 2. Large deposits of sand and gravel transported from the Upper Reach impact flood conveyance in the Middle Reach.

Photo 3. Old cars and concrete scraps are common forms of failing bank-protection practices in the Lower Reach.

Photo 4. Native Bonneville cutthroat trout (image courtesy of the USDA Forest Service http://www.fs.usda.gov/detail/htnf/learning/nature-science/?cid=fsm9_026891).

Photo 5. Old, disposed automobiles ("Detroit riprap") from several decades ago present a major safety hazard to people using the river in the Lower Reach.

Photo 6. Wetlands and backwaters in the Middle and Lower Reaches provide habitat for waterbirds and shorebirds such as the American avocet.

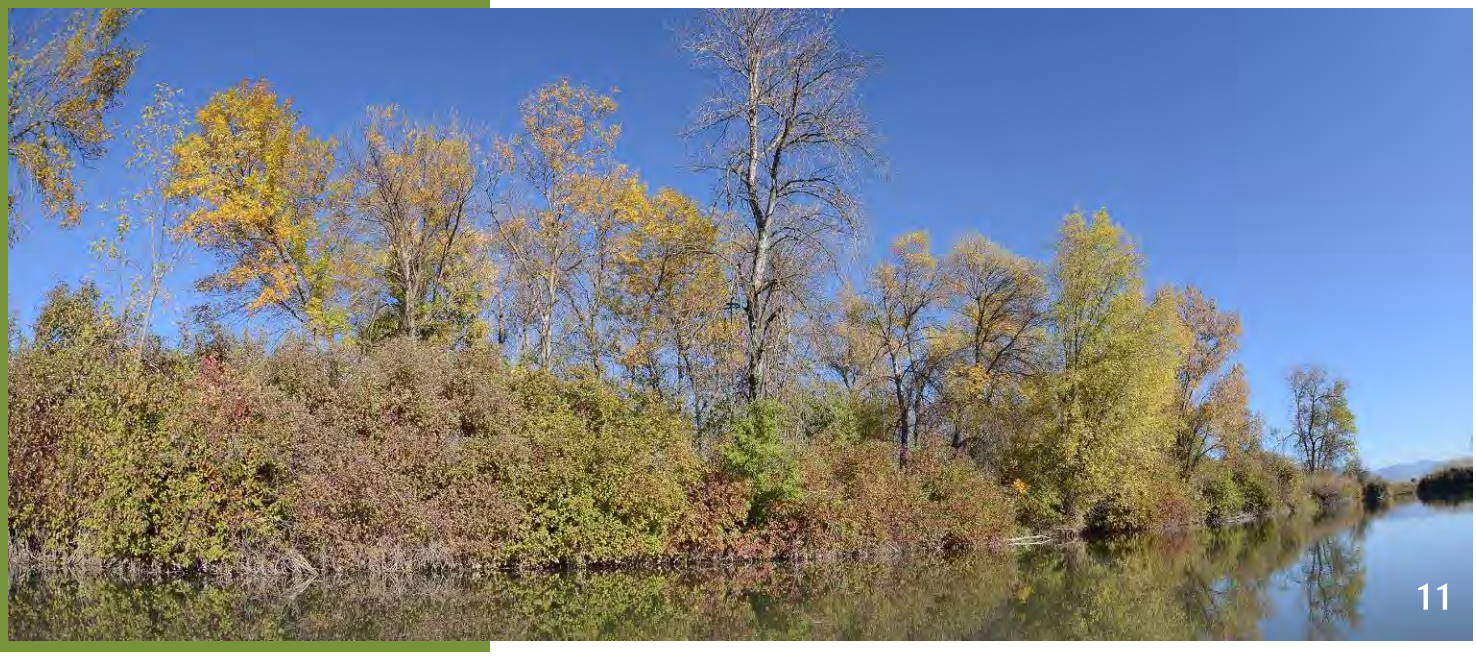
Photo 7. Residential development in the Upper Reach resulting in cross-channel bank erosion.

Photo 8 The Logan River Trail in the Middle Reach. The berm left of the trail, created in the mid-1980s, is composed of dredged sand and gravel piles created after the 1983–1984 floods. Major channel changes occurred during these floods.

Photo 9. Large gravel bars near Rendezvous Park formed during the 2011 floods. Gravel deposition at the railroad crossing, Park Avenue Bridge, and 1000 West are major flood concerns.

Photo 10. Eroding streambank in the Lower Reach. Streambanks that have been cleared of riparian vegetation are susceptible to erosion and create downstream water-quality problems.

Photo 11. Some riparian areas on the Lower Reach have multilayered, native riparian vegetation along the streambank and across the floodplain. Protecting the vegetation in these areas and restoring native species in degraded areas would improve floodplain function, water quality, aesthetics, and habitats for aquatic and avian species.



Logan River Task Force Participants

Member	Affiliation	Expertise/Title
Akina, Russ	Logan City	parks and recreation director
Artz, Neal	Cache Anglers	natural resources management and rural sociology
Allred, Mike	Utah Division of Water Quality	environmental scientist
Davies, Eve	PacifiCorp	environmental scientist
DeRito, Jim	Trout Unlimited	fisheries restoration
Dettenmaier, Megan	USU	forestry extension
Fotheringham, Bob	Cache County	irrigation districts
Hardman, Jon	Natural Resource Conservation Service	district conservationist
Hawkins, Chuck	USU	stream ecology and assessment
Henderson, Bracken	Utah Association of Conservation Districts	zone 1 coordinator
Horsburgh, Jeff	USU-Utah Water Research Lab	engineer
Houser, Lance	Logan City	assistant engineering
Howe, Frank	Bridgerland Audubon	avian ecology
McKee, Mac	USU-Utah Water Research Lab	engineer
Messner, Nancy	USU	water quality and watershed management
Nielsen, Mark	Logan City	public works director
Roper, Brett	USU	stream and fish ecology
Runharr, Josh	Cache County	development services director
Sorenson, Kent	Utah Division of Wildlife Resources	habitat biologist
Thompson, Paul	Utah Division of Wildlife Resources	aquatic program manager
Toth, Dick	USU	bioregional planning and watershed resources management
Warren-Kretzschmar, Barty	USU	bioregional planning and urban spaces
Wheaton, Joe	USU	fluvial geomorphology and river restoration
Wilcock, Peter	USU	river sedimentation and stream restoration

Advisors	Affiliation	Expertise/Title
Booton, Beth	Citizen	recreationist
Daugs, Nathan	Utah Association of Conservation Districts	planner
de Giorgio, Joan	The Nature Conservancy	conservation planning
Norman, Nate	Cache Valley Wildlife Association	river restoration revegetation

Key Logan River Task Force Contacts

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ATTACHMENT A
Logan River Restoration
Conservation Action Plan
Summary Spreadsheet
May 2016

The attached Summary Spreadsheet provides greater detail for readers who are interested in delving into the specifics of the indicators, existing and desired conditions, and strategic actions of the Logan River Conservation Action Plan (CAP). Indicators are used to rate existing and desired conditions by reach of the river (upper, middle, and lower). Reaches are illustrated in Figure 1.

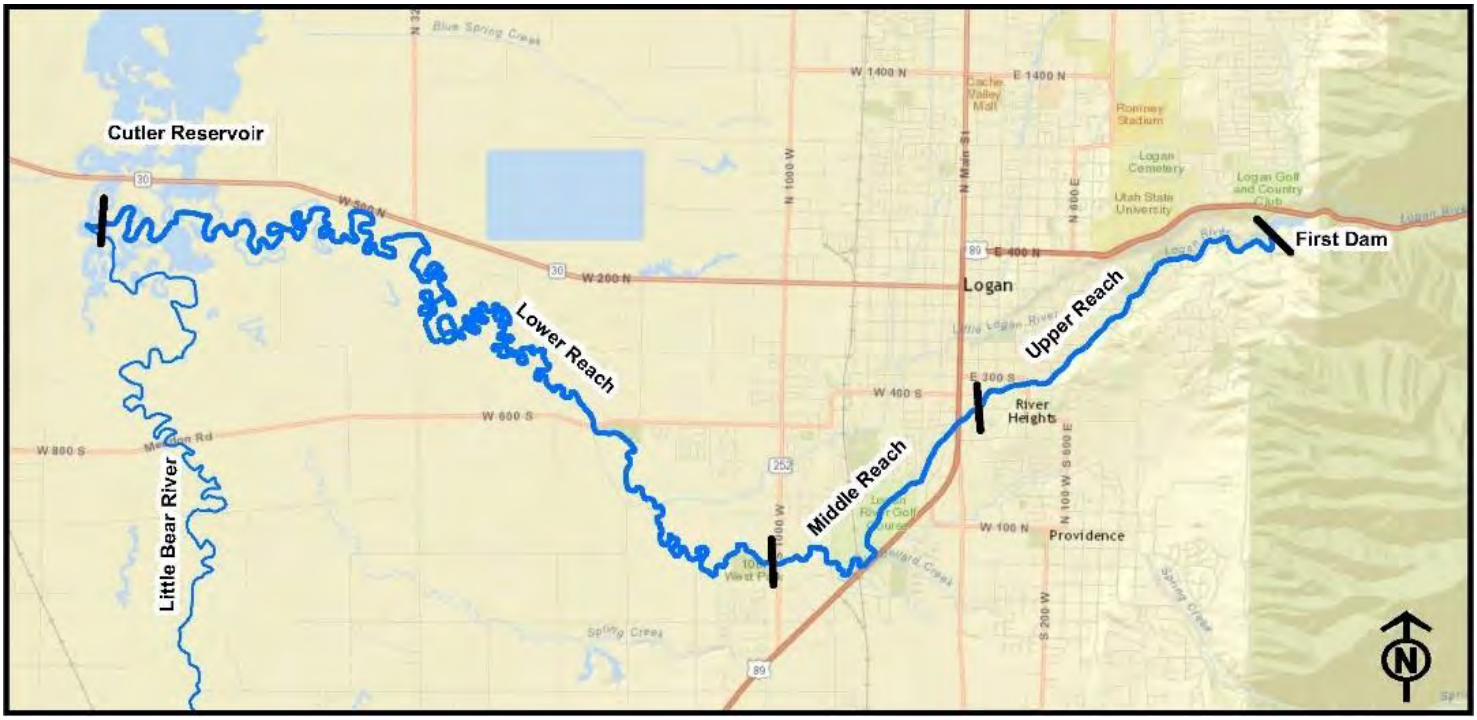

Figure 1. Logan River Restoration Conservation Action Plan (CAP) study area.

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Key Attribute	Indicator	Reach	Current Rating	Desired Rating	Attribute Rationale	Issues/Concerns/Threats	Strategic Actions
Flow Regime	Flow Regime (Spring Peak Flows)	Upper	Good	Good	Natural flow regime is important for maintaining channel capacity and habitat conditions	1) New water development project diverting or storing spring snowmelt 2) Climate change (transition from snow to rain dominate precipitation)	1) Evaluate water development projects which would significantly affect peak flows 2) Evaluate the cumulative effects of any future water development projects with respect to climate change
		Middle	Good	Good			
		Lower	Good	Good			
Flow Regime	Flow Regime (Summer Base Flow)	Upper	Poor	Good	Summer base flows are critical for maintaining good water quality and a functional aquatic ecosystem	Low summer flows	1) Help secure and manage instream flows recognizing existing water rights 2) Participate with governmental and non-governmental organizations that would find and manage water for instream flows 3) Evaluate the instream flow initiatives and potentially support the formation of a water conservancy district
		Middle	Poor	Good			
		Lower	Poor	Good			
Hydrology	Flood Conveyance Through Reach	Upper	Fair	Good	Flooding risk to private and public property is assessed using this indicator	Upper Reach: 1) Encroachment of floodway by development and channel alterations 2) Encroachment onto public property 3) Lack of connection with floodplains 4) Lack of space for channel migration when accumulations of sand/gravel occur 5) Backwater and flooding impacts caused by Crockett Diversion 6) Materials used for bank stabilization (I.e. concrete, boulders, etc.) fail and accumulate in channel	Use an adaptive approach to improve flood conveyance through a combination of the following actions: 1) Determine existing sand, gravel, and woody debris transport and/or accumulation rates 2) Provide space for sand/gravel accumulations within the active floodplain such that channel capacity is maintained through natural bar development/meander migration processes. Methods for providing space include removal of floodplain encroachment and levees as well as through purchasing floodway easements or land acquisitions 3) Remove channel constrictions and over-accumulations of downed woody debris within floodplain 4) Design pressure relief points for sediment accumulation 5) Inform public of necessity of obtaining a state stream alteration permit before taking actions 6) Conduct municipal or county review of state stream alteration applications (Logan City Engineer to coordinate with DWQ Watershed Coordinator and DWR Habitat Manager to request that stream alteration permit applications be forwarded to local governments for comments related to goals and objectives from the CAP)
		Middle	Fair	Good		Middle Reach: 1) Encroachment of floodway by development and channel alterations 2) Encroachment onto public property 3) Lack of connection with floodplains 4) Lack of space for channel migration when accumulations of sand/gravel occur 5) Accumulation of sand/gravel and woody debris 6) Materials used for bank stabilization (I.e. concrete, boulders, etc.) fail and accumulate in channel	
		Lower	Fair	Good		Lower Reach: 1) Accumulation of sand/gravel and woody debris 2) Materials used for bank stabilization (I.e. concrete, old cars, etc.) fail and accumulate in channel 3) Lack of space for channel migration when accumulations of sand/gravel occur	

Key Attribute	Indicator	Reach	Current Rating	Desired Rating	Attribute Rationale	Issues/Concerns/Threats	Strategic Actions
Hydrology	Floodplain Function	Upper	Poor	Fair	Functioning floodplains provide a variety of services including flood control, water quality/filtration, and wildlife habitat	Upper Reach: 1) Encroachment of floodway by development and channel alterations 2) Channelization and unnatural bank stabilization practices	Use an adaptive approach to improve floodplain function through a combination of the following actions: 1) Provide stream channel and floodplain guidance (best management practices) for property owners and municipalities 2) Support public riparian planting and bank treatment workshop 3) Remove/pull back fill and levees that disconnect the channel from the floodplain wherever possible 4) Restore banks wherever possible that are lined with unnatural materials (concrete rubble, cars, walls, etc.) 5) Increase public awareness and enforcement of Logan City floodplain and riparian vegetation ordinances 6) Enable floodplain function through ordinance, easements, or acquisition
		Middle	Poor	Fair		Middle Reach: 1) Encroachment of floodway by development and channel alterations 2) Channelization and unnatural bank stabilization practices 3) Lack of connection with floodplains	
		Lower	Poor	Good		Lower Reach: 1) Encroachment of floodway by development and channel alterations 2) Channelization and unnatural bank stabilization practices 3) Lack of connection with floodplains	
Hydrology	Instream Habitat	Upper	Fair	Good	Instream habitat is important aesthetically and critical for all aquatic species living in the river	1) Channelization and unnatural bank stabilization practices 2) Low summer flows 3) Poor water quality 4) Fish migration barriers 5) Lack of local oversight of state stream alteration permits 6) Lack of Logan City floodplain ordinance enforcement	1) Provide stream channel guidance (best management practices) for property owners and municipalities 2) Promote "net-gain" habitat improvement philosophy into any future channel projects 3) Construct and maintain diverse instream habitat, including stable woody materials 4) Conduct municipal or county review of state stream alteration applications (Logan City Engineer to coordinate with DWQ Watershed Coordinator and DWR Habitat Manager to request that stream alteration permit applications be forwarded to local governments for comments related to goals and objectives from the CAP) 5) Educate citizens regarding best management practices within floodplain (for example, by distributing the Riparian Planting Guide and workshops)
		Middle	Fair	Good			
		Lower	Fair	Good			
Water Quality	State Water Quality Standards for All UDEQ Beneficial Uses	Upper	Good	Very Good	Clean water is aesthetically pleasing and critical for all aquatic species living in the river	1) Low summer flows 2) Poor water quality 3) Sediment releases from First Dam 4) Loss and fragmentation of native, multi-layered riparian vegetation	1) Help secure and manage instream flows recognizing existing water rights 2) Promote native vegetation planting program on all properties to transition vegetation towards native species 3) Oppose damaging sediment releases from First Dam maintenance operations
		Middle	Good	Very Good			
		Lower	Fair	Good			
Aquatic Biology	Trout Density & Size	Upper	Poor	Very Good	Brown trout are the existing, dominant game fish in the river and the primary draw for anglers. Larger trout are important to high quality fishing experiences to residents and visitors	1) Lack of diverse habitat for desired species 2) Simplification of habitat by dredging 3) Poor water quality 4) Low summer flows 5) Sediment releases from First Dam	1) Construct and maintain diverse instream habitat, including stable woody materials 2) Ensure sufficient summer base flow for fish survival 3) Ensure water quality is sufficient for fish survival 4) Oppose damaging sediment releases from First Dam maintenance operations
		Middle	Poor	Very Good			
		Lower	Poor	Very Good			
Aquatic Biology	Benthic Invertebrates Observed/Expected (UTDEQ Predictive Model)	Upper	Very Good	Very Good	Diverse invertebrate species composition is indicative of a healthy riverine system	1) Lack of diverse habitat for desired species 2) Low summer flows 3) Poor water quality 4) Sediment releases from First Dam 5) Effects of First Dam on daily temperature variations (upper reach)	1) Construct and maintain diverse instream habitat, including stable woody materials 2) Ensure sufficient summer base flow for desired species survival 3) Oppose damaging sediment releases from First Dam maintenance operations 4) Work with State and academic experts to determine other strategic actions
		Middle	Fair	Very Good			
		Lower	Poor	Good			

Key Attribute	Indicator	Reach	Current Rating	Desired Rating	Attribute Rationale	Issues/Concerns/Threats	Strategic Actions
Riparian Ecology	Riparian Vegetation Condition	Upper	Poor	Fair	Natural riparian vegetation provides a variety of important riverine functions	1) Channelization and unnatural bank stabilization practices 2) Loss and fragmentation of native, multi-layered riparian vegetation	1) Educate citizens regarding best management practices within floodplain (for example, by distributing the Riparian Planting Guide and workshops) 2) Promote native vegetation planting program on all properties to transition vegetation towards native species 3) Provide stream channel and floodplain guidance (best management practices) for property owners and municipalities 4) Increase public awareness and enforcement of Logan City floodplain and riparian vegetation ordinances 5) Control undesirable and non-native vegetation (beyond official noxious weeds list)
		Middle	Poor	Good			
		Lower	Poor	Good			
Riparian Ecology	Cache County Noxious Weeds	Upper	Good	Very Good	Noxious weeds compete with native vegetation and reduce habitat for native animals	1) Upstream and within watershed noxious weed seed sources 2) Lack of funding	1) Promote weed control within river corridor and watershed 2) Encourage native vegetation planting along river corridor 3) Education citizens regarding noxious weeds and treatment (distribute Riparian Planting Guide, workshops) 4) Provide environmental education along river trails
		Middle	Poor	Very Good			
		Lower	Poor	Very Good			
Terrestrial Biology	Bird Species Richness and Diversity	Upper	Fair	Good	Birds are an important aesthetic component of the Logan River and indicator of ecosystem health. Birders contribute to local economies by feeding birds, buying equipment, and purchasing travel-related items.	1) Loss and fragmentation of native, multi-layered riparian vegetation 2) Lack of invertebrate food source	1) Promote native vegetation planting program on all properties to transition vegetation towards native species 2) Construct and maintain diverse instream habitat, including stable woody materials 3) Conserve important nesting/foraging features of diverse riparian habitat (e.g. snags) 4) Develop diversity/richness monitoring strategy
		Middle	Fair	Very Good			
		Lower	Fair	Very Good			
Terrestrial Biology	Amphibians and Reptiles	Upper	Fair	Very Good	Amphibians and reptiles are an important aesthetic component of the Logan River and indicator of ecosystem health.	1) Destruction of hibernation sites 2) Erosion and sedimentation 3) Loss of riparian habitat to development and river channelization 4) Poor water quality 5) Predation by bullfrogs	1) Maintain or improve riparian habitat and wetlands 2) Encourage homeowners to create habitat, such as fishless ponds with native vegetation 3) Encourage homeowners to tolerate snakes on their property
		Middle	Fair	Very Good			
		Lower	Poor	Fair			
Recreation	Trail Continuity	Upper	Poor	Very Good	Even small breaks in trail systems can prevent widespread trail use and/or have potential for injury to trail users and to cause trespass	1) Lack of public space for river access 2) Lack of funding	1)Work with Logan Parks and Recreation Advisory Board 2) Identify gaps in existing trail system 3) Determine best opportunity to connect existing trail system 4) Enable trail connectivity through ordinance, easements, or acquisition 5) Construct new trail segments 6) Remove barriers to existing trails connectivity 7) Determine and provide a Main Street crossing (pedestrian crossing light, bridge, underpass, etc.)
		Middle	Poor	Very Good			
		Lower	Poor	Very Good			
Recreation	Blue Recreation (tubing, kayaking, canoeing, paddle boarding)	Upper	Poor	Very Good	Navigability of the Logan River is an important safety consideration (hazards that may exist on the bed, banks, and across the river.	1) Legal authority and accessibility to remove hazards 2) Lack of funding	1) Incorporate evaluation of hazards into annual street dept. evaluation of river hazards.
		Middle	Good	Very Good			
		Lower	Poor	Very Good			

Key Attribute	Indicator	Reach	Current Rating	Desired Rating	Attribute Rationale	Issues/Concerns/Threats	Strategic Actions
Recreation	Legal Access To River Bed (wading)	Upper	Very Good	Very Good	1) River access is important for public uses of river 2) Help prevent private property impacts such as trespass	1) Legal riverbed access may change due to state law (Public Trust Doctrine) 2) Poor etiquette (noise, trash, trespass, etc.) 3) Future urban development and enclosure of riverway	1) Develop appropriate facilities (parking especially) to support public access 2) Acquire property or easements for access 3) Provide public education, such as legal access map and appropriate river behavior
		Middle	Very Good	Very Good			
		Lower	Very Good	Very Good			
Recreation	Legal Access To River Bank (above high-water line)	Upper	Poor	Fair	1) River access is important for public uses of river 2) Help prevent private property impacts such as trespass	1) Lack of public space for river access 2) Poor etiquette (noise, trash, trespass, etc.) 3) Future urban development and enclosure of riverway	1) Work with city and county to build or improve facilities to enable public use of the river 2) Enable river access through ordinance, easements, or acquisition 3) Provide public education, such as legal access map and appropriate river etiquette
		Middle	Poor	Fair			
		Lower	Poor	Fair			
Recreation	Access facilities (pedestrian/ADA access points, parking, boat launches, desirable river features for kayaking, tubing, canoeing)	Upper	Poor	Good	Logan River is a public amenity and should have appropriate facilities to enable access and use	1) Lack of public space for river access 2) Landowner opposition to new public facilities 3) Potential for recreation user conflicts to arise as accessibility and use increases 4) Safety hazards to river users, including concrete and metal debris (addressed under the Blue Trails indicator)	1) Work with city and county to build or improve facilities to enable public use of river 2) Create appropriate access points and exits for kayaking and tubing. Identify these on signage and maps including information about rules and regulations, river ratings (whitewater classifications), etc. 3) In designing river restoration projects, incorporate water features that enhance boating access and experience, particularly for kayaking. 4) Maintain and improve the navigability of the river for kayaking and tubing, including access/exit locations, river features that enhance the boating experience (kayak waves), and that address safety concerns 5) Address private property concerns (see strategic actions for adverse impacts to private property from public recreation)
		Middle	Fair	Very Good			
		Lower	Poor	Good			
Recreation	Fishing success/catch rate of Salmonids (Brown Trout and Whitefish)	Upper	Fair	Very Good	Fishing success/catch rates are important for the angler experience	1) Lack of diverse habitat for desired species 2) Low summer flows 3) Poor water quality	1) Construct and maintain diverse instream habitat, including stable woody materials 2) Ensure sufficient summer base flow for desired species survival 3) Ensure water quality is sufficient for fish survival 4) Oppose damaging sediment releases from First Dam maintenance operations
		Middle	Fair	Very Good			
		Lower	Poor	Good			
Recreation	Blue Ribbon Fishery (BRF) Status	Upper	Fair	Very Good	High-quality fishing experiences are important to residents and visitors	1) Lack of public space for river access 2) Lack of diverse habitat for desired species 3) Low summer flows 4) Poor water quality	1) Construct and maintain diverse instream habitat, including stable woody materials 2) Ensure sufficient summer base flow for desired species survival 3) Ensure water quality is sufficient for fish survival 4) Work with city and county to build or improve facilities to enable public use of the river 5) Enable river access through ordinance, easements, or acquisition
		Middle	Good	Very Good			
		Lower	Poor	Good			

Key Attribute	Indicator	Reach	Current Rating	Desired Rating	Attribute Rationale	Issues/Concerns/Threats	Strategic Actions
Private Property	Adverse Impacts to Private Property from Public Recreation	Upper	Fair	Very Good	Acknowledging private property along river channel is a top priority	1) Lack of public space for river access 2) Poor etiquette (noise, trash, trespass, etc.)	1) Include facilities (i.e. designated access locations, parking, signage, fences, law enforcement) which reduce incidence of property trespass 2) Provide and maintain trash collection facilities and public education to reduce litter 3) Local government to work with landowners and state agencies to implement a coordinated walk-in access program 4) Provide public education, such as legal access map and appropriate river etiquette
		Middle	Fair	Very Good			
		Lower	Fair	Very Good			
Private Property	Adverse Impacts to Private Property from River Restoration Actions	Upper	Fair	Very Good	Changes to flood conveyance and the riparian corridor could have anticipated or unanticipated consequences for adjacent private properties	1) Unintended consequences from actions 2) Lack of funding	1) Facilitate early public involvement in river restoration projects 2) Implement well-designed river restoration projects based on the CAP 3) Conduct follow-up public involvement to evaluate project success, identify issues that warrant resolution, and improve future projects
		Middle	Fair	Very Good			
		Lower	Fair	Good			

Logan River Conservation Action Plan (CAP) Monitoring Protocol

June 2020

1. INTRODUCTION

1.1. Logan River Watershed

The Logan River, an integral part of the greater Bear River ecosystem, originates within the Bear River Mountains in the headwaters of Logan Canyon and terminates at its confluence with the Little Bear River in Cutler Reservoir. The river is an asset to residents of Logan City and Cache County and has historically supported many beneficial uses. The Logan River was an important resource for Native Americans and pioneers and remains valuable today. Cache Valley citizens are attracted to the river and enjoy the aesthetics, recreational values, and wildlife resources associated with this high-quality river, which supports fish, wildlife, and many plant species unique to riparian and wetland habitats. The Logan River also provides water for irrigation, municipal water supply, and hydroelectricity.

1.2. Logan River Conservation Action Plan

To protect the Logan River from degradation and the growing threats of floodplain development, a Conservation Action Plan (CAP) was developed in 2016 for the portions of the Logan River from First Dam (at the mouth of Logan Canyon) through Cache Valley to the confluence with the Little Bear River at Cutler Reservoir (Figure 1). The development of a short- and long-range vision for the river was needed to coordinate and prioritize conservation efforts and ensure a sustainable river system for future generations. Stakeholder groups representing residential, commercial, recreational, and agricultural interests participated in the development of this CAP. The CAP is a dynamic set of objectives that can be revised as needed when new threats or conservation solutions are identified. More CAP information, planning process, methods, and individual reach description can be found in Appendix A.

FIGURE 1. LOGAN RIVER RESTORATION CONSERVATION ACTION PLAN (CAP) STUDY AREA DIVIDED BY REACHES.

1.3. Logan River Task Force

In 2014, the Logan River Task Force (Task Force) was formed and was composed of a group of Utah State University professors, state and local government officials, and interest group representatives including but not limited to Logan City, Utah Division of Water Quality (DWQ), Utah Division of Wildlife Resources (DWR), Utah Division of Water Rights (Stream Alterations), Natural Resources Conservation Services (NRCS), Utah Association of Conservation Districts, Trout Unlimited, Bridgerland Audubon Society, USU Extension, USU College of Natural Resources, USU College of Engineering (Water Lab). The main goal of the Task Force is to develop a method for improving areas along the Logan River. The Task Force and Logan City are working with BIO-WEST, Inc. (BIO-WEST), a local environmental consulting firm, to develop and implement the CAP and design restoration concepts for the river. This monitoring protocol provides the foundation for river network monitoring of the CAP indicators and seconds as part of the storm water monitoring for Logan City. More Task Force information can be found in Appendix A.

2. OBJECTIVES

The main objective of monitoring is to assess the physical, chemical, and biological characteristics of the Logan River and determine individual and cumulative successes of various restoration projects and conservation efforts being implemented within the Study Area (Figure 1). The first CAP restoration project implemented was at Denzil Stewart Nature Park fall 2016 in the residential dominated Upper Reach, followed by two larger restoration projects near Rendezvous Park implemented 2017-2019 in the recreational portion of the Middle Reach, followed by the Main Street to 100 East restoration project 2018-2019 in the commercial portion of the Middle Reach. The CAP approach was adapted for the Logan River and includes environmental, recreational, and public values.

2.1. CAP Indicators (Existing, Desired) and Key Attributes

The Task Force selected a broad range of river health indicators and public uses in order to identify existing and desired conditions for the Logan River. A total of 22 indicators were chosen, many apply to the entire river, but the CAP separates existing and desired conditions for specific reaches where it is appropriate to do so. Existing and desired conditions for each indicator are rated on the color-coded, four-point scale: poor, fair, good, and very good (Appendix A). In addition, each indicator rationale is explained and strategic actions to achieve or maintain the desired conditions are listed. To monitor the conditions of Logan River and its riparian corridor, the following attributes are being monitored and analyzed by a wide group of partners.

3. KEY ATTRIBUTES

3.1. Flow Regime

Flow regime is a critical monitoring component of aquatic ecosystems as it shapes river channels and floodplains, dictates ecological processes and determines the biodiversity of river ecosystems. The CAP includes two indicators of flow regime:

- Spring peak flows, which are generally good conditions for all study area reaches as all upstream dams are run-of-the-river diversion structures that do not have significant storage capacity, allowing for a generally natural spring runoff conditions in the study area reaches of the river.

- Summer base flows, which are generally poor conditions for all reaches due to water diversions into Cache Valley irrigation canals.

The USGS gage 10109000 Above First Dam captures the flow regime right before it enters the CAP study area. Streamflow is also monitored at 3 locations on the Logan River (Figure 2) established through the Innovative Urban Transitions and Aridregion Hydro-sustainability (iUTAH) project, now operated by the Logan River Observatory (lro.usu.edu). The stations record gage height, water temperature and water quality attributes. Gage height is later converted to stream discharge using flow-stage rating curves developed for each site. All of the sites in the CAP Logan River study area—Logan River at the Utah Water Research Laboratory (UWRL) bridge, Logan River at Main Street, and Logan River at Mendon Road—have been operational since 2014 and collect data in fifteen-minute intervals. Continuous data is also being collected on Spring Creek and the Blacksmith Fork River just above their respective confluences with Logan River. In addition to continuous data, discharge is measured periodically at these sites. Discharge is also measured bi-monthly during the water quality data collection at following sites (UDWQ): Logan River near the Trapper Trails Council Boy Scouts of America Building, Spring Creek before Logan River confluence, Logan River at Park Avenue, Logan River Above Trapper Park Diversion, and the Little Logan River before Logan River confluence.

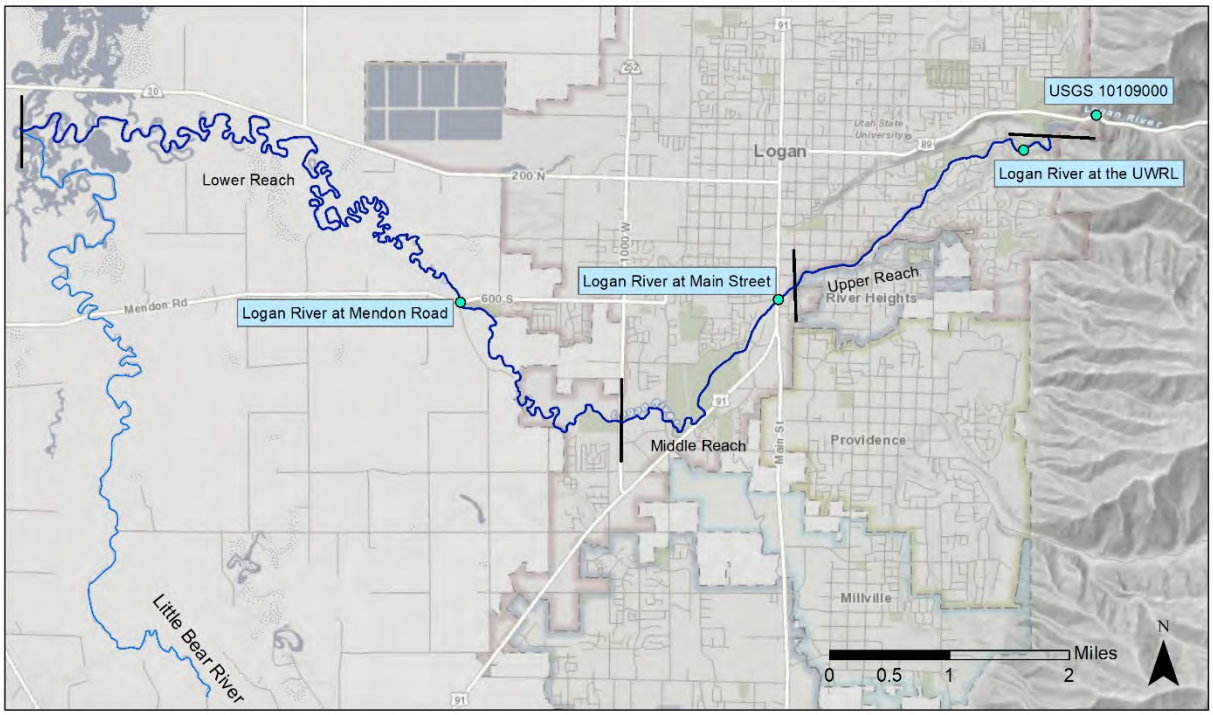

FIGURE 2. LOGAN RIVER CONTINUOUS FLOW AND WATER QUALITY MONITORING STATIONS. USGS GAGE IS LOCATED ABOVE THE STUDY AREA WITH THREE LOGAN RIVER OBSERVATORY SITES THROUGHOUT THE STUDY AREA, ONE IN EACH REACH (UPPER, MIDDLE, LOWER).

3.2. Water Quality and Temperature

Water quality and temperature data are collected at different spatial and temporal scales throughout the study area by different groups. Continuous temperature and water quality are measured at all Logan River Observatory locations. The water quality measurements include dissolved oxygen (DO), pH, specific conductance, turbidity, nitrogen as dissolved nitrate (NO3), Fluorescent Dissolved Organic Matter (FDOM), chlorophyll Fluorescence; the last three are only recorded at the most upstream (Logan River at UWRL) and downstream site (Logan River at Mendon Road). Grab samples collected by UDWQ bi-monthly include: temperature, DO, specific conductance, turbidity, pH, Filtered Nutrients-Phosphate (TDP) D-Nitrite+Nitrate (No2-+No3-), D-Total Nitrogen (inorganic), Unfiltered Nutrients-Ammonia as NH3, Nitrite + Nitrate (NO2 +NO3), and Phosphorus (T-PO4). Temperature was also measured continuously at fifteen locations throughout the study area at fifteen-minute intervals from July through November 2019. There were various projects conducted by iUTAH and USU that captured temperature and water quality throughout the study area over the recent period of time, including storm drain sampling in 2015. There are multiple monitoring locations proposed in addition to existing locations that will be installed as additional funding is acquired.

The CAP indicators for water quality are the State water quality standards for all beneficial uses, which were assessed by the Task Force as having good quality in the Upper and Middle Reaches but fair conditions in the Lower Reach. Water temperatures and dissolved oxygen concentrations in the 2014 303d listing were within State 3A Standards at the Main Street Logan River Observatory gage (above Middle Reach) but exceedances of both water temperatures >20 °C and <6mg/l of dissolved oxygen had occurred for the past two years at the Mendon Logan River Observatory gage (below Middle Reach).

3.3. Sediment Regime

BIO-WEST conducted bedload and suspended sediment sampling in the Middle Reach near Rendezvous Park during 2016 and 2017 runoff seasons. Sediment samples were collected at three locations during the 2016 season and resulted in 9 samples all together. The 2017 sampling season included two locations on Logan River (above and below Rendezvous Park), and included a new location on Blacksmith Fork, resulting in 8 samples for Logan River and 4 samples for Blacksmith Fork River. Bedload samples were dried, sieved, and weighed by BIO-WEST. Water samples were processed by USU Analytical Laboratories and analyzed for total phosphorus (TP, mg/L) and total suspended solids (TSS, mg/L).

Bedload samples were collected using the Toutle River sediment sampler (TR-2) lowered from the bridges (Figure 3). The sampler was borrowed from USU and has a 6”x12” inlet nozzle and 1.4 expansion ratio. Each sample was collected using ten verticals (stations) 6 minutes each. This resulted in one-hour samples. Collected samples were bagged and brought to the lab for further analysis. This included drying off the samples, separating sediment from any organic material and sieving the samples in to individual size classes. The size classes ranged from very fine sand (0.075 mm) to a small cobble (64 mm). Particle size distribution for each sample, bedload transport and total (bedload + suspended load) load were calculated.

FIGURE 3. LOGAN RIVER BEDLOAD SEDIMENT SAMPLING USING TOUTLE RIVER SEDIMENT SAMPLER (TR-2). A) SAMPLING FROM THE GOLF CART BRIDGE. B) GOLF COURSE ROAD BRIDGE SAMPLING.

Painted rocks were part of the initial sediment sampling campaign in 2016 (Figure 4). A pebble count was performed upstream of the Golf Cart Bridge using heel-to-toe method (Wolman, 1954) and the D50 (median of the cumulative frequency particle-size distribution) and D84 was determined. The rocks in the D50 (66 – 73 mm) and D84 (95 – 105 mm) range were then collected and painted with two different colors. Rocks in D84 range were placed on one line while the rocks in the range of D50 were placed on the second line about 50 ft apart both covering the active channel width. After a moderate spring runoff receded, the distance of moved rocks from the original line was recorded for each particle that moved. The D84 line contained 100 particles and had 100% success of recovering the moved rocks. The D50 line contained 200 particles and recovery success rate was 70%. This is due to some of the rocks being carried longer distance or being buried by other particles and not visible during the recovery time.

FIGURE 4. PAINTED ROCKS PLACED ACROSS THE CHANNEL BEFORE THE HIGH FLOWS (A) AND AFTER THEY MOVED AFTER THE HIGH FLOWS RECEDED IN 2016.

3.4. Hydrology, Channel Change and Floodplain Function

CAP indicators include flood conveyance and floodplain function. The baseline flood conveyance condition as assessed by the Task Force was fair. The Task Force's assessment was that flood conveyance for the infrequent runoff event (>25-yr flood event) through all reaches was being partially impacted by sand/gravel deposition and woody debris accumulation. Floodplain function was assessed as poor condition for all three reaches. Poor condition is described in the CAP as being a condition in which floodplain functions are severely limited with widespread portions of the floodplain non-existent on one or both sides of channel. The floodplain is highly manipulated and/or disconnected from the channel due to anthropogenic factors such as channelization, bank manipulation, filling and/or levee development. The banks that have been restored were literally lined with concrete slabs and trash, and was used as a near town disposal site by previous land owners in their attempt to stabilize the banks.

The CAP also includes an indicator for instream habitat, assessed as fair condition for all three reaches (34-66% departure from natural). This indicator includes consideration of hydraulic complexity and habitat diversity, including a natural sequence of pools and riffles, a variety of pool sizes and depths, and stable woody materials in the bed and banks.

Multiple USU groups are involved in monitoring of channel change and instream habitat. TheEcogeomorphology and Topographic Analysis Lab (Dr. Joseph Wheaton) provided a pre-construction survey of the channel and used LiDAR data to explore geomorphic units for approximately two miles of Logan River (Figure 5). The study reach included Logan River through Rendezvous Park and the study shows conditions prior to restoration project (2017). The study was funded by Logan City and used the Geomorphic Unit Tool (GUT) which delineates instream geomorphic units from topography using a 3-tiered hierarchical classification adapted from Wheaton et al., 2015. A post-construction survey and geomorphic unit mapping is recommended to compare types and quantity of habitats accomplished with the Rendezvous Park restoration projects to-date.

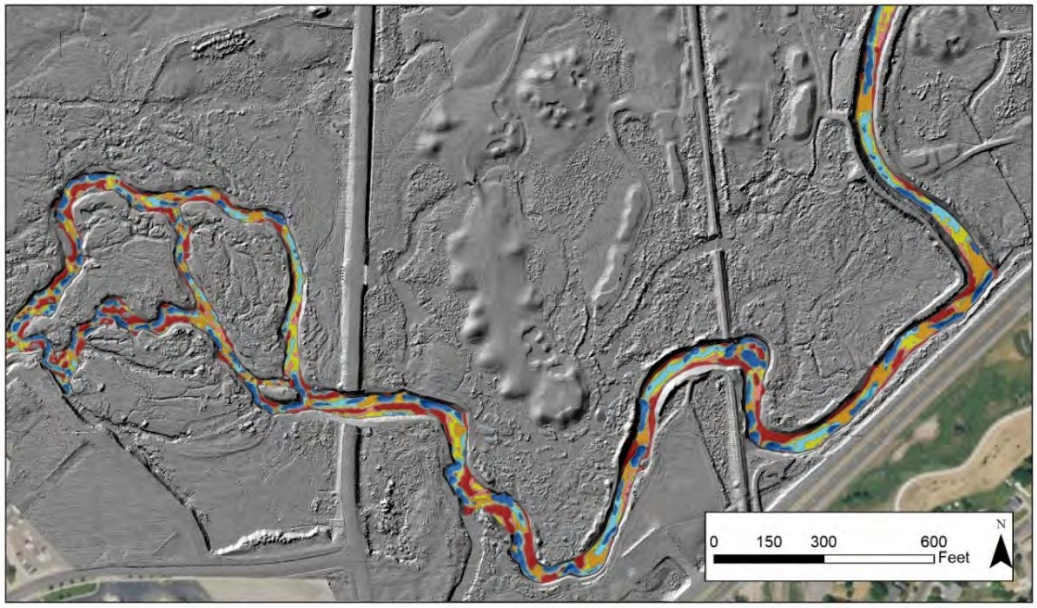

FIGURE 5. SECTION OF LOGAN RIVER THROUGH RENDEZVOUS PARK WHERE GEOMORPHIC UNIT TOOL (GUT) WAS USED TO DELINEATE PRE-CONSTRUCTION INSTREAM GEOMORPHIC UNITS FROM TOPOGRAPHY.

The Hydrology and Fine Sediment Lab under Dr. Patrick Belmont uses Logan River as part of the field classes. Additional cross-sections were surveyed to study the channel change in the Rendezvous Park area in 2018.

Logan City surveys the Logan River and its floodplain for flood conveyance, floodplain mapping, and hydraulic modeling. The latest dataset collected captures post-restoration conditions in 2019.

3.5. Riparian Ecology (including weeds)

CAP indicators of riparian ecology are riparian vegetation condition and extent of noxious weed invasion. Riparian vegetation was assessed by the Task Force as having poor condition for all three reaches, representing a 66% or greater departure from natural condition. Noxious weed conditions were assessed as good for the Upper Reach (minimally present), but poor condition for the Middle and Lower Reaches (noxious weeds common in the riparian corridor).

BIO-WEST has been conducting yearly riparian vegetation monitoring needed for the CWA Section 404 permit as required for the Rendezvous Park restoration projects. To ensure success of the restoration project, BIO-WEST is monitoring riparian and wetland vegetation conditions at Rendezvous Park for 3-5 years of anticipated required post-construction monitoring, or until the performance standards are met (BIO-WEST, 2018, Table 4). The pre-construction (2017), year one post-construction (2018), and year two post-construction (2019) conditions were mapped and photo documented up to this date along the Logan River at Rendezvous Park as part of the Rendezvous Park Channel and Floodplain Restoration Project (BIO-WEST, 2018, 2019). The project is subject to U.S. Army Corps of Engineers wetland monitoring and will be monitored through 2020.

Thirty-four vegetation-monitoring points were established throughout the restoration area in 2017 and three more were added in 2018 for the Confluence to Park Avenue section restored in 2019. These monitoring plots were located on existing upland levees and trails, wetland areas, and locations modified by the new design. The plots were established to show the existing conditions of the site and record changes through future growing seasons (Figure 6). The plot locations were recorded using a sub-meter accurate GPS unit. Plots 1-34 were monitored and photographed in July 2017 and one year later monitored and photographed again in August 2018. Plots 35-37 were monitored and photographed in December 2018. All plots were monitored again in 2019 and monitoring report was prepared which is nearly ready to be submitted to the U.S. Army Corps of Engineers. The monitoring includes an estimate of aerial percent cover of each vegetation strata (tree, shrub, herbaceous) by dominant species within a 30-foot radius of each point. At the same time, photographs are being taken from each point center in the four cardinal directions. Other relevant information such as soil moisture, hydrology indicator observations and any visible channel instability indicators in riverine channel and wetland restoration and enhancement areas are recorded as well. The photographs and monitoring data forms provide a simple and rapid assessment of changes within the project area from one year to the next.

Weed treatment, as part of the riparian ecology, is project based as well and it has been in place for the Denzil Stewart Nature Park and Rendezvous Park Channel and Floodplain Restoration Projects. BIO-WEST monitors for noxious and/or invasive weeds in the restoration areas and applies mechanical and/or chemical treatment as necessary to control spread of undesirable vegetation during the 3-5 year

anticipated required monitoring. The success criteria include 80% or more of native vegetation cover with less than 1% noxious weed cover after 3 years of monitoring.

The monitoring plan does not currently include a protocol for monitoring weeds throughout the CAP reaches. Potentially a monitoring protocol could be developed in coordination with Logan City and the Cache County Weed Control Program. A volunteer-effort riparian area weed control effort could be organized or combined with other volunteer weed control efforts that are done in the area. Another possibility would be to conduct weed control through the College of Natural Resources intern program.

At publicly accessible restoration areas (Denzil Stewart Nature Park and Rendezvous Park), existing sign boards could have information posted about weeds that the public can help pull and dispose of. Information can be posted at key times (spring) when this would be most effective.

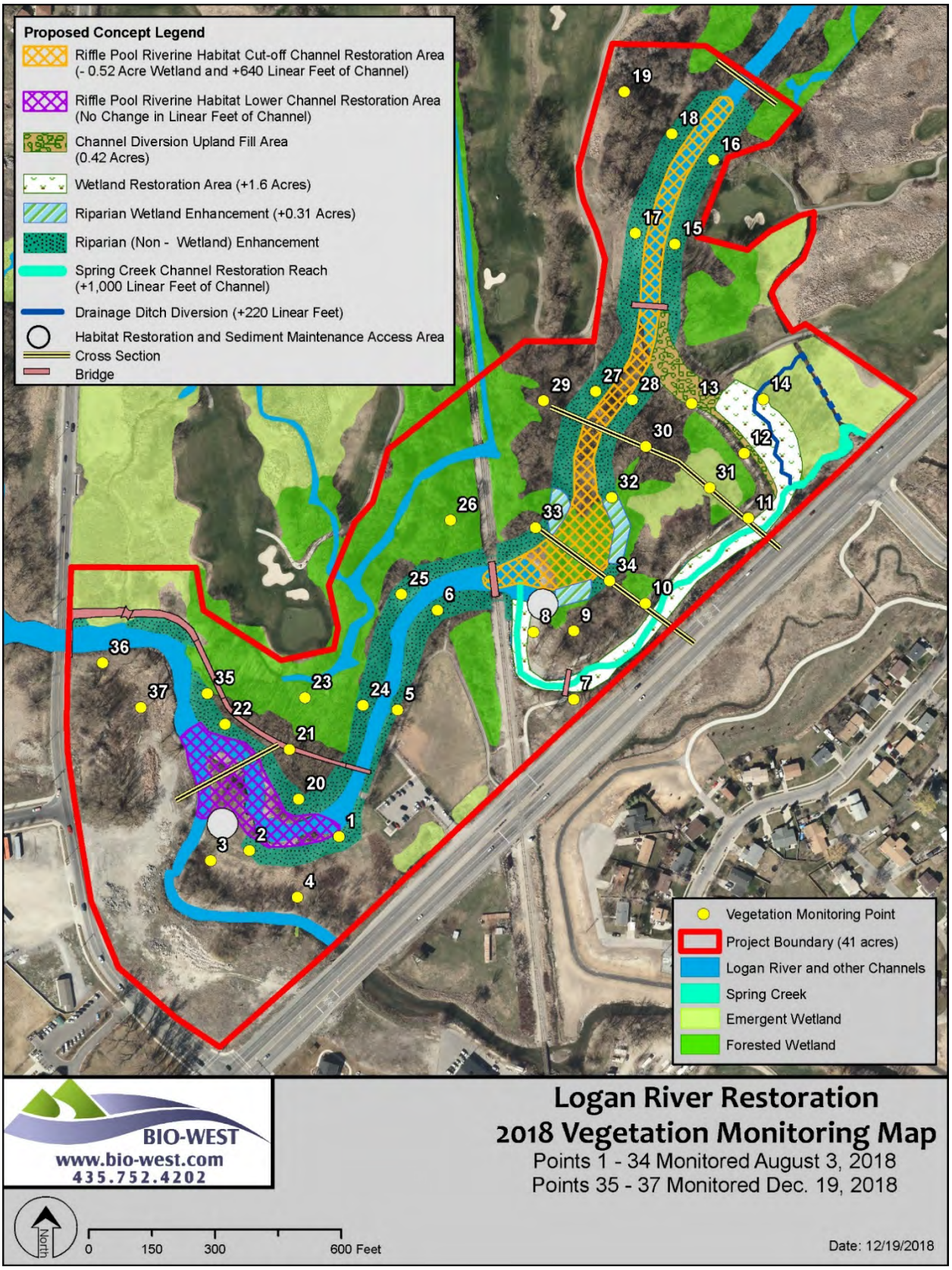

FIGURE 6. LOGAN RIVER RESTORATION AT RENDEZVOUS PARK VEGETATION MONITORING MAP.

3.6. Aquatic Biology

CAP indicators of aquatic biology are trout density and size and benthic invertebrate expected taxa presence. The Task Force's baseline assessment of the trout indicator was poor condition in all three reaches. Improvements to instream habitat and summer base flows are likely necessary to achieve higher trout density and size. Baseline conditions for benthic invertebrate taxa were assessed as being very good in the upper reach (greater than 85% of expected taxa present) and declining to poor condition in the lower reach (less than 70% of expected taxa present).

3.6.1. Fish

Multiple monitoring efforts took place or still continue on different parts of Logan River. Some of the previous monitoring studies could be used for baseline data if more surveys and monitoring is planned in the future.

i) Previous monitoring

2001 to 2008 Logan River Monitoring: The USU Fish Ecology Lab (Dr. Phaedra Budy) monitored the fish community of the Logan River annually at eight long-term sites from 2001 to 2008. Sites spanned from the upper headwaters (Franklin Basin) to the lower Logan River (Rendezvous Park area, 1000W Bridge). The overall objectives of this study were to monitor and evaluate the population dynamics, abundance, and distribution of trout in the Logan River, and to determine the present and potential impacts of disease, habitat, interspecific interactions and recruitment in determining the abundance and distribution of trout species (Budy, P. et al., 2009, 2010).

Fish were collected during base flow conditions using a three-pass depletion technique. Block nets were placed at the lower and upper end of each stream section (100 m sections in the headwaters and tributaries, 200 m in the mainstem). Electrofishing voltage varied depending on the stream conditions (216 - 387 µS/cm, 8 - 15 oC, ~40-Hz pulsed DC, ~160 - 500 V, 0.2 - 4 amps). The backpack-mounted electrofishing unit for smaller streams, and a canoe-mounted electrofishing unit for the larger mainstem surveys were used. Captured fish were anesthetized with a light dose of MS-222 (aka Finquel). Lengths (mm total length, TL) and weights (g) were recorded for all fish, and in addition, fish were checked for external signs of whirling disease (e.g., black tail, deformities of the cranium, mandible, or vertebrae). When possible, 10 subadults and 10 adults from each species were kept. The subadult cutthroat trout was classified as fish < 150 mm TL and subadult brown trout as fish < 180 mm TL based on prior size-at-age information (Budy et al. 2001, 2002, 2003, 2004, 2005). These fish were euthanized using a lethal dose of MS-222 and placed on ice in labeled bags after lengths and weights were measured. These fish were used for diet analysis, PCR testing for *Myxobolus cerebralis*, tissue collection, and scales and otoliths
were taken for ageing analysis. In 2008, as in 2007 and 2006, due to concerns that the surveys may be causing impacts to these trout which exhibit high site-fidelity rates (on average 92%; Budy et al. 2007b), new random sample site locations were selected. Random site selection options included the original site (2001 – 2005 sample seasons) or upstream or downstream of the top or bottom of the original site; however, some modifications were made for logistical and safety concerns.

Condition analysis

All captured fish was weighed (nearest 0.01 g) and measured (nearest mm total length, TL). The length-weight relationship was calculated, and the condition of all fish using Fulton's K (Fulton's KTL = W / L3 × 100,000) were computed. These calculations were then compared seasonally and temporally when sample sizes were adequate.

Population estimates

The population abundance was estimated using a closed model, generalized maximum likelihood removal estimator calculated in Program MARK (White and Burnham 1999). Based on previous analyses (Budy et al. 2005), the population abundance and recapture probabilities for fish (> age-0, > 100 mm) at each site were calculated. The abundance was then scaled up to determine the total number of fish per linear km and/or fish per m^2, and express these estimates as fish per km with 95% confidence intervals.

Trout population trends

The population trend for cutthroat trout and brown trout was estimated using population estimates from seven years of depletion sampling, 2001 – 2008 (only to 2007 for brown trout), using linear regression of log-transformed annual changes in population growth rate as a function of time step (Morris and Doak 2002). The trend was expressed as lambda (λ), the annual population growth rate with 95% confidence intervals. An overall λ for the entire Logan River population was also calculated and based on pooled abundance estimates across sites. A $\lambda > 1$ indicated positive population trend, $\lambda = 1$ indicated no change in population growth rate, and a $\lambda < 1$ indicated the population is declining; however, given the short, time series available, when 95% confidence intervals overlap 1.0, the population increase or decrease could not be ruled out completely. In the analyses, the research team accounted for losses of fish due to take of sample fish (for parasite and diet analyses) and mortalities incurred during sampling events due to electroshocking or other stressors, such that final λ values represent the observed trend at each site, in the absence of these minor fish losses.

Whirling disease analyses

For a subsample of cutthroat trout and brown trout, fish heads from each specimen were removed, frozen, and tested for prevalence of *M. cerebralis* following the polymerase chain reaction method (Hsp-70 gene segment PCR; Andree et al. 1998). PCR samples were processed by Pisces-Molecular LLC (Boulder, Colorado).

Abiotic and biotic variables

Sampling for physical, chemical, and biological characteristics of stream habitat was generally conducted prior to fish sampling.

- *Temperature* — Temperature at each site was recorded at 90-minute intervals using temperature loggers set in stream, generally year-round; however, not all data loggers were recovered due to high, spring run-off flows or mechanical failures in some years.
- *Discharge* — Discharge was measured using the mid-section method (Harrelson et al., 1994). Thus, we measured depth and mean water column velocity at 20-30 locations along a cross-sectional transect at each site using an electromagnetic flow meter. Although collected, those measurements are not reported here. We also tracked stream flows online using USGS real-time water data (Gage: USGS site 10109000; Website: *http://waterdata.usgs.gov/nwis/rt*) to obtain daily mean flows for the Logan River above First Dam (Cache County, Utah, Hydrologic Unit Code 16010203, Latitude 41°44'36", Longitude 111°46'55" NAD27, Drainage area 214 square miles, Gage datum 1,426 m above sea level NGVD29).
- *Other abiotic variables* — In addition to temperature information from data loggers set in selected index sites, we collected a suite of abiotic variables including water conductivity, pH, turbidity, salinity, and dissolved oxygen.

2016 fish survey:
The 180-meter-long stretch of river in the Rendezvous Dog Park section was surveyed using 3-pass depletion technique with both, upstream and downstream end blocked by nets. The abundance estimates for brown trout, carp, whitefish, sculpin, Utah sucker, and rainbow trout were calculated. The estimates are shown in the table below (Table 1, Budy, P., unpublished data, 2016).

Table 1. Population estimate of fish species present in the Rendezvous Dog Park section of the Logan River, Utah in September 2016, prior to habitat restoration work. Abundance estimate (with lower and upper 95% confidence intervals) for a 180-m section is shown, along with an expanded fish per km estimate.

Species	Estimate	Lower CI	Upper CI	Number per km
Brown trout	87.8	81.2	108.4	488
Mountain whitefish	65.2	17.9	1260	362
Mottled sculpin	867.3	452.0	2279	4818
Rainbow trout	1	–	–	6
Utah sucker	1	–	–	6
Common carp	1	–	–	6

ii) Current monitoring

Logan River monitoring from Blacksmith Fork River confluence to Rendezvous Park pedestrian bridge:
A full fish survey monitoring conducted in 2016 and 2018. The survey is planned to be repeated every two years.

Logan River monitoring by fish habitat unit:
Fish survey monitoring by habitat unit (riffle/run and pool) is a yearly monitoring by USU fish class and provides information on relative number of fish and species per habitat unit in the stretch of the Logan River between the confluence with Blacksmith Fork River and railroad bridge. The monitoring started in 2015 and usually takes place in September.

3.6.2. Macroinvertebrate

Benthic macroinvertebrates inhabit the sediment or live on the bottom substrates of rivers. The macroinvertebrate assemblages in rivers reflect overall biological integrity of the benthic community and monitoring these assemblages is useful in assessing the status of the water body and discerning trends. Benthic communities respond differently to a wide array of stressors. As a result of this, it is often possible to determine the type of stress that has affected a benthic macroinvertebrate community (Plafkin et al., 1989; Klemm et al., 1990). Because many macroinvertebrates have relatively long-life cycles of a year or more and are relatively immobile, macroinvertebrate community structure is a function of past conditions.

The macroinvertebrate monitoring for Logan River is part of multiple research efforts and groups.

i) Project based sampling for Rendezvous Park Channel and Floodplain Restoration Project was conducted by BLM/USU National Aquatic Monitoring Center (Bug Lab) in August 2017 (pre-project). Samples were taken from five different locations along the Rendezvous Park reach:

Logan River downstream from confluence with Blacksmith Fork River, Logan River at dog park below the bridge, Logan River, above railroad crossing, Logan River above the golf cart bridge, and Logan River above the restoration project work zone. The multimetric approach was used, where different structural and functional attributes of the assemblage are characterized as "metrics". Individual metrics that respond to different types of stressors are scored against expectations under conditions of minimal human disturbance. The individual metric scores are then summed into an overall index value that is used to judge the overall level of impairment of an individual river reach. Common metrics used to asses the freshwater biological integrity for Logan River were used, as well as basic field and lab processing methods. The values of richness-based metrics were standardized to operational taxonomic units (OTUs; Cuffney at al., 2007) and a fixed count of 300. The density metrics were based on the raw taxa list. The Utah Department of Environmental Quality (UTDEQ) 2015 all seasons model observed/expected (O/E) index was used to asses the biological conditions of sampled sites. O/E models compare the macroinvertebrate taxa observed at sites of unknown biological condition (i.e., 'test sites') to the assemblages expected to be found in the absence of anthropogenic stressors (see Hawkins et al. 2000 for details). Biological condition was subsequently assessed based on the precision of the reference site data set used to develop the UTDEQ O/E model (mean =1.002744, standard deviation (SD) = 0.2139), with test sites scoring less than one SD below the mean of reference sites in "Good" biological condition (i.e. comparable to reference conditions); sites scoring between one SD and two SD in "Fair" biological condition; and sites scoring more than two SD below the mean of reference sites in "Poor" biological condition. Detailed information on methods could be found in the metadata provided by the Bug Lab and also available at http://www.usu.edu/buglab/SampleProcessing/ResultsAndReports/#item=85.

ii) Middle/ Lower Logan River Reach monitoring includes sampling conducted by Utah State University researchers and groups, Department of Water Quality as well as data associated with EPA projects (Environmental Monitoring and Assessment Program, EMAP). The data are available through the Western Center for Monitoring and Assessment of Freshwater Ecosystems (WMC) and the National Aquatic Monitoring Center (NAMC) database of biological and environmental data (http://www.qcnr.usu.edu/wmc/data).

3.7. Terrestrial Biology

CAP indicators for terrestrial biology include:

- Bird species richness and diversity, calculated using Shannon-Wiener Index. Baseline conditions were assessed by the Task Force as Fair for all three reaches
- Native vs. nonnative amphibian and reptile species composition. Baseline conditions were assessed as fair in the Upper and Middle Reaches and poor in the Lower Reach.

3.7.1 Birds

The Logan River Bird Monitoring Protocol (LRBMP) is based on a hybrid of the Utah Riparian Bird Monitoring Program and the USGS Breeding Bird Survey (Howe, 2016). The protocol requires extensive

expertise in identification of Utah birds by sight and sound. It is designed to yield an annual diversity index value (Shannon-Wiener) and a species richness estimate. The LRBMP is also intended to lead to a "citizen science" bird monitoring protocol that will require less expertise in identification of all Utah birds and focus on several select species; this protocol will be developed after 3-5 years of LRBMP data is collected.

The planned protocol includes specification regarding the timing, sampling points, data collection methods, and data analysis.

Surveys are completed once between 1 June and 15 July to capture breeding birds and avoid migrants. Surveys should be conducted from sunrise to no later than 10:00. The 2-3 sampling points randomly located for each 0.5 river miles (RM) provide relatively uniform coverage of the river from 1st dam (RM 0.0) to the Mendon Bridge (RM 8.7) (Figure 7-9). Points have been established below Mendon Bridge to Cutler Reservoir but have not been surveyed because of access and logistical issues. Points are named based on the RM in which they occur, for example, sampling point 0.5a is the first point below 1st dam between RM 0.0 and RM 0.5. and sampling point 3.0c is the last point between RM 2.5 and RM 3.0. Points were randomly selected within each 400 m stretch of the river and adjusted slightly where trespass on private property was an issue (permission to trespass was granted at most locations). Point locations were established using Google Earth (*.kml file) and uploaded to a GPS unit after conversion to *.gpx file. At each sampling point, the sampling point's number, starting time, and all birds seen or heard in a 5-minute time period are recorded. The fly-overs are recorded separately (this is to separate birds that are "using" the site from those that are simply passing by/flying over it, e.g., birds that are foraging above the site would not be counted as fly-overs. To avoid double counting (i.e., counting the same bird at 2 different points), birds are recorded from the sampling point to a distance ½ the way to any adjacent sampling points. Any obvious pairs, juveniles with or without parent(s), and nests are noted as well. Any excessive noise that continuously impacts the ability to hear birds singing at a point is noted.

For the entire survey, survey date, as well as starting and ending time, temperature (°F), wind (Beaufort Scale) and sky (0=clear or few clouds, 1=partly cloudy, 2=mostly cloudy or broken clouds, 4=fog, 5=drizzle, 7=snow, 8=rain showers. If the temperature is above 80°, wind is greater than 5, or Sky is 7 or 8 or 4 with <250 m visibility) the surveys are not conducted.

Data analysis follows the Utah Riparian Bird Monitoring Program. Species richness is calculated as the number of different species within each Logan River Task Force Reach (Upper = RM 0.0– 3.0, Middle = RM 3.0-5.5, Lower = RM>5.5). Similarly, a Shannon-Wiener Index of species diversity is calculated for each river reach.

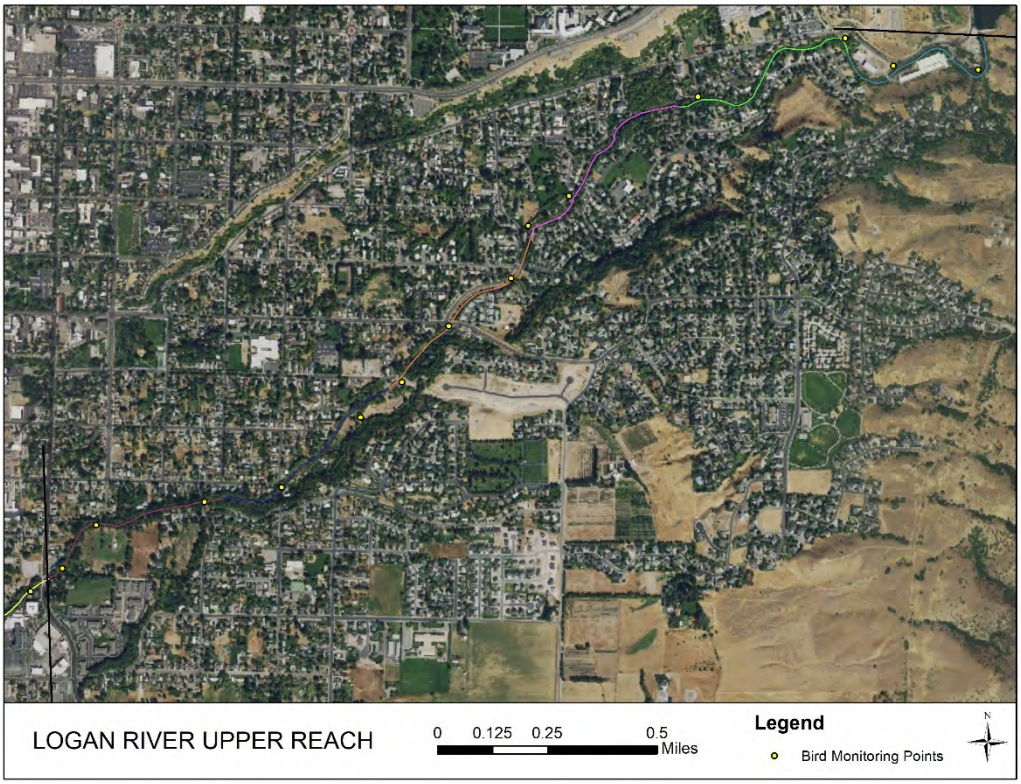

FIGURE 7. BIRD MONITORING SAMPLING POINTS AND INDIVIDUAL RIVER SEGMENTS FOR THE UPPER REACH.

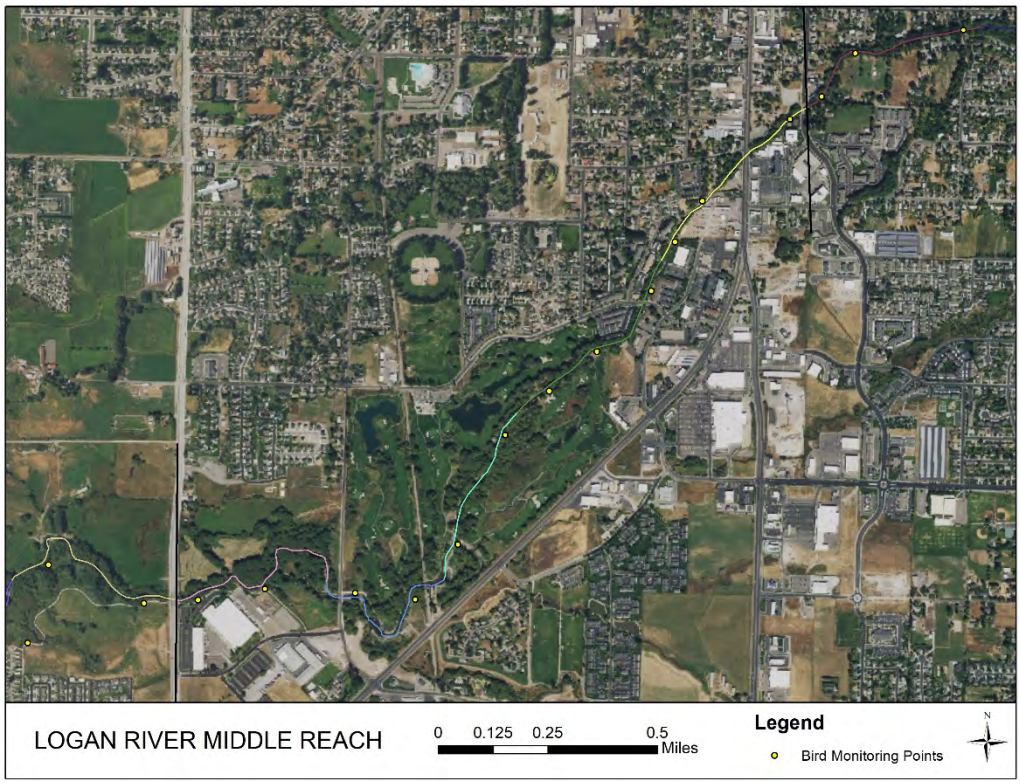

FIGURE 8. BIRD MONITORING SAMPLING POINTS AND INDIVIDUAL RIVER SEGMENTS FOR THE MIDDLE REACH.

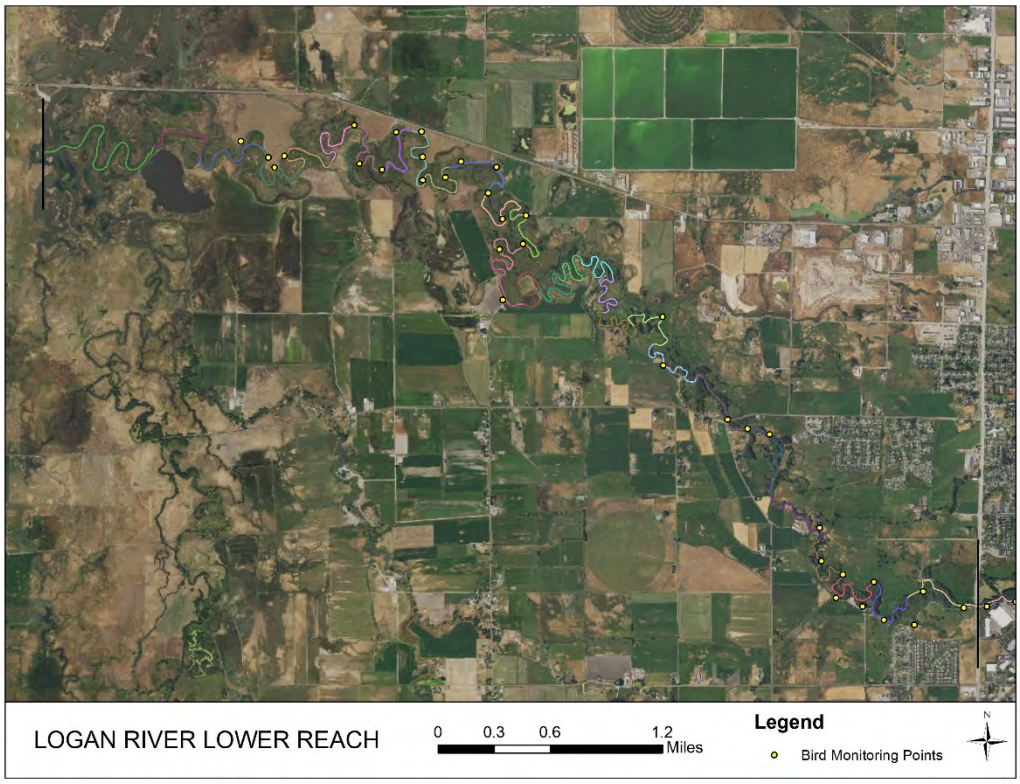

FIGURE 9. BIRD MONITORING SAMPLING POINTS AND INDIVIDUAL RIVER SEGMENTS FOR THE LOWER REACH.

3.7.2. Amphibians and Reptiles

Native species for the Logan River CAP study area include two snakes: wandering garter snake (*Thamnophis elegans vagrans)* and common garter snake *(Thamnophis sirtalis);* three frogs:northern leopard frog (*Lithobates pipiens*), boreal chorus frog (*Pseudacris maculate*), and woodhouse's toad), and tiger salamander (Ambystoma tigrinum). All of these species except for the toad and the salamander occur in all three reaches; the toad and the salamander likely occur only in the Lower Reach.

A baseline assessment of condition by reach, based on professional judgement, was: Upper Reach: fair, Middle Reach: fair, Lower Reach: poor. Potential threats to improved condition may include: destruction of hibernation sites, erosion and sedimentation, loss of riparian habitat to development and river channelization, poor water quality, and possible predation by bullfrogs.

In general, river and riparian restoration projects that increase floodplain habitat will be more beneficial for amphibians, by creating side channels and ponds, for example, and may be detrimental to some existing habitat for reptiles that are not riparian-dependent (e.g, garter snakes that have established hibernacula along the Logan River). Hibernacula can be inadvertently destroyed by earthmoving and grubbing activity during construction of a restoration project. Mapping hibernacula prior to construction could be used to potentially avoid removal if this can be accomplished with the project design.

For monitoring, some individual observations have been made for Rendezvous Park (Rendezvous Park Herp Monitoring, 2019) but f a protocol for monitoring by reach still needs to be planned and implemented. The USU Student Chapter of the Wildlife Society survey (Rendezvous Park Herp Monitoring, 2019) conducted in spring of 2019 could be used as a template for a monitoring protocol.

The monitoring consists of two sets of surveys, conducted in the spring. Each survey set includes both visual encounter and auditory surveys. The first survey set is conducted within 1 week of first observing garter snakes at known hibernacula locations (late March/early April), and the second survey set is conducted about a month later (late April/early May). The first visual encounter survey aims to identify areas where garter snakes are likely to have hibernacula under the assumption that the snakes have not moved far from their hibernacula yet. The second visual encounter survey aims to identify areas where garter snakes are most abundant after they have had time to move away from their hibernacula locations. Observations of herpetofauna other than garter snakes are also of interest and searched for during the visual encounter surveys. Visual encounter surveys consist of club members searching the full extent of the survey area and recording the species and GPS coordinates of all herpetofauna encountered.

Visual encounter surveys are conducted in the evening, and auditory surveys are conducted at least 30 minutes after sunset on the same day. Auditory surveys consist of a 2-minute acclimation period at each survey location prior to 3 minutes of listening for calling frogs. In addition to yearly reports, the results of the auditory surveys are also uploaded to FrogWatch USA.

Data collected during these visual encounter and auditory surveys are summarized as follows:

- Wandering garter snake kernel density quantiles
- Observations of non-wandering garter snake species
- Auditory survey results
- Wandering garter snake habitat use through time
- Wandering garter snake habitat use versus availability

The visual encounter surveys covered a total area of 5.62 ha, 1.67 ha of which has been “Treated” and 3.95 ha of which has been left “Untreated” during the river restoration project. For the purpose of this protocol, “Treated” areas are those which have had their vegetation removed, and “Untreated” areas are those that still retain their pre-restoration vegetation as determined via time-lapse Google Earth imagery (Figure 10). For results and detail information refer to Rendezvous Park Herp Monitoring (2019) or contact the USU Student Chapter of Wildlife Society at usuwildlife@gmail.com.

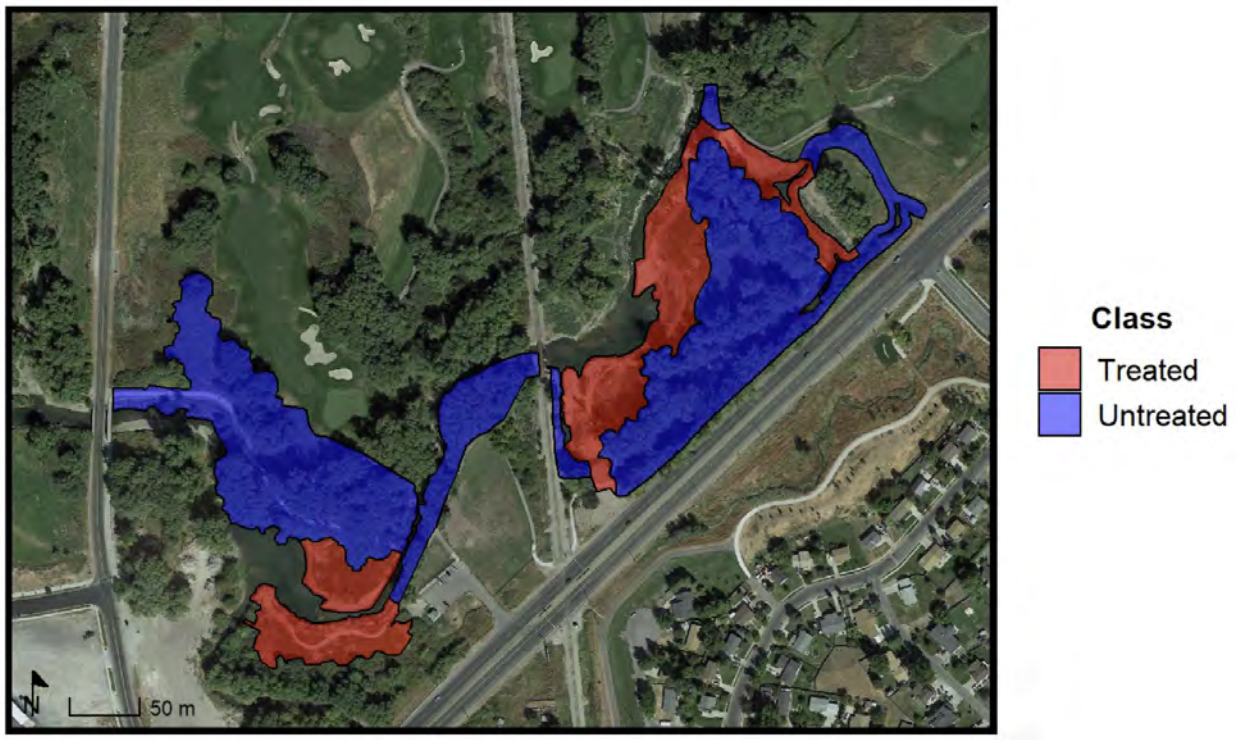

FIGURE 10. LOGAN RIVER RENDEZVOUS PARK HERP SURVEY AREA; GOOGLE EARTH IMAGE FROM SEPT. 14, 2018 (RENDEZVOUS PARK HERP MONITORING, 2019).

Another possibility for monitoring, or additional technology that could be deployed, would be to utilize frog loggers at key locations to monitor frogs over time, such as restoration areas at Rendezvous Park were frog ponds were created in the restoration design. Depending on the location loggers can also be used to detect bats.

3.8. Recreation

CAP indicators of recreation quality and baseline conditions as assessed by the Task Force are:

- Trail miles per river mile—the ratio of trail miles per river miles provides an indicator of the quantity of riparian or river trail experience available for the public to experience the river
- Trail continuity—baseline condition of poor in all reaches with no continuous trails through any reach
- Blue Trail—assessed based on the presence of river hazards/navigability of the river, assessed as having good baseline condition for the Middle Reach but poor in the Upper and Lower Reaches
- Legal access to the river bed (wading) —assessed as very good in all reaches (greater than 75% of reach accessible by wading)
- Legal access to the river bank (walking) —assessed as poor condition in all reaches (less than 25% of river bank publicly accessible)

- Access facilities (pedestrian/ADA access points, parking, boat launches, desirable river features for kayaking, tubing, canoeing) —assessed as poor in the Upper and Lower Reaches (no facilities) and fair in the Middle Reach (some facilities)
- Fishing success—assessed by catch rates of brown trout and whitefish, with baseline condition of fair in the upper and middle reaches and poor in the lower reach.
- Blue Ribbon Fishery status—the degree to which a river reach would be able to satisfy criteria for designation as a Blue Ribbon Fishery; baseline condition of the Upper Reach was fair, the Middle Reach, good, and the Lower Reach, poor.

3.8.1. Trails

A river trail for the purposes of the CAP is identified as a trail segment located in the riparian zone of Logan River and/or a trail segment providing the river experience (for example, an upland trail segment overlooking the river). Currently, no protocol for monitoring and assessing the quality of the trail system has been established or implemented throughout the study area reaches. In the CAP, the Logan River Task Force proposed that the general quality of river trails condition by evaluating the length of the trails, trail continuity, legal access to river bank and river bed, and presence of access facilities.

The ratio of trail miles per river mile (Trail Miles/ River Miles) by individual reaches will be used to account for new trails added as new projects are completed. The internal trails coming into or close to the river from the upland trail will be a part of the river trail. The following bracketing of conditions is proposed:

i) Poor Condition: < 50 %

ii) Fair Condition: 50 – 100 %

iii) Good Condition: 100 – 150 %

iv) Very Good Condition: > 150 %

Trail continuity is designed to capture any breaks, for example at-grade road crossings without the pedestrian crossings, and/or signals. The CAP project is not promoting trail development through property of unwilling landowners. Therefore, trail continuity would be achieved by routes that connect existing and future parks, trails, and access points without necessarily paralleling the river throughout the entire river corridor. Possibly property could be acquired for river access or park development/expansion. The following bracketing of conditions is proposed:

i) Poor Condition: more than two breaks within the reach

ii) Fair Condition: two breaks

iii) Good Condition: one break

iv) Very Good Condition: no breaks

Legal access reflects legal access to river bank and/or river bed using public property, not private property. In case of river bed (wading) river is assumed to be a public water (Public Trust Doctrine). For both, river bank and bed the evaluation goes as follow:

i) Poor: < 25 % of reach length

ii) Fair: 25 – 50 % of reach length

iii) Good: 50 – 75 % of reach length

iv) Very Good: > 75 % of reach length

Ensuring the legal access also addresses the impact on private property from public recreation. Littering, vegetation trampling, damage to fences, parking problems, trespassing or other negative impacts were noted by riverside landowners in stakeholder interviews completed by the Task Force leading up to development of the CAP. Access facilities, including pedestrian/ADA access points, parking, boat launches indicate river access or support river use. The determination of adequacy is based for each reach separately:

i) Poor: adequate on no facility types

ii) Fair: adequate on 1-2 facility types

iii) Good: adequate on 2-3 facility types

iv) Adequate on all 4 facility types

3.8.2. Blue Recreation/Trail

A Blue Trail is a river adopted by communities that are dedicated to improving family friendly recreation such as fishing, boating, hiking, and wildlife watching, and conserving the river and surrounding lands (American Rivers.org, Logan River Blue Trail Master Plan, January 2020).

The Logan City Council officially adopted the Logan River Blue Trail Master Plan in January 2020. The plan envisions the Logan River as a world-class recreational asset adding to existing community amenities and tourist attractions. The Plan has four main goals:

- Improve and develop river access points and improve recreational access to the Logan River (including carry-in watercraft access)
- Create and maintain safe river passage
- Promote the Logan River Blue Trail as a community amenity
- Foster community involvement, volunteerism, and stewardship of the Logan River.

The plan describes existing conditions of the Logan River relative to creating a Blue Trail. Current hazards to navigation are described along with appropriate treatments to provide safe passage. The plan identifies a network of access points to provide a variety of river experiences, ranging from leisurely family floats to day-long river excursions (Figure 11).

Many of the access points utilize City-owned property and are within Logan River Restoration project areas. General concepts for ecologically sound, ADA accessible landings are provided. Existing access resources, such as public parking and restrooms, are identified, along with conceptual designs for future facilities. The plan lays out a phased development strategy starting with the core area from Rendezvous Park to Trapper Park (Phase 1), expanding upstream to Stewart Park and downstream to 600 South Bridge near 2000 West (Phase 2), and culminating with future additional linkages. However,

development of the Logan River Blue Trail should be driven by opportunities as it develops, regardless of its phase. In addition to access facilities, this plan outlines the location and concept for a proposed kayak play park on a short, section of the river from 100 North to Center Street in Logan.
For more details on the Logan River Blue Trail please see Logan River Blue Trail Master Plan (January 2020).

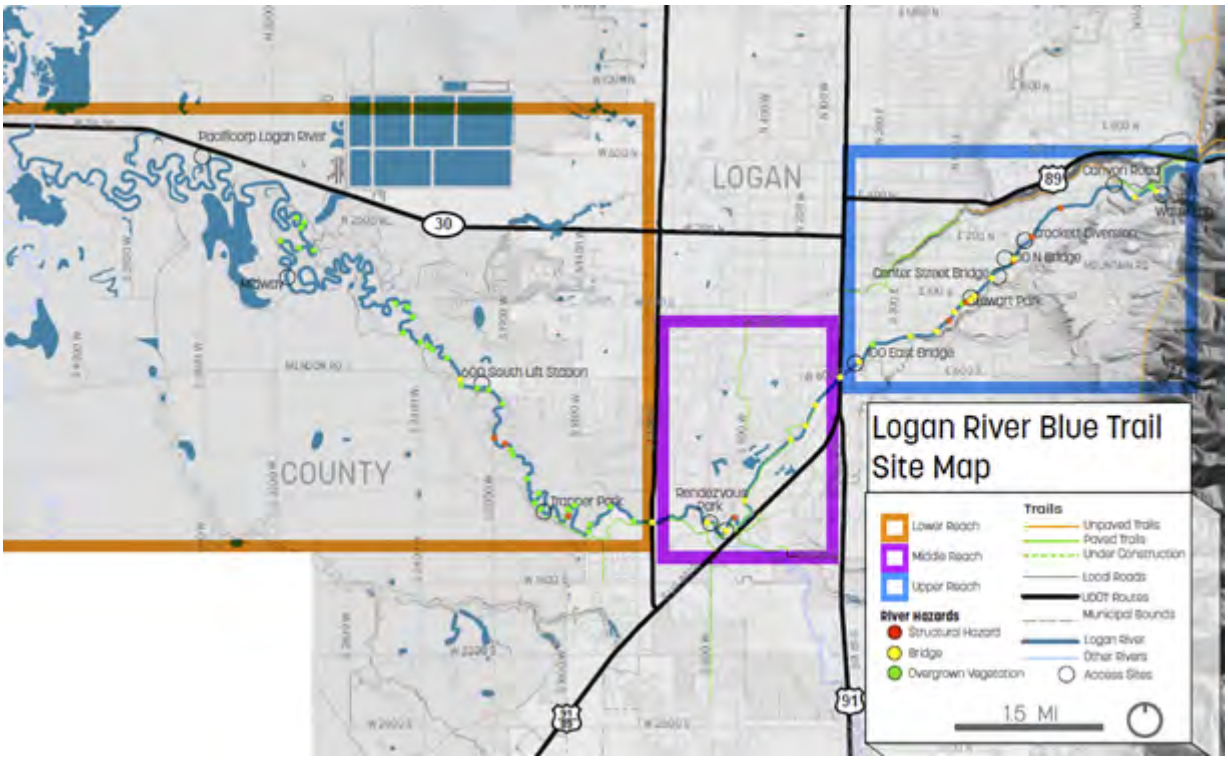

FIGURE 11. EXISTING CONDITIONS OF THREE REACHES OF LOGAN RIVER WITH CURRENT KNOWN OBSTACLES, LAND USES, ROAD AND TRAIL NETWORKS, AND PROPERTY OWNERSHIP ALONG THE RIVER (LOGAN RIVER BLUE TRAIL MASTER PLAN, 2020).

3.8.3. Fishing

The Logan River supports a popular fishery for native Bonneville cutthroat trout (*Oncorhynchus clarkii utah*), naturalized brown trout (*Salmo trutta*), stocked rainbow trout (*O. mykiss* including albino strains), and naturalized brook trout (*Salvelinus fontinalis*). A creel census conducted in the Upper Reach and upstream in 2002 revealed that the fishery gets consistent, moderate pressure, is fished by a wide variety of anglers, and most angling is catch and release (Budy et al. 2003). The great majority of the anglers ranked their fishing trip on the Logan River as “very satisfactory”, the highest possible category, demonstrating the popularity of this fishery for recreation enthusiasts; in addition, most (94%) caught trout on the Logan River are released, further indicating a community commitment to the future sustainability of the resource (Budy et al. 2003). This was consistent with 2017 creel survey where 95% of the fish were released (Budy et al., 2017).

The Trout Unlimited with cooperation of Utah State University, Utah Division of Wildlife Resources and USGS performed a creel survey on approximately 6.4 km (4 miles) of the Lower Reach of Logan River from April 1st to October 31st, 2019. The angler effort and catch data to calculate mean monthly catch

rates were collected. In addition, continuous stream temperature and flow from a river gage was collected and monthly means were calculated. The goal of the study was to determine if river flows and higher water temperatures influence angler catch rates of Brown Trout in the Lower Reach of Logan River (Coleman, DeRito, Penne, Thiede, Budy, 2020).

3.9. Property Impacts

The CAP includes two indicators of property impacts. One is potential adverse impacts associated with recreation use of the river on private property, such as litter or vandalism. Baseline condition was assessed as fair for all reaches, based on interviews and conversations with property owners at the time the CAP was being developed. The other indicator is the potential impacts of river restoration projects on private property owners. The Task Force also assessed this indicator as fair condition for all reaches as the baseline condition, and a key reason why the CAP was developed, to improve public input/knowledge of changes being made to the Logan River and to reduce the experience of adverse effects from these changes.

In general, stream proximity and quality have positive effects on property values and sales (Nicholls and Crompton, 2017). The effects of restoration projects on residential property value are inconclusive as some studies report increases – California properties studies which saw 3 - 13 % increase in property value (Streiner and Loomis, 1996) and some report decreases in values – Western Oregon stream frontage study showed 3 – 11 % price reduction for an average house (Mooney and Eisgruber, 2001). The benefits of river restoration along Logan River are being anecdotally identified but have not been systematically measured to date and there is not currently an identified monitoring protocol for these indicators. The river trail is one of the most popular places to walk, run and ride in Logan and is used extensively by the nearby residents.

Periodic surveys/interviews of riverside landowners (residential, commercial, and agricultural) could be included in the trails monitoring protocol previously described. Even a periodic/annual check-in phone call to a limited number of riverfront property owners by a Task Force representative prior to Task Force meetings could help maintain interest in the CAP; this is being done informally as projects and activities associated with the CAP and other river-focused projects are occurring, but could be better documented in Task Force meeting notes, for example.

3.10. Repeat Photography

Repeat photography is being used to qualitatively capture the success of individual restoration projects. Photography series can help illustrate changes in multiple CAP indicators: riparian vegetation, floodplain function, and recreation opportunity. Repeat photography is also being used in public outreach materials: brochures, website, signage. BIO-WEST is collaborating with Utah Department of Agriculture and Utah Water Watch to collect a restoration-project-based repeat photography database. BIO-WEST and the volunteer through Utah Water Watch takes photographs several times per year to show conditions prior to construction/restoration, during, and after restoration is complete (Figure 12). In addition to ground repeat photography, some aerial drone images are repeated over time as well (Figure 13).

FIGURE 12. REPEAT PHOTOGRAPHY AT LOGAN RIVER RESTORATION AT STEWART NATURE PARK.

FIGURE 13. AERIAL REPEAT PHOTOGRAPHY OF LOGAN RIVER RESTORATION AT RENDEZVOUS PARK.

4. LOGAN RIVER RESTORATION PROJECTS

4.1. Projects Completed

- Denzil Stewart Nature Park
- Rendezvous Park and Lower Golf Course
- Main Street to 100 East

Revegetation and weed control are still in progress for these projects.

1.2. Current projects and maintenance

- Logan City removed accumulated gravels in the upper end of the upper pool at Rendezvous Park which was used for riprap work on the eroding banks upstream of the golf cart bridge and upstream of the upper pool. This work was completed and the site reseeded April 2020. Additional wetland plantings will be planned when the Covid19 social distancing protocols are not needed.

1.3. Planned Projects

Stream restorations of wetland mitigation projects for:

- Kunzler Property East – part of SR30 Wetland Mitigation, Park Ave to 10th West (UDOT)
- Kunzler Property West – 73-acre conservation easement below 10th West (Logan City)

1.4. Potential Projects

- UWRL hillslope stabilization (Logan City, US Army Corps of Engineers)
- Crockett Diversion to Denzil Stewart Nature Park – diversion structure remodel, two bridge replacements, trail connections
- Providence Canal Diversion to River Heights Bridge – fish barrier removal, diversion and canal replacement, bank stabilization, floodplain restoration
- Main Street West (?)
- Restoration of upstream portion of the Golf Course Reach (Logan City)
- Projects included in the Logan River Blue Trail Master Plan

REFERENCES

Andree KB, MacConnell E, Hedrick RP. A nested polymerase chain reaction for the detection of genomic DNA of Myxobolus cerebralis in rainbow trout Oncorhynchus mykiss. Diseases of Aquatic Organisms. 1998 Oct 8;34(2):145-54.

Budy, P., E.A. de la Hoz, and G.P. Thiede. 2002. Logan River whirling disease study: factors affecting trout population dynamics, abundance, and distribution in the Logan River, Utah. Annual Report to Utah Division of Wildlife Resources. Utah Cooperative Fish and Wildlife Research Unit. Logan, Utah. 67 pages.

Budy, P., E.A. de la Hoz, and G.P. Thiede. 2001. Logan River whirling disease study: factors affecting trout population dynamics, abundance, and distribution in the Logan River, Utah. Annual Report to Utah Division of Wildlife Resources. Utah Cooperative Fish and Wildlife Research Unit. Logan, Utah. 64 pages.

Budy, P., G.P. Thiede, E.A. de la Hoz, and S. Vatland. 2003. Logan River whirling disease study: factors affecting trout population dynamics, abundance, and distribution in the Logan River, Utah. 2002 Annual Report to Utah Division of Wildlife Resources. USGS Utah Cooperative Fish and Wildlife Research Unit. Logan, Utah. 50 pages.

Budy, P., P. McHugh, and G.P. Thiede. 2004. Logan River whirling disease study: factors affecting trout population dynamics, abundance, and distribution in the Logan River, Utah. 2002 Annual Report to Utah Division of Wildlife Resources. USGS Utah Cooperative Fish and Wildlife Research Unit. Logan, Utah. 61 pages.

Budy, P., P.M. McHugh, G.P. Thiede, and E. VanDyke. 2005. Logan River whirling disease study: factors affecting trout population dynamics, abundance, and distribution in the Logan River, Utah. 2004 Annual Report to Utah Division of Wildlife Resources. UTCFWRU 2005(2):1-129.

Budy, P., G.P. Thiede, E.S. Hansen, and J. Wood. 2007a. Logan River whirling disease study: factors affecting trout population dynamics, abundance, and distribution in the Logan River, Utah. 2006 Annual Report to Utah Division of Wildlife Resources. Sport Fish Restoration. Grant number XIII. Project F-47-R. 52 pages.

Budy, P., G.P. Thiede, P. McHugh. 2007b. A quantification of the vital rates, abundance, and status of a critical population of endemic cutthroat trout. North American Journal of Fisheries Management 27:593-604.

Budy, P., Thiede, G., Meredith, C., Seidel, S., Logan River whirling disease study: factors affecting trout population dynamics, abundance, and distribution in the Logan River, Utah, Annual Report, USGS Utah Cooperative Fish and Wildlife Research Unit, 2009.

Budy, P., Thiede, G., Meredith, C., Chaston, R., Logan River whirling disease study: factors affecting trout population dynamics, abundance, and distribution in the Logan River, Utah, Annual Report, USGS Utah Cooperative Fish and Wildlife Research Unit, 2010.

Budy et al., unpublished Logan River data, 2016.

Coleman, T., J. DeRito, C. Penne, G.P. Thiede, and P. Budy. 2020. Fishing success goes with the flow: correlation between stream flow and temperature and angler catch rates. Oral presentation. Annual Meeting of the Utah Chapter of the American Fisheries Society, St. George, Utah, 26-27 February 2020.

Cuffney TF, Bilger MD, Haigler AM. Ambiguous taxa: effects on the characterization and interpretation of invertebrate assemblages. Journal of the North American Benthological Society. 2007 Jun;26(2):286-307.

Hawkins CP, Norris RH, Gerritsen J, Hughes RM, Jackson SK, Johnson RK, Stevenson RJ. Evaluation of the use of landscape classifications for the prediction of freshwater biota: synthesis and recommendations. Journal of the North American Benthological Society. 2000 Sep;19(3):541-56.

Howe, F., Logan River Bird Monitoring Protocol, 2016.

Klemm, D. J., Lewis, P. A., Fulk, F. and Lazorchak, J. M.: 1990, *Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters*, EPA.600/4-90/030, Environmental Monitoring Systems Laboratory, Office of Modeling, Monitoring Systems, and Quality Assurance, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH.

Lazorchak JM, Klemm DJ, Peck DV, editors. Environmental Monitoring and Assessment Program Surface Waters: Field operations and methods for measuring the ecological condition of wadeable streams.

Logan River Restoration Conservation Action Plan (CAP), Logan River Task Force, Logan City, BIO-WEST, May 2016.

Logan River Restoration at Rendezvous Park, 2017 Pre-construction Riparian Vegetation Conditions Monitoring Report, BIO-WEST, Inc., 2018.

Logan River Restoration at Rendezvous Park, 2018 Year 1 (Post-construction) Riparian Vegetation Conditions Monitoring Report, BIO-WEST, Inc., 2019.

Logan River Restoration at Rendezvous Park, 2018 Year 2 (Post-construction) Riparian Vegetation Conditions Monitoring Report, BIO-WEST, Inc., 2020.

Logan River Blue Trail Master Plan, January 2020.
Mooney, S., & Eisgruber, L. M. (2001). The influence of riparian protection measures on residential property values: The case of the Oregon plan for salmon and watersheds. Journal of Real Estate Finance and Economics, 22, 273–286. https://doi.org/10.1023/A:1007899716050

Morris WF, Doak DF. Quantitative conservation biology. Sinauer, Sunderland, Massachusetts, USA. 2002.

Nicholls S, Crompton JL. The effect of rivers, streams, and canals on property values. River Research and Applications. 2017 Nov;33(9):1377-86.

Plafkin, J. L., Barbour, M. T., Porter, K. D., Gross, S. K. and Hughes, R. M. 1989. *Rapid bioassessment protocols for use in streams and rivers*, Benthic macroinvertebrates and fish. EPA/444/4–89/001 160Washington: Office of Water Regulations and Standards, U.S. Environmental Protection Agency.

Rendezvous Park Herp Monitoring, The USU Student Chapter of The Wildlife Society's Rendezvous Park herp monitoring project, 2019.

Streiner, L., & Loomis, J. B. (1996). Estimating the benefits of urban stream restoration using the hedonic price method. Rivers, 5, 267–278.

Wheaton JM, Fryirs KA, Brierley G, Bangen SG, Bouwes N, O'Brien G. Geomorphic mapping and taxonomy of fluvial landforms. Geomorphology. 2015 Nov 1;248:273-95.

White GC, Burnham KP. Program MARK: survival estimation from populations of marked animals. Bird study. 1999 Jan 1;46(sup1): S120-39.

http://www.usu.edu/buglab/SampleProcessing/ResultsAndReports/#item=85.

http://www.qcnr.usu.edu/wmc/data