Appendix B ENGINEERING STUDIES

The following engineering reports were used in preliminary evaluations of the Upper Main Ditch Piping Project and were used to develop and support the analysis in this Draft EIR.

B.1 DOMENICHELLI AND ASSOCIATES UPPER MAIN DITCH PIPING BASIS OF DESIGN REPORT (JULY 24, 2014)
B.2 DOMENICHELLI AND ASSOCIATES FINAL UPPER MAIN DITCH BASIS OF DESIGN REPORT UPDATES TECHNICAL MEMORANDUM (JANUARY 29, 2016)
B.3 DOMENICHELLI AND ASSOCIATES UPPER MAIN DITCH ALIGNMENT ALTERNATIVES (MARCH 9, 2018)
B.4 HYDROSCIENCE WATER QUALITY IMPACT ANALYSIS (DECEMBER 2016)
B.5 TULLY AND YOUNG MAIN DITCH WATER LOSS TECHNICAL MEMORANDUM (FEBRUARY 2017)
B.6 YOUNGDAHL CONSULTING GROUP, INC. GROUNDWATER RESOURCES IMPACT ANALYSIS FOR EL DORADO IRRIGATION DISTRICT UPPER MAIN DITCH PIPING PROJECT (APRIL 7, 2017)
B.7 EL DORADO IRRIGATION DISTRICT CONSUMPTION REPORT (2016)
B.8 DOMENICHELLI AND ASSOCIATES UPPER MAIN DITCH PIPELINE 60 PERCENT DESIGN (2018)
B.9 WESTMARK GROUP MAIN DITCH - FOREBAY RESERVOIR TO RESERVOIR 1 SEPTIC SYSTEM AND DOMESTIC WELL LOCATIONS REPORT (2013)
Appendix B Engineering Studies

B.1 DOMENICHELLI AND ASSOCIATES UPPER MAIN DITCH PIPING BASIS OF DESIGN REPORT (JULY 24, 2014)
UPPER MAIN DITCH PIPING
BASIS OF DESIGN REPORT

PREPARED FOR:

El Dorado Irrigation District

Prepared By:

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July 24, 2014
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APPENDIX B – Project Site Photos
APPENDIX C – Project Calculations
APPENDIX D – Construction Details
APPENDIX E – EID Provided Design Data
APPENDIX F – Opinion of Probable Construction Costs
EXECUTIVE SUMMARY

The purpose of this Basis of Design Report (BODR) is to determine final design criteria and prepare a 10% level of design for the piping of the Upper Main Ditch for the El Dorado Irrigation District (EID). The pipeline will be approximately three miles in length and travel along the Main Ditch between Forebay Reservoir and Reservoir 1 Water Treatment Plant (WTP). EID intends to construct a pipe that will replace the open ditch, convey raw water, reduce leakage and losses, and improve the water quality of water entering the treatment plant.

Pipeline Material Selection

Three pipe materials, Polyvinyl Chloride (PVC), Ductile Iron Pipe (DIP), and High Density Polyethylene Pipe (HDPE), were reviewed and evaluated. PVC pipe was selected based on its cost, estimated service life, hydraulic capacity, and ease of construction.

Pipeline Alignment Selection

Three alignments were reviewed. Alignment#1 follows the existing ditch alignment for 15,400 feet. Alignment #2 follows the existing ditch for 11,550 feet and has a 1,750 feet cross country portion that will require a creek crossing, an access road in relatively steep terrain, and erosion control at a blow off valve at the low point at the creek, for a total length of 13,300 feet. Alignment #3 follows the existing ditch for 6,100 feet and has a portion within Blair Road for approximately 6,800 feet, which will require saw cutting, asphalt removal, structural backfill, road repair, pavement/slurry placement, centerline restriping, and traffic control, for a total length of 12,900 feet.

Alignment #1 was selected as the preferred alignment due to ease of installation, least easement acquisition requirements, reduced O&M, and lowest cost.

Hydraulic Analysis

The hydraulic analysis is based on the recommended Alignment #1, design drawings for the Forebay Dam Modification project and a limited topographic survey prepared by Alan Divers, PLS. EID provided maximum and minimum operating water surface elevations in the Forebay Reservoir as a baseline for the hydraulic calculations. Based on a maximum design flow of 40 cfs, the recommended pipe size will be a combination of 36-inch and 42-inch diameter PVC pipe.

Other Design Considerations

- There are three existing EID raw water customers served from the Main Ditch. Continuation of service to these customers will be required.

- The need for a pig launching facility was initially reviewed, however Forebay water quality and flows above minimum scouring velocity eliminate the need for further consideration.
• At the inlet to the WTP a structure is proposed that will dissipate energy from the discharge pipe, and collect and screen debris that may enter the system at Forebay Reservoir.

Construction Schedule

The project must be constructed during the annual El Dorado Canal outage. The outage generally occurs from October through December each year. For this project the outage may be extended thru February. In order to construct approximately 15,400 feet of new pipe in Alignment #1 during the canal outage, either the contractor will have to use multiple construction crews, or construct the project during two separate annual outages. It is anticipated the project will require two construction seasons.

Preliminary Opinion of Probable Costs

A preliminary Opinion of Probable Construction Cost was prepared for each alignment. The estimated project costs are summarized below.

• Alignment #1 – Approximately $6.0 million
• Alignment #2 – Approximately $6.0 million
• Alignment #3 – Approximately $6.7 million.
SECTION 1 – PURPOSE, BACKGROUND AND OBJECTIVES

Purpose

The purpose of the Main Ditch Piping project is to replace an approximately three mile long section of water supply ditch with a buried pipeline. The pipeline will reduce losses due to seepage and improve the water quality entering the treatment plant. An independent report by Jones & Stokes Engineers estimated that a significant volume of water, up to 1,300 acre feet/year is lost along this stretch of the Main Ditch. This basis of design report (BODR) describes project challenges and solutions, provides final design parameters and includes 10% design plans and total cost estimate for the proposed pipeline.

The following provides a brief overview of the main ditch and project challenges.

Background

The EID Upper Main Ditch is a section of the El Dorado Ditch built by mining interests to convey water to the Placerville area in the late 1800s. The ditch and water rights were then sold to the Western States Gas and Electric Company in the early 1900s, primarily for hydro-power generation. A smaller portion of the ditch water was maintained for delivery to some agricultural users. Over time, after several name changes and through agreements with the power company, EID took over the rights and responsibilities for delivering the non-power generating water to the irrigation and domestic water users from the ditch system. Currently, EID has taken over all water rights and facilities along the original El Dorado Canal (Project 184).

The Main Ditch is the section of the El Dorado Ditch from the El Dorado Forebay Reservoir, northeast of Pollock Pines, downstream to the Placerville area. The portion of the ditch ending at the Reservoir 1 Water Treatment Plant (WTP) is designated as the Upper Main Ditch (see Figure 1). The Upper Main Ditch is used to convey raw water from the Forebay Reservoir to EID’s Reservoir 1 WTP. This Upper Main Ditch section is the portion under review for replacement with a pipeline.
Existing Upper Main Ditch Description

The Upper Main Ditch is approximately three miles long and conveys raw water to the Reservoir 1 water treatment plant facilities. A short section of ditch (approximately 300 lineal feet) runs from the treatment plant diversion down to a 54-inch bypass pipe that outlets into the Middle Main Ditch reach. Figures 2 and 3 show the ditch at the Reservoir 1 Treatment Plant Diversion.
The entire Upper Main Ditch is fairly uniform in section, with a top width ranging from 14 to 20 feet, and slope of approximately 0.1% to 0.2%. The ditch profile is relatively constant throughout the project reach.

There are currently three customers receiving raw water along the project reach prior to the Reservoir 1 water treatment plant. See Appendix E for raw water customer location maps.
Concentrated storm runoff flows enter the ditch at several locations. The drainage area tributary to the upper ditch is approximately 315 acres.

Figures 4 and 5 show a typical ditch and bench configuration. The bench is located on the downhill side of the ditch and ranges in width from 7 to 12-feet.

Figure 4. Typical ditch/access path configuration (Looking Downstream)

Figure 5. Typical ditch/access path configuration (Looking Upstream)
Figure 6 shows the inlet to the Main Ditch at the existing Forebay Reservoir outlet. This structure will be reconstructed as part of the Forebay Dam Modifications project, slated for construction in 2015-2016.

Additional site photos are provided in Appendix B. The photos provide a pictorial overview of the ditch and structures (bridges, pipe crossings, culverts, etc.) that exist at the time of this report.

Future Projects Affecting Design

There are two known construction projects along the ditch alignment that will affect the design of the new improvements. The improvements are the Forebay Dam Modification Project and the Blair Road Bridge Replacement Project. Each project is described below.

Forebay Dam Modification Project

The Forebay Reservoir, constructed in 1922, receives water from the 22-mile-long El Dorado Canal, which originates at the South Fork of the American River at Kyburz. EID is currently planning to make several modifications to the dam and reservoir. The dam modification project will strengthen and raise the earthen dam 10-feet to satisfy regulatory requirements and increase its water storage capacity. EID has provided construction documents of the dam modifications prepared by GEI Consultants. The construction period is anticipated to begin in the spring of 2015 and be completed in the fall of 2016.

Specific to the Main Ditch project, the dam modification project will construct a new valve house at the inlet to the ditch below the Forebay. The valve house will be the terminus of a 36-inch steel pipe that conveys water from the trash rack covered inlet structure in the reservoir, to the ditch. An 18-inch diameter orifice plate will be installed in the 36-inch steel pipe that will
restrict the discharge opening, and reduce the head of the Main Ditch. The orifice plate will be removed when the ditch is piped.

These future modifications will be considered during the design of the piping system for the Upper Main Ditch.

**Blair Road Bridge Replacement Project**

El Dorado County Department of Transportation is currently planning to replace the Blair Road Bridge crossing of the Main Ditch. The bridge was built in 1935 and is 79 years old. It is a 15-feet wide, 35-feet long, one-lane crossing, made of reinforced concrete slab with concrete barrier rail. Based on the El Dorado County website, the anticipated project schedule has the plans, specifications and estimates (PS&E) being developed in fiscal year (FY) 2014/15, right of way acquisition in FY 2015/16, and the construction in FY 2016/17. The bridge will be closed for approximately 60 days during construction. The project includes removal of the Blair Road drainage culvert and associated flows otherwise flowing into the Main Ditch. Figures 7 and 8 show the existing Main Ditch and Blair Road Bridge crossing.

Coordination between the Blair Road Bridge replacement design and the Upper Main Ditch pipeline design will be necessary to ensure that improvements will be compatible.

![Figure 7. Blair Road/Main Ditch Crossing (Looking Downstream)](image)
Report Objectives

The objectives of this BODR include:

1. Evaluating options for pipe materials with respect to construction, pressure ratings, life cycle, joint type and bonding, hydraulic capacity, and cost.
2. Evaluating alignment alternatives, including following existing ditch alignment, cross country, and/or Blair Road crossing sections.
3. Providing a hydraulic analysis of the new pipe section.
4. Providing design recommendations including: typical large diameter pipeline installation details; typical and special end connection details; evaluation of the need for weighted collars to prevent floatation during dewatering; customer raw water connections; valves (blow-offs, ARVs, isolations); access points along the pipeline length; special construction at points of obstructions or shallow depths; and existing storm drain connections and potential diversion of water over pipeline alignment.
5. Estimating construction costs based on 10% level of design, recommended pipe type, estimated quantity of backfill, and alternative cost differences.
Available Data

For the purposes of preparing this BODR, EID provided the following data, which are included in Appendix E for reference:

- Initial Survey Data Points for the Ditch Alignment
- Available Parcel Maps of adjacent properties - Forebay to Res 1
- Wetland Delineation Report, EN2 Resources
- Cultural Resources Summary, Cardno ENTRIX
- Septic and Well Report, Westmark Group
- Proposed Forebay Dam Modifications, GEI Consultants
- Reservoir 1 WTP Inlet Facilities Plan
- Existing Raw Water Customer Locations
SECTION 2 – PIPELINE MATERIAL SELECTION

General Considerations

Selection of pipeline material is dependent on several factors that all lead to optimizing life cycle costs. Along with the actual cost of the pipe, the final installation needs to be suitable for pressure, external loadings, easily serviceable, and have a long service life, without excessive installation costs. This report section summarizes factors used in the final pipe material selection.

Material Selection Criteria

The following criteria were used to evaluate pipeline material alternatives:

- **Service Life Expectancy** – Estimated service life of 50-100 years.
- **Corrosion Potential** – Corrosion potential if active corrosion protection and/or cathodic protection is not provided.
- **Hydraulic Capacity** –
  - Maximum capacity of 40.0 cubic feet per second (cfs).
  - Average velocity of 5 feet per second (fps).
- **Pressure Rating** – Minimum of 50 psi.
- **Operation and Maintenance** – Ease of long term repair and maintenance.
- **Constructability Factors** –
  - Alignment Considerations – Allowable deflections.
  - Joint Type and Bonding – Restrained, ease of assembly in field.
  - Backfill requirements – Maximum use of native materials for backfill.
  - Thermal Expansion – Thermal expansion and contraction tolerance.
  - Continuation of existing raw water services (three total) – Ability to service existing customers.
- **Costs** – Material and construction costs.
Pipe Materials Evaluated

The following pipeline materials were evaluated relative to the alignment conditions, basic pipeline criteria and overall costs.

1. Polyvinyl Chloride (PVC)
2. High Density Polyethylene (HDPE)
3. Ductile Iron (DI)

The advantages and disadvantages of each of the pipeline materials are discussed below.

PVC Pipe

Polyvinyl Chloride (PVC) pipe is a common application for buried pressure pipe conveying non-potable and potable water. Table 1 provides a summary of the advantages and disadvantages of PVC pipe. A discussion of the qualities of PVC pipe relative to the selection criteria is provided below.

Table 1. Advantages/Disadvantages of PVC Pipe Material

<table>
<thead>
<tr>
<th>PVC Pipe Material</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Life Expectancy</td>
<td>Light weight susceptible to floatation</td>
<td>Fittings and Restraints may have corrosion potential</td>
</tr>
<tr>
<td>Non-corrosive</td>
<td>Fittings and Restraints may have corrosion potential</td>
<td>Gasketed joints may be subject to root intrusion</td>
</tr>
<tr>
<td>Good hydraulic capacity (low friction)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowest Cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light weight – Easy to handle and install</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tight turning radius made by joint deflection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low thermal expansion – can be contained within joints</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Service Life Expectancy – Life expectancy for PVC pipe is estimated at 100-years or more, with a guarantee of 50-years.

Corrosion Potential – PVC pipe does not undergo galvanic corrosion, though metal fittings and restraint collars may require cathodic protection if site conditions are warranted. Per EID standards, cast iron pipe fittings and restrained joints shall be wrapped in polyethylene (8 mils minimum thickness). Corrosion potential is not a factor for PVC pipe.

Hydraulic Capacity - PVC pipe has a Hazen-Williams C-Factor of 150, and a Manning’s ‘n’ value of 0.009 (per JM Eagle Big Blue C905 PVC pipe). For design purposes, a lower Hazen-Williams C-Factor value of 140 should be used to take into account air, turbulence, sediment, etc. inside the pipeline. The inside diameter of a 36-inch DR 51 (80 psi) PVC pipe is 36.71-
inches and 42.65-inches for a 42-inch pipe. At this pressure rating and sizes PVC has sufficient hydraulic capacity.

**Constructability –**

- **Alignment Considerations** – Installing large diameter PVC pipe on a radius is difficult due to the large moment of inertia in the pipe. Pipe manufacturers recommend a maximum joint deflection of up to 1.5 degrees. Using 20-foot pipe lengths will produce a radius of 764 feet. If the laying length was reduced to 10 feet, with the same joint deflection, the radius reduces to 382 feet. A high deflection coupling is available that will allow deflections up to 3 degrees, which will produce a radius of 382 feet. If the laying length was reduced to 10 feet, with the same joint deflection, the radius reduces to 191 feet. The result in decreasing the laying length of the pipe will allow for a tighter turning radius, rather than placing cast iron fittings at turns. Based on the preliminary alignments evaluated there will be several locations where fittings will be required to remain within the existing easement, regardless of turning radius.

- **Joint Type and Bonding** – PVC pipe is joined together by gasket joints and, in conjunction with restrained mechanical joints, can eliminate the need for concrete thrust blocking.

- **Cover** – PVC pressure pipe can be buried with a minimum depth of cover from 1 foot in H20 live load traffic conditions, with manufacturer recommended bedding and backfill (95% relative compaction). As discussed later in Section 5 Ancillary Facilities and Construction Issues, the minimum depth of cover may need to be increased to eliminate the possibility of pipe floatation and protect during construction traffic.

- **Floatation** – Since the pipeline will be dewatered for two months each year, the pipeline may experience floatation should groundwater levels be high enough in the pipe trench. Concrete collars may be used to anchor the pipe to prevent floatation. Concrete collars can serve a second purpose as a trench dam. Concrete trench dams, placed along the pipe alignment, can be installed to stop water that may follow the pipe backfill bedding. Drain pipe could be placed at selected areas to remove the water from the pipe backfill bedding and discharge it to daylight on the downhill side of the pipe, which will aid in eliminating floatation.

- **Pipe Connections** – PVC has available saddles for easy adaption of blow-off, combination air vacuum release valves, and raw water service taps.

- **Thermal Expansion** – The coefficient of thermal expansion for PVC pipe is approximately 0.04-inch per 100 ft per degree Fahrenheit change. Since the joints are gasketed, the thermal expansion can be contained and spread out within the joints. Being buried pipe and having a relatively consistent water temperature means that thermal expansion will not be too much once the system is in use. The greatest amount of thermal expansion is anticipated to be during the refilling of the system with cold water each January and the end of the yearly canal outage.
Costs – PVC pipe weighs the same per linear foot as HDPE. Similar to HDPE pipe, the flexibility and relatively light-weight nature of the pipe reduces shipping, handling and installation efforts and costs. The material costs for PVC for 36-inch pipe is approximately $60 per foot and $78 for 42-inch diameter. Relative to the other pipe materials evaluated the material and installation costs for PVC are considered low.

HDPE Pipe

High Density Polyethylene (HDPE) pipe is applicable for both gravity and pressure pipe systems. Table 2 provides a summary of the advantages and disadvantages of HDPE pipe. A discussion of the qualities of HDPE pipe relative to the selection criteria is provided below.

Table 2 Advantages/Disadvantages of HDPE Pipe Material

<table>
<thead>
<tr>
<th>HDPE Pipe Material</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Life Expectancy</td>
<td>Light weight susceptible to floatation</td>
<td></td>
</tr>
<tr>
<td>Non-corrosive</td>
<td>Specialty contractor for thermal fusion</td>
<td></td>
</tr>
<tr>
<td>Joints are butt-fusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good hydraulic capacity (low friction)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowest Cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tightest bending radius of all three materials reviewed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavier weight decreases susceptibility to floatation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Service Life Expectancy – Life expectancy for HDPE pipe is estimated between 50- to 100-years.

Corrosion Potential – HDPE pipe does not undergo galvanic corrosion and may be safely installed in ‘hot’ soils that would otherwise attack metal pipes and fittings, therefore there would be no need for cathodic protection.

Hydraulic Capacity - HDPE pipe has a Hazen-Williams C-Factor of 150, and a Manning’s ‘n’ value of 0.009. For design purposes, a lower Hazen-Williams C-Factor value of 140 should be used to take into account air, turbulence, sediment, etc. inside the pipeline. The inside diameter of a 36-inch DR 32.5 (63 psi) HDPE pipe is 33.65-inches and 39.26-inches for a 42-inch pipe.

Constructability –

- Alignment Considerations – HDPE pipes can be bent to a tighter radius than PVC for the same size pipe. For example a 42-inch HDPE pipe with a pressure rating of 160 psi (DR13.5) has a minimum radius of 100 feet, while an HDPE pipe with a pressure rating of 65 psi (DR32.5) has a minimum radius of 157 feet. Based on the preliminary
alignments evaluated there will be several locations where fittings will be required to remain within the existing easement, regardless of turning radius.

- **Joint Type and Bonding** – HDPE pipe sections are joined together by butt fusion welding, and can be treated as a continuous pipeline without joints. Fused joints are superior to gasket joints for leak prevention. HDPE pipe and fittings joined by heat fusion are self-restrained and therefore do not require thrust blocks, provided the entire system is fused. All individuals involved in the joining of HDPE pipe systems, whether it be using the typical heat fusion methods or employing mechanical connections, should be fully trained and qualified in accordance with applicable codes and standards and/or as recommended by the pipe or fitting manufacturer. Pipe fusion requires an energy source for thermal fusion, in the remote areas the project is located may present difficulty providing the power requirements.

- **Cover** – HDPE pipe can be buried with a minimum depth of cover from 2 feet in no traffic conditions, to 3 feet where H2O live load is anticipated. Due to HDPE’s density being slightly less than water, the pipe will float even when it’s full of water. Since the pipeline will be dewatered for two months each year, the pipeline may experience floatation should ground water levels be high enough in the pipe trench. Concrete collars may be used to anchor the pipe to prevent floatation. Concrete collars can serve a second purpose as a plug drain. Plug drains, placed along the pipe alignment, can be used to block water that may follow the pipeline alignment in the backfill bedding and divert the water to daylight on the downhill side of the pipeline will eliminate floatation.

- **Floatation** – Since the pipeline will be dewatered for two months each year, the pipeline may experience floatation should groundwater levels be high enough in the pipe trench. Concrete collars may be used to anchor the pipe to prevent floatation. Concrete collars can serve a second purpose as a trench dam. Concrete trench dams, placed along the pipe alignment, can be installed to stop water that may follow the pipe backfill bedding. Drain pipe could be placed at selected areas to remove the water from the pipe backfill bedding and discharge it to daylight on the downhill side of the pipe, which will aid in eliminating floatation.

- **Pipe Connections** – Due to the flexing of the HDPE pipe, taps for blow off and combination air vacuum release valves, and raw water services, will require full circumference tapping sleeves, which will introduce a potential for leakage. Flange connections will require installation of a backing ring.

- **Thermal Expansion** – Placing pipe that has been in direct sunlight in a cooler trench will result in thermal contraction of the pipe’s length. This contraction can generate force that could result in pull out at mechanical couplings or other buried structures. Allow the pipe to cool before making connections to an anchored joint, flange, or a fitting that requires protection against excessive pull out forces. Covering the pipe with embedment will facilitate cooling. The unrestrained coefficient of thermal expansion for HDPE pipe is approximately 0.108-inch per 100 ft per degree Fahrenheit change.
Costs – The flexibility and relatively light-weight nature of HDPE pipe reduce shipping, handling, and installation efforts and costs. Although normally used for lower pressure and raw water applications, HDPE pipe has been approved by the NSF (National Sanitary Foundation) for use in potable water systems. HDPE pipe weighs the same per linear foot as PVC. Similar to PVC pipe, the flexibility and relatively light-weight nature of the pipe reduces shipping, handling and installation efforts and costs. The material costs for HDPE for 36-inch pipe is approximately $70 per foot and $95 for 42-inch diameter. Relative to the other pipe materials evaluated the material and installation costs for HDPE are considered low.

Ductile Iron Pipe

Ductile iron (DI) pipe is a common application for buried pressure pipe conveying potable water. The durability of the thicker iron pipe ensures a long life and less potential for structural failure. EID standards require DIP be wrapped in a minimum 8 mil polyethylene wrap per AWWA/ANSI. Table 3 provides a summary of the advantages and disadvantages of DI pipe.

Table 3. Advantages/Disadvantages of DIP Pipe Material

<table>
<thead>
<tr>
<th>DIP Material</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Life Expectancy</td>
<td>Pipe and fittings are susceptible to corrosion</td>
<td></td>
</tr>
<tr>
<td>Tight turning radius</td>
<td>Gasketed joints may be subject to root intrusion</td>
<td></td>
</tr>
<tr>
<td>and/or fabricated fittings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can be installed at a</td>
<td>Highest Cost</td>
<td></td>
</tr>
<tr>
<td>minimum cover in H20 loading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low thermal expansion</td>
<td>Pipe is heavy, making installation more difficult</td>
<td></td>
</tr>
<tr>
<td>– can be contained within</td>
<td></td>
<td></td>
</tr>
<tr>
<td>joints</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavier weight decreases</td>
<td>Hydraulic capacity starts lower than PVC and HDPE, and will</td>
<td></td>
</tr>
<tr>
<td>susceptibility to floatation</td>
<td>decrease further with time.</td>
<td></td>
</tr>
<tr>
<td>High Pressure Rating</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Service Life Expectancy – Life expectancy for DI pipe is estimated at 100-years.

Corrosion Potential – DI pipe and fittings undergoes galvanic corrosion and may not be safely installed in ‘hot’ soils without the need for cathodic protection.

Hydraulic Capacity – New DI pipe has a Hazen-Williams C-Factor of 140 (Per DIPRA), with a Manning’s ‘n’ value of 0.011 for new pipe. Hazen-Williams C-Factor values will decay to 100-110 as the pipe ages. The lower C-Factor should be used for design. Based on this information DI pipe is not as efficient as PVC or HDPE.
Constructability –

- **Alignment Considerations** – The ductile iron pipe manufacturers recommend curved alignments be made by deflecting the pipe at the joints. A deflection angle of 4 degrees at a joint will produce an offset in an 18 feet section of approximately 15-inches. Consecutive deflections at joints using 18 feet sections of pipe will produce a radius of 258 feet. Following EID’s requirement to use 80% of the manufacturer’s maximum deflection increases the minimum radius to 323 feet. Based on the preliminary alignments evaluated there will be several locations where fittings will be required to remain within the existing easement, regardless of turning radius.

- **Joint Type and Bonding** – DI pipe is joined together by gasket joints and, in conjunction with restrained mechanical joints, can eliminate the need for concrete thrust blocking.

- **Cover** – DI pipe can be buried with a minimum depth of cover from 1 foot in H2O live load traffic conditions, with manufacturer recommended bedding and backfill (95% relative compaction, Type 5 trench).

- **Floatation** – Since the pipeline will be dewatered for two months each year, the pipeline may experience floatation should groundwater levels be high enough in the pipe trench. Concrete collars may be used to anchor the pipe to prevent floatation. Concrete collars can serve a second purpose as a trench dam. Concrete trench dams, placed along the pipe alignment, can be installed to stop water that may follow the pipe backfill bedding. Drain pipe could be placed at selected areas to remove the water from the pipe backfill bedding and discharge it to daylight on the downhill side of the pipe, which will aid in eliminating floatation.

- **Pipe Connections** – DI pipe has available saddles for easy adaption of blow-off, combination air vacuum release valves, and raw water service taps.

- **Thermal Expansion** – The coefficient of thermal expansion for DIP pipe is approximately 0.00744-inch per 100 ft per degree Fahrenheit change. Since the joints are gasketed, they will provide enough clearance to account for thermal growth.

** Costs** – At larger diameters, ductile iron is more competitive on straight runs of pipeline. The preferred alignment alternative follows the existing ditch alignment and will require a significant quantity of DI fittings and thrust restraints. Additionally, at the diameters being considered, DI fittings for pipe bends become expensive. In the diameters being reviewed in this BODR, DI pipe is the heaviest material on a per linear foot basis. The relatively heavy-weight nature of the pipe increases shipping, handling and installation efforts and costs. The material costs for DI for 36-inch pipe is approximately $220 per foot and $245 for 42-inch diameter. Relative to the other pipe materials evaluated the material and installation costs for DI are considered high.
Evaluation of Pipe Material Alternatives

Table 4 below outlines the comparison of pipe materials.

Table 4. Comparison of Pipeline Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>ID and Pressure Ratings</th>
<th>Cost $/LF Delivered</th>
<th>Hydraulic Capacity-Hazen Williams</th>
<th>Minimum Cover</th>
<th>Estimated Service Life (Years)</th>
<th>Turning Radius</th>
<th>Construct-ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC 36”</td>
<td>36.71” ID 42.65” ID DR51 80psi</td>
<td>$60/ft $78/ft</td>
<td>150 Use 140 for design</td>
<td>1 ft H2O Loading Compaction to 95%</td>
<td>100 years with a 50 year guarantee</td>
<td>382 ft (20ft length at 3 Degree Deflection)</td>
<td>Light weight material per foot, easy to handle and install in remote areas</td>
</tr>
<tr>
<td>PVC 42”</td>
<td>42.65” ID DR51 80psi</td>
<td>$60/ft $78/ft</td>
<td>150 Use 140 for design</td>
<td>1 ft H2O Loading Compaction to 95%</td>
<td>100 years with a 50 year guarantee</td>
<td>382 ft (20ft length at 3 Degree Deflection)</td>
<td>Light weight material per foot, easy to handle and install in remote areas</td>
</tr>
<tr>
<td>HDPE 36”</td>
<td>33.65” ID 39.26” ID DR32.5 63psi</td>
<td>$70/ft $95/ft</td>
<td>150 Use 140 for design</td>
<td>1 to 2 ft H2O Loading</td>
<td>50-100</td>
<td>126 ft – 36” 147 ft – 42”</td>
<td>Light weight material per foot, difficult to install with fusion equipment in remote areas</td>
</tr>
<tr>
<td>HDPE 42”</td>
<td>39.26” ID DR32.5 63psi</td>
<td>$70/ft $95/ft</td>
<td>150 Use 140 for design</td>
<td>1 to 2 ft H2O Loading</td>
<td>50-100</td>
<td>126 ft – 36” 147 ft – 42”</td>
<td>Light weight material per foot, difficult to install with fusion equipment in remote areas</td>
</tr>
<tr>
<td>Ductile Iron Pipe 36”</td>
<td>37.54” ID 43.18” ID 150psi</td>
<td>$220/ft $245/ft</td>
<td>140 Decreases to 100 – 115 over time</td>
<td>1 ft with Type 5 Trench</td>
<td>100</td>
<td>258 ft (18ft length at 4 Degree Deflection)</td>
<td>Heaviest weight material per foot, difficult to handle in remote areas</td>
</tr>
<tr>
<td>Ductile Iron Pipe 42”</td>
<td>43.18” ID 150psi</td>
<td>$220/ft $245/ft</td>
<td>140 Decreases to 100 – 115 over time</td>
<td>1 ft with Type 5 Trench</td>
<td>100</td>
<td>258 ft (18ft length at 4 Degree Deflection)</td>
<td>Heaviest weight material per foot, difficult to handle in remote areas</td>
</tr>
</tbody>
</table>

PVC, HDPE, and DIP are governed by AWWA or ASTM standards. PVC and HDPE are corrosion resistant. Cast Iron and DIP fittings, for PVC pipe and DIP respectively, are prone to corrosion, if the soil type supports that activity.

According to the pipe manufactures, the Hazen-Williams coefficient for PVC and HDPE are both 150, while new DIP has a coefficient of 140, and decreases down to 100 to 115 with age. Utilized in the Hazen-Williams equation, which relates the flow of water in a pipe with the physical properties of the pipe and the pressure drop caused by friction, the higher the coefficient, the less friction loss will occur. All pipes mentioned in this report have a smooth internal surface, which provides excellent hydraulic properties.

They are all used in the water industry and have a design life of at least 50 years (with some of the manufactures stating 100 years).

Properly installed all of the pipe joints are watertight. Both PVC and DIP use a rubber gasketed joint. The thermal fusion joining process for HDPE pipe will leave a truly watertight joint.
PVC pipe cost delivered to the job site is approximately 80% the cost of HDPE pipe, and 30% the cost of DIP. Based on weight per foot, DIP weights approximately 2 times as much as similar sized HDPE and PVC. The heavier weight will factor into higher associated handling costs (delivery and construction). In locations where a fitting would be required, HDPE fittings are more expensive than cast iron or ductile iron fittings, which are used for PVC and DIP. Maximum depth of cover was not reviewed in this report due to the relatively shallow depths anticipated for the pipeline construction. Minimum depth of cover, however, is a consideration of the pipe material analysis. Construction equipment loading, and EID inspection vehicle traffic, are the anticipated live loads the pipe will experience during its life span, see table below.

For curved alignments, both PVC and DIP utilize deflections at joints. Of the two, DIP has the tightest turning radius at 258 feet, assuming an 18 foot length of pipe at a 4 degree deflection. HDPE pipe has the smallest overall turning radius of 126 feet (36-inch) to 147 feet (42-inch).

Based on standard pipe sizes (diameters) and desired design flow, the varied pipe materials above have slightly different sizes that can convey the desired flow rate. See Section 5, Hydraulic Analysis, for more details.

**Pipe Material Recommendation**

Based on the evaluation provided above, PVC is the recommended pipe material. The following summarizes the reasons for this recommendation:

- Cost delivered to the job site is approximately 65% of the cost of HDPE, and 30% the cost of DIP. Given the time and cost savings associated with handling the lighter PVC pipe, the cost per foot installed will be significantly less than DIP. Additionally, the cost per foot installed for PVC pipe will be significantly less than HDPE due to the high cost associated with fusing large diameter HDPE in remote areas.
- A Hazen-Williams C-Factor of 150 (140 for design) result in good hydraulic capacity. C-Factor remains high throughout life cycle, unlike DIP which will diminish over time, therefore requiring a larger diameter pipe for conveyance of the maximum design flow than PVC or HDPE.
- Life expectancy; 50 to 100 years.
- Minimal thermal expansion issues due to gasketed joints.
- Although PVC does not have the smallest turning radius, the alignment can be recommended with high deflection couplings, shorter lengths of pipe, and fabricated fittings.
- With proper backfill and compaction requirements, PVC pipe will support external loads from construction activities and EID maintenance vehicles driving the alignment.
SECTION 3 – ALIGNMENT ALTERNATIVES

General Considerations

Three alignment alternatives were analyzed to determine their feasibility. These alternatives can be broken down into the following alignments:

- **Alternative 1** – Existing Ditch Alignment
- **Alternative 2** – South Fork of Long Canyon Creek Cross Country Alignment
- **Alternative 3** – Blair Road Alignment

The alignment alternatives, from the connection at the Forebay valve house to Reservoir 1 WTP, are shown in Appendix A. The following describes each alignment and the advantages/disadvantages of each.

**Alignment #1 – Existing Ditch Alignment**

Alignment #1 would follow the existing ditch for approximately 15,400 feet. The new pipe will be placed within the ditch, and backfilled with engineered fill and select backfill material. Above the pipe, the finished cross slope grade will be a minimum of 2% towards the downslope. By filling in the ditch with an out sloped grade, the drainage flow path will be returned to historic, pre-ditch conditions.

Based on a site walk, there are approximately 50 trees located on the ditch bench and 400 trees located within the ditch. The tree types were not identified and those trees smaller than 4-inch diameter at breast height were not counted. The trees were divided up between trees within the ditch, defined from ditch top of bank to ditch top of bank, and trees within the ditch bench section, defined from ditch top of bank to top downhill slope. Assuming 50% of the trees will be removed for construction of the new pipe and access, approximately 225 trees will be removed. Actual trees to be removed will be determined during final design, based on proximity to pipe, construction access, and hazard trees.

The maximum static pressure of 23 psi in Alignment #1 is based on the maximum spillway elevation of Forebay Reservoir and is approximately 3807.6 (NAVD88). The ground elevations were obtained from a limited topographic survey by Alan Divers, PLS.

Alignments #1 and #2 would pass under the Blair Road Bridge. As previously mentioned, El Dorado County is planning to replace the Blair Road Bridge. The bridge is slated to be replaced within the next couple of years, which may be constructed prior to the Main Ditch replacement project. EID has been coordinating with El Dorado County DOT to make sure the culvert under Blair Road is large enough. This will allow for minimal construction challenges and reduced costs at the crossing.

A detailed preliminary opinion of probable construction costs for Alignment #1 is provided in Appendix C. The estimated project costs for alignment #1 are $6,012,000.

The following table summarizes the advantages and disadvantages to Alignment #1.
Table 5. Advantages/Disadvantages of Alignment #1

<table>
<thead>
<tr>
<th>Alignment #1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Advantages</td>
<td>Disadvantages</td>
</tr>
<tr>
<td>Follows existing ditch alignment</td>
<td>Total pipe length = 15,400 feet (Longest)</td>
</tr>
<tr>
<td>Requires the least new permanent easements</td>
<td>More tree removal then Alignment #3</td>
</tr>
<tr>
<td>Relatively low construction costs</td>
<td></td>
</tr>
<tr>
<td>Minimum static head on pipeline</td>
<td></td>
</tr>
<tr>
<td>Fewer low points</td>
<td></td>
</tr>
<tr>
<td>No pipe in paved areas</td>
<td></td>
</tr>
<tr>
<td>Relatively low maintenance and operations</td>
<td></td>
</tr>
</tbody>
</table>

Alignment #2 – South Fork Long Canyon Creek Cross Country Alignment

Alignment #2 will follow the existing ditch for approximately 11,500 feet. The cross country portion of the alignment, as shown on Alignment 2 exhibit in Appendix A, is 1,750 feet long. The total length of Alignment #2 is approximately 13,250 feet. Alignment #2 will abandon approximately 3,960 feet of the existing ditch. This section of abandoned ditch will be filled with compacted fill to return the drainage pattern to pre-ditch conditions. A new permanent easement will be required for this section of Alignment #2. Trees will be removed along the cross country alignment to construct the pipeline and access road. A blow off valve will be needed at the low point in the cross country alignment to drain the pipe in an emergency, for routine maintenance, or for winter shut down; this will occur at the South Fork Long Canyon Creek crossing. Erosion control will be required at the blow off valve to protect the creek. Should sediment enter the pipe system, it may deposit at the low point. Periodic cleaning may be required, which may produce significant interruption in water delivery service.

As previously mentioned, based on a site walk there are approximately 50 trees located on the ditch bench, 400 trees located within the ditch. We anticipate that with the cross country route, approximately 100 more trees will be removed, bringing the total to approximately 325 trees. Actual trees to be removed will be determined during final design, based on proximity to pipe, construction access, and hazard trees.

The maximum static pressure in Alignment #2 is based on the maximum spillway crest elevation of Forebay Reservoir and is approximately 63 psi. The ground elevation at the low spot at the creek is based on USGS quad maps. Due to the increase in pressure at the low point at the Long Canyon Creek crossing, the pipe pressure class crossing the creek would need to be increased from DR51 to DR41 to accommodate the increase in pressure.

Alignment #2 will cross two parcels; APN 101-240-45 is approximately 25.9 acres and will be nearly bisected by Alignment #2, and APN 101-220-02 is approximately 11.6 acres and will have a portion of its western area bisected by Alignment #2. At the time of this report, both properties are owned by the same trust based on county assessor data.

A detailed preliminary opinion of probable construction costs for Alignment #2 is provided in Appendix C. The estimated project costs for Alignment #2 are $5,997,000.
The following table summarizes the advantages and disadvantages to Alignment #2.

**Table 6. Advantages/Disadvantages of Alignment #2**

<table>
<thead>
<tr>
<th>Alignment #2</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follows existing ditch alignment for most of project reach</td>
<td>More tree removal than Alignment #3</td>
<td></td>
</tr>
<tr>
<td>Relatively low construction cost</td>
<td>Requires new permanent easement bisecting properties</td>
<td></td>
</tr>
<tr>
<td>Total pipe length = 13,250 feet – Shorter than Alignment #1</td>
<td>Access to cross country portion difficult</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Creek crossing permitting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Erosion control at creek crossing blow-off</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sediment may tend to deposit at low point</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Periodic cleaning may lead to significant interruption in water delivery service</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Higher pressure pipe required</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Higher maintenance</td>
<td></td>
</tr>
</tbody>
</table>

**Alignment #3 – Blair Road Alignment**

Alignment #3 will follow the existing ditch for approximately 6,100 feet. The Blair Road portion of the alignment, as shown on Alignment #3 exhibit in Appendix A, is 6,800 feet long. The total length of Alignment #3 is approximately 12,900 feet. Alignment #3 will deviate from the existing ditch alignment at Pinewood Lane, where it will follow Pinewood Lane to Blair Road. The pipe will remain within the existing public right of way of Blair Road. Due to the narrow right-of-way along Blair Road with limited shoulder area, this alignment will be within the paved roadway. Alignment #3 will rejoin the existing ditch alignment at the Blair Road crossing of the Main Ditch. Alignment #3 will abandon approximately 9,300 feet of the existing ditch. This section of abandoned ditch will be filled with compacted engineered fill to return the drainage pattern to pre-ditch conditions. A blow off valve will be needed at each of the low points in the Blair Road in order to drain the pipe. Erosion control will be required at the blow off valve to protect the drainage swales. See figures 9 and 10 below for photos of Blair Road.

With this alignment tree removal will be necessary for only half of the ditch length therefore the number of trees to be removed would be approximately 110 trees, half of Alignment #1.
The maximum static pressure in Alignment #3 is based on the maximum spillway crest elevation of Forebay Reservoir and is approximately 75 psi. The ground elevation at the low spots at the Blair Road creek crossings are based on USGS quad maps. Due to the increase in pressure of the...
low point at the Long Canyon Creek crossing, the pressure class will need to be increased from DR51 to DR41 at the crossing to accommodate the increase in pressure.

The trench width in Blair Road would be approximately 5 feet. The total width of pavement removal will be 7 feet with an additional one foot on each side of the trench (T-trench). El Dorado County standards require a minimum 3-inch AC over 8-inch Class 2 AB pavement replacement section.

Based on the EID facility map, there are no sewer facilities located within Blair Road. There is a 6-inch AC waterline located within a portion of Blair Road from Pinewood Drive to Apple Creek Road. Since the new line is a raw water pipeline, separation standards will apply.

A detailed preliminary opinion of probable construction costs for Alignment #3 is provided in Appendix C. The estimated project costs for Alignment #3 are $6,676,000.

The Blair Road alignment is more costly (approximately 2%) than Alignments #1 and #2 due to extensive work within the road, which would include traffic control, pavement replacement, etc.

The following table summarizes the advantages and disadvantages to Alignment #3.

<table>
<thead>
<tr>
<th>Alignment #3</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Requires the least new permanent easement and utilizes existing public utility easement</td>
<td>Maximum static head on pipeline</td>
</tr>
<tr>
<td>Total pipe length = 12,900 feet (shortest)</td>
<td>Work in Blair Road – Pavement replacement, slurry seal, traffic control, and impact to local residents</td>
</tr>
<tr>
<td>Least tree removal</td>
<td>Highest construction cost</td>
</tr>
<tr>
<td>Access to portion of pipe in Blair Road</td>
<td>Higher costs and disruption to public for any future repairs in Blair Road</td>
</tr>
<tr>
<td></td>
<td>Higher pressure pipe required</td>
</tr>
</tbody>
</table>

Alignment Right-of-Way Requirements

Existing Easements

Based on reviewing available mapping information (Parcel Maps, Record of Surveys, and Assessor Parcel Maps) provided by EID, the existing Main Ditch right-of-way varies between not defined (or not available), to 25-feet wide (12.5-feet on either side of centerline), to 50-feet wide. There are 48 individual parcels adjacent to the existing ditch alignment. Many of the parcels are not defined by map and are only defined by Deeds of Trust, which were not provided for this report. During the final design of the project, the project surveyor will provide the Title Reports for all the parcels to define the limits of the existing easement.

This report assumes a minimum 25-foot easement (12.5-feet on either side of ditch centerline) for purposes of determining possible right-of-way needs.
Temporary Easement Requirements

Temporary easements during construction will be necessary to provide staging areas, access to the project alignment, and space along the alignment for transport and installation of the project pipeline and appurtenances. The staging areas will be for storing equipment, and pipeline materials. The precise acreage of the staging areas will be determined during the final design phase of the project. Any staging areas negotiated by the contractor will require written access agreements between the property owner and the contractor.

Temporary construction easements will be subject to agreements with the property owners. Tree removal in the temporary easement areas will be restricted as set forth in the construction contract documents.

Estimate of Right-of-Way Requirements

Table 8 provides estimates of total right of way acreages which are based on the estimated typical easement needs described above. These estimates will be preliminary until final design is complete and more precise alignments are established. Permit and environmental compliance conditions may also have an effect on the final right of way delineations.

<table>
<thead>
<tr>
<th>Alignment</th>
<th>Approximate Length</th>
<th>Permanent Easement Requirements</th>
<th>Temporary Easement Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment #1 - Pipeline in Existing Ditch</td>
<td>15,400 LF</td>
<td>0.5 acres</td>
<td>1.8 acres</td>
</tr>
<tr>
<td>Staging Areas &amp; Access</td>
<td>N/A</td>
<td>N/A</td>
<td>2.0 acres</td>
</tr>
<tr>
<td><strong>ALIGNMENT #1 TOTALS</strong></td>
<td></td>
<td><strong>0.5 acres</strong></td>
<td><strong>3.8 acres</strong></td>
</tr>
<tr>
<td>Alignment #2- Pipeline in Existing Ditch and Cross Country</td>
<td>Ditch – 11,500 LF Cross Country – 1,750 LF</td>
<td>1.3 acres</td>
<td>1.5 acres</td>
</tr>
<tr>
<td>Staging Areas &amp; Access</td>
<td>N/A</td>
<td>N/A</td>
<td>2.0 acres</td>
</tr>
<tr>
<td><strong>ALIGNMENT #2 TOTALS</strong></td>
<td></td>
<td><strong>1.5 acres</strong></td>
<td><strong>3.5 acres</strong></td>
</tr>
<tr>
<td>Alignment #3- Pipeline in Existing Ditch and Blair Road</td>
<td>Ditch 6,100 LF Blair Road 6800 LF</td>
<td>0.3 acres</td>
<td>0.7 acres</td>
</tr>
<tr>
<td>Staging Areas &amp; Access</td>
<td>N/A</td>
<td>N/A</td>
<td>2.0 acres</td>
</tr>
<tr>
<td><strong>ALIGNMENT #3 TOTALS</strong></td>
<td></td>
<td><strong>0.3 acres</strong></td>
<td><strong>2.7 acres</strong></td>
</tr>
</tbody>
</table>
Preferred Alignment Recommendation

Alignment #1 was selected as the preferred alignment, for the following reasons:

- **Cost:** Alignment #1’s estimated cost is approximately the same as Alignment #2’s estimated cost. Although construction costs are similar, Alignment #2 costs have a greater potential to increase due to uncertainties such as the rugged terrain, right-of-way acquisition, access to the pipe section and additional tree removal, blow-off requirements, and erosion control. Alignment #3’s estimated construction cost is the highest of the three alternatives.

- **Permanent Easement Acquisition:** Alignment #1 has relatively low easement requirements. Alignment #2’s cross country alignment will bisect the parcel of land it crosses. EID will have to work with the land owner to agree on an alignment and cost of a permanent easement. This will take time and may increase the estimated land cost estimated.

- **Disruption to Local Residents:** Alignment #1 will have the least effect on local residents. The project will primarily stay within EID’s existing right of way and take place off of public roads. Alignment #3 would have significant disturbance to local residents due to the construction activities within Blair Road.

- **Access for Future Maintenance:** Alignment #1 will maintain access similar to the existing ditch along the relatively flat gradient and away from traffic issues. Alignment #2 will have a steep access road at the low crossing and will require added maintenance at the major blowoff location at the creek. Along with added blowoffs for Alignment #3, any repairs to the pipeline in Blair Road will require pavement removal/replacement and traffic control for access.

- **Environmental Concerns:** Alignment #1 has minimal environmental concerns due to utilizing the existing ditch alignment. The new crossing at Long Canyon Creek and maintenance concerns at the blow-off operations will create environmental concerns that will need to be addressed and mitigated for in Alignment #2.
SECTION 4 – PREFERRED ALIGNMENT HYDRAULIC ANALYSIS

Hydraulic Analysis

To determine pipeline sizing recommendations, a preliminary hydraulic analysis was performed to calculate a hydraulic grade line (HGL) throughout the preferred alignment at the minimum and maximum reservoir levels and flow rates. A hydraulic analysis was performed on the recommended alignment (Alignment #1) using the preferred pipeline material (PVC).

Pipe Sizing Criteria

Given the design flow rate of 40 cfs, pipe length of approximately 15,400 feet, and limited elevation differential, head loss due to friction will be the controlling criteria. Based on static conditions measured from the Forebay dam crest elevation to the inlet of Reservoir 1 Water Treatment Plan, the minimum and maximum static pressures will be 13 psi (minimum normal water surface elevation) and 23 psi respectively.

The following table provides a summary of the general design criteria used for the hydraulic calculations for the Main Ditch project.

Table 9. Summary of Hydraulic Design Criteria

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Criteria Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Design Flow</td>
<td>40 cfs</td>
</tr>
<tr>
<td>Minimum Design Flow</td>
<td>7 cfs</td>
</tr>
<tr>
<td>Pipe Size and Material</td>
<td>36” and 42” diameter PVC, C905, DR51</td>
</tr>
<tr>
<td>Velocity</td>
<td>Minimum 2.5 fps</td>
</tr>
<tr>
<td></td>
<td>Maximum 10.0 fps</td>
</tr>
<tr>
<td>Available Pressure – Forebay to Res 1 WTP</td>
<td>Minimum 13 psi (static, measure from minimum normal water surface elevation)</td>
</tr>
<tr>
<td></td>
<td>Maximum 23 psi (static, measured from dam crest elevation)</td>
</tr>
<tr>
<td>Inlet Elevation to Res 1 WTP</td>
<td>3754.30 ft (NAVD 88)</td>
</tr>
<tr>
<td>HGL Elevation at Inlet to Res 1 WTP</td>
<td>Approximately 3756.2 ft (NAVD 88)</td>
</tr>
</tbody>
</table>

Hydraulic Grade Line Calculations

An important consideration in the selection of pipeline materials and the preferred alignment is the hydraulic grade line (HGL) and associated pressures that would result along the pipeline.
Detailed HGL calculations were performed on the preferred alignment using field survey cross sections at five locations along the existing canal alignment, USGS topographic maps, and the design flow. Detailed calculations are provided in Appendix C.

The maximum and minimum normal operating water surface elevations in Forebay Reservoir, after the dam modification project is complete, will be 3800.56 feet and 3785.56 feet respectively (NAVD88 Datum), providing a normal water surface operating range of 15 feet. At the Reservoir 1 WTP, based on a provided topographic survey, the elevation of the existing inlet to the plant is approximately 3754.30, therefore the static head will range from 31.3 to 46.3 feet. The new pipe will be sized to convey the maximum design flow while operating within this normal operating range. Table 10 below lists several key elevations for the Forebay Dam Modifications based on construction plans and exhibits prepared by GEI Consultants. Elevations are provided in the three different datum utilized, PG&E, NVGD29, and NAVD88 datum. The survey information provided by Alan Divers, PLS and located in Appendix E is based on the NAVD88 datum, which is the most current basis.

Table 10. Summary of Key Elevations of Forebay Dam Proposed Modifications (GEI Plans Dated 2013)

<table>
<thead>
<tr>
<th>Proposed Dam Improvement Locations</th>
<th>Datum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PG&amp;E</td>
</tr>
<tr>
<td>Dam Crest Elevation</td>
<td>3814.0</td>
</tr>
<tr>
<td>Sill Elevation of Emergency Spillway</td>
<td>3807.0</td>
</tr>
<tr>
<td>Maximum Normal Operating Elevation</td>
<td>3807.0</td>
</tr>
<tr>
<td>Minimum Normal Operating Elevation</td>
<td>3792.0</td>
</tr>
<tr>
<td>Centerline of Valve House 36” Outlet Pipe Elevation</td>
<td>3782.75</td>
</tr>
</tbody>
</table>

Note: PG&E Datum to NVGD29 Datum is -9.4 ft. NVGD29 Datum to NAVD88 Datum is +2.96 ft.

The Forebay Dam Modification Plans (Sheet C-40), provide discharge rating curves for the outlet of the new 36-inch steel pipe at the proposed valve house, with and without a proposed 18-inch diameter flow restriction plate. The rating curve identifies discharge flow rates at various reservoir water surface elevations. By back calculating the flow rate with the corresponding reservoir elevation, the approximate head losses were determined within the new discharge system. This loss includes the intake structure and trash rack, piping, bends, and other miscellaneous losses (gate valve, exit etc.) associated with the new reservoir outlet structure.

For the hydraulic analysis of the new pipe system, at a flow rate of 40 cfs, the calculated head loss through the existing dam outlet system is approximately 1.2 feet. At a flow rate of 7 cfs the calculated head loss will be approximately 0.2 feet.

Table 11 below gives the calculated friction slope in the 36-inch and 42-inch PVC DR51 pipes at maximum and minimum design flow rates. Both PVC pipe sizes have a Hazen-Williams C-factor of 140 (for design).
### Table 11. Calculated Friction Slope in 36” and 42” PVC

<table>
<thead>
<tr>
<th>Design Flow</th>
<th>Friction Slope (ft/ft) in 36” PVC (1)</th>
<th>Friction Slope (ft/ft) in 42” PVC (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 cfs Maximum</td>
<td>0.00200</td>
<td>0.00100</td>
</tr>
<tr>
<td>7 cfs Minimum</td>
<td>0.00008</td>
<td>0.00004</td>
</tr>
</tbody>
</table>

(1) 36” PVC (36.71” ID DR51), 42” PVC (42.65” ID DR51)

### Hydraulic Grade Line Calculations for 36” PVC Pipe

Initially a 36-inch PVC pipe was analyzed in the preferred Alignment #1, which is 15,400 feet long. The following table identifies the head losses in the pipe system including:

- Inlet Losses
- Pipe Friction Losses
- Bend Losses
- Exit Losses

### Table 12. Summary of Head Losses in 36” PVC

<table>
<thead>
<tr>
<th>Design Flow</th>
<th>Head Losses (2)</th>
<th>Forebay Outlet and Pipe Losses (ft)</th>
<th>Pipe Friction Losses (ft) (3)</th>
<th>Bend Losses (ft) (4)</th>
<th>Exit Loss (ft)</th>
<th>Total Loss (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 cfs Maximum</td>
<td>34.8</td>
<td>1.2</td>
<td>30.9</td>
<td>2.5</td>
<td>0.2</td>
<td>34.8</td>
</tr>
<tr>
<td>7 cfs Minimum</td>
<td>1.8</td>
<td>0.2</td>
<td>1.2</td>
<td>0.4</td>
<td>0.0</td>
<td>1.8</td>
</tr>
</tbody>
</table>

(2) See Hydraulic Grade Line Calculations in Appendix C for further detail for each calculated loss.

(3) Pipe friction loss based on 15,400 LF of pipe and friction slope from Table 11.

(4) Bend losses in the piped system are estimated at this time, assuming approximately twenty-five 45 degree bends.

At the maximum design flow rate the total head loss in the 36-inch piped system will be approximately 34.8 feet, and 1.8 feet at the minimum design flow rate. The following table identifies the calculated HGL elevation at the inlet to the Reservoir 1 WTP, assuming starting at the maximum and minimum water surface elevation in Forebay Reservoir.
Table 13. Summary of Calculated HGL Elevations (NAVD 88) based on 36” PVC

<table>
<thead>
<tr>
<th>Forebay Reservoir HGL (ft)</th>
<th>Design Flow</th>
<th>Total Loss (ft) (2)</th>
<th>HGL Elevation at Res 1 WTP Inlet (ft)</th>
<th>Available Head at Res 1 WTP (ft) (3)</th>
<th>Comments (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3799.6 Maximum</td>
<td>40 cfs Maximum</td>
<td>34.8</td>
<td>3764.8</td>
<td>8.6</td>
<td>Calculated HGL is above Inlet HGL Elevation to Res 1 WTP</td>
</tr>
<tr>
<td></td>
<td>7 cfs Minimum</td>
<td>1.8</td>
<td>3797.8</td>
<td>41.6</td>
<td>Calculated HGL is above Inlet HGL Elevation to Res 1 WTP</td>
</tr>
<tr>
<td>3785.6 Minimum</td>
<td>40 cfs Maximum</td>
<td>34.8</td>
<td>3750.8</td>
<td>&lt;5.4&gt; (4)</td>
<td>Calculated HGL is below Inlet HGL Elevation to Res 1 WTP</td>
</tr>
<tr>
<td></td>
<td>7 cfs Minimum</td>
<td>1.8</td>
<td>3783.8</td>
<td>27.6</td>
<td>Calculated HGL is above Inlet HGL Elevation to Res 1 WTP</td>
</tr>
</tbody>
</table>

(1) Water Surface Elevation at Inlet to Res 1 WTP = approximately 3756.2 ft (NAVD 88).
(2) Total Loss from Table 12.
(3) Available head measured from calculated HGL – Water Surface Elevation at Res 1 WTP.
(4) Calculated HGL below inlet elevation to Res 1 WTP.

Based on the information presented above and in Table C5 in Appendix C, a 36-inch PVC pipe cannot provide the maximum design flow rate to the treatment plant at all normal operating water surface elevations in Forebay Reservoir. At the minimum normal operating water surface elevation the 36-inch PVC piped system capacity will be limited to approximately 37 cfs. The minimum water surface elevation required in Forebay Reservoir to provide the maximum design flow rate is approximately 3791.0 feet (NAVD88), 5.4 feet higher than minimum normal water surface elevation.

**Hydraulic Grade Line Calculations for 42” PVC Pipe**

A 42-inch PVC pipe was also analyzed for the preferred Alignment #1. The following table identifies the head losses in the pipe system.
Table 14. Summary of Head Losses in 42” PVC

<table>
<thead>
<tr>
<th>Design Flow</th>
<th>Forebay Inlet and Pipe Losses (ft)</th>
<th>Pipe Friction Losses (ft) (2)</th>
<th>Bend Losses (ft) (3)</th>
<th>Exit Loss (ft)</th>
<th>Total Loss (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 cfs Maximum</td>
<td>1.2</td>
<td>14.9</td>
<td>2.5</td>
<td>0.1</td>
<td>18.7</td>
</tr>
<tr>
<td>7 cfs Minimum</td>
<td>0.2</td>
<td>0.6</td>
<td>0.4</td>
<td>0.0</td>
<td>1.2</td>
</tr>
</tbody>
</table>

(1) See Hydraulic Grade Line Calculations in Appendix C for further detail for each calculated loss.
(2) Pipe friction loss based on 15,400 LF of pipe and friction slope from Table 11.
(3) Bend losses in the piped system are estimated at this time.

At the maximum design flow rate the total head loss in the 42-inch piped system will be approximately 18.7 feet, with a total head loss of 1.2 feet at the minimum design flow rate. The following table identifies the calculated HGL elevation at the inlet to the Reservoir 1 WTP, assuming starting at the maximum and minimum water surface elevation in Forebay Reservoir.

Table 15. Summary of Calculated HGL Elevations (NAVD 88) based on 42” PVC

<table>
<thead>
<tr>
<th>Forebay Reservoir HGL (ft)</th>
<th>Design Flow</th>
<th>Total Loss (ft) (2)</th>
<th>Inlet to Reservoir 1 WTP HGL (ft)</th>
<th>Available Head at Res 1 WTP (ft) (3)(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3799.6 Maximum</td>
<td>40 cfs Maximum</td>
<td>18.7</td>
<td>3780.9</td>
<td>24.7</td>
</tr>
<tr>
<td></td>
<td>7 cfs Minimum</td>
<td>1.2</td>
<td>3798.4</td>
<td>42.2</td>
</tr>
<tr>
<td>3785.6 Minimum</td>
<td>40 cfs Maximum</td>
<td>18.7</td>
<td>3766.9</td>
<td>10.7</td>
</tr>
<tr>
<td></td>
<td>7 cfs Minimum</td>
<td>1.2</td>
<td>3784.4</td>
<td>28.2</td>
</tr>
</tbody>
</table>

(1) Water Surface Elevation at Inlet to Res 1 WTP = approximately 3756.2 ft (NAVD 88).
(2) Total Loss from Table 15.
(3) Available head measured from calculated HGL – Water Surface Elevation to Res 1 WTP.
(4) Calculated HGL elevation in all cases above inlet HGL elevation at Res 1 WTP

Based on the information presented above and in Table C6 in Appendix C, a 42-inch PVC pipe can provide the maximum design flow rate to the treatment plant at all normal operating water surface elevations in Forebay Reservoir.

**Hydraulic Grade Line Calculations for a Combination of 36” and 42” PVC Pipe**

Based on the previous HGL calculations for 36-inch and 42-inch PVC pipes, a 42-inch PVC can provide the maximum design flow throughout the normal operating range of Forebay Reservoir, while a 36-inch PVC cannot provide the maximum design flow throughout the reservoir’s
normal operating range. To provide the most cost effective design, a system was analyzed that contained a combination of 36-inch and 42-inch PVC pipes.

The location of the transition from 36- to 42-inch pipe was determined by reviewing where the HGL crosses below the top of the 36-inch pipe. Figure A5 in Appendix A shows the HGL for the combination pipe system. Increasing the pipe diameter will reduce the pipe friction slope. By maintaining the HGL above the top of pipe, the pipe will flow under pressure conditions during all normal operating water surface elevations.

The following analysis will upsize the downstream pipe system feeding the water treatment plant in order to reduce the head losses due to friction in the 36-inch PVC pipe. In the table below the head losses in the piped system are identified assuming a combination of 36-inch and 42-inch PVC pipe.

Table 16. Summary of Head Losses in Combination 36” and 42” PVC

<table>
<thead>
<tr>
<th>Design Flow</th>
<th>Head Losses (1)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Forebay Inlet and Pipe Losses (ft)</td>
<td>Pipe Friction Losses (ft) (2)</td>
<td>Bend Losses (ft) (3)</td>
<td>Exit Loss (ft)</td>
<td>Total Loss (ft)</td>
</tr>
<tr>
<td>40 cfs Maximum</td>
<td>1.2</td>
<td>23.6</td>
<td>2.5</td>
<td>0.1</td>
<td>27.4</td>
</tr>
<tr>
<td>7 cfs Minimum</td>
<td>0.2</td>
<td>0.9</td>
<td>0.4</td>
<td>0.0</td>
<td>1.5</td>
</tr>
</tbody>
</table>

(1) See Hydraulic Grade Line Calculations in Appendix C for further detail for each calculated loss.
(2) Pipe friction loss based on 8,400 LF of 36” PVC and 7,000 LF of 42” PVC pipe and friction slopes from Table 11.
(3) Bend losses in the piped system are estimated at this time.

At the maximum design flow rate the total head loss in the combination 36-inch and 42-inch piped system will be approximately 27.4 feet, with a total head loss of 1.5 feet at the minimum design flow rate. The following table identifies the calculated HGL elevation at the inlet to the Reservoir 1 WTP, assuming starting at the maximum and minimum water surface elevation in Forebay Reservoir.
Table 17. Summary of Calculated HGL Elevations (NAVD 88) based on 36” and 42” PVC

<table>
<thead>
<tr>
<th>Forebay Reservoir HGL (ft)</th>
<th>Design Flow (cfs)</th>
<th>Total Loss (ft) (2)</th>
<th>Inlet to Reservoir 1 WTP HGL (ft)</th>
<th>Available Head at Res 1 WTP (ft) (3)(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3799.6 Maximum</td>
<td>40</td>
<td>27.4</td>
<td>3772.2</td>
<td>16.0</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>1.5</td>
<td>3798.1</td>
<td>41.9</td>
</tr>
<tr>
<td>3785.6 Minimum</td>
<td>40</td>
<td>27.4</td>
<td>3758.2</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>1.5</td>
<td>3784.1</td>
<td>27.9</td>
</tr>
</tbody>
</table>

(1) Water Surface Elevation at Inlet to Res 1 WTP = Approximately 3756.2 ft (NAVD 88)
(2) Total Loss from Table 16
(3) Available head measured from calculated HGL – Water Surface Elevation to Res 1 WTP.
(4) Calculated HGL elevation in all cases above inlet HGL elevation at Res 1 WTP

Based on the information presented above and in Table C7 in Appendix C, a combination of 8,400 feet of 36-inch and 7,000 feet of 42-inch PVC pipes can provide the maximum design flow rate to the treatment plant at all normal operating water surface elevation in Forebay Reservoir. A profile of the ground surface and the hydraulic gradient for the preferred alignment are shown on Figure A5 in Appendix A. From the HGL exhibit, pressures along the pipeline can be derived. The highest possible pressure in the new pipe system, measured from the dam crest elevation of 3807.56 (NAVD88), is approximately 23 psi at the inlet structure to Reservoir 1 with the inlet structure’s valve closed (static).

Blair Road Bridge Hydraulic Considerations

As previously mentioned, El Dorado County Department of Transportation is planning to replace the Blair Road Bridge crossing of the Main Ditch. Based on the hydraulic analysis, it is anticipated the Main Ditch Pipe will be a 42-inch at this location. If the opening under the new bridge is too small to accommodate the pipe, then one of the following options may be selected:

Option 1: Split (bifurcate) pipe into two smaller pipes under bridge – parallel pipelines.
- Reduce the size of the Main Ditch Pipe from 42-inches down to a minimum of two 30-inch pipes. These two 30-inch pipes will maintain a similar cross sectional area as compared to a single 42-inch pipe. A pressure rated, concrete structure, with maintenance openings, will be required immediately up and downstream of the bridge to split and join the pipes.

Option 2: Reduce pipe size under bridge – single pipeline.
- Downsize the pipe as it passes under the bridge, then upsize immediately downstream of the bridge. A pressure rated structure at the upstream end should be installed for maintenance.

Option 3: Excavate underneath the bridge to increase clearance – single pipeline.
• Excavate underneath the bridge opening to accommodate the 42-inch pipe, assuming the horizontal opening distance is available.

Options 1 and 2 are problematic due to the restrictions in the pipe that could increase the probability of blockage caused by any material that gets into the pipe system. Maintenance would be difficult while in use because the pipe would be under pressure. Each of these two options would restrict flows, and increase the head loss at the bridge. To compensate for the additional head loss, the length of required 42-inch pipe will need to be increased.

Option 3 will have no significant impact on the hydraulic design, therefore is the preferred option at the Blair Road Bridge. In order to make sure Option 3 can be utilized, EID should coordinate with El Dorado County DOT to make provisions in the bridge design documents to accommodate a 42-inch PVC pipe at the bridge.
SECTION 5 - ANCILLARY FACILITIES AND CONSTRUCTION ACTIVITIES

This section describes project facilities, construction activities, and design parameters incorporated into the project design other than the pipeline itself. Ancillary facilities include valves, raw water meters to existing customers, and upstream and downstream connections. Additional construction activities and design parameters include work construction sequencing, minimum pipe depth, pipe and trench bedding and backfill requirements, import and borrow material, pipe loading, groundwater and floatation mitigation, maintenance and access requirements, and storm water management.

Valves

Several types of valves will be required along the new pipeline.

Isolation Valves

The pipeline will connect to the valve house at Forebay Reservoir where a 36-inch bonneted knife gate valve will be available to isolate flows from the reservoir. A butterfly valve will be installed at the downstream inlet into the Reservoir 1 WTP to throttle the flows to the desired flow rate. Intermediate isolation valves will not be required.

Air/Vacuum Release Valves

Combination air/vacuum release valves (A/VRV) should be located at all significant high points along the pipe alignment and installed on the downstream side of isolations valves. A/VRVs will release air trapped in the line, primarily during filling, and will allow air into the line during emptying of the pipeline. In addition to high points, A/VRVs should also be installed on constant slopes every 1,000 feet.

Based on a preliminary sizing, it is anticipated the A/VRVs will be approximately 6-inch valves. The size of the A/VRVs will be confirmed during final design and will be based on the following EID design and selected manufactured parameters:

- When the pipeline is being filled, the air pressure across the valve is not to exceed 2 psi.
- When the line is to be drained, the pressure across the valve is not to exceed 5 psi.

Blow-off Valves

Blow-off valve (BOV) assemblies shall be located at low points in the line to facilitate line draining and to allow the removal of sediments that may accumulate in the low areas. Based on a preliminary sizing, it is anticipated the BOV’s will be 6-inch to 8-inch in size. The sizes shall be confirmed during final design and sized to satisfy the following EID conditions:

- The section of pipe the blow-off valve is serving should be capable of being drained within 2 to 4 hours.
- The blow-off shall be capable of creating a velocity of not less than 2.5 fps in the pipeline for the removal of sediments.
- Erosion control practices shall be used where the water from the blow-off is discharged.
• At a minimum, locate a BOV at the inlet to the Reservoir 1 WTP.

Customer Raw Water Meters

There are three existing raw water metered customers served from the ditch. See Appendix D for a typical raw water meter connection detail. A basket strainer shall be installed between the point of connection to the pipeline and the water meter. The basket strainer shall be located in a meter box adjacent to the meter and easily accessed for maintenance and cleaning of the basket.

Pig Launch

A pig launching facility was initially considered for the project, but ruled out due to the anticipated improved water quality at the intake structure from the Forebay Reservoir Dam Modification Project, and the scouring velocities from the flows in the pipeline.

The improvements to the intake structure and dam modifications will decrease the likelihood of sediment and debris from entering the pipe.

At the maximum design flow of 40 cfs the velocities will be 5.4 to 4.0 fps in a 36-inch and 42-inch PVC pipe respectively. To remove sediment and debris that may have entered the pipe, a minimum scour velocity of at least 2.5 fps is recommended. In a 36-inch PVC pipe this will equate to 18.4 cfs. At the minimum design flow of 7 cfs in a 36-inch PVC pipe, the velocity is 1.0 fps, which is slower than the scour velocity. Any sediment that may enter the pipe system at this velocity will settle out. However, scouring will occur at flow rates greater than 18.4 cfs, and sediment accumulation should not be an issue.

Connection at Forebay Reservoir Valve House

The Forebay Dam Modification drawings by GEI Consultants (see Appendix E), show a 36-inch inside diameter steel pipe placed along with a flow restriction plate with an 18-inch circular opening bolted to the end. The Main Ditch Piping project will remove this flow restriction plate, extend approximately 20 feet of 36-inch steel pipe to the end of the new concrete transition structure, and connect a 36-inch steel to PVC transition coupling. The new 36-inch PVC pipe will connect to the transition coupling. One new A/VRV will be installed at the high point. See Appendix D for a preliminary connection detail.

Inlet Structure at Reservoir 1 Water Treatment Plant

A new structure at the inlet to the treatment plant is proposed to dissipate energy from the pipeline. The structure is proposed to be a concrete box with a concrete cover, see detail in Appendix D. The cover shall have two openings into the structure for access and cleaning.
The PVC pipe will transition to a steel pipe that connects to a throttling valve prior to entering the concrete outlet structure. Due to anticipated daily fluctuations in the Forebay Reservoir water surface elevation, the throttling valve will be automated to regulate the flows to the treatment plant. The throttling valve will keep the pipe in a pressure condition which will avoid air problems, and will have a full flow indicating/controlling loop to be detailed in the final design.

The inlet structure is based on an energy dissipater design by the United States Department of the Interior Bureau of Reclamation in their 1978 publication of Design of Small Canal Structures. With the Forebay at the maximum operating water surface level, the pipe system will have excess head at the inlet structure. The valve at the entrance will be throttled to burn off extra head depending on the water surface elevation in the Forebay. The throttled inlet will increase the velocities of the discharge jet of water. A vertical hanging baffle is placed across the entrance to the structure that will dissipate the excess energy from the high velocity water jet. The incoming water jet’s energy is dissipated primarily by striking the baffle, and to a lesser degree by eddies that are formed after the jet strikes the baffle.

The structure will have an 18-inch sump to collect any debris that may enter the system at the Forebay intake. The level of debris will need to be monitored and cleaned as needed. A screen should be placed at the entrance to the treatment plant to keep floating debris from entering, similar to the current screen.

**Construction Sequencing**

The following steps are anticipated in the construction and installation of the new Main Ditch Piping:

- **Step 1** – Clearing and grubbing ditch and bench in preparation for placement of pipe and access.
- **Step 2** – Scarify and compact the existing ditch subgrade in preparation of engineered fill.
- **Step 3** – Place engineered fill from a selected borrow source within the existing ditch.
- **Step 4** – Trench through the engineered fill for the new pipe, placing trench spoils on the adjacent bench. The anticipated pipe trench will be less than five feet deep to avoid the need for shoring. When workers are required to enter the trench, they should be protected as required by the Occupational Safety and Health Standards Administration for the Construction Industry (OSHA). See Appendix D for typical trench sections.
- **Step 5** – Lay the pipe within the excavated trench.
- **Step 6** – Backfill the pipe with specified bedding material and compact. Place final backfill using the trench spoils from Step 4. Provide minimum cover over the pipe to support construction equipment.

Access to the preferred alignment will be limited to a few locations due to the existing topography and lack of access roads. In order to efficiently construct the new pipeline, it is anticipated that a ‘race track” method for construction will be used. Placement of the pipe following the steps above will occur in one direction, with construction traffic, such as excavation equipment, rock and water trucks, backhoes, and excavators, flowing in the same
direction between the nearest upstream and downstream access points. The one way traffic will keep equipment moving during the course of construction, so the bench will need to be cleared and maintained open as construction moves along. Completed backfilling of the pipe trench to proposed finished grade will provide the necessary support to keep the pipe from crushing under the weight of the construction equipment.

**Minimum Pipe Depth**

Minimum pipe depth is based on using the selected PVC material. PVC pipes are classified as flexible pipes and flex without breaking when loaded externally from soil weight and vehicular traffic.

When PVC pipe encounters external loading, its diameter will begin to deflect. Since the pipe is buried in supportive soil, the stiffness of the soil will resist the deflection. By itself the pipe may not support much weight, but the soil/pipe system can have a tremendous load capacity.

Because a PVC pipe flexes rather than breaks when loaded, a limit is placed on pipe deflection. Industry recommendations for maximum deflection for PVC pressure pipes is 5%. In order to determine the suitability of a particular burial depth the Modified Iowa Equation is used. The table below identifies the percent deflection from Highway H20 loading from a depth of cover over the pipe from 1 foot to 4 feet, based on the following assumptions:

- Backfill Weight = 120 lb/cf
- Backfill Soil Class I – ¾” Crushed Rock
- Modulus of Soil Reaction (E’) = 3000 psi
- Pipe Stiffness = 14 psi
- Live Load = Highway H20 Loading

Table 18 identifies percent pipe deflection versus cover over pipe under the loading conditions described above.

**Table 18. Percent Deflection Based On Cover from H20 Loading**

<table>
<thead>
<tr>
<th>Cover Over Pipe, Ft</th>
<th>Pipe Deflection %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.74</td>
</tr>
<tr>
<td>2</td>
<td>0.50</td>
</tr>
<tr>
<td>3</td>
<td>0.38</td>
</tr>
<tr>
<td>4</td>
<td>0.34</td>
</tr>
</tbody>
</table>

For additional information see Appendix C – Calculations
Pipe Bedding and Pipe Zone Backfill

The pipe zone is defined as a minimum of six to twelve inches below the pipe invert to one foot above the top of the pipe.

The bottom of the trench should be firm, smooth, free of standing water, and free of any soft or hard spots, large rocks, and any foreign material.

Imported granular bedding material should be used to level out the irregular trench bottom and to allow an easily shaped bedding surface. The thickness of bedding material should be a minimum of 6-inches. The minimum permissible sidewall clearance between installed pipe and trench side walls should be 12-inches. Table C1 identifies approximately 46,000 cubic yards of fill required.

Ditch and Trench Backfill

Backfill in the pipe trench above the pipe zone and in the remaining ditch section shall be free from organic matter, debris, and rocks larger than 6-inches in diameter or length, and compacted to at least 90 percent, and 95 percent at road crossings relative to ASTM 1557.

The top 6-inches of fill over the pipe is the final backfill, and shall be compacted to 95 percent relative to ASTM 1557 at driveways, and 90 percent relative to ASTM 1557 in non-roadway areas. Encroachment permit conditions will take precedence when more restrictive.

In order to prevent groundwater from flowing horizontally along the pipeline in the trench backfill, horizontal cut-offs will need to be constructed every 1000 feet. The material may be either controlled low strength material (CLSM) or structural concrete, and must extend vertically at least 6-inches below the bottom of the pipe bedding material to above the ground water level or the pipe zone, whichever is higher.

Import Material and Potential Borrow Site

As described in the section above, backfill in the pipe trench above the pipe zone and in the remaining ditch section shall be 6-inch minus, and compacted to at least 90 percent relative to ASTM 1557. In order to reduce import costs, nearby borrow areas will need to be identified during final design.

EID has a potential borrow site, Piney Point Stockpile Site, which has approximately 40,000 cubic yards of available material. The site is located approximately 6 miles east of the Sly Park Road and Highway 50 overcrossing on the north side of Highway 50 near post mile 38.3. The material was stockpiled by Caltrans as result of a landslide years ago, and has been placed by special use permit with the US Department of Agriculture Forest Service.

Pipe Loads

The external loads that will be imposed on the buried pipe are dependent on the subsurface conditions, the type of pipe, width of trench, the height of soil above the pipe and the method of pipe placement and backfill conditions. The effect of traffic loads on the pipeline should be
considered for the portions of the alignment beneath pavement, driveways, and access (maintenance) roads. Traffic loads should be added to the soil loads. As pipe is installed it will be continuously driven over by construction equipment working farther downstream.

Live loads caused by standard highway loadings will be determined during final design and based on the pipeline profile depth and anticipated traffic loads based on AASHTO HS-20 wheel loads.

It will be the responsibility of the contractor and pipe supplier to make sure that the pipe is handled, stored, and installed properly so that there is no undue stress placed on the pipe due to construction activities.

Groundwater

Based on the NRCS Web Soil Survey for El Dorado County, the majority of the soils found along the ditch alignment are classified as Hydrologic Soil Group B. Group B soils have moderate infiltration rates when thoroughly wetted, and consist chiefly of moderately deep to deep, and moderately well to well drained soils, with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.30 inches per hour). The soil survey lists the depth to water table as greater than 200 cm (6.5’). See Appendix C for web soil survey reports. Due to the minimal depth of pipe installation, groundwater is not anticipated under most conditions.

Floatation

As mentioned above, groundwater is not anticipated under most conditions, however the project will be constructed during the canal outage which occurs during the rainy season. Open and partially filled trenches, along with a porous backfill, may fill up with runoff and cause localized pipe floatation issues. Table 19 below identifies when floatation may occur and under what conditions. If floatation occurs, then a concrete anchor slab will be required to prevent flotation of the pipe, assuming proper anchorage of the pipe to the slab.

The pipe shall be rigidly anchored or weighed to prevent floatation when CLSM is placed.

The buoyancy calculations were made with the following assumptions. These assumptions should be verified during final design.

- 36” PVC, DR51, 64.3 lbs/ft
- Backfill dry density = 110 lbs/cf (Sandy Soil)
- Backfill Specific Gravity = 2.65
- Design Factor of Safety = 1.5
Table 19. Pipe Buoyancy Calculations

<table>
<thead>
<tr>
<th>Pipe cover (ft)</th>
<th>Water Level above pipe (ft)</th>
<th>Will the pipe float? Yes or No</th>
<th>If pipe floats, minimum depth of concrete anchor (in) (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>Yes</td>
<td>6.5</td>
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<tr>
<td>1</td>
<td>1</td>
<td>Yes</td>
<td>10.3</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>No</td>
<td>NA</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>Yes</td>
<td>0.2</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Yes</td>
<td>4.0</td>
</tr>
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<td>No</td>
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<tr>
<td>2.5</td>
<td>2</td>
<td>No</td>
<td>NA</td>
</tr>
</tbody>
</table>

(1) Assume concrete anchor has a density of 150 lbs/cf (submerged density 87.6 lbs/cf), has a width equal to the pipe diameter (3.2 ft), and is properly anchored to the pipe.

See Appendix C for additional pipe buoyancy calculations.

Maintenance and Repair Access

The selected alignment has sufficient area to allow EID personnel to access all points along the alignment. Access will be provided from public roads that cross the Main Ditch. The access is assumed to be a minimum of 12 feet wide adjacent to and over the pipeline. The entire access will be located within existing and any newly acquired easements.

Storm Water

The Main Ditch currently conveys both storm water runoff as well as flows from Forebay Reservoir to the Reservoir 1 WTP. When the ditch is piped and backfilled, storm water runoff will be directed as sheet flow back to historic drainage patterns, with some locations of concentrated flow occurring due to existing topography. Due to California Department of Public Health regulations and water quality issues there will be no storm drain connections to the Main Ditch Pipe.

Based on a review of USGS quad topographic maps, the drainage area tributary to the Main Ditch between Forebay and Reservoir 1 WTP is approximately 315 acres. Three locations were identified downhill of the Main Ditch where further analysis is needed during the project final design. Two of the locations occur at drainage crossing of Blair Road, and the third is located upstream of one of the crossings on an unnamed creek. See Figure 12 for the two Blair Road crossing locations. Since the drainage structures on Blair Road were installed after construction of the ditch, and the project will change the drainage patterns, the resulting increased flow rates to some of these downstream facilities should be analyzed.
The following table identifies the watershed area and the percent increase due to the project as measured from the two Blair Road drainage crossings.

Table 20. Blair Road Drainage Crossing Watershed Increase Summary

<table>
<thead>
<tr>
<th>Blair Road Crossing Location (1)</th>
<th>Existing Watershed Below Main Ditch (ac)</th>
<th>Proposed Watershed (ac) (2)</th>
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<tr>
<td>#2</td>
<td>71</td>
<td>247</td>
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(1) See Figure 12 for locations  
(2) Including Watershed Area above the Main Ditch

The first location is identified as Blair Road Crossing #1. This is the location where an unnamed tributary to Iowa Canyon Creek crosses Blair Road. After the project, the watershed will increase from 17 acres to 106 acres. A hydrologic and hydraulic analysis at the culvert under Blair Road should be performed to determine if the effects from the project will have any significant impact, such as flooding over the roadway.

The second location is the Blair Road / Long Canyon South Fork crossing, identified as the Blair Road Crossing #2. After the project, the watershed will increase from 71 acres to 247 acres. As mentioned above, an analysis should be performed to determine impacts at the crossing due to the project.
The third location is sited adjacent to the un-named tributary to Iowa Canyon Creek upstream of the Blair Road Crossing #1. During final design, a hydraulic analysis with a topographic survey is recommended that will provide accurate elevations to determine any impacts from the increase in watershed area.

The El Dorado County Drainage Manual requires drainage facilities for areas greater than 100 acres be designed to safely convey the 100-year storm runoff. All available headwater depth of the culvert may be utilized for these facilities. We recommend using the US Army Corps of Engineers Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) computer modeling program to calculate the 100-year storm design flows. The runoff should be based on a Soil Conservation Service (SCS) hypothetical 24-hour storm pattern, using County rainfall data.

Runoff and losses should be based on SCS curve numbers and Natural Resources Conservation Service (NRCS) soil survey data for the region. The soils are generally medium to medium-high in permeability and the amount of impervious area is small. Routing of runoff in the HMS model should be performed using Muskingum-Cunge routing methods for open channel flow.
SECTION 6 - PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST

The following Opinion of Probable Construction Cost (OPCC) developed for the 10% BODR is based on the use of PVC pipe. A complete topographic survey and geological investigations will be necessary including precise pipe length, backfill volumes, and number/size of trees impacted, during the design phase to refine these costs.

The total cost presented in the OPCC includes an allowance for design/engineering/surveying of 7 percent, Construction Administration/Overhead of 8 percent, general conditions, taxes, and miscellaneous items of 15 percent, a contractor overhead and profit of 12 percent, and a 25 percent contingency.

Right-of-way costs of approximately $40,000 to $150,000 per acre are estimated for easements through the residential portions of the alignment. Temporary construction easements are estimated to average $5,000 per acre.

Total estimated construction cost for the preferred alignment of the 36” and 42” diameter pipeline and appurtenances is approximately $4.5 million. Other related costs to the District for this project will add another $1.5 million. A breakdown of the costs for each of the alignment alternatives can be found in Tables F1, F2, and F3 in Appendix F, and are summarized in Table 21 below.

<table>
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<th>Alignment Number</th>
<th>Construction Costs (1)</th>
<th>Other Costs (2)</th>
<th>Total Cost</th>
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<td>$4,517,600</td>
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<td>$6,012,000</td>
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<td>2</td>
<td>$4,349,644</td>
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<td>$5,997,000</td>
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<td>3</td>
<td>$5,037,800</td>
<td>$1,637,500</td>
<td>$6,676,000</td>
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(1) Construction Costs include costs associated with Main Ditch Piping, such as connections at Forebay and Reservoir 1 WTP, pipe material and appurtenances, tree removal, earthwork, contractor overhead and profit and construction contingency.

(2) Other costs include Temporary and Permanent Easement Acquisition; Title Search Service; Design, Engineering, and Surveying; Construction Administration and Overhead; General Conditions, Taxes, and Miscellaneous Items.
SECTION 7 – PRELIMINARY PROJECT SCHEDULE

The preliminary project schedule illustrated in Figure G-1 incorporates mobilization, construction, testing, and final completion of the project. A typical canal outage occurs between October and December, however for this project EID may extend the canal outage through February. The Reservoir A WTP can typically satisfy demands through March if needed to accommodate the extended outage. All construction and testing schedule components will need to occur during the approximately 21 week canal outage. A work week is assumed to be Monday through Friday. In this time period, approximately 10,500 feet of 36-inch PVC and 4,900 feet of 42-inch PVC waterline will need to be installed, tested, and accepted by EID.

Pipe installation and backfill is the largest single activity. This schedule estimates approximately 114 days (23 weeks) to construct the pipeline based on the following assumptions.

- Locations where there is limited access to the construction area assume 100 feet/day pipe installation.
- Locations where there is adequate access to the construction area assume 300 feet/day pipe installation.
- Assume 40% of the preferred alignment has adequate access and 60% of the alignment has limited access.

Allowing for mobilization and testing periods, weather delays typical for this time of year, and the holidays, it is apparent that the project cannot be completed within a single canal outage with a single construction crew. The use of multiple crews for the pipeline construction may reduce the project time down to one canal outage, but could increase the overall construction costs and increase the traffic, and noise impacts. Therefore it is recommended that the project be planned over two construction seasons.
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SECTION 8 – CONCLUSIONS

A summary of the selected criteria is provided below along with a description of next steps for the project. A preliminary opinion of probable costs for the project determined a budgetary cost of $6,012,000 for the preferred alignment. This cost will be refined as final design proceeds.

BODR Design Criteria

The following design criteria developed as part of this BODR will be utilized for the final design of the Upper Main Ditch Pipeline:

- Pipeline Material – PVC C905 SDR 51
- Pipeline Size – Combination of 36-inch and 42-inch (lengths to be determined following detailed survey during final design)
- Pipeline Alignment – Following existing ditch alignment (Alignment #1)
- Isolation Valves – At beginning and end of pipeline only, no intermediate isolation valves.
- Air/Vacuum Release Valves – At high points and every 1,000 feet
- Blow-off Valves – At low points
- Customer Raw Water Services – Connect to existing water services per typical raw water meter connection
- Connection to Forebay Reservoir Valve House – Per connection detail provided in Appendix D
- Inlet Structure at Reservoir 1 – Per connection detail provided in Appendix D
- Crossing at Blair Road – Coordinate crossing with Blair Road Construction
- Access Road – 12-ft access road provided along and above the new pipeline
- Construction Schedule – Recommended to phase the project over two construction seasons (October – February)

Recommended Next Steps

Following acceptance of the BODR the next steps recommended for the Upper Main Ditch Pipeline Project include:

- Detailed topographic survey
- Geotechnical analysis to determine backfill requirements and groundwater levels
- Detailed easement search (title report search) to determine existing and required new easements
- Detailed hydrologic and hydraulic analysis based on the survey for key drainage areas
- Final environmental documentation
- Final design preparation
Appendix A
Main Ditch Alignment, Access, and HGL Exhibits
APPROXIMATE ALIGNMENT 2 TOTAL PIPE LENGTH = 13,800 LF
OF WHICH 11,500 LF IS LAID WITHIN EXISTING MAIN DITCH ALIGNMENT, AND 1,750 LF IS LAID CROSS COUNTRY.

LEGEND
- ALIGNMENT #2 - EXISTING DITCH
- ALIGNMENT #2 - CROSS COUNTRY
RESERVOIR WATER TREATMENT PLANT

ALIGNMENT #3 - EXISTING DITCH
ALIGNMENT #3 - BLAIR ROAD

APPROXIMATE ALIGNMENT #3 TOTAL PIPE LENGTH = 12,800 LF.
OF WHICH 6,100 LF. IS LAID WITHIN EXISTING MAIN DITCH ALIGNMENT,
AND 6,800 LF. IS LAID WITHIN BLAIR ROAD.
EXISTING FLOWING ELEVATIONS (FLOWING AT 40 CFS)

MAX NORMAL OPERATING HGL = 3772.2 (NAVD 88)
MIN NORMAL OPERATING HGL = 3758.2 (NAVD 88)

MAX NORMAL OPERATING HGL: UPSTREAM OF OUTLET STRUCTURE
MIN NORMAL OPERATING HGL: DOWNSTREAM OF OUTLET STRUCTURE

EXISTING FLOWING ELEVATIONS BASED ON INFORMATION PROVIDED BY ALAN DIVERS, P.E.
ELEVATIONS ARE BASED ON NAVD 88.

TRANSMISSION FROM MAXIMUM NORMAL OPERATING HGL ELEVATION (FLOWING AT 40 CFS)
INTEGRAL STRUCTURE TO RESTRICT FLOW WITH BUTTERFLY VALVE AND DISSIPATE ENERGY

MINIMUM NORMAL OPERATING HGL ELEVATION (FLOWING AT 40 CFS)

RES 1, RES INLET STRUCTURE: TO RESTRICT FLOW WITH BUTTERFLY VALVE AND DISSIPATE ENERGY

SCALE: 1" = 1-000'

DESIGNER: DOMENICHELLI & ASSOCIATES
1701 Tovar Avenue, Suite 105
El Dorado Hills, CA 95762
Phone: (916) 932-1919
Fax: (916) 932-1916

PLACERVILLE, CALIFORNIA 95667
ACCESS LOCATIONS SHOWN ARE POSSIBLE LOCATIONS BASED ON SITE WALK. DISTRICT AND CONTRACTOR SHALL COORDINATE WITH PRIVATE PROPERTY OWNERS TO GAIN ACCESS FROM PRIVATE PROPERTY.
Appendix B
Project Site Photos
PHOTO 1– Reservoir 1 Water Treatment Plant
PHOTO 2– Reservoir 1 Water Treatment Plant

PHOTO 3-Existing private access road bridge and drainage pipe crossing
PHOTO 4-Private access road bridge and drainage pipe crossing (looking upstream)

PHOTO 5-Ditch trash rack (looking downstream)
PHOTO 6-Gunite ditch section (looking upstream)

PHOTO 7-Gunite ditch section (looking upstream)
PHOTO 8-Gunite ditch section and driveway bridge (looking upstream)

PHOTO 9-Gunite ditch section and driveway bridge (looking upstream)
PHOTO 10-Gunite ditch section and driveway bridge (looking upstream)
PHOTO 11-Parshall flume (looking downstream)

PHOTO 12-Parshall flume
PHOTO 13-Blair Road Bridge (looking upstream)

PHOTO 14-Blair Road Bridge (looking downstream)
PHOTO 15-Private pedestrian bridge (looking upstream)

PHOTO 16-House (APN 101-210-36) below Main Ditch adjacent to drainage channel
PHOTO 17-Private bridge (looking upstream)

PHOTO 18-Private bridge (looking downstream)
PHOTO 21-Small structure (looking upstream)

PHOTO 22-Pinewood Ct culvert crossing (looking upstream)
PHOTO 23-Pinewood Ct crossing (looking downstream)

PHOTO 24-Private driveway bridge (looking downstream)
PHOTO 25-Rock slope protection at sharp bend in Main Ditch (looking upstream)

PHOTO 26-Forebay Reservoir Spillway Pipe (looking upstream)
PHOTO 27-Forebay Reservoir Spillway Pipe (looking upstream)

PHOTO 28-Forebay Reservoir Spillway Pipe (looking upstream)
PHOTO 29-Gunite Main Ditch section (looking downstream)

PHOTO 30-Upstream beginning of Main Ditch
Appendix C
Project Calculations
Table C1 Alignment #1 Cut/Fill/Pipe Trench Class 2 AB Backfill Quantities

<table>
<thead>
<tr>
<th>Station (1)</th>
<th>Area Cut (SF)</th>
<th>Average Area Cut (SF)</th>
<th>Volume Cut (CF)</th>
<th>Volume Cut (CY)</th>
<th>Area Fill (SF)</th>
<th>Average Area Fill (SF)</th>
<th>Volume Fill (CF)</th>
<th>Volume Fill (CY)</th>
<th>Cumulative Cut (CY)</th>
<th>Cumulative Fill (CY)</th>
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<th>Average Pipe Trench Class 2 AB Backfill (SF)</th>
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(1) Stationing from Forebay to Res 1
Sections at Stations per Main Ditch Survey Points.pdf
PVC Pipe with 2.5 FT minimum cover
Approximate 1 FT over-ex below pipe
* Without Removing Pipe and Pipe Trench Class 2 AB Volume
** Total Fill Minus Pipe Trench Class 2 AB

Total Cut (CY) 1900
Total Fill (CY)* 45700
Total Pipe Trench Class 2 AB Backfill (CY) 9700
Total Fill (CY)** 36000
## Table C2 Alignment #2 Cut/Fill/Pipe Trench Class 2 AB Backfill Quantities

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<thead>
<tr>
<th>Main Ditch Alignment Station (1)</th>
<th>Area Cut (SF)</th>
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<th>Volume Cut (CF)</th>
<th>Volume Cut (CY)</th>
<th>Area Fill (SF)</th>
<th>Average Area Fill (SF)</th>
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<th>Volume Fill (CY)</th>
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<th>Cumulative Fill (CY)</th>
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<th>Average Pipe Trench Class 2 AB Backfill (SF)</th>
<th>Volume Pipe Trench Class 2 AB Backfill (CF)</th>
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(1) Stationing from Forebay to Res 1
Sections at Stations per Main Ditch Survey Points.pdf
PVC Pipe with 2.5 FT minimum cover
Approximate 1 FT over-ex below pipe

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(2) Cross country alignment

* Without Removing Pipe and Pipe Trench Class 2 AB Volume
** Total Fill Minus Pipe Trench Class 2 AB

Note: Abandoned section of Alignment #2 shall be filled with engineered fill to return drainage pattern to pre-ditch conditions.
**Table C3 Alignment #3 Cut/Fill/Pipe Trench Class 2 AB Backfill Quantities**

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<th>Station (1)</th>
<th>Area Cut (SF)</th>
<th>Average Area Cut (SF)</th>
<th>Volume Cut (CF)</th>
<th>Volume Cut (CY)</th>
<th>Area Fill (SF)</th>
<th>Average Area Fill (SF)</th>
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(1) Stationing from Forebay to Res 1
Sections at Stations per Main Ditch Survey Points.pdf
PVC Pipe with 2.5 FT minimum cover
Approximate 1 FT over-ex below pipe

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<th>Blair Road Station (2)</th>
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<th>Blair Road Volume Cut (CY)</th>
<th>Area Fill (SF)</th>
<th>Average Area Fill (SF)</th>
<th>Blair Road Volume Fill (CF)</th>
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(2) Blair Road alignment

* Without Removing Pipe and Pipe Trench Class 2 AB Volume
** Total Fill Minus Pipe Trench Class 2 AB

Note: Abandoned section of Alignment #3 shall be filled with engineered fill to return drainage pattern to pre-ditch conditions.
Table C4 Pipeline Buoyancy Calculations

Given:
| Backfill dry density (lbs/cf) | 110 | Sandy Soil |
| Backfill Specific Gravity     | 2.65 |

Pipe Depth of Cover (ft) 2
Water Level Above Pipe (ft) 0
Factor of Safety 1.25

Results:

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<th>Material Type</th>
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<th>PVC</th>
<th>DIP</th>
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<td>DIPS 42”</td>
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<td>Pipe Rating</td>
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<td>Pipe Weight (lbs/ft)</td>
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<td>151.37</td>
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</table>

| Outside Diameter (in) | 42 | 48 | 44.5 | 38.3 | 44.5 | 44.5 | 44.5 | 44.5 |
| Displaced Water Weight (lbs) | -600.3 | -784.1 | -673.9 | -499.2 | -673.9 | -673.9 | -673.9 | -673.9 |
| Summation of Forces (lbs) (Pipe Weight+Displaced Water) | -527.6 | -608.0 | -522.6 | -434.9 | -585.8 | -565.7 | -538.4 | -500.1 |

| Inundated Backfill Density (lbs/cf) | 68.5 | 68.5 | 68.5 | 68.5 | 68.5 | 68.5 | 68.5 | 68.5 |
| Weight of Inundated backfill (lbs) | 90.0 | 117.6 | 101.1 | 74.9 | 101.1 | 101.1 | 101.1 | 101.1 |

| Weight of backfill above water level (lbs) | 770.0 | 880.0 | 815.8 | 702.2 | 815.8 | 815.8 | 815.8 | 815.8 |
| Total Weight of Backfill (lbs) | 860.0 | 997.6 | 916.9 | 777.0 | 916.9 | 916.9 | 916.9 | 916.9 |

| Total Weight of Backfill with Factor of Safety (lbs) | 688.0 | 798.1 | 733.5 | 621.6 | 733.5 | 733.5 | 733.5 | 733.5 |
| Net Total Displacement (lbs) (+Will not float/-Will float) | 160.4 | 190.1 | 210.9 | 186.7 | 147.7 | 167.8 | 195.1 | 233.4 |

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<th>DIP</th>
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<td>Will Float</td>
<td>Will Float</td>
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<tr>
<td>Pipe Cover 2ft, Water Level Above Pipe 0ft</td>
<td>Will Not Float</td>
<td>Will Not Float</td>
<td>Will Not Float</td>
</tr>
<tr>
<td>Pipe Cover 2ft, Water Level Above Pipe 2ft</td>
<td>Will Float</td>
<td>Will Float</td>
<td>Will Float</td>
</tr>
<tr>
<td>Pipe Cover 2.5ft, Water Level Above Pipe 0ft</td>
<td>Will Not Float</td>
<td>Will Not Float</td>
<td>Will Not Float</td>
</tr>
<tr>
<td>Pipe Cover 2.5ft, Water Level Above Pipe 2.5ft</td>
<td>Will Float</td>
<td>Will Float</td>
<td>Will Float</td>
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<td>Pipe Cover 3ft, Water Level Above Pipe 0ft</td>
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<td>Will Not Float</td>
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<td>Will Not Float</td>
<td>Will Not Float</td>
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</table>
### Table C5A Maximum Flow

| Q (cfs) | Starting Upstream Water Surface Elevation at Forebay Reservoir (ft) | Forebay Reservoir Starting Water Surface Elevation Description | Length (ft) | Outlet Inv (ft) | Inlet Inv (ft) | HGL slope (ft/ft) | Pipe Friction Loss (ft) | Velocity (fps) | Forebay Inlet & Discharge Losses (ft) | Assumed Bend Losses (ft) | Exit Loss Coefficient C_o | Exit Loss (ft) | Downstream HGL at Res 1 WTP Inlet (ft) | HGL Difference (ft) |
|---------|---------------------------------------------------------------|---------------------------------------------------------------|--------------|----------------|----------------|------------------|----------------------|----------------|-----------------------------------|------------------------|------------------------|----------------|--------------------------------------|----------------|---|
| 40.0    | 3799.6 Maximum Normal                                          |                                               | 15400        | 3752.70        | 3773.35        | 0.0020           | 30.9                  | 5.44            | 1.2                               | 2.5                    | 0.5                    | 0.2            | 3764.8                               | 34.8           |
| 40.0    | 3785.6 Minimum Normal                                           |                                               | 15400        | 3752.70        | 3773.35        | 0.0020           | 30.9                  | 5.44            | 1.2                               | 2.5                    | 0.5                    | 0.2            | 3750.8                               | 34.8           |

### Table C5B Minimum Flow

| Q (cfs) | Starting Upstream Water Surface Elevation at Forebay Reservoir (ft) | Forebay Reservoir Starting Water Surface Elevation Description | Length (ft) | Outlet Inv (ft) | Inlet Inv (ft) | HGL slope (ft/ft) | Pipe Friction Loss (ft) | Velocity (fps) | Forebay Inlet & Discharge Losses (ft) | Assumed Bend Losses (ft) | Exit Loss Coefficient C_o | Exit Loss (ft) | Downstream HGL at Res 1 WTP Inlet (ft) | HGL Difference (ft) |
|---------|-------------------------------------------------------------------|---------------------------------------------------------------|--------------|----------------|----------------|------------------|----------------------|----------------|-----------------------------------|------------------------|------------------------|----------------|--------------------------------------|----------------|---|
| 7.0     | 3799.6 Maximum Normal                                              |                                               | 15400        | 3752.70        | 3773.35        | 0.0001           | 1.2                   | 0.95            | 0.2                               | 0.4                    | 0.5                    | 0.0            | 3797.8                               | 1.8            |
| 7.0     | 3785.6 Minimum Normal                                               |                                               | 15400        | 3752.70        | 3773.35        | 0.0001           | 1.2                   | 0.95            | 0.2                               | 0.4                    | 0.5                    | 0.0            | 3783.8                               | 1.8            |
Table C6 42" PVC Preliminary Main Ditch Piped Hydraulics

27-Jun-14

Pipe Material: PVC DR51 42", 42.65" ID  Hazen Williams C = 140

Starting Downstream Invert 3752.7
Entrance Loss Coefficient, Ke from FHWA 1985
Elevations based on NAVD88 Datum

Table C6A Maximum Flow

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<tr>
<th>Q (cfs)</th>
<th>Starting Upstream Water Surface Elevation at Forebay Reservoir (ft)</th>
<th>Forebay Reservoir Starting Water Surface Elevation Description</th>
<th>Length (ft)</th>
<th>Outlet Inv (ft)</th>
<th>Inlet Inv. (ft)</th>
<th>HGL slope (ft/ft)</th>
<th>Pipe Friction Loss (ft)</th>
<th>Velocity (fps)</th>
<th>Forebay Inlet &amp; Discharge Losses (ft)</th>
<th>Assumed Bend Losses (ft)</th>
<th>Exit Loss Coefficient $C_o$</th>
<th>Exit Loss (ft)</th>
<th>Downstream HGL at Res 1 WTP Inlet (ft)</th>
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Table C6A Minimum Flow

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Table C7 Combination of 36" and 42" PVC Preliminary Main Ditch Piped Hydraulics

27-Jun-14
Pipe Material: PVC DR51 36", 36.71" ID Hazen Williams C = 140
Pipe Material: PVC DR51 42", 42.65" ID Hazen Williams C = 140

Starting Downstream Invert 3752.7
Entrance Loss Coefficient, Ke from FHWA 1985
Elevations based on NAVD88 Datum

Table C7A Maximum Flow

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<tr>
<th>Q (cfs)</th>
<th>Starting Upstream Water Surface Elevation at Forebay Reservoir (ft)</th>
<th>Forebay Reservoir Surface Elevation Description</th>
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<th>36° Outlet Inv. (ft)</th>
<th>Inlet Inv. (ft)</th>
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<th>42&quot; Length (ft)</th>
<th>42° HGL slope (ft/ft)</th>
<th>42&quot; Pipe Friction Loss (ft)</th>
<th>Total Pipe Friction Loss (ft)</th>
<th>36&quot; Velocity (fps)</th>
<th>42&quot; Velocity (fps)</th>
<th>Forebay Inlet &amp; Discharge Losses (ft)</th>
<th>Assumed Bend Losses (ft)</th>
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<td>3785.6 Minimum Normal 8400 3752.70 3773.35 0.0020 16.8 7000 0.0010 6.8 23.6 5.4 4.0 1.20 2.5 0.50 0.1 3758.2 27.4</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Table C7A Minimum Flow

<table>
<thead>
<tr>
<th>Q (cfs)</th>
<th>Starting Upstream Water Surface Elevation at Forebay Reservoir (ft)</th>
<th>Forebay Reservoir Surface Elevation Description</th>
<th>36&quot; Length (ft)</th>
<th>36° Outlet Inv. (ft)</th>
<th>Inlet Inv. (ft)</th>
<th>36&quot; HGL slope (ft/ft)</th>
<th>36&quot; Pipe Friction Loss (ft)</th>
<th>42&quot; Length (ft)</th>
<th>42° HGL slope (ft/ft)</th>
<th>42&quot; Pipe Friction Loss (ft)</th>
<th>Total Pipe Friction Loss (ft)</th>
<th>36&quot; Velocity (fps)</th>
<th>42&quot; Velocity (fps)</th>
<th>Forebay Inlet &amp; Discharge Losses (ft)</th>
<th>Assumed Bend Losses (ft)</th>
<th>Exit Loss Coefficient C_o</th>
<th>Exit Loss (ft)</th>
<th>Downstream HGL at Res 1 WTP Inlet (ft)</th>
<th>HGL Difference (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.0</td>
<td>3799.6 Maximum Normal 8400 3752.70 3773.35 0.00008 0.7 7000 0.000038 0.3 0.9 1.0 0.7 0.20 0.4 0.50 0.0 3798.1 1.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.0</td>
<td>3785.6 Minimum Normal 8400 3752.70 3773.35 0.00008 0.7 7000 0.00000 0.3 0.9 1.0 0.7 0.20 0.4 0.50 0.0 3784.1 1.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
Minimum Depth of Burial for PVC Pipe

Based on JM Eagle Technical Bulletin for *Depth of Burial for PVC Pipe*, January 2009

Solve for pipe deflection in PVC Pressure Pipes using Modified Iowa Equation:

\[
\text{% DEFINITION} = \frac{0.1 \times (W' + P)}{0.149 \times (PS) + 0.061 \times E'} 
\]

Where:

\text{% DEFINITION} = \text{predicted percentage of diametric deflection.}

\text{W'} = \text{Live Load (lbs/in}^2\text{): pressure transmitted to the pipe from traffic on the ground surface. Live Load values are found in Table 2.}

\text{P} = \text{Prism Load (lbs/in}^2\text{): pressure acting on the pipe from the weight of the soil column above the pipe (also called “Dead Load”). Prism Load values are found in Table 3.}

\text{PS} = \text{Pipe Stiffness (lbs/in}^2\text{): a flexible pipe’s resistance to deflection in an unburied state. Pipe Stiffness values for JM Eagle products are found in Table 4.}

\text{E'} = \text{Modulus of Soil Reaction (lbs/in}^2\text{): stiffness of the embedment soil. Values for Modulus of Soil Reaction are found in Table 5.}

Per Table 1 Below the maximum deflection for PVC Pressure Pipes is 5%.

### Table 1

<table>
<thead>
<tr>
<th>MAXIMUM RECOMMENDED DIAMETRIC DEFLECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC Pressure Pipes</td>
</tr>
<tr>
<td>PVC Sewer / Drain Pipes</td>
</tr>
<tr>
<td>PVC Electrical Conduits</td>
</tr>
<tr>
<td>HEIGHT OF COVER (FT)</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
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<tr>
<td>7</td>
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<tr>
<td>8</td>
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<tr>
<td>10</td>
</tr>
<tr>
<td>12</td>
</tr>
<tr>
<td>14</td>
</tr>
<tr>
<td>16</td>
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<tr>
<td>18</td>
</tr>
<tr>
<td>20</td>
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<tr>
<td>22</td>
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<tr>
<td>24</td>
</tr>
<tr>
<td>26</td>
</tr>
<tr>
<td>28</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>35</td>
</tr>
<tr>
<td>40</td>
</tr>
</tbody>
</table>

¹ Simulates 20 ton truck traffic + impact.
² Simulates 80,000 lb/ft railway load + impact.
³ 150,000 lbs. dual tandem gear assembly; 26-inch spacing between tires and 66-inch center-to-center spacing between fore and aft tires under a rigid pavement 12 inches thick + impact.
⁴ Negligible live load influence.
Table 3

<table>
<thead>
<tr>
<th>HEIGHT OF COVER (FT)</th>
<th>SOIL UNIT WEIGHT (LBS/FT³)</th>
<th>100</th>
<th>110</th>
<th>120</th>
<th>125</th>
<th>130</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>0.69</td>
<td>0.76</td>
<td>0.83</td>
<td>0.87</td>
<td>0.90</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>1.39</td>
<td>1.53</td>
<td>1.67</td>
<td>1.74</td>
<td>1.81</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>2.08</td>
<td>2.29</td>
<td>2.50</td>
<td>2.60</td>
<td>2.71</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>2.78</td>
<td>3.06</td>
<td>3.33</td>
<td>3.47</td>
<td>3.61</td>
</tr>
</tbody>
</table>

Table 4

<table>
<thead>
<tr>
<th>PRESSURE RATING (PSI)</th>
<th>SDR</th>
<th>PIPE STIFFNESS (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>64</td>
<td>7</td>
</tr>
<tr>
<td>80</td>
<td>51</td>
<td>14</td>
</tr>
</tbody>
</table>

Table 5

<table>
<thead>
<tr>
<th>SOIL CLASS</th>
<th>PIPE BEDDING MATERIALS</th>
<th>E' FOR DEGREE OF COMPACTION OF PIPE ZONE BACKFILL (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>Crushed Rock</td>
<td>1,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±2</td>
</tr>
<tr>
<td>Class II</td>
<td>Coarse-grained Soils</td>
<td>2,000</td>
</tr>
<tr>
<td></td>
<td>with little or no fines</td>
<td>±2</td>
</tr>
<tr>
<td>Class III</td>
<td>Fine-grained Soils</td>
<td>3,000</td>
</tr>
<tr>
<td></td>
<td>(LL &lt; 50)</td>
<td>±1</td>
</tr>
<tr>
<td>Class IV</td>
<td>Fine-grained Soils</td>
<td>4,000</td>
</tr>
<tr>
<td></td>
<td>(LL &lt; 50)</td>
<td>±0.5</td>
</tr>
</tbody>
</table>

Note: **L**. = Liquid limit
**S**. Or any borderline soil beginning with one of these symbols (i.e. GM-GC, GC-GSC)
**D**. For ±1% accuracy and predicted deflection of 2%, actual deflection would be between 2% and 4%.

* ASTM Designation D 2487, USBR Designation E-3
* LL = Liquid limit
* D = Or any borderline soil beginning with one of these symbols (i.e. GM-GC, GC-GSC)

Accuracy in Terms of Percentage Deflection

PIPE DEFLECTION, % Including a MOVING Wheel Load

<table>
<thead>
<tr>
<th>Depth, Ft</th>
<th>36.000</th>
<th>42.000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>0.74 %</td>
<td>0.74 %</td>
</tr>
<tr>
<td>2.00</td>
<td>0.50 %</td>
<td>0.50 %</td>
</tr>
<tr>
<td>3.00</td>
<td>0.38 %</td>
<td>0.38 %</td>
</tr>
<tr>
<td>4.00</td>
<td>0.34 %</td>
<td>0.34 %</td>
</tr>
</tbody>
</table>

H20 Live Load

K = 0.100
PS = 14 psi
E’ = 3000 psi

Prism Load, Wp, Condition Backfill Weight = 120 Lb / Ft ^ 3

(Note: If 'Over' is printed, the calculated deflection exceeded the allowable deflection)

EXTERNAL LOAD, Lb / Ft Including a MOVING Wheel Load

<table>
<thead>
<tr>
<th>Depth, Ft</th>
<th>36.000</th>
<th>42.000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>5883.2</td>
<td>6863.7</td>
</tr>
<tr>
<td>2.00</td>
<td>3981.3</td>
<td>4644.8</td>
</tr>
<tr>
<td>3.00</td>
<td>3015.3</td>
<td>3517.9</td>
</tr>
<tr>
<td>4.00</td>
<td>2734.1</td>
<td>3189.7</td>
</tr>
</tbody>
</table>
Appendix D
Construction Details
**CONSTRUCTION NOTES**

1. PUMPS SHALL BE REQUIRED FOR ANY EXCAVATION OVER 15 FT IN DEPTH, INTO WHICH A PERSON IS REQUIRED TO DESCEND OR ANY EXCAVATION LESS THAN 5 FT IN DEPTH IN SOILS WHERE HAZARDOUS GROUND MOVEMENT MAY BE EXPECTED AND INTO WHICH A PERSON IS REQUIRED TO DESCEND.

2. PURPLE PIPE TO BE LAID WITH CURB UP ON EACH JOINT.

3. SIDE LICENSED SHALL CONFORM TO JURISDICTIONAL METER BOARD, METER CONDITION AND SPECIFICATIONS.

4. COMPARTMENT IS RELATIVE TO NEW TRENCH.

**TYPICAL DITCH SECTION**

**TRENCH WIDTH TABLE**

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>MIN</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24&quot;</td>
<td></td>
<td></td>
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<tr>
<td>30&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CONCRETE TRENCH DAM DETAIL**

- TOP OF TRENCH DAM TO EXTEND INTO REHABILITATION ZONE EXTENDING 10 FT BEYOND MAIN DITCH OR 10 FT INTO INTERMEDIATE BACKFILL, WHICHEVER IS GREATER.
- SIDE OF TRENCH DAM TO EXTEND INTO INTERMEDIATE BACKFILL 12" MINIMUM OR TO TOP OF GROUND WATER HGL.

**SECTION A-A**

- CONCRETE TRENCH DAM APPROXIMATELY 10 FT CORNER TO CORNER.
- PLACE CONCRETE TRENCH DAM AT APPROXIMATELY EVERY 100 FT ALONG PIPELINE ALIGNMENT.

**WARNING**

- DETAIL COMPLIES WITH ACCORDING TO ASTM 1557.
FOREBAY VALVE HOUSE CONNECTION

PLAN VIEW

11" ~ 36" STEEL PIPE

FLOW RESTRICTION PLATE

PLUG 3" VENT PIPE

NEW 36" 0 STEEL PIPE

NEW 36" 0 PVC PIPE

2" AVRV

CONCRETE APRON

FOREBAY VALVE HOUSE CONNECTION

PROFILE VIEW
Appendix E
EID Provided Design Data
<table>
<thead>
<tr>
<th>Panel</th>
<th>Number</th>
<th>Date</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>RS</td>
<td>30/24/1</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>PM</td>
<td>13/88/A</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>PM</td>
<td>10/65/1</td>
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<td>38</td>
<td>PM</td>
<td>10/65/2</td>
<td></td>
</tr>
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<td>PM</td>
<td>10/65/3</td>
<td>RS 30/13</td>
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<td>PM</td>
<td>26/80/1</td>
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<td>35</td>
<td>PM</td>
<td>26/80/2</td>
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<tr>
<td>34</td>
<td>PM</td>
<td>20/71/D</td>
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<td>33</td>
<td>PM</td>
<td>20/71/B</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>PM</td>
<td>20/71/A</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>R/S</td>
<td>25/94</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>R/S</td>
<td>26/61</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>PM</td>
<td>45/31/2</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>PM</td>
<td>45/31/1</td>
<td></td>
</tr>
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<td>20</td>
<td>PM</td>
<td>21/138/C</td>
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<td>15</td>
<td>PM</td>
<td>3/87/B</td>
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<td>13</td>
<td>PM</td>
<td>3/87/A</td>
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<td>11</td>
<td>PM</td>
<td>8/85/3</td>
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<td>PM</td>
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<td></td>
</tr>
<tr>
<td>9</td>
<td>PM</td>
<td>5/151/B</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>PM</td>
<td>8/85/1</td>
<td></td>
</tr>
</tbody>
</table>
Acreages Are Estimates

This map is not a survey. It was prepared by the El Dorado County Assessor's office for assessment purposes only. Area calculations and descriptions are not guaranteed. Values should verify those with the assessor.
PARCEL MAP
A PORTION OF THE N.W. 1/4 OF SEC. 36, T.11N., R.12E., M.D.M.
COUNTY OF EL DORADO STATE OF CALIFORNIA
AUGUST, 1978 SCALE: 1"=50'
RECORDING ENGINEERING R.C.E 26363

SURVEYOR'S CERTIFICATE:
This map was prepared by me or under my direction and is based upon a field survey in conformance with the requirements of the subdivision map act at the request of Charles Vanderpool on July 1, 1978. I hereby state that the parcel map procedures of the local agency have been complied with and that this parcel map conforms to the approved tentative map and the conditions of approval thereof which were required to be fulfilled prior to the filing of the parcel map.

COUNTY SURVEYOR'S CERTIFICATE:
This map conforms with the requirements of the subdivision map act and local ordinance.
DATED: 7/12/1978
FRED W. DEBERRY L.S. 2403
COUNTY SURVEYOR
COUNTY OF EL DORADO

COUNTY RECORDER'S CERTIFICATE:
Filed this 23rd day of October, 1978, at 3:50 P.M. in book 21 of parcel maps, at page 189, at the request of Charles Vanderpool.

DOCUMENT NO. 105241

ASSessor's Parcel Map No. 8:54:11 Tentative Map P 78-281 approved 9/5/78

PARCEL A 1.002 Ac

Parcel B 2.003 Ac

Parcel C 3.870 Ac

LEGEND
- Found N/E C.I.P. stamped L.S. 2883
- 1/4 ECLP driven as shown
- Set N/E C.I.P. stamped R.C.E 26363
- 1/4 N/P.I.P. driven R.C.E. 19046
- 1/4 N/E C.I.P. stamped 1/8

BASIS OF BEARINGS
The direction of this survey is true north
The point is based upon monuments found in the field.

REFERENCES
30 A 196

E. MARINI 1094-568

REDMOND W. C. "A" 18

POLLOK PINES SUBDIVISION

G. ANDERSON 1399-560

C. GUNN 798-587

H. ARMSTRONG 937-673

480' NON-EXCLUSIVE ROAD & DITCH
207' NON-BUILDING ESTATE BASEMENT
28.6' NON-BUILDING & DRAINAGE DITCH

REFERENCES
30 A 196

REMARKS
21-138
RECORD OF SURVEY
A PORTION OF THE N 1/2 OF THE
SW 1/4 OF THE NN 1/4 OF SECTION 36
T. 11 N., R. 12 E., M.D.M.
COUNTY OF EL DORADO ~ STATE OF CALIFORNIA
MAY, 2002
SCALE: 1' = 100'

DAVID F. WADDELL - LAND SURVEYOR

SHEET 2 of 2

BASIS OF BEARINGS:
The Meridian of this survey is identical to that of P.M. 45-31, as based upon found monuments, and is true north.

NOTES:
1) The purpose of this survey is to delineate the Description of Parcel A as set forth in 458-446 O.R., as amended by the boundary line agreement set forth in 1641-25 O.R.
2) Refer to P.M. 45-31 for Section 36 break-down.

REFERENCES:
1) P.M. 20-11
2) P.M. 24-140
3) P.M. 49-31
4) 458-446 O.R.
5) 254-524 O.R.

LEGGEND
O = FIND MONUMENT AS INDICATED HEREON
E = FIND REBAR w/ ALUM. CAP STAMPED R.C.E. 22180 - 1994
F = FIND 1/2", C.I.P. STAMPED AS INDICATED.
H = SET 3/4", C.I.P. STAMPED LAS 5526-2002
I = SET 1/2", C.I.P. STAMPED AS INDICATED.
N = COMPUTATION POINT, NOTHING FOUND OR SET.

EXISTING ASSESSOR'S PARCEL NO. 101-210-01
BASIS OF BEARINGS

THE MEASURING OF THIS SURVEY IS TRUE NORTH AND IS IDENTICAL TO THAT OF REF 3-BT.

REFERENCES
RS 3-BT
RS 3-15
RS 3-BT
B.L.A. 1641-231

LEGEND

• SET 3/4" CIP STAMPED R.C.E. 22180-1978
• FOUND 3/4" CIP I STAMPED R.C.E. 22180-1978
• FOUND 3/4" OPEN PIPE I STAMPED R.C.E. 22180-1978
• FOUND 3/4" CIP STAMPED R.C.E. 58960
• FOUND AS SHOWN

SURVEYOR'S CERTIFICATE

THIS MAP WAS PREPARED BY ME OR UNDER MY SUPERVISION AND IS BASED UPON A FIELD SURVEY CONFORMING WITH THE REQUIREMENTS OF THE SURVEYOR'S CERTIFICATE AT THE REQUEST OF JUNE MARCO ON APRIL 2, 1978.

I HEREBY STATE THAT THE PARCEL MAP PROCEDURES OF THE LOCAL AGENCY HAVE BEEN COMPLIED WITH AND THAT THIS PARCEL MAP CONFORMS TO THE APPROVED TENTATIVE MAP AND THE CONDITIONS OF APPROVAL THEREOF WHICH WERE REQUIRED TO BE FULFILLED PRIOR TO THE FILING OF THE PARCEL MAP.

RECORDERS CERTIFICATE

FILED THIS 27TH DAY OF SEPTEMBER, 1978 AT 5:30 P.M. IN BOOK XYZ OF PARCEL MAPS AT PAGE 76 AT THE REQUEST OF W.W. FURTWANGLER.

COUNTY SURVEYOR'S CERTIFICATE

THIS MAP COMPLIES WITH THE REQUIREMENTS OF THE SURVEYOR'S CERTIFICATE AT THE REQUEST OF JUNE MARCO, DATE OF REQUEST OF 6-1978.

RECORDERS CERTIFICATE

FILED THIS 27TH DAY OF SEPTEMBER, 1978 AT 5:30 P.M. IN BOOK XYZ OF PARCEL MAPS AT PAGE 76 AT THE REQUEST OF W.W. FURTWANGLER.

TENTATIVE, MAP NO. PTV-769 APPROVED 1-23-78
HA RISS, JR.
539/499
PARCEL 2
1.6 ACRES

MILLEY, PATRICIA
539/499

HARRIS, JR.
1307/765

HARRIS, JR.
522/463

PARCEL 1
139 ACRES

PARCEL 3
1077 - 145
104.18'
231.90'
233.52'
233.52'

37
37
38

302 ACRES

PARCEL MAP
OF A PORTION OF THE N.E. 1/4 OF THE S.E. 1/4, SECTION 35, T11N, R13E, M.O.M.

COUNTY OF EL DORADO
STATE OF CALIFORNIA
JANUARY 1975
SCALE 1" = 50'
RICHARD J. COUGHLAN
L.R. 3227

SURVEYOR'S CERTIFICATE
THIS MAP WAS PREPARED BY ME OR UNDER MY DIRECTION AND IS BASED UPON A FIELD SURVEY IN CONFORMITY WITH THE REQUIREMENTS OF THE SUBDIVISION MAP ACT AT THE REQUEST OF RICHARD J. COUGHLAN ON APRIL 1975. I HEREBY CERTIFY THAT IT CONFORMS TO THE APPROVED TENTATIVE MAP AND THE CONDITIONS OF APPROVAL THEREOF.

COUNTY SURVEYOR'S CERTIFICATE
THIS MAP CONFORMS TO THE REQUIREMENTS OF THE SUBDIVISION MAP ACT AND LOCAL ORDINANCE.
Dated: Mar 1975

RECORDERS CERTIFICATE
FILED THIS 19TH DAY OF MARCH, 1975, AT 8:30 A.M. IN BOOK 10 OF PARCEL MAPS, AT PAGE 65, AT THE REQUEST OF RICHARD J. COUGHLAN.

TENTATIVE PARCEL MAP NO. 774 - 562 APPROVED 6 APRIL 75
PARCEL MAP
A PORTION OF THE S.E. 1/4 OF SECTION 35
T.II.N., R12E., M.D.M.
COUNTY OF EL DORADO
STATE OF CALIFORNIA
DECEMBER 1976
SCALE 1 in = 50 ft.

SURVEYOR'S CERTIFICATE
This map was prepared by me or under my direction and is based upon a field survey in conformance with the subdivision map act at the request of R.A. Brown on October 24, 1976, and hereby certify that it conforms to the approved tentative map and the conditions of approval thereof.

NATHAN C. MCCARTHY
RCE 5856

COUNTY SURVEYOR'S CERTIFICATE
This map conforms with the requirements of the subdivision map act and local ordinance dated Dec. 1976.

FRED G. DEFLROY
COUNTY SURVEYOR
COUNTY OF EL DORADO

COUNTY Recorder's Certificate
Filed this 13th day of December, 1976 at 10:30 A.M. in Book CA of Parcel Maps at page 336 at the request of R.A. Brown.

JAMES M. WHITNEY
COUNTY RECORDER
COUNTY OF EL DORADO

Basis of Bearings
The meridian of this parcel map is identical to that of Country Manor Subdivision.

References
3D B-97
3D C-75

Legend
- 1/4 x 1/4 C.T. STAMPED IT RCE 5840
- 1/4 x 1/4 C.T. STAMPED RCE 5890
- 1/4 x 1/4 C.T. IT
- 1/4 x 1/4 C.T. SET IN CONC. ACCEPTED AS CORR. TAGGED IT RCE 5870

JAMES M. WHITNEY
COUNTY RECORDER
COUNTY OF EL DORADO

By
DEPUTY COUNTY RECORDER

County Recorder's Certificate
Filed this 13th day of December, 1976 at 10:30 A.M. in Book CA of Parcel Maps at page 336 at the request of R.A. Brown.

1388

3-88

EXISTING ASSESSORS PARCEL NO. 0-07-8
TENTATIVE MAP MAP 76-58A
APPROVED 12-14-76

13-88

13-88
MEMORANDUM

DATE: November 9, 2012

TO: Dan Corcoran, El Dorado Irrigation District

FROM: Kris Kiehne

SUBJECT: Preliminary Wetland Delineation Report for El Dorado Irrigation District’s Main Ditch – Forebay to Reservoir 1 Project

EN2 Resources, Inc. (EN2) is pleased to submit the enclosed Preliminary Wetland Delineation Report (Report) on the results of the wetland delineation performed for the three-mile long section of the Main Ditch (Ditch) from Forebay to Reservoir 1. Thank you for your prompt review of the Draft Report. Your suggested changes and edits have been incorporated.

This report fulfills the requirement for Task 2 of this contract. Should the Corps require field verification of this report, EN2 staff will participate in the field visit and incorporate all changes requested by the Corps.

We appreciate the opportunity to support the District on this project. If you have any questions regarding the enclosed, please do not hesitate to contact me at (530) 626-1401.

Enclosure
Preliminary Wetland Delineation Report

Main Ditch – Forebay to Reservoir 1

Property Representative: El Dorado Irrigation District

November 9, 2012

Prepared for:
El Dorado Irrigation District
2890 Mosquito Road
Placerville, CA 95667

Prepared by:
EN2 Resources, Inc.
1024 Simon Drive, Suite H
Placerville, CA 95667
(530) 626-1401
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1.0 INTRODUCTION

1.1 Project Description

Owner: El Dorado Irrigation District
Representative: Dan Corcoran, El Dorado Irrigation District
APN #: Not Applicable
PLSS: Section 35, Township 11N, Range 12E MDBM
Project Size: 14.5 acres

The Main Ditch (Ditch) is owned by the El Dorado Irrigation District (District). The proposed project (Project) would pipe a three-mile section of the unlined earthen ditch in order to reduce leakage and losses and improve the quality of water entering the water treatment plant at Reservoir 1. The Project is located within the U.S. Geological Survey (USGS) 7.5-minute Pollock Pines Quadrangle (Figure 1) within El Dorado County. The Ditch is located in Pollock Pines, California, and conveys water from El Dorado Forebay to Reservoir 1. The Ditch abuts private properties and occasionally traverses privately held parcels through easements. No parcel number is assigned to the property.

EN2 Resources, Inc. (EN2) was authorized by the District to prepare this wetland delineation report to map and document potential wetlands and other “Waters of the U.S.” within and directly adjacent to the proposed Project, which may be subject to the U.S. Army Corps of Engineers’ (Corps) jurisdiction under Section 404 of the Clean Water Act (CWA). Specifically, the District directed EN2 Resources to investigate potentially jurisdictional features in a study area within 10 feet upslope and 25 feet downslope of the centerline of an approximately 3-mile long section of the Ditch and potential staging areas for the Project representing the anticipated limits of work.

1.2 Directions to the site

From the Corps Sacramento District office, travel east on J Street toward 14th Street, turn right at 15th Street, followed by a left onto X Street. Veer left to enter eastbound, Highway 50. Continue eastbound for approximately 50 miles to Pollock Pines. Take Exit 60 for Sly Park Road, turn left onto County Road E16/Sly Park Road. Turn left onto Pony Express Trail, take the first right onto Forebay Road.
2.0 METHODS

This preliminary wetland delineation (PWD) was prepared in accordance with the 1987 Corps of Engineers Wetlands Delineation Manual (USACE, 1987) and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (USACE, 2010). The site was surveyed in October 2012 to gather the necessary soil, vegetation, and hydrology data to prepare the preliminary wetland delineation report. Data were collected according to procedures of the above referenced documents for making a “routine determination” and entered into the Wetland Determination Data Forms (Appendix A).

EN2 Biologist Kristine Kiehne served as the principal author of the report. Ms. Kiehne has over ten years of professional experience completing a variety of biological studies and preparing associated reports. Ms. Virginia Meyer, Ph.D., served as principal field investigator and editor for the report and Mr. Jeremy Waite of EN2 assisted in both the field investigation and writing the report.

On October 2 and 7, 2012 field data were collected at the site for the PWD. Observation/data points were determined based on field conditions. At each observation point, the site was examined for hydrophytic vegetation, hydric soils, and wetland hydrology and recorded on the attached data sheets (Appendix A) per the 1987 Manual and the 2010 Supplemental Manual.

Vegetation was sampled and quantified at each point by estimating the percent cover of each taxon within the observation area. Taxa were identified to species level wherever possible using the Jepson Manual: Vascular Plants of California, Second Edition nomenclature (Baldwin, et al 2012) and the CalFlora database (CalFlora, 2012). The National List of Plant Species That Occur in Wetlands: (Western Mountains) and the USDA PLANTS database were consulted to determine the wetland indicator status for each plant [Upland (UPL), Facultative Upland (FACU), Facultative (FAC), Facultative Wetland (FACW), and Obligate (OBL)] (Lichvar R.W. and Kartesz J.T., 2009; USDA/NRCS, 2012).

Soil pits were dug to a depth necessary to locate any hydric soil indicators. Soil texture was determined in the field by approximating the percentage of sand, silt, and clay using the U.S. Department of Agriculture (USDA) soil texture triangle. Soil colors were determined using the Munsell Soil Color Charts (Munsell, 2000). The soils were classified using the USDA soil texture nomenclature as described in the University of Florida Extension Fact Sheet SL-29 (Brown 2003). Hydric soil indicators described in the Supplemental Manual (USACE, 2012) were used to determine if hydric soils were present.

Wetland hydrology indicators were evaluated at potential wetlands. All existing conditions are described in more detail in Section 3.2. Wetland hydrology determinations were based upon direct or indirect evidence as described in both the 1987 Manual and the 2010 Supplemental Manual.

Locations where Wetland Determination forms were completed were mapped in the field using a Trimble Nomad GPS unit. GPS data captured in the field were post-processed using the GPS Pathfinder Office software to differentially correct the positions taken in the field (remove
atmospheric and other environmental effects). These field-mapped boundaries were compared to orthorectified aerial photography (see sources below). Final edits to the data and all maps were made using ArcGIS Ver. 10.0 software. All data were collected at UTM NAD83, Zone 10 coordinates.

The following preliminary background data were collected prior to going to the field:

The USGS 7.5-minute Pollock Pines topographic quadrangle map (Photo-revised 1973): The quad map was reviewed for existing waters and other potential wetland features or topography that indicated the potential for drainage or ponding (Figure 1).

National Hydrography Dataset (NHD) (USGS 2012): File geodatabase features of the hydrographic data for the region were downloaded from the USGS NHD Geodatabase and mapped for the Project (Figure 2).

National Wetlands Inventory (NWI) (USFWS 2012): File geodatabase features of existing, mapped NWI wetlands were downloaded from the USFWS Wetlands Geodatabase and mapped for the Project (Figure 2).

Soil Survey Geographic (SSURGO) Database of the El Dorado Area, California Data and Web-based survey descriptions (NRCS 2012a and b). The soil survey was reviewed to determine which soil series have been mapped on-site and whether any hydric soils are present. Digital GIS shapefiles of the mapped soils obtained from the NRCS were downloaded and mapped for the Project (Figure 3).

Habitat Classification: The habitat was classified by reviewing the Manual of California Vegetation classification scheme and based on knowledge of plant communities in the region (Sawyer, J.O. and T. Keeler-Wolf. 2009). These vegetation communities can be cross-walked with other vegetation classification schemes as necessary.

Aerial Photography: National Agricultural Imagery Program (NAIP) 2009 El Dorado County, color, orthorectified 0.3 meter pixel resolution and aerial imagery from Bing in October 2012.
3.0 RESULTS AND DISCUSSION

3.1 Project Setting and Habitat Classification

Setting

The Project is in the USDA Land Resource Region (LRR) C, Mediterranean California. The Project is located in the Sierra Nevada Mountains (USDA Major Land Resource Area 22A), approximately 10 miles east of Placerville, CA. The region is characterized by mountainous terrain with steep river canyons. Elevations in the Sierra Nevada region range from approximately 2,000 feet to over 14,000 feet above mean sea level. The elevation at the Project is between 3,700 and 3,800 feet.

The three-mile long section of the Ditch traverses the contour of the canyon on the south slope from El Dorado Forebay in Pollock Pines to Reservoir 1 on Gilmore Road. Figure 2 shows the Project in relation to mapped waters and wetlands in the NHD and NWI. Figure 3 shows the soils within and surrounding the Project.

Habitat Classification

There are several vegetation types within the Project area. Areas along the Ditch are dominated by big leaf maple (Acer macrophyllum) or by conifer species such as white fir (Abies concolor) or incense cedar (Calocedrus decurrens). The understory vegetation is composed of Pacific dogwood (Cornus nuttallii) and lesser amounts of California hazelnut (Corylus cornuta var. californica), mountain alder (Alnus incana var. tenuifolia), California rose (Rosa californica) and many sapling maples, cedars and Douglas fir (Pseudotsuga menziesii). Herbaceous vegetation was comprised of mountain misery (Chamaebatia foliolosa), grasses (Elymus spp.), and weedy species such as hedgehog dogtail grass (Cynosurus echinatus). Vegetation data were collected and classified using the Second Edition of Manual of California Vegetation (MCV) (Sawyer, J.O. and T. Keeler-Wolf 2009). Additional vegetation data are available in the data sheets (Appendix A) and a summary of observed hydrophytic vegetation observed is provided in Table 2.

Based on the vegetation information collected during field visits and the MCV, White fir is the dominant conifer throughout most of the Project area, classifying this vegetation within the Abies concolor Forest Alliance (Sawyer, J.O. and T. Keeler-Wolf 2009). The other conifers making up the overstory include incense cedar (Calocedrus decurrens), ponderosa pine (Pinus ponderosa), and occasional Douglas fir (Pseudotsuga menziesii). Black oaks (Quercus kelloggii) are scattered throughout the overstory as well. The understory is composed primarily of Pacific dogwood and bigleaf maple and saplings of the dominant conifer species listed above.
3.2 Existing Conditions

3.2.1 Climate

The regional climate is Mediterranean, characterized by wet winters and dry summers. Precipitation is a mixture of rain and snow. Most of the precipitation occurs as rain from mid-October through April. Conditions at the Project site were drier than average: the rainfall total at the Pacific House Station (October 1, 2011 to October 1, 2012) was 38.8 inches, which is 74% of the average of 52.26 inches for this period (CDEC 2012, NRCS 2012d). These conditions are typical of the State. The Department of Water Resources Bulletin 120 stated that precipitation statewide was 75% of average to date as of October 1, 2012 (DWR 2012).

3.2.2 Hydrology

The NWI and NHD data (Figure 2) showed no wetlands in the Project area.

3.2.3 Soils

The NRCS Soil Survey indicates that there are five soil series within the study area (NRCS 2012 a,b) (Figure 3). The soil series map units are Cohasset loam 9-30% slopes (the majority of the Ditch); Josephine very rocky loam, 15 to 50 percent slopes (northern portion of Ditch); Josephine gravelly loam, 9-15% slopes (northern portion of Ditch); McCarthy cobbly loam, 9-50% slopes (southern end of Ditch); Mariposa-Josephine very rocky loam, 15-50% slopes (northern end of Ditch).

The Cohasset series consists of deep and very deep, well-drained soils that formed in material weathered from volcanic rock. These soils are on plateau-like uplands and have slopes of 2 to 50 percent. The Josephine series consists of deep, well-drained soils that formed in colluvium and residuum weathered from altered sedimentary and extrusive igneous rocks. Josephine soils are on broad ridgetops, toeslopes, footslopes, and side slopes of mountains. Slopes are 2 to 75 percent. The Mariposa series consists of moderately deep well drained soils formed in material weathered from tilted slates and schists. These soils are on ridges and sides of mountains. Slopes are 2 to 75 percent. The McCarthy series consists of moderately deep well drained soils formed in material weathered from andesitic mudflows. McCarthy soils are on gently sloping to very steep slopes of dissected plateau-like areas. Slopes are 2 to 75 percent.

None of these soil types is listed as a hydric soil by the National Soil Information System (NASIS) on the National List of Hydric Soils (NRCS 2012 c).

3.3 Wetlands

Wetlands are defined as “(t)hose areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas” (USACE, 1987). No
wetland areas were identified within the Project area. Field data sheets from the survey are included in Appendix A.

3.4  Deepwater Aquatic Habitats

Deepwater aquatic habitat is defined as, “…areas that are permanently inundated at mean annual water depths ≥6.6 feet or permanently inundated areas ≤6.6 feet in depth that do not support rooted-emergent or woody plant species” (USACE, 1987). There are no deepwater habitats within the Project area.

3.5  Other Waters

Other waters include any other water features that are not wetlands or deepwater aquatic habitats. These other waters include streams, creeks, ditches, and other types. The Main Ditch itself is not considered jurisdictional for purposes of Section 404 of the Clean Water Act. Although historically the ditch could flow back to Waters of the U.S., several long stretches have been previously filled in downstream of Reservoir 1 the ditch no longer has hydrologic connectivity downstream. Therefore, there are no features in the Project area that fit this definition.
4.0 SUMMARY OF FINDINGS

The Main Ditch had been de-watered as part of its annual maintenance several days prior to the field investigation. The bottom of the Ditch was still saturated and in some places still had standing water. The only wetland indicators found were hydrophytic plants that were found intermittently two to three feet up the sides of the Ditch and fully contained within the Ditch. A summary list of these plants is given in Table 2. A total of six Wetland Determination Data forms were completed for the study area (Appendix A). Only one site, MD-4, met the Dominance Test threshold for Vegetation. However, none of the sites had either hydric soil indicative of a wetland area or met the test for Wetland Hydrology. Soils tested to 18 inches in depth were compared with a Munsell soil color chart and were routinely bright red in color (with a hue of 2.5YR or 5YR), having neither a bright nor dark value (3 or 4) with low chroma values of 2-4. The color throughout the samples was uniform and no sample displayed redox features or mottling associated with wetland soils. The colors indicate a soil with high iron content that is highly oxidized and not a wetland soil.

A conservative approach was taken when classifying and mapping the Main Ditch. Georeference points were taken wherever the hydrophytic plants were found. However, no wetlands or other waters were identified within the Project area (a summary is presented below in Table 1).

This document represents a preliminary wetland determination and delineation subject to verification by the Corps.

The Corps-verified wetland delineation will be used to determine direct and indirect impacts to Waters of the U.S. (identified above) as a result of the proposed Project.

Table 1. Summary of Wetlands and Other Waters of the U.S.

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<thead>
<tr>
<th>Type</th>
<th>Label</th>
<th>Area (Acres / feet²)</th>
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<tr>
<td>Wetlands</td>
<td>Total Wetland</td>
<td>Total wetland 0</td>
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<tr>
<td>Other Waters</td>
<td>None</td>
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Table 2. Wetland Indicators

<table>
<thead>
<tr>
<th>Species</th>
<th>Code</th>
<th>Status</th>
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<tr>
<td>Alnus rhombifolia</td>
<td>ALRH2</td>
<td>FACW</td>
</tr>
<tr>
<td>Juncus arcticus Wild. ssp. littoralis</td>
<td>JUARL</td>
<td>FACW</td>
</tr>
<tr>
<td>Rumex crispus</td>
<td>RUCR</td>
<td>FAC</td>
</tr>
<tr>
<td>Rumex obtusifolius</td>
<td>RUOB</td>
<td>FAC</td>
</tr>
<tr>
<td>Scirpus microcarpus</td>
<td>SCMI2</td>
<td>OBL</td>
</tr>
<tr>
<td>Darmera peltata</td>
<td>DAPE</td>
<td>OBL</td>
</tr>
<tr>
<td>Athyrium filix-femina</td>
<td>ATFI</td>
<td>FAC</td>
</tr>
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</table>
Figure 2. National Hydrography Dataset And National Wetlands Inventory

El Dorado Irrigation District
Forebay to Reservoir 1

Notes
Bing Imagery: October 2011
Township 11 North Range 12 East MDBM
-120.5979 deg W, 38.7591 deg N
Created by: Jeremy Waites
Date: 10/17/2012

1:12,000

Ditch
Stream / River
NWI Wetland

0 300 600 1,200 Feet
Figure 3 - Natural Resources Conservation Service Soil Data

El Dorado Irrigation District
Forebay to Reservoir 1

Notes
Imagery Source:
Bing Aerial Maps October 2011
Township 11 North Range 12 East MDBM
-120.5979 deg W, 38.7591 deg N
Created by: Jeremy Waites
Date: 10/11/2012

1:12,000

Ditch
Cohasset loam
Josephine gravelly loam
Josephine very rocky loam
Mariposa-Josephine very rocky loam
McCarthy cobbly loam
Figure 4. Project Boundary

El Dorado Irrigation District
Forebay to Reservoir 1

Notes
Imagery Source:
Bing Aerial Maps October 2011
Township 11 North Range 12 East MDBM
-120.5979 deg W, 38.7591 deg N
Created by: Jeremy Waites
Date: 10/11/2012

1:12,000

Project Boundary
25 ft Downslope; 10 ft Upslope

Imagery Source:
Bing Aerial Maps October 2011
Township 11 North Range 12 East MDBM
-120.5979 deg W, 38.7591 deg N
Created by: Jeremy Waites
Date: 10/11/2012

1:12,000

Project Boundary
25 ft Downslope; 10 ft Upslope
### 5.0 REPORT AUTHORS

The following individuals prepared the text presented in this analysis.

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<tr>
<th>Name</th>
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<th>Role</th>
<th>Experience</th>
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<td>32+ years of environmental regulatory compliance for water, energy, and land resource development.</td>
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<td></td>
<td>C.S.U. Sacramento</td>
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<td>Report Production</td>
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<td></td>
<td>Folsom Lake College</td>
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6.0 REFERENCES


Appendix A

Wetland Determination Data Forms
**WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region**

**Project/Site:** Main Ditch  
**City/County:** El Dorado  
**Sampling Date:** 10/2/2012

**Applicant/Owner:** El Dorado Irrigation District  
**State:** CA  
**Investigator(s):** Kiehne, Waites  
**Section, Township, Range:** S35, T11N, R12E  
**Landform (hillslope, terrace, etc.):** Canal Bench  
**Local relief (concave, convex, none):** None  
**Slope (%):** 2  
**Subregion (LRR):** Western Range  
**Latitude:** 38.7548  
**Longitude:** -120.6098  
**Datum:** WGS84  
**Soil Subunit Name:** McCarthy Cobbly Loam  
**NWI classification:** Non-wetland

**Summary of Findings**

- Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
- Are Vegetation, Soil, or Hydrology significantly disturbed? Are “Normal Circumstances” present? Yes? X No (If needed, explain any answers in Remarks.)
- Are Vegetation, Soil, or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

**Vegetation - Use scientific names of plants**

<table>
<thead>
<tr>
<th>Tree Stratum (Plot size: 20 x 20)</th>
<th>Absolute % Cover</th>
<th>Dominance Species?</th>
<th>Indicator Status</th>
<th>Species?</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Abies concolor</td>
<td>10</td>
<td>Y</td>
<td>UPL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Calocedrus decurrens</td>
<td>1</td>
<td>N</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Sequoia giganteum</td>
<td>5</td>
<td>N</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>16</td>
<td>Total Cover</td>
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<table>
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<th>Absolute % Cover</th>
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<th>Indicator Status</th>
<th>Species?</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Corylus cornuta</td>
<td>5</td>
<td>N</td>
<td>FACU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Cornus nuttallii</td>
<td>1</td>
<td>N</td>
<td>FACU</td>
<td></td>
<td></td>
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<tr>
<td>3. Quercus kelloggii</td>
<td>2</td>
<td>N</td>
<td>-</td>
<td></td>
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</tr>
<tr>
<td>4. Chamaebatia foliosa</td>
<td>25</td>
<td>Y</td>
<td>-</td>
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<tr>
<td>5.</td>
<td>33</td>
<td>Total Cover</td>
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<th>Absolute % Cover</th>
<th>Dominance Species?</th>
<th>Indicator Status</th>
<th>Species?</th>
<th>Indicator Status</th>
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<tbody>
<tr>
<td>1. Pteridium aquilum</td>
<td>20</td>
<td>Y</td>
<td>FACU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Asarum lemmonei</td>
<td>1</td>
<td>N</td>
<td>OBL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Osmorhiza berteri</td>
<td>1</td>
<td>N</td>
<td>FACU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Galium triflorum</td>
<td>1</td>
<td>N</td>
<td>FACU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Ribes roezlii</td>
<td>1</td>
<td>N</td>
<td>-</td>
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<td>6.</td>
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<td>7.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>24</td>
<td>Total Cover</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Woody Vine Stratum (Plot size: )</th>
<th>Absolute % Cover</th>
<th>Dominance Species?</th>
<th>Indicator Status</th>
<th>Species?</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rubus armeniacus</td>
<td>1</td>
<td>N</td>
<td>FACU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Lonicera interrupta</td>
<td>1</td>
<td>N</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Total Cover</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| % Bare Ground in Herb Stratum    | 5                 | % Cover of Biotic Crust | 0               |

| Hydrophytic Vegetation Present?  | Yes X No |

**Remarks:**

Hydrophytic Vegetation Indicators:

1 - Rapid Test for Hydrophytic Vegetation
2 - Dominance Test is >50%
3 - Prevalence Index is ≤3.0
4 - Morphological Adaptations1 (Provide supporting data in Remarks or on a separate sheet)
5 - Wetland Non-Vascular Vegetation

1Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.
Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

<table>
<thead>
<tr>
<th>Depth (inches)</th>
<th>Color (moist)</th>
<th>%</th>
<th>Color (moist)</th>
<th>%</th>
<th>Type</th>
<th>LOC</th>
<th>Texture</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>2.5YR 3/4</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Vfine</td>
<td>Uniform through profile.</td>
</tr>
</tbody>
</table>

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.) Indicators for Problematic Hydric Soils:

- Histosol (A1)
- Histic Epipedon (A2)
- Black Histic (A3)
- Hydrogen Sulfide (A4)
- Depleted Below Dark Surface (A1)
- Thick Dark Surface (A12)
- Sandy Mucky Mineral (S1)
- Sandy Gleyed Matrix (S4)
- 2 cm Muck (A10)
- Stripped Matrix (S6)
- Loamy Mucky Mineral (F1)
- Very Shallow Dark Surface (TF12)
- Red Parent Material (TF2)
- Depleted Matrix (F3)
- Redox Surface (F6)
- Depleted Dark Surface (F7)
- Sandy Gleyed Matrix (F2)
- Other (Explain in Remarks)

Restrictive Layer (if present):

- Type: 
- Depth (inches): 

Hydric Soil Present? Yes □ No □

Hydrology

Wetland Hydrology Indicators:

<table>
<thead>
<tr>
<th>Primary Indicators (minimum of one required; check all that apply)</th>
<th>Secondary Indicators (2 or more required)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Water (A1)</td>
<td>Water-Stained Leaves (B9) (MLRA 1, 2, 4A, 4B)</td>
</tr>
<tr>
<td>High Water Table (A2)</td>
<td></td>
</tr>
<tr>
<td>Saturation (A3)</td>
<td></td>
</tr>
<tr>
<td>Water Marks (B1)</td>
<td>Aquatic Invertebrates (B13)</td>
</tr>
<tr>
<td>Sediment Deposits (B2)</td>
<td>Hydrogen Sulfide Odor (C1)</td>
</tr>
<tr>
<td>Drift Deposits (B3)</td>
<td>Oxidized Rhizospheres along Living Roots (C3)</td>
</tr>
<tr>
<td>Algal Mat or Crust (B4)</td>
<td>Presence of Reduced Iron (C4)</td>
</tr>
<tr>
<td>Iron Deposits (B5)</td>
<td>Recent Iron Reduction in Plowed Soils (C6)</td>
</tr>
<tr>
<td>Surface Soil Cracks (B6)</td>
<td>Stunted or Stressed Plants (D1) (LRR A)</td>
</tr>
<tr>
<td>Inundation Visible on Aerial Imagery (B7)</td>
<td>Other (Explain in Remarks)</td>
</tr>
<tr>
<td>Sparsely Vegetated Concave Surface (B8)</td>
<td></td>
</tr>
</tbody>
</table>

Field Observations:

<table>
<thead>
<tr>
<th>Surface Water Present? Yes □ No □ X Depth (inches):</th>
<th>Wetland Hydrology Present? Yes □ No □</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Table Present? Yes □ No □ X Depth (inches):</td>
<td></td>
</tr>
<tr>
<td>Saturation Present? Yes □ No □ X Depth (inches):</td>
<td></td>
</tr>
</tbody>
</table>

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
### WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

**Project/Site:** Main Ditch  
**City/County:** El Dorado  
**Sampling Date:** 10/2/2012  
**Applicant/Owner:** El Dorado Irrigation District  
**State:** CA  
**Sampling Point:** MD-2  
**Investigator(s):** Kiehne, Waites  
**Section, Township, Range:** S35, T11N, R12E  
**Landform (hillslope, terrace, etc.):** Canal Bench  
**Local relief (concave, convex, none):** None  
**Subregion (LRR):** Western Range  
**Latitude:** 38.7551  
**Longitude:** -120.6081  
**Datum:** WGS84  
**Soil Map Unit Name:** Kiehne, Waites  
**NWI classification:** None  
**Hydric Soil Present?** Yes  
**Wetland Hydrology Present?** Yes  
**Hydrophytic Vegetation Present?** Yes  
**Is the Sampled Area within a Wetland?** Yes

### VEGETATION - Use scientific names of plants

<table>
<thead>
<tr>
<th>Stratum</th>
<th>(Plot size: 20 x 20)</th>
<th>Absolute % Cover</th>
<th>Domainance Species?</th>
<th>Indicator Status</th>
<th>Dominance Test worksheet:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tree Stratum</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Number of Dominant Species</td>
</tr>
<tr>
<td>1. Atrus rhombifolia</td>
<td>1</td>
<td>N</td>
<td>FACW</td>
<td>0 (A)</td>
<td></td>
</tr>
<tr>
<td>2. Calocedrus decurrens</td>
<td>10</td>
<td>N</td>
<td>UPL</td>
<td>1 (B)</td>
<td></td>
</tr>
<tr>
<td>3. Abies concolor</td>
<td>32</td>
<td>Y</td>
<td>FACU</td>
<td>1 (B)</td>
<td></td>
</tr>
<tr>
<td>4. Acer macrophytum</td>
<td>11</td>
<td>Total Cover</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sapling/Shrub Stratum</strong></td>
<td>20 x 20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Cornus nutallii</td>
<td>5</td>
<td>N</td>
<td>FACU</td>
<td>1 (B)</td>
<td></td>
</tr>
<tr>
<td>2. Ceanothus integerrimus</td>
<td>1</td>
<td>N</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Maianthemum racemosum</td>
<td>5</td>
<td>N</td>
<td>FAC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Herb Stratum</strong></td>
<td>5 x 5 ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Pteridium aquilinum</td>
<td>5</td>
<td>N</td>
<td>FAC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Trientalis borealis ssp. latifolia</td>
<td>1</td>
<td>N</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Galium triflorum</td>
<td>1</td>
<td>N</td>
<td>FACU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Maianthemum racemosum</td>
<td>5</td>
<td>N</td>
<td>FAC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>6.</td>
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<td>7.</td>
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<td>8.</td>
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<tr>
<td>9.</td>
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<td></td>
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<tr>
<td>10.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Woody Vine Stratum</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Symphoricarpos albus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Rubus armeniacus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>% Bare Ground in Herb Stratum</strong></td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Hydrophytic Vegetation Present?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>X</th>
</tr>
</thead>
</table>

### Hydrophytic Vegetation Indicators:

1. Rapid Test for Hydrophytic Vegetation
2. Dominance Test is >50%
3. Prevalence Index is ≤3.0
4. Morphological Adaptations
5. Wetland Non-Vascular Vegetation

### Remarks:

- Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.
Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

<table>
<thead>
<tr>
<th>Depth (inches)</th>
<th>Color (moist)</th>
<th>%</th>
<th>Color (moist)</th>
<th>%</th>
<th>Type</th>
<th>LO C</th>
<th>Texture</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>2.5YR3/2</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Vfine</td>
<td></td>
</tr>
</tbody>
</table>

1Type: C=Concentration, D=Depletion, RM=Reduced Matrix.  2Location: PL=Pore Lining, RC=Root Channel, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.) Indicators for Problematic Hydric Soils:

- Histosol (A1)
- Histic Epipedon (A2)
- Black Histic (A3)
- Hydrogen Sulfide (A4)
- Depleted Below Dark Surface (A10)
- Thick Dark Surface (A12)
- Sandy Mucky Mineral (S1)
- Sandy Gleyed Matrix (S4)

Hydric Soil Present? Yes ☒ No ☐ X

Restrictive Layer (if present):

Type: 
Depth (inches):

Remarks: Depth of duff layer 3 inches

Hydrology

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)
- Surface Water (A1)
- High Water Table (A2)
- Saturation (A3)
- Water Marks (B1)
- Sediment Deposits (B2)
- Drift Deposits (B3)
- Algal Mat or Crust (B4)
- Iron Deposits (B5)
- Surface Soil Cracks (B6)
- Inundation Visible on Aerial Imagery (B7)
- Sparsely Vegetated Concave Surface (B8)

Secondary Indicators (2 or more required)
- Water-Stained Leaves (B9) (except MLRA 1, 2, 4A, and 4B)
- Salt Crust (B11)
- Aquatic Invertebrates (B13)
- Hydrogen Sulfide Odor (C1)
- Oxidized Rhizospheres along Living Roots (C3)
- Presence of Reduced Iron (C4)
- Recent Iron Reduction in Plowed Soils (C6)
- Stunted or Stressed Plants (D1) (LRR A)
- Other (Explain in Remarks)

Geomorphic Position (D2)
Shallow Aquitard (D3)
FAC-Neutral Test (D5)
Raised Ant Mounds (D6)
Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ☒ No ☐ X
Water Table Present? Yes ☒ No ☐ X
Saturation Present? Yes ☒ No ☐ X

Wetland Hydrology Present? Yes ☒ No ☐ X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
## WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

**Project/Site:** Main Ditch  
**City/County:** El Dorado  
**Sampling Date:** 10/2/2012

**Applicant/Owner:** El Dorado Irrigation District  
**Investigator(s):** Kiehne, Waites  
**Section, Township, Range:** S35, T11N, R12E  
**Landform (hillside, terrace, etc.):** Canal Bench  
**Subregion (LRR):** Western Range  
**Latitude:** 38.7577  
**Longitude:** -120.601  
**Datum:** WGS84  
**Soil Map Unit Name:** Cohasset Loam  
**NWI classification:** Non-wetland

**Are climatic / hydrologic conditions on the site typical for this time of year?** Yes X No  
**Are “Normal Circumstances” present?** Yes? X No  
**Are Vegetation _____, Soil _____, or Hydrology ____ significantly disturbed?**  
**Are Vegetation _____, Soil _____, or Hydrology naturally problematic?** (if needed, explain any answers in Remarks.)

### SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

<table>
<thead>
<tr>
<th>Hydrophytic Vegetation Present?</th>
<th>Yes</th>
<th>No X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydric Soil Present?</td>
<td>Yes</td>
<td>No X</td>
</tr>
<tr>
<td>Wetland Hydrology Present?</td>
<td>Yes</td>
<td>No X</td>
</tr>
</tbody>
</table>

**Is the Sampled Area within a Wetland?** Yes X No

**Remarks:** Picutres 79-81

### VEGETATION - Use scientific names of plants

<table>
<thead>
<tr>
<th>Tree Stratum (Plot size: 20 x 20)</th>
<th>Absolute % Cover</th>
<th>Dominance Status</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Calocedrus decurrens</td>
<td>1</td>
<td>N UPL</td>
<td>Y FACU</td>
</tr>
<tr>
<td>2. Abies concolor</td>
<td>70</td>
<td>Y UPL</td>
<td>FACU</td>
</tr>
<tr>
<td>3. Acer macrophyllum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>72 Total Cover</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sapling/Shrub Stratum (Plot size: 20 x 20)</th>
<th>Absolute % Cover</th>
<th>Dominance Status</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Abies concolor</td>
<td>10</td>
<td>N UPL</td>
<td>Y FACU</td>
</tr>
<tr>
<td>2. Acer macrophyllum</td>
<td>10</td>
<td>N FACU</td>
<td></td>
</tr>
<tr>
<td>3. Cornus nuttallii</td>
<td>2</td>
<td>N FACU</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>22 Total Cover</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Herb Stratum (Plot size: 5 x 5 ft)</th>
<th>Absolute % Cover</th>
<th>Dominance Status</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Maianthemum racemosum</td>
<td>1</td>
<td>N FACU</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 Total Cover</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Woody Vine Stratum (Plot size: )</th>
<th>Absolute % Cover</th>
<th>Dominance Status</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lonicera interrupta</td>
<td>1</td>
<td>N -</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 Total Cover</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Hydrophytic Vegetation Present?** Yes X No

**% Bare Ground in Herb Stratum** 5  
**% Cover of Biotic Crust** 0

**Remarks:**

### Hydrophytic Vegetation Indicators

1 – Rapid Test for Hydrophytic Vegetation
2 - Dominance Test is >50%
3 - Prevalence Index is ≤3.0
4 - Morphological Adaptations2 (Provide supporting data in Remarks or on a separate sheet)
5 – Wetland Non-Vascular Vegetation

1Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.
SOIL

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

<table>
<thead>
<tr>
<th>Depth (inches)</th>
<th>Matrix</th>
<th>Redox Features</th>
<th>Type</th>
<th>LOC</th>
<th>Texture</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>2.5YR 3/4</td>
<td>100</td>
<td>Color (moist)</td>
<td>%</td>
<td>Color (moist)</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 cm Muck (A10)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Red Parent Material (TF2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Very Shallow Dark Surface (TF12)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Other (Explain in Remarks)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.) Indicators for Problematic Hydric Soils:
1 Indicates of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ________________________
Depth (inches): ________________________

Hydric Soil Present? Yes ______ No ______ X ______

Remarks: One foot duff layer

HYDROLOGY

Wetland Hydrology Indicators:
Primary Indicators (minimum of one required; check all that apply)

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Water (A1)</td>
<td>Water-Stained Leaves (B9) (except MLRA 1, 2, 4A, and 4B)</td>
</tr>
<tr>
<td>High Water Table (A2)</td>
<td>Salt Crust (B11)</td>
</tr>
<tr>
<td>Saturation (A3)</td>
<td>Aquatic Invertebrates (B13)</td>
</tr>
<tr>
<td>Water Marks (B1)</td>
<td>Hydrogen Sulfide Odor (C1)</td>
</tr>
<tr>
<td>Sediment Deposits (B2)</td>
<td>Oxidized Rhizospheres along Living Roots (C3)</td>
</tr>
<tr>
<td>Drift Deposits (B3)</td>
<td>Presence of Reduced Iron (C4)</td>
</tr>
<tr>
<td>Algal Mat or Crust (B4)</td>
<td>Recent Iron Reduction in Plowed Soils (C6)</td>
</tr>
<tr>
<td>Iron Deposits (B5)</td>
<td>Stunted or Stressed Plants (D1) (LRR A)</td>
</tr>
<tr>
<td>Surface Soil Cracks (B6)</td>
<td>Other (Explain in Remarks)</td>
</tr>
<tr>
<td>Inundation Visible on Aerial Imagery (B7)</td>
<td></td>
</tr>
<tr>
<td>Sparsely Vegetated Concave Surface (B8)</td>
<td></td>
</tr>
</tbody>
</table>

Secondary Indicators (2 or more required)

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water-Stained Leaves (B9) (MLRA 1, 2, 4A, and 4B)</td>
<td></td>
</tr>
<tr>
<td>Drainage Patterns (B10)</td>
<td></td>
</tr>
<tr>
<td>Dry-Season Water Table (C2)</td>
<td></td>
</tr>
<tr>
<td>Saturation Visible on Aerial Imagery (C2)</td>
<td></td>
</tr>
<tr>
<td>Geomorphic Position (D2)</td>
<td></td>
</tr>
<tr>
<td>Shallow Aquitard (D3)</td>
<td></td>
</tr>
<tr>
<td>FAC-Neutral Test (D5)</td>
<td></td>
</tr>
<tr>
<td>Raised Ant Mounds (D6) (LRR A)</td>
<td></td>
</tr>
<tr>
<td>Frost-Heave Hummocks (D7)</td>
<td></td>
</tr>
</tbody>
</table>

Field Observations:
Surface Water Present? Yes ______ No ______ X ______ Depth (inches): ______
Water Table Present? Yes ______ No ______ X ______ Depth (inches): ______ (includes capillary fringe)
Saturation Present? Yes ______ No ______ X ______ Depth (inches): ______

Wetland Hydrology Present? Yes ______ No ______ X ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: El Dorado Irrigation District
City/County: El Dorado
Sampling Date: 10/2/2012

Applicant/Owner: Kiehne, Waites
Investigator(s): Kiehne, Waites
Landform (hillslope, terrace, etc.): Canal Bench
Local relief (concave, convex, none): None
Slope (%): 2
Subregion (LRR): Western Range
Latitude: 38.7577
Longitude: -120.5961
Datum: WGS84

Soil Map Unit Name: Cohasset loam
NWI classification: Non-wetland

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation, Soil, or Hydrology significantly disturbed? Are “Normal Circumstances” present? Yes? X No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Are Vegetation, Soil, or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

<table>
<thead>
<tr>
<th>ISO SUSTAINABILITES</th>
<th>20 x 20 ft.</th>
<th>5 x 5 ft.</th>
<th>0 x 0 ft.</th>
<th>0 x 0 ft.</th>
</tr>
</thead>
</table>

 Hydrophytic Vegetation Present? Yes X No
 Hydric Soil Present? Yes X No
 Wetland Hydrology Present? Yes X No

Is the Sampled Area within a Wetland? Yes X No

Remarks:
Pic 83-86

Remarks:

VEGETATION - Use scientific names of plants

<table>
<thead>
<tr>
<th>Tree Stratum (Plot size: 20 x 20 ft.)</th>
<th>Absolute % Cover</th>
<th>Dominance Species?</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>N</td>
<td>FACU</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>N</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>N</td>
<td>FACW</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>N</td>
<td>FACU</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sapling/Shrub Stratum (Plot size: 20 x 20 ft.)</th>
<th>Absolute % Cover</th>
<th>Dominance Species?</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>Y</td>
<td>FAC</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>N</td>
<td>FAC</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>N</td>
<td>FACW</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>N</td>
<td>FACU</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Herb Stratum (Plot size: 5 x 5 ft.)</th>
<th>Absolute % Cover</th>
<th>Dominance Species?</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15</td>
<td>Y</td>
<td>OBL</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>N</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>N</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>N</td>
<td>FACU</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>N</td>
<td>FAC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Woody Vine Stratum (Plot size: 20 x 20 ft.)</th>
<th>Absolute % Cover</th>
<th>Dominance Species?</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

% Bare Ground in Herb Stratum % Cover of Biotic Crust

Hydrophytic Vegetation Indicators:
1 - Rapid Test for Hydrophytic Vegetation
2 - Dominance Test is >50%
3 - Prevalence Index is ≤3.0
4 - Morphological Adaptations (Provide supporting data in Remarks or on a separate sheet)
5 - Wetland Non-Vascular Vegetation

Problematic Hydrophytic Vegetation (Explain)

Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.
SOIL Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

<table>
<thead>
<tr>
<th>Depth</th>
<th>Matrix</th>
<th>Redox Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>(inches)</td>
<td>Color (moist) %</td>
<td>Color (moist) %</td>
</tr>
<tr>
<td>12</td>
<td>2.5YR 3/4 100</td>
<td></td>
</tr>
</tbody>
</table>

1Type: C=Concentration, D=Depletion, RM=Reduced Matrix. 2Location: PL=Pore Lining, RC=Root Channel, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.) Indicators for Problematic Hydric Soils:
- Histosol (A1)
- Histic Epipedon (A2)
- Black Histic (A3)
- Hydrogen Sulfide (A4)
- Depleted Below Dark Surface (A1 *)
- Thick Dark Surface (A12)
- Sandy Mucky Mineral (S1)
- Sandy Gleyed Matrix (S4)

Restrictive Layer (if present):
- Hydric Soil Present? Yes No X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:
- Surface Water (A1)
- High Water Table (A2)
- Saturation (A3)
- Water Marks (B1)
- Sediment Deposits (B2)
- Drift Deposits (B3)
- Algal Mat or Crust (B4)
- Iron Deposits (B5)
- Surface Soil Cracks (B6)
- Inundation Visible on Aerial Imagery (B7)
- Sparsely Vegetated Concave Surface (B8)

Secondary Indicators (2 or more required)
- Water-Stained Leaves (B9) (except MLRA 1, 2, 4A, and 4B)
- Salt Crust (B11)
- Aquatic Invertebrates (B13)
- Hydrogen Sulfide Odor (C1)
- Oxidized Rhizospheres along Living Roots (C3)
- Presence of Reduced Iron (C4)
- Recent Iron Reduction in Plowed Soils (C6)
- Stunted or Stressed Plants (D1) (LRR A)
- Other (Explain in Remarks)

Field Observations:
- Surface Water Present? Yes No X
- Water Table Present? Yes No X
- Saturation Present? Yes No X

Wetland Hydrology Present? Yes No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Surface water in ditch
**WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region**

**Project/Site:** Main Ditch  
**City/County:** El Dorado  
**Sampling Date:** 10/2/2012

**Applicant/Owner:** El Dorado Irrigation District  
**State:** CA  
**Investigator(s):** Kiehne, Waites  
**Section, Township, Range:** S35, T11N, R12E  
**Landform (hillslope, terrace, etc.):** Canal Bench  
**Local relief (concave, convex, none):** None  
**Subregion (LRR):** Western Range  
**Longitude:** -120.5909  
**Datum:** WGS84  
**Soil Map Unit Name:** McCarthy Cobbly Loam  
**NWI classification:** Non-wetland

---

**Are climatic / hydrologic conditions on the site typical for this time of year?**  
Yes X No  
(If no, explain in Remarks.)

**Are Vegetation _____ , Soil _____, or Hydrology _____ significantly disturbed?**  
Are “Normal Circumstances” present?  
Yes? X No  
(If needed, explain any answers in Remarks.)

**SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.**

---

**VEGETATION - Use scientific names of plants**

<table>
<thead>
<tr>
<th>Tree Stratum (Plot size: 20 x 20 ft)</th>
<th>Absolute % Cover</th>
<th>Dominance Species?</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Calocedrus decurrens</td>
<td>40</td>
<td>Y</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sapling/Shrub Stratum (Plot size: 20 x 20 ft)</th>
<th>Absolute % Cover</th>
<th>Dominance Species?</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rubus parviflorus</td>
<td>35</td>
<td>Y</td>
<td>FAC</td>
</tr>
<tr>
<td>2. Abies concolor</td>
<td>1</td>
<td>N</td>
<td>UPL</td>
</tr>
<tr>
<td>3. Acer macrophyllum</td>
<td>2</td>
<td>N</td>
<td>FACU</td>
</tr>
<tr>
<td>4. Cornus nuttallii</td>
<td>2</td>
<td>N</td>
<td>FACU</td>
</tr>
<tr>
<td>5. Rosa californica</td>
<td>2</td>
<td>N</td>
<td>FAC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Herb Stratum (Plot size: 5 x 5 ft)</th>
<th>Absolute % Cover</th>
<th>Dominance Species?</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Adenocaulon bicolor</td>
<td>20</td>
<td>Y</td>
<td>-</td>
</tr>
<tr>
<td>2. Iris hortensis</td>
<td>2</td>
<td>N</td>
<td>-</td>
</tr>
<tr>
<td>3. Galium triflorum</td>
<td>2</td>
<td>N</td>
<td>FACU</td>
</tr>
<tr>
<td>4. Junus balticus</td>
<td>2</td>
<td>N</td>
<td>OBL</td>
</tr>
<tr>
<td>5. Trientalis borealis</td>
<td>1</td>
<td>N</td>
<td>-</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Woody Vine Stratum</th>
<th>Absolute % Cover</th>
<th>Dominance Species?</th>
<th>Indicator Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rubus armeniacus</td>
<td>50</td>
<td>Y</td>
<td>FACU</td>
</tr>
<tr>
<td>2. Lonicera interrupta</td>
<td>5</td>
<td>N</td>
<td>-</td>
</tr>
</tbody>
</table>

| % Bare Ground in Herb Stratum | 10 |
| % Cover of Biotic Crust        | 0  |

**Hydrophytic Vegetation Present?**  
Yes X No

**Remarks:**  
Bare ground on bench trail

---

**Hydrophytic Vegetation Indicators:**

1. Rapid Test for Hydrophitic Vegetation  
2. Dominance Test is >50%  
3. Prevalence Index is ≤3.0  
4. Morphological Adaptations (Provide supporting data in Remarks or on a separate sheet)  
5. Wetland Non-Vascular Vegetation

---

**Prevalence Index worksheet:**

<table>
<thead>
<tr>
<th>Total % Cover of:</th>
<th>Multiply by:</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBL species</td>
<td>2 x 1 = 2</td>
</tr>
<tr>
<td>FACW species</td>
<td>0 x 2 = 0</td>
</tr>
<tr>
<td>FAC species</td>
<td>35 x 3 = 105</td>
</tr>
<tr>
<td>FACU species</td>
<td>56 x 4 = 224</td>
</tr>
<tr>
<td>UPL species</td>
<td>0 x 5 = 0</td>
</tr>
</tbody>
</table>

| Column Totals    | 93 x 331 = 301 |

| Prevalence Index | = B/A = 3.56 |

---

**Dominance Test worksheet:**

<table>
<thead>
<tr>
<th>Number of Dominant Species</th>
<th>That Are OBL, FACW, or FAC:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Dominant Species Across All Strata:</td>
<td>3</td>
</tr>
</tbody>
</table>

**Remarks:**

- Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.
### SOIL

**Profile Description:** (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

<table>
<thead>
<tr>
<th>Depth (inches)</th>
<th>Color (moist)</th>
<th>%</th>
<th>Color (moist)</th>
<th>%</th>
<th>Type</th>
<th>LOC</th>
<th>Texture</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>2.5YR 4/4</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Uniform thorough profile.</td>
</tr>
</tbody>
</table>

1^Type: C=Concentration, D=Depletion, RM=Reduced Matrix.  2^Location: PL=Pore Lining, RC=Root Channel, M=Matrix.

**Hydric Soil Indicators:** (Applicable to all LRRs, unless otherwise noted.) Indicators for Problematic Hydric Soils:

- Histosol (A1)
- Histic Epipedon (A2)
- Black Histic (A3)
- Depleted Below Dark Surface (A1^1)
- Thick Dark Surface (A12)
- Sandy Mucky Mineral (S1)
- Sandy Gleyed Matrix (S4)

2^Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

**Hydric Soil Present?**

- Yes
- No
- X

**Restrictive Layer (if present):**

- Type: ____________________________
- Depth (inches): ____________________

**Remarks:**

**HYDROLOGY**

**Wetland Hydrology Indicators:**

<table>
<thead>
<tr>
<th>Primary Indicators (minimum of one required; check all that apply)</th>
<th>Secondary Indicators (2 or more required)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Water (A1)</td>
<td>Water-Stained Leaves (B9)</td>
</tr>
<tr>
<td>High Water Table (A2)</td>
<td>Water-Stained Leaves (B9) (MLRA 1, 2, 4A, and 4B)</td>
</tr>
<tr>
<td>Saturation (A3)</td>
<td>Salt Crust (B11)</td>
</tr>
<tr>
<td>Water Marks (B1)</td>
<td>Aquatic Invertebrates (B13)</td>
</tr>
<tr>
<td>Sediment Deposits (B2)</td>
<td>Hydrogen Sulfide Odor (C1)</td>
</tr>
<tr>
<td>Drift Deposits (B3)</td>
<td>Oxidized Rhizospheres along Living Roots (C3)</td>
</tr>
<tr>
<td>Algal Mat or Crust (B4)</td>
<td>Presence of Reduced Iron (C4)</td>
</tr>
<tr>
<td>Iron Deposits (B5)</td>
<td>Recent Iron Reduction in Plowed Soils (C6)</td>
</tr>
<tr>
<td>Surface Soil Cracks (B6)</td>
<td>Stunted or Stressed Plants (D1) (LRR A)</td>
</tr>
<tr>
<td>Inundation Visible on Aerial Imagery (B7)</td>
<td>Other (Explain in Remarks)</td>
</tr>
<tr>
<td>Sparsely Vegetated Concave Surface (B8)</td>
<td></td>
</tr>
</tbody>
</table>

**Field Observations:**

- Surface Water Present? Yes  No  X
- Water Table Present? Yes  No  X
- Saturation Present? Yes  No  X

( includes capillary fringe)

**Wetland Hydrology Present?**

- Yes
- No
- X

**Remarks:**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:
**WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region**

<table>
<thead>
<tr>
<th>Project/Site:</th>
<th>Main Ditch</th>
</tr>
</thead>
<tbody>
<tr>
<td>City/County:</td>
<td>El Dorado</td>
</tr>
<tr>
<td>Sampling Date:</td>
<td>10/7/2012</td>
</tr>
<tr>
<td>Applicant/Owner:</td>
<td>El Dorado Irrigation District</td>
</tr>
<tr>
<td>Investigator(s):</td>
<td>Kiehne, Waites</td>
</tr>
<tr>
<td>Landform (hillslope, terrace, etc.):</td>
<td>Canal Bench</td>
</tr>
<tr>
<td>Local relief (concave, convex, none):</td>
<td>None</td>
</tr>
<tr>
<td>Subregion (LRR):</td>
<td>Western Range</td>
</tr>
<tr>
<td>Soil Map Unit Name:</td>
<td>McCarthy Cobbly Loam</td>
</tr>
<tr>
<td>NWI classification:</td>
<td>Non-wetland</td>
</tr>
</tbody>
</table>

### Remarks:
Plants along canal banks. Area up along canal and up bank to bench.

### VEGETATION - Use scientific names of plants

<table>
<thead>
<tr>
<th>Stratum</th>
<th>(Plot size:</th>
<th>Absolute % Cover</th>
<th>Dominance Species?</th>
<th>Indicator Status</th>
<th>Indicator</th>
<th>Number of Dominant Species</th>
<th>Hydric Soil Present?</th>
<th>Wetland Hydrology Present?</th>
<th>Wetland Hydrology Present?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree Stratum</td>
<td>20 x 20 ft</td>
<td>1. <em>Cornus nutallii</em></td>
<td>10</td>
<td>N</td>
<td>FACU</td>
<td>1 (A)</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. <em>Pseudotsuga menziesii</em></td>
<td>50</td>
<td>Y</td>
<td>FACU</td>
<td>1 (A)</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. <em>Calocedrus decurrens</em></td>
<td>5</td>
<td>N</td>
<td>-</td>
<td>1 (A)</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. <em>Quercus kelloggi</em></td>
<td>1</td>
<td>N</td>
<td>-</td>
<td>1 (A)</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Sapling/Shrub Stratum</td>
<td>20 x 20 ft</td>
<td>1. <em>Ceanothus integerrimus</em></td>
<td>5</td>
<td>N</td>
<td>-</td>
<td>1 (A)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. <em>Calocedrus decurrens</em></td>
<td>10</td>
<td>Y</td>
<td>-</td>
<td>1 (A)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. <em>Pteridium aquilinum</em></td>
<td>5</td>
<td>N</td>
<td>FACU</td>
<td>1 (A)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. <em>Pinus ponderosa</em></td>
<td>1</td>
<td>N</td>
<td>FACU</td>
<td>1 (A)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. <em>Rubus armeniacus</em></td>
<td>1</td>
<td>N</td>
<td>FACU</td>
<td>1 (A)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Herb Stratum</td>
<td>5 x 5 ft</td>
<td>1. <em>Dichroima petalas</em></td>
<td>20</td>
<td>Y</td>
<td>OBL</td>
<td>1 (A)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. <em>Juncus arcticus Wild. ssp. littoralis</em></td>
<td>5</td>
<td>N</td>
<td>FACW</td>
<td>1 (A)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. <em>Cynosorus echinoides</em></td>
<td>1</td>
<td>N</td>
<td>UPL</td>
<td>1 (A)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. <em>Potentilla gracilis</em></td>
<td>1</td>
<td>N</td>
<td>FAC</td>
<td>1 (A)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. <em>Cirsium vulgare</em></td>
<td>1</td>
<td>N</td>
<td>FACU</td>
<td>1 (A)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. <em>Adenocaulon bicolor</em></td>
<td>1</td>
<td>N</td>
<td>-</td>
<td>1 (A)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. <em>Maianthemum racemosa</em></td>
<td>1</td>
<td>N</td>
<td>FAC</td>
<td>1 (A)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8. <em>Elymus glaucus</em></td>
<td>5</td>
<td>N</td>
<td>FACU</td>
<td>1 (A)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Woody Vine Stratum</td>
<td>(Plot size:</td>
<td>1.</td>
<td></td>
<td></td>
<td>0 Total Cover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% Bare Ground in Herb Stratum</td>
<td>6</td>
<td>% Cover of Biotic Crust</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Hydrophytic Vegetation Present?
Yes No x

### Remarks:
Hydrophytic Vegetation Indicators:
1. Rapid Test for Hydrophitic Vegetation
2. Dominance Test is >50%
3. Prevalence Index is ≤3.0
4. Morphological Adaptations (Provide supporting data in Remarks or on a separate sheet)
5. Wetland Non-Vascular Vegetation

Problematic Hydrophytic Vegetation (Explain): Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

### Hydric Soil Present?
Yes No x

### Wetland Hydrology Present?
Yes No x

### Are climatic / hydrologic conditions on the site typical for this time of year?
Yes No (If no, explain in Remarks.)

### Are Vegetation , Soil , or Hydrology significantly disturbed?
Yes No (If needed, explain any answers in Remarks.)

### Are Vegetation , Soil , or Hydrology naturally problematic?
Yes No (If needed, explain any answers in Remarks.)

### SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

<table>
<thead>
<tr>
<th>Hydrophytic Vegetation Present?</th>
<th>Is the Sampled Area within a Wetland?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

### Prevalence Index worksheet:

<table>
<thead>
<tr>
<th>Total % Cover</th>
<th>Multiply by:</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBL species</td>
<td>20 x 1 = 20</td>
</tr>
<tr>
<td>FACW species</td>
<td>5 x 2 = 10</td>
</tr>
<tr>
<td>FAC species</td>
<td>2 x 3 = 6</td>
</tr>
<tr>
<td>FACU species</td>
<td>73 x 4 = 292</td>
</tr>
<tr>
<td>UPL species</td>
<td>1 x 5 = 5</td>
</tr>
<tr>
<td>Column Totals:</td>
<td>101 x 333 = 333</td>
</tr>
</tbody>
</table>

**Prevalence Index** = B/A = 3.30

### Hydrophytic Vegetation Indicators:
1. Rapid Test for Hydrophitic Vegetation
2. Dominance Test is >50%
3. Prevalence Index is ≤3.0
4. Morphological Adaptations (Provide supporting data in Remarks or on a separate sheet)
5. Wetland Non-Vascular Vegetation

### Remarks:
Plants along canal banks. Area up along canal and up bank to bench.
**SOIL**

**Profile Description:** (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

<table>
<thead>
<tr>
<th>Depth (inches)</th>
<th>Matrix</th>
<th>Redox Features</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>2.5YR 4/8</td>
<td></td>
<td>Vfine Iron rich</td>
</tr>
<tr>
<td>5YR 3/3</td>
<td></td>
<td></td>
<td>Could be organic matter</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Indicator Type</th>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C=Concentration, D=Depletion, RM=Reduced Matrix. PL=Pore Lining, RC=Root Channel, M=Matrix.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Hydric Soil Indicators:** (Applicable to all LRRs, unless otherwise noted.) Indicators for Problematic Hydric Soils:

- No HYDROLOGY
- Wetland Hydrology Indicators:

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Histosol (A1)</td>
<td>Sandy Redox (S5) 2 cm Muck (A10)</td>
</tr>
<tr>
<td>Histic Epipedon (A2)</td>
<td>Stripped Matrix (S6) x Red Parent Material (TF2)</td>
</tr>
<tr>
<td>Black Histic (A3)</td>
<td>Loamy Mucky Mineral (F1) except MLRA 1 Very Shallow Dark Surface (TF12)</td>
</tr>
<tr>
<td>Hydrogen Sulfide (A4)</td>
<td>Loamy Gleyed Matrix (F2) Other (Explain in Remarks)</td>
</tr>
<tr>
<td>Depleted Below Dark Surface (A1)</td>
<td>Depleted Matrix (F3)</td>
</tr>
<tr>
<td>Thick Dark Surface (A12)</td>
<td>Redox Dark Surface (F6)</td>
</tr>
<tr>
<td>Sandy Mucky Mineral (S1)</td>
<td>Depleted Dark Surface (F7) 3Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.</td>
</tr>
<tr>
<td>Sandy Gleyed Matrix (S4)</td>
<td>Redox Depressions (F8)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Restrictive Layer (if present):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type:</td>
</tr>
<tr>
<td>Depth (inches):</td>
</tr>
</tbody>
</table>

Dark illuvial organic matter in soil profile.

**HYDROLOGY**

**Wetland Hydrology Indicators:**

- Primary Indicators (minimum of one required; check all that apply)
- Secondary Indicators (2 or more required)

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>x Surface Water (A1)</td>
<td>Water-Stained Leaves (B9) (except MLRA 1, 2, 4A, and 4B)</td>
</tr>
<tr>
<td>High Water Table (A2)</td>
<td>Water-Stained Leaves (B9) (MLRA 1, 2, 4A, and 4B)</td>
</tr>
<tr>
<td>Saturation (A3)</td>
<td>Drainage Patterns (B10)</td>
</tr>
<tr>
<td>Water Marks (B1)</td>
<td>Dry-Season Water Table (C2)</td>
</tr>
<tr>
<td>Sediment Deposits (B2)</td>
<td>Saturation Visible on Aerial Imagery (C2)</td>
</tr>
<tr>
<td>Drift Deposits (B3)</td>
<td>Oxidized Rhizospheres along Living Roots (C3)</td>
</tr>
<tr>
<td>Algal Mat or Crust (B4)</td>
<td>Geomorphic Position (D2)</td>
</tr>
<tr>
<td>Iron Deposits (B5)</td>
<td>Shallow Aquitard (D3)</td>
</tr>
<tr>
<td>Surface Soil Cracks (B6)</td>
<td>FAC-Neutral Test (D5)</td>
</tr>
<tr>
<td>Inundation Visible on Aerial Imagery (B7)</td>
<td>Raised Ant Mounds (D6) (LRR A)</td>
</tr>
<tr>
<td>Sparsely Vegetated Concave Surface (B8)</td>
<td>Frost-Heave Hummocks (D7)</td>
</tr>
</tbody>
</table>

**Field Observations:**

- Surface Water Present? Yes x No Depth (inches): 0
- Water Table Present? Yes No x Depth (inches): 0
- Saturation Present? Yes x No Depth (inches): 0

**Wetland Hydrology Present?** Yes x No

(includes capillary fringe)

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Canal flowing
Appendix B
Photographs
Photo 1. Soil pit for WD-1. Soil is uniform in color 2.5YR 3/4.

Photo 2. Soil pit for MD-2. Soil is uniform in color, 2.5YR 3/2.
Location. Wetland Obligate species *Darmera peltata* growing in Ditch is shown.

Photo 3. MD-4

Hydrophytic plants include *D. peltata*, and *Juncus balticus*. 

Photo 5. Location of MD-6.

Photo 8. Soil pit dug in ditch at MD-6. Color is 2.5YR 4/8.
Photo 10. *Athyrium filix-femina*, growing on north-facing slope, on side of ditch. This species was seen only on north-facing slopes, in the Ditch.
May 22, 2013

Mr. Dan Corcoran  
Environmental Division Manager  
El Dorado Irrigation District  
2890 Mosquito Road  
Placerville, Ca 95667

Subject: Main Ditch - Forebay Reservoir to Reservoir 1  
Septic System and Domestic Well Locations Report  
Pollock Pines, California

Dear Dan: 

The Westmark Group, Inc. (Westmark) is pleased to present this letter report that includes the results of the research completed for an inventory of locations of septic systems and domestic wells on parcels adjoining the Main Ditch along the section from Forebay Reservoir to Reservoir 1 in Pollock Pines, California. Our scope of work was developed based on discussions with the El Dorado Irrigation District (District) and a description of the information desired by the District regarding proposed ditch improvements. The work was completed under the existing On-Call Professional Services contract (Regulatory Permitting) between the District and Westmark.

The research was conducted by accessing available public information on septic systems and wells from local and state agencies. Westmark requested septic system and water well information from the El Dorado County Environmental Management Department (EMD) files for the parcels adjoining the Main Ditch according to the list of properties provided by the District. A search of well completion reports on file with the California Department of Water Resources (DWR) within Sections 25 and 36, T 11 N, R 12 E (includes the project study area) was also requested to obtain any additional well reports for the adjoining parcels that may not have been recorded in the EMD files.

The approximate locations of septic system areas and wells are shown on Westmark’s Drawings 1, 2 and 3 (attached). Those locations were determined by review of the provided agency records, observation of aerial photographs, and by observations made during a site walk. A summary of the adjoining property data, agency record information and site observations/comments is provided on attached Table 1.

Summary of Search Results:  
EMD File Search  
Copies of the file information from the EMD records were obtained and reviewed to identify the sizes and locations of the documented septic systems. Where available, the site plans marked as “As-Built” or “Field Copy” were used to position on Westmark’s drawings, the field-installed locations and dimensions of the system components, as well as the distances the disposal trenches and septic tanks are set back from the Main Ditch.
Review of the EMD file records provided indicate 28 parcels adjoining the ditch are developed with onsite wastewater disposal systems. The file review also indicates water wells are developed on 8 parcels adjoining the ditch.

**DWR Search Results**

The DWR provided a compact disc containing a summary table of the water wells with well completion reports on file in Sections 25 and 36, T 11 N, R 12 E, and copies of the accompanying well completion reports. Review of the summary and the reports indicates 5 water wells are reported as developed on parcels adjoining the ditch. These 5 wells are also reported in the EMD files. Seven of the well completion reports provided were found to contain inadequate or no information on the location of the well documented by the driller’s report, and therefore the well’s parcel location within the searched area (sections 25 and 36) and its potential to be on a parcel adjacent to the ditch could not be determined.

**Site Walk Results**

On May 7, 2013, Westmark personnel conducted a site walk along the study section of the ditch to visually verify the record search findings, and to possibly identify additional residences/structures not reported in the records that would likely use an onsite wastewater disposal system. The site walk was also conducted to observe any surface structures that would indicate the likely presence of water wells that were not listed in agency files searched. Six residential structures were observed during the site walk, on parcels adjoining the ditch that likely operate disposal systems that were not included in the agency file records provided. Observations of the ditch location on property numbers 1 – 7 also provided information regarding the ditch alignment through those properties as indicated on Drawing 1.

One additional property (APN 101-161-06-100, end of Marjorie Way) not included in the District’s list of adjoining properties, was observed to be developed with a residence and likely septic system. As the northwest property corner of this parcel is located at the ditch, the property and likely septic system area are shown and listed on Drawing 3 and Table 1.

We appreciate the opportunity to assist the District on this project, and please do not hesitate to call with any questions regarding the information contained in this report.

Sincerely,

*The Westmark Group, Inc.*

Michael Vander Dussen, P.G., C.E.G.
Senior Engineering Geologist

Robert Kull, P.E.
Vice President of Operations

Enclosures: Drawings 1, 2 and 3
Table 1
## Table 1
Main Ditch - Forebay Reservoir to Reservoir 1 Septic System and Domestic Well Locations
El Dorado Irrigation District

<table>
<thead>
<tr>
<th>Property Number</th>
<th>El Dorado County Assessor’s Parcel Number</th>
<th>Parcel Map/Record of Survey Reference</th>
<th>Property Improvements</th>
<th>Onsite Wastewater Disposal System</th>
<th>Domestic Water Well (CA DWR Records)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Record on file (EDC EMD</td>
<td>Approximate Distance from Ditch (feet)</td>
<td>Record on file (EDC EMD</td>
<td>Approximate Distance from Ditch (feet)</td>
</tr>
<tr>
<td>1</td>
<td>101-330-60-100</td>
<td>residence</td>
<td>yes</td>
<td>300</td>
<td>yes</td>
<td>300</td>
</tr>
<tr>
<td>2</td>
<td>101-330-59-100</td>
<td>garage/shop</td>
<td>no</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>101-330-58-100</td>
<td>residence</td>
<td>yes</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>101-330-56-100</td>
<td>no improvements</td>
<td>no</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>101-330-55-100</td>
<td>residence</td>
<td>yes</td>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>101-330-52-100</td>
<td>no improvements</td>
<td>no</td>
<td></td>
<td></td>
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<tr>
<td>7</td>
<td>101-330-51-100</td>
<td>residence</td>
<td>yes</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>101-352-31-100</td>
<td>PM 8/85/1</td>
<td>no improvements</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>101-350-26-100</td>
<td>residence</td>
<td>yes</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>101-350-32-100</td>
<td>residence</td>
<td>yes</td>
<td>100</td>
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<td></td>
</tr>
<tr>
<td>11</td>
<td>101-350-33-100</td>
<td>residence</td>
<td>no</td>
<td>~150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>101-240-10-100</td>
<td>residence</td>
<td>yes</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>101-240-11-100</td>
<td>residence</td>
<td>yes</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>101-240-45-100</td>
<td>residence</td>
<td>no</td>
<td>~900</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>101-240-14-100</td>
<td>residence</td>
<td>yes</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>101-240-42-100</td>
<td>residence</td>
<td>no</td>
<td>~100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>101-240-24-100</td>
<td>residence</td>
<td>no</td>
<td>~100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>101-240-33-100</td>
<td>residence</td>
<td>no</td>
<td>~900, ~100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>101-220-15-100</td>
<td>residence</td>
<td>no</td>
<td>~100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>101-220-07-100</td>
<td>PM 21/138/C</td>
<td>no improvements</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>101-220-08-100</td>
<td>residence</td>
<td>yes</td>
<td>~400, ~350</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>101-220-03-100</td>
<td>no improvements</td>
<td>no</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>101-220-17-100</td>
<td>PM 45/31/1</td>
<td>residence</td>
<td>yes</td>
<td>100</td>
<td>220</td>
</tr>
<tr>
<td>24</td>
<td>101-220-18-100</td>
<td>PM 45/31/2</td>
<td>residence</td>
<td>yes</td>
<td>120</td>
<td>280</td>
</tr>
<tr>
<td>25</td>
<td>101-220-02-100</td>
<td>no improvements</td>
<td>no</td>
<td></td>
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<tr>
<td>26</td>
<td>101-220-01-100</td>
<td>no improvements</td>
<td>no</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>101-030-12-100</td>
<td>2 residences</td>
<td>yes</td>
<td>~580, ~120, ~650</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>101-220-13-100</td>
<td>R/5 26/61</td>
<td>no improvements</td>
<td>~540</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>101-030-48-100</td>
<td>residence, tree farm</td>
<td>no</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>101-210-01-100</td>
<td>R/5 25/94</td>
<td>residence</td>
<td>yes</td>
<td>320</td>
<td>640</td>
</tr>
<tr>
<td>31</td>
<td>101-210-96-100</td>
<td>PM 20/71A</td>
<td>2 residences</td>
<td>yes</td>
<td>180</td>
<td>200</td>
</tr>
<tr>
<td>32</td>
<td>101-210-35-100</td>
<td>no improvements</td>
<td>no</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>101-210-37-100</td>
<td>PM 20/71/B</td>
<td>no improvements</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>101-210-39-100</td>
<td>PM 20/71/D</td>
<td>residence</td>
<td>yes</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>101-210-45-100</td>
<td>PM 26/80/1</td>
<td>residence</td>
<td>yes</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>101-210-44-100</td>
<td>PM 26/80/1</td>
<td>residence</td>
<td>yes</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>37</td>
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Westmark Group Project 13-1987-01
El Dorado Irrigation District
Main Ditch-Forebay to RES 1 Project
Cultural Resources Survey Report
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Executive Summary

The El Dorado Irrigation District (District) is proposing to conduct evaluations and technical studies to support environmental review associated with piping a section of its Main Ditch, which is identified as the Main Ditch – Forebay to Reservoir 1 Water Treatment Plant (RES 1) Project (Project). The purposes of the Project are to reduce water leakage and loss in the ditch and to conserve District water supplies. The Project is an important strategy recognized by the El Dorado County Water Agency (EDWCA) Water Resources Development and Management Plan. Reducing water conveyance losses in the ditch will also allow the District more flexibility in meeting water supply needs.

The Project is located on District property or District easements. A small segment of the upstream portion of the ditch near El Dorado Forebay is also located within the Federal Energy Regulatory Commission (FERC) Project 184 boundary in El Dorado County. The Area of Potential Effects (APE) for the Project comprises an area within 10 feet upslope and 25 feet downslope of the centerline of the Main Ditch from Forebay to RES 1 as well as six potential staging and access areas in proximity to the ditch. The District is pursuing WaterSMART grant funding from the U.S. Bureau of Reclamation. If grant funds are awarded or another federal nexus is created, the Project will be subject to the legal requirements of Section 106 of the National Historic Preservation Act (NHPA) 1966 and its implementing regulations, as amended, as well as the California Environmental Quality Act (CEQA) (Public Resources Code 21000 et seq.) 1970, as amended.

The District contracted Cardno ENTRIX to conduct archaeological and historical investigations for the Project. These investigations were conducted in October and November 2012 and included: a records search at the North Central Information Center at California State University, Sacramento; archival research; a sacred lands search conducted by the Native American Heritage Commission (NAHC); pedestrian surface survey of the Project APE; completion of a report that documents the results of archaeological and historical investigations and presents measures, as appropriate, for the protection of cultural resources (e.g., prehistoric sites, historic sites, historic buildings, and isolated artifacts) within the Project APE; and determining the eligibility of sites in the Project APE for inclusion on the National Register of Historic Places (NRHP) and the California Register of Historical Resources (CRHR).

Cardno ENTRIX archaeological and historical investigations identified the previously recorded El Dorado Canal, CA-ELD-511H/P-9-599, within the Project APE. The El Dorado Canal, CA-ELD-511H/P-9-599, which is currently used by the District, is adjacent to private residences; is spanned by bridges/walkways; and modern facilities are located along the canal. The El Dorado Canal appears to follow its original alignment and continues to be used as originally designed, however, the integrity of setting, feeling, association, design, materials, and workmanship of the canal are compromised. Consequently, it does not appear that CA-ELD-511H/P-9-599 meets the eligibility criteria for inclusion on the National Register of Historic Places and the California Register of Historical Resources. Consequently, implementation of the Project would not affect the El Dorado Canal, CA-ELD-511H/P-9-599, and a finding of “No Historic Properties Affected” appears appropriate for the Project. Similarly, implementation of the Project would not impact any historical resources as defined in CEQA.
1 Introduction

1.1 Project Description
The El Dorado Irrigation District (District) is proposing to conduct evaluations and technical studies to support environmental review associated with piping a section of its Main Ditch, which is identified as the Main Ditch – Forebay to Reservoir 1 Water Treatment Plant (RES 1) Project (Project). The purposes of the Project are to reduce water leakage and lose in the ditch and conserve District water supplies. The Project is an important strategy recognized by the El Dorado County Water Agency (EDWCA) Water Resources Development and Management Plan. Reducing water conveyance losses in the ditch will also allow the District more flexibility in meeting water supply needs.

The Project is located within on District property or existing District easements. A small portion of the upstream portion of the ditch near El Dorado Forebay is also located within the Federal Energy Regulatory Commission (FERC) Project 184 boundary in El Dorado County. The Area of Potential Effects (APE) for the Project comprises an area within 10 feet upslope and 25 feet downslope of the centerline of the Main Ditch from Forebay to RES 1 as well as six potential staging and access areas in proximity to the ditch. The District is pursuing WaterSMART grant funding from the U.S. Bureau of Reclamation. If grant funds are awarded or another federal nexus is created, the Project will be subject to the legal requirements of Section 106 of the National Historic Preservation Act (NHPA) 1966 and its implementing regulations, as amended, as well as the California Environmental Quality Act (CEQA) (Public Resources Code 21000 et seq.) 1970, as amended.

1.2 Project Location
The Project is located north of U.S. Highway 50 (U.S. 50) near Pollock Pines in El Dorado County along the Main Ditch between Forebay and RES 1 (Figures 1-2). The Project is primarily located in a dispersed residential area that is forested. The Project area is easily accessed from existing paved roads.

1.3 Scope of Work
Cardno ENTRIX was contracted to conduct archaeological and historical investigations for the Main Ditch – Forebay to Reservoir 1 Water Treatment Plant Project. These investigations were conducted in October and November 2012 and included: a records search at the North Central Information Center at California State University, Sacramento; archival research; a sacred lands search conducted by the Native American Heritage Commission (NAHC); pedestrian surface survey of the Project APE; completion of a report that documents the results of archaeological and historical investigations and presents measures, as appropriate, for the protection of cultural resources (e.g., prehistoric sites, historic sites, historic buildings, and isolated artifacts) within the Project APE; and determining the eligibility of sites in the Project APE for inclusion on the National Register of Historic Places (NRHP) and the California Register of Historical Resources (CRHR).

1.3.1 Cultural Resources Identification
The record search for the Project completed on October 17, 2012 identified that the Project APE is previously surveyed (cf., Snoke 1977; Gould 1993; Levy 1996; Allen 1999, 2003; and Historic Resource Associates 2006). The records search also identified the El Dorado Canal, site CA-ELD-511H/P-9-599, which is also identified as the District’s Main Ditch; two short segments of the canal identified as P-9-3718-H and P-9-4147 (P-9-3718-H is located within the Project APE and P-9-4147 is outside the Project APE, but within a ¼ mile of it); and site CA-ELD-2424-H/P-9-3717-H, a historic ranch that is located along the canal (see Appendix A, Site Records).
Figure 1. Project Vicinity Map
Figure 2. Project Location Map
Survey of the Project APE (i.e., the area along the ditch and Project staging areas) was conducted on October 22 and 23, 2012 by Ashley Hallock, M.A. and Michella Rossi, B.A. The entire Project APE was surveyed by Ms. Hallock and Rossi using parallel transects adjacent to the sides of the El Dorado Canal Ditch and across proposed Project staging areas. Surface visibility was generally good across the Project APE. Pedestrian surface survey did not identify any new cultural resources, but did identify that the El Dorado Canal/Main Ditch is crossed by bridges (i.e., five vehicular bridges) and pedestrian walkways (i.e., seven foot bridges) and that segments of the canal are bordered by private residences and landscaped areas (e.g., vegetation, rock walls, and sand bags). These features along the El Dorado Canal/Main Ditch were documented during the survey (see Appendix A, Site Record).

Archaeological and historical investigations are adequate for the Project, and a reasonable effort has been made to identify cultural resources within the Project APE. These investigations did not identify any new prehistoric sites, historic sites, or significant isolated artifacts within the Project APE. The overall Project area is developed and its sensitivity for unidentified or buried sites is low. It is not anticipated that implementation of the Project, which does not include extensive excavation, would uncover any significant buried deposits of cultural resources.

1.3.2 Site Recording

The record for the El Dorado Canal, site CA-ELD-511H/P-9-599, was updated as part of the current cultural resources investigations to reflect the current condition of the canal between Forebay and RES 1. The site record update is included in Appendix A of this report.

1.4 Native American Consultation

Cardno ENTRIX requested a sacred lands search and a list of Native American contacts for the Project from the Native American Heritage Commission (NAHC). The sacred lands search was completed by the NAHC on November 20, 2012 and did not identify any sensitive Native American cultural resources either within or near the Project APE (Appendix B). Cardno ENTRIX sent letters soliciting information regarding the Project area to all the groups and individuals identified by the NAHC as part of the sacred lands search. None of the Native American groups and individuals contacted regarding the Project has responded to the request for information.

1.5 Project Personnel

Cardno ENTRIX professional cultural resources staff performed all current archaeological and historical investigations for the Project. Field and archival research for the Project was conducted in October and November 2012. John A. Nadolski, M.A. was responsible for overall project management and implementation, including report writing. He was assisted by Ashley Hallock, M.A., Michella Rossi, B.A., and Melissa Nugent, M.A. Mr. Nadolski and Ms. Hallock meet the Secretary of the Interior’s Standards and Guidelines for Professional Qualifications in archaeology and history.
# Environmental Context

The Project is located at approximately 3,800 feet in elevation in the north-central Sierra Nevada. The environment of the north-central Sierra Nevada is quite diverse, but the geography of the Project area primarily ranges from gently sloping to relatively flat.

## 2.1 Geography

The north-central Sierra Nevada, bounded on the east by the Great Basin and the west by the Central Valley of California, is:

> a piece of the earth's crust that rose thousands of feet along a series of faults, or fractures, on its eastern side, tilting westward in the process to form an asymmetrical mountain range with a broad, gently sloping western flank and a narrow precipitous eastern escarpment (Whitney 1979:18).

The western flank forms a broad, gently sloping ramp rising eastward from the floor of the Central Valley. There is a relatively narrow belt of undulating foothills and broad valleys that extends to an elevation of approximately 2,000 feet along the western edge of this ramp. Above 2,000 feet in elevation, the topography is rugged and characterized by southwest trending ridges. These ridges separate deep river canyons, which are steep and up to 3,000 feet deep. Above this rugged canyon country is the crest of the Sierra Nevada, which approaches 10,000 feet in elevation. The crest of the Sierra Nevada is punctuated by passes, which were important to prehistoric and historic trade and travel.

## 2.2 Geology

The geology of the Sierra Nevada is primarily characterized by igneous and metamorphic rocks of diverse composition and age (Norris and Webb 1990:63). These rocks are called the "basement" or subjacent series. In the north-central Sierra Nevada, sedimentary and volcanic rocks overlie the subjacent series and are known as the superjacent series (Norris and Webb 1990:63). The description of the geologic composition of the north-central Sierra Nevada may be enhanced by subdividing it into four areas, which include the foothills, the mid-slope, the crest, and the immediately adjacent western edge of the Great Basin. The current project is located in the mid-slope area that primarily consists of Paleozoic metasediments and metamorphic rocks (e.g., slates and graywackes) with areas of intrusive Mesozoic granitic rocks and Cenozoic basalts (Hill 1975; Norris and Webb 1990).

## 2.3 Hydrology

Water has been a primary agent in sculpting landforms of the north-central Sierra Nevada. Rivers, such as the American, Cosumnes, Mokelumne, Calaveras, Stanislaus, Tuolomne, and Merced of the western slope, and the Truckee, Carson, and Walker of the eastern slope, dissect the landscape, creating a series of valleys. The Project is located near the South Fork of the American River. The river canyon facilitated travel from the crest of the Sierra Nevada to the Central Valley from the prehistoric period to the present day.

## 2.4 Flora

Kuchler's (1977) classification of the natural vegetation of California defines 54 vegetation associations that are lumped into nine larger order categories. These communities include: California prairie; blue oak-grey pine forest; chaparral; Sierra yellow pine forest; Sierra montane forest; upper montane-subalpine forest; alpine communities; northern Jeffrey pine forest; sagebrush steppe; and juniper-pinyon woodland (Kuchler 1977). Sierra yellow pine forest and Sierra montane forest best describe the vegetation in the Project area.
2.5  Fauna

The Project area provides habitat for a wide range of animal species including some species whose availability and abundance vary seasonally and by altitude. Native Americans and Euroamericans exploited many of these animal species for both food and other uses. These species include: salmonids (i.e., salmon and trout); other freshwater fishes (e.g., minnows, suckers, and freshwater surfperch); quail; grouse; pigeons; doves; rabbits; pikas; squirrels; fur-bearing carnivores (e.g., marten); and artiodactyl herbivores (i.e., deer) (Jackson et al. 1994: Unit I, Volume B, Chapter 6.6).

2.6  Summary

The north-central Sierra Nevada has a long and complex natural history. Part of this history is represented in the various geologic and geographic features of the area. The area is dominated by the Sierra Nevada and its associated foothills, which are bisected by a number of steep canyons cut into the terrain by several large rivers and their tributaries. The rivers and their valleys provide water and habitat for flora and fauna, and also provide a system of travel corridors from the Central Valley of California across the crest of the Sierra Nevada.
3 Cultural Context

The Project is primarily associated with historic sites and features; consequently a detailed description of the prehistory and ethnography of the Project area will not be presented. The history of the Project area and the development of gold mining and water companies will be highlighted.

3.1 Prehistory

The archaeology of the north-central Sierra Nevada is complex, and related to the surrounding areas such as the Central Valley, Southern Sierra Nevada, and the Great Basin. The project area, however, is primarily associated with the Martis Complex.

In 1953, Heizer and Elsasser presented the first cultural chronology for the Sierra Nevada. This chronology was based on survey work conducted to the east of the crest of the Sierra Nevada around Lake Tahoe and parts of the drainages of the Truckee and Carson Rivers. Heizer and Elsasser (1953) identified two "complexes"; the earliest cultural group was named the Martis Complex; and the subsequent group was named the King's Beach Complex.

Heizer and Elsasser (1953) defined the Martis Complex based on nine criteria derived from data obtained from thirteen sites. These nine criteria are: 1) the use of basalt as the preferred lithic material for tools; 2) the rare use of chert and obsidian for tool production; 3) the use of roughly chipped, large, heavy projectile points; 4) the use of the mano and metate; 5) the use of bowl mortars with cylindrical pestles; 6) the use of boatstones and atlatls; 7) an economy primarily based on hunting and supplemented by the gathering of seeds; 8) the use of large numbers of basalt flake scrapers; and 9) the frequent use of expanded base, finger held drills (Heizer and Elsasser 1953:19). Heizer and Elsasser (1953:20) suggest that the Martis Complex may be related to other basalt-using complexes in the Great Basin, the Mohave Desert, and the Early Horizon in the Central Valley of California.

Elsasser continued research along both the east and west sides of the Sierra crest, and provided additional data to aid in characterizing the Martis Complex and defining its possible relationships to other cultures. In 1960, he published the results of excavations at three Martis Complex sites that expanded the known territory of the Martis Complex to include the upper elevations of the western slope of the Sierra Nevada (Elsasser 1960). Elsasser (1960:68) suggested Martis people most likely hunted large, seasonally migratory animals, such as deer and antelope, which they followed between the lower and higher elevations of the Sierra Nevada. Elsasser (1960) also emphasized the expanding and apparently widespread distribution of the Martis Complex across the mid-elevations of the Sierra Nevada.

Elsasser was reluctant to speculate on the relationship between the Martis Complex and other cultural groups in the Central Valley of California or the Great Basin. He (1960:29) believed that there were no dominant point types to characterize the Martis Complex and that they were not properly analyzed to be useful as "time markers". Regardless, Elsasser's data suggest a relationship between the Martis Complex and the Early/Middle Horizon of Central California. Elsasser (1960) dated the beginning of the Martis Complex at approximately 2,500 B.P. and its termination at approximately 1,500 B.P.

Elston (1971) augmented the work of Heizer and Elsasser (1953) by exploring the relationship between the Martis Complex, Kings Beach Complex, and the historic Washoe. Elston (1971) identified a "pre-Martis" culture, the Spooner Complex, and suggested a revision of the Martis Complex. The Spooner Complex is dated between 7,000 B.P. and 3,000 B.P. (Elston 1971:135). Elston proposed that the Spooner Complex represents the initial colonization of the higher elevations of the Sierra Nevada by groups from the western Great Basin who were seeking refuge from the conditions induced by elevated temperatures during the Altithermal period. In addition, Elston (1971:136-137) suggested dividing the Martis Complex into two phases. Phase 1 dating from 3,000 B.P.-2,000 B.P. and Phase 2 dating from 2,000 B.P.-1,500 B.P.
Elston et al. (1977) provided an additional explanation for the areal distribution of the Martis Complex and also a refinement of the cultural chronology for the north-central Sierra Nevada. Elston et al. (1977:19) suggest that the Martis Complex may represent exploitation of the Sierra Nevada by both California and Great Basin groups using similar tool kits to exploit similar environments. Elston et al. (1977) divided the Martis Complex into three phases; Early Martis (4,000-3,500 B.P.), Middle Martis (3,500-2,500 B.P.), and Late Martis (2,500-1,500 B.P.). Subsequently, Elston et al. (1994:16) state that their original tripartite division for Martis is not substantiated and divide the Martis Complex into two phases, Early (5,000-3,000 B.P.) and Late Martis (3,000-1,500 B.P.). Elston et al. (1994:16) emphasize, however, that Early and Late Martis merely define blocks of time, since nothing is really known about culture change beyond the changing frequencies of point types.

Recent archaeological research in the area such as the work of Jackson and Ballard (1999) at CA-ELD-145 near Camino; Boyd (1998) at Sly Park Reservoir; Rood (1999) at CA-ELD-175 at Sand Flat Campground; Baker (2000) along the Forestick Divide; and Nadolski (2003) at the False Walrus site, 05-03-56-730 has provided a wealth of information regarding occupation and use of the American River Watershed dating from the Archaic through the Late Sierran Period. Additional research in the project area will certainly enhance our understanding of the occupation and use of the American River Watershed.

3.2 Ethnography

Prior to the arrival of Euroamericans in the region, California was inhabited by groups of Native Americans speaking more than 100 different languages and occupying a variety of ecological settings. Kroeber (1925, 1936), and others (i.e., Murdock 1960; Driver 1961), recognized the uniqueness of California Native Americans and classified them as belonging to the California culture area. Kroeber (1925, 1936) further subdivided California into four subculture areas, Northwestern, Northeastern, Southern, and Central. The Central area encompasses the current Project area and includes the Nisenan or Southern Maidu and Northern Sierra Miwok. The Washoe also utilized the Project area, but are included in the Great Basin culture area. Kroeber (1925:916), however, states that California and the Great Basin are regions of close cultural kinship that should be joined into a larger culture area with the Sacramento River Delta area as a center of major cultural development.

Nisenan inhabit the drainages of the Yuba, Bear, and American rivers, and also the lower reaches of the Feather River, extending from the east banks of the Sacramento River on the west to the mid-/high elevations of the western flank of the Sierra Nevada (Wilson and Towne 1978). Northern Sierra Miwok inhabit the southern end of the area bounded on the north by the Cosumnes River, extending beyond the Calaveras River to the south, demarcated on the west by the 500 foot elevation contour, and continuing toward the east to beyond the snowline (Levy 1978). Washoe historically inhabited the region east of the crest of the Sierra Nevada into Carson Valley, extending from the Walker River in the south to Honey Lake in the north, with peripheral territory extending to the mid-elevations of the west Sierra slope (d’Azevedo 1986). All three ethnographic groups probably exploited resources in the Project area.

3.3 History

The first Euroamericans to make contact with Native Americans in the Project area were either Spanish explorers or mountain men trapping in and exploring the region. Spanish exploration of the Central Valley did not begin until the late 1700s, and the eastern edges of the Central Valley and the Sierra Nevada were not explored until the early 1800s. In 1808 Gabriel Moraga explored the Mokelumne, Cosumnes, and American Rivers, passing near modern day Folsom (Beck and Haase 1974). He named the river “Rio de las Llamas” (River of Sorrows). The name was changed to “Rio de los Americanos” (American River) by Mexican Governor Alvarado in 1837 because the river was so popular with American fur traders. Subsequent exploration of the general Project area is credited to mountain men such as Jedediah Smith who crossed the Sierra Nevada into California in 1826 (Beck and Haase 1974). Smith traveled along the American, Sacramento, and Cosumnes Rivers, and also probably passed through...
current Pleasant Valley (Brooks 1977). Other explorers such as Ewing Young, Joseph Walker, John Fremont, and Christopher “Kit” Carson soon followed Smith. In 1844 Fremont crossed the Sierra Nevada near Lake Tahoe and descended the west slope in proximity to the American River, which he eventually followed to Sutter’s Fort. Many of the trails, however, used by these early explorers and subsequent immigrants were not newly discovered routes, but rather Native American trails that were already in use.

Early explorations of the Sierra Nevada and its flanks were soon followed by groups of Euroamerican immigrants moving west. The first of these immigrant groups was the Bartleson-Bidwell party that crossed the Sierra Nevada in 1841 and followed the Stanislaus River into the Central Valley (Beck and Haase 1974). The Joseph Chiles and Joseph Walker parties followed the crossing of the Sierra Nevada by the Bartleson-Bidwell party in 1843 (Beck and Haase 1974). Chiles crossed the Sierra Nevada following the Malheur and Pit Rivers into the Central Valley, and then traveled south along the Sacramento River. Walker, on the contrary, traveled south along the eastern front of the Sierra Nevada to Walker Lake where he crossed into Owens Valley, and eventually the Central Valley using what is now known as Walker’s Pass. Subsequently, in 1844 the Stevens-Murphy party crossed the Sierra Nevada and probably is the first immigrant group to enter California via the Truckee and Bear Rivers. The route followed by this group became known as the California Trail, and develops into a popular trail into California during the Gold Rush. The successful crossing of the mountains by the Stevens-Murphy party, however, is followed by the 1846 disaster of the Donner Party.

The Mexican-American War, which began in 1846, also affected the exploration of the Project area, including the identification of new trails across the Sierra Nevada. The exploits of the Mormon Battalion and the establishment of the Mormon Emigrant Trail (MET) highlight these activities. After serving in the Mexican-American War, members of the Mormon Battalion worked at both Sutter’s Fort and Coloma. The Mormons, however, in 1848 decided to return to Salt Lake City following a route through current Pleasant Valley, Sly Park and Jenkinson Lake, Leek Springs, Carson Pass, and Hope Valley (Owens 1989). This route eventually became known as the Carson Wagon Road, and provided an alternative trail across the Sierra Nevada to the California Trail along the Truckee River. This route, however, was not popular until the onset of the Gold Rush.

3.3.1 Gold Rush Era Mining

California’s Gold Rush began with the discovery of gold at Sutter’s Mill on the American River in 1848. By 1849, the gold discovery ignited a world-wide frenzy that brought a large number of people from all over the world to California gold country. In 1849, most miners were working in the Mother Lode, the area between the Yuba River in northern California and Mariposa County in southern California. The Mother Lode is an area rich in gold that consists of a strip of land across the Sierra Nevada foothills, varying in width from 10 to 20 miles, and in elevation from 1,200 to 2,000 feet.

Immigrants from around the world arrived in California seeking their fortune in the gold fields. Some miners commonly called “argonauts” or “forty-niners” arrived by ship in San Francisco, while others came over the Sierra Nevada using previously established trails. Two of these trails are the California Trail and the MET. The MET soon became a popular route to Placerville and the gold fields of the Sierra Nevada. A spur of this trail also turned north at Placerville and headed to Georgetown. John Calhoun, better known as “Cock-Eyed” Johnson, identified another major spur of the MET between 1851 and 1853 (Petershagen 1991; Supernowicz 1983, 1993a). This new spur road was known as Johnson’s Cut-Off and it left the MET near Echo Summit following a trail over the Sierra Nevada and into Placerville generally along the current alignment of Highway 50. In addition, another route, the Georgetown Cut-Off or Georgetown Junction Road, split off from Johnson’s Cut-Off near current Wright’s Lake Road and headed directly to Georgetown. Johnson’s Cut-Off and the Georgetown-Tahoe Wagon Road/Rubicon Trail provided two options to reach Georgetown, and the gold mining areas surrounding it, from Lake Tahoe. Some of these roads in the area became so heavily used that they became major thoroughfares, and in some cases toll roads. Indeed, they supported overland stage traffic after 1850 and the Pony Express between 1860 and 1861 (Supernowicz 1983, 1993a; Petershagen 1991).
The earliest mining activity required water to wash lighter sands and gravels away from the heavier gold. From 1848 to 1850, miners could profitably work the easiest and most accessible diggings in or adjacent to water sources, along creeks, gulches, river bars, and river banks. During this early period, simple forms of mining predominated. Most of the miners worked independently of each other and were concentrated in the Mother Lode region of the Sierra Nevada foothills. They used implements including pans, picks, shovels, rockers, long toms, and sluices. The pan, or batea, was used by mixing water and gravel in the pan, then with circular flipping motions, washing the lighter soil over the side until only the heavier gold-bearing residue remained in the pan. Experienced Mexican miners, from Sonora, Mexico, may have introduced the first pans.

Other simple, hand-operated implements included the rocker, long tom, and sluice. All of these implements required water to wash over the auriferous gravel to extract gold. Because of its high specific gravity, gold settled in the bottom of these devices as other lighter material was washed away. The rocker, or cradle, was developed in 1848, probably by miners with gold mining experience in Mexico or Georgia. The rocker washed gravel on a perforated plate as auriferous dirt was poured into the oblong box through a sieve. Water carried away the lighter dirt, and the gold remained in the bottom of the rocker. The machine was “rocked” side to side to speed the washing.

Another early innovation used by miners was the long tom, which is a short washing sluice with a perforated iron plate at the lower end to catch gold particles. At the upper end, gravel and water were mixed together as they entered the tom, usually through an inverted funnel to employ a greater force of water. The wider lower end slowed the water so that more gold would be caught. As water flowed through the tom, miners shoveled dirt in with the water. This operation usually required three or more men. Through working together on the rocker and long tom, miners first began cooperative efforts in retrieving gold.

The practice of river mining also developed during the initial phase of gold mining in the Sierra Nevada. The early miners built dams, ditches, and flumes to divert rivers and streams from their natural channels in order to work the ore-bearing soils at the bottom of the streams. As early as 1849, companies of miners on the American River planned to turn the river from its channel. This type of mining was heavily dependent upon the weather, and river miners wanted a long, dry season that would keep the rivers’ flow low. The dams, flumes, and canals used to divert the stream were temporary engineering works, typically built for one season, with new structures planned for following years. A variety of diversion structures were used: L-shaped wing dams, wooden flumes, and diversion canals were all used to expose the riverbed. Later companies captured entire streams and diverted them from their channels in large ditches, mammoth wooden flumes, or through bedrock tunnels. Dams diverted water from the rivers’ natural course, while the flumes, canals, or tunnels channeled water away from the river beds. Below the area being worked, the water was dropped back into the natural streambed. These techniques continued in use until the late 1850s.

3.3.2 Large-Scale Mining, Hydraulic Mining, and Water Ditches

Across California from the mid-1850s to the mid-1860s the era of the single prospector working a successful placer operation declined as gold mining transitioned from small scale to large scale production (JRP and Caltrans 2000). By the early 1850s, easily mined placer deposits along and in streams were generally exhausted, and miners had to look for gold in other locations. Some of these new locations were away from rivers and streams. Mining away from a regular and reliable source of water required bringing water to a mining site. Miners required water because there were two primary methods of recovering gold, winnowing or washing, from soil or sand. Winnowing involved tossing gold-bearing soil into the air and using wind to blow away lighter soils, leaving the heavier gold behind. Washing soils to recover gold was more efficient, but it required a substantial amount of water. Consequently, miners began to convey water to their “dry diggings” or mining sites. The typical method of water conveyance was an earthen ditch.
The first ditches associated with mining activities were usually short and built with minimal effort in terms of design and construction (JRP and Caltrans 2000). For example, miners working near rivers would simply dig small ditches to supply water to long toms or other mining equipment near water sources. The first significant attempt to convey water to an area away from a stream occurred at Coyote Hill in Nevada County in March 1850. In the spring of 1850, miners dug a ditch along Coyote and Little Deer Creeks near Nevada City to carry water to long toms located near, but away from the creeks. The success of this 1.5 mile long ditch led quickly to the excavation of many other ditches across the state. In El Dorado County, the first ditch built to convey water to a mining site was the 3 mile long Coloma Ditch, which was completed around 1855 at an estimated cost of $10,000 (JRP and Caltrans 2000).

As surface diggings began to produce smaller and smaller quantities of gold, miners turned to deeper auriferous beds and new mining techniques such as hydraulic mining that required large amounts and volumes of water. By the mid-1860s hydraulic mining was a common method of gold extraction in California. This method had a dramatic impact on mining in California and also helped to transform the California mining industry from a small-scale primarily individual or small group endeavor to a complex enterprise with financiers, mine managers, mining and water engineers, and mine workers with specialized skills. Hydraulic mining also had a dramatic impact on California's landscape and environment because it depleted fresh water supplies in natural channels, destroyed mountainsides, and sent debris-laden run-off to the rivers that deposited it in the Central Valley.

3.3.2.1 Hydraulic Mining

Hydraulic mining developed from ground sluice mining, which was widely used in California in the early 1850s. Ground sluicing involves running water and gravel through a ditch to precipitate out gold-bearing gravel deposits. The heavier gold and sand would settle in the bottom of a shallow ditch, and the gold could then be removed by panning. A more advanced method of sluicing employed a wooden trough with a rippled bottom that would catch the heavier gold as clay, sand, gravel, and stones were washed out the tail end of the sluice. Usually a group of sluice boxes were attached together to facilitate gold extraction and minimize loss of gold out the end of the sluice. With the development of sluicing and ditch construction, miners soon became less concerned with collecting every particle of gold and more interested in washing vast quantities of soil and capturing more gold in the same amount of time as previous, more labor intensive methods. Indeed, volume rather than efficiency became the rule.

Hydraulic mining quickly became the principal method of mining more deeply buried deposits of gold in California. Hydraulic mining consists of focusing large quantities of water shot through a hose and nozzle against a mountainside to wash away gold bearing soils. Sluices were then used to recover gold from the soils. Typically, the large volumes of water necessary for hydraulic mining were delivered to mining sites from sources several miles away by ditches, tunnels, and/or flumes. To generate sufficient pressure to wash away soils water ditches would be constructed above the elevation of the mining site at which point it would be transferred to a hose with pressure being generated by the action of water falling from higher to lower elevations. The water would then be shot out of the hose through a nozzle or monitor to remove gold bearing soils from a mountainside. Using hydraulic mining, a miner could quickly wash away greater amounts of soil and gravels than was previously possible with other mining methods. J. Ross Browne and James W. Taylor estimated in 1867 that a miner with a rocker could wash 1 cubic yard of earth a day; with a long tom 2 yards a day; with a sluice alone 4 yards a day; and by hydraulic mining 50 to 100 yards per day (JRP and Caltrans 2000). The more soils that could be washed and processed generally translated into the recovery of more gold.

Anthony Chabot and Edward E. Matteson are credited with having the most influence on the development of hydraulic mining in California (JRP and Caltrans 2000). In the spring of 1852, Anthony Chabot improved his ground sluicing operation at Buckeye Hill, east of Nevada City by attaching a canvas hose to the flume that brought water to his claim. The canvas hose greatly increased the range that water could be run over a sluicing area. In addition to hydraulic mining, Chabot was influential in the development of water companies in California. During the 1850s he built, or secured interests in, mining ditches in Yuba

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and Sierra counties. Subsequently, in the late 1850s and early 1860s, Chabot and two partners formed the San Francisco City Water Works, which merged in 1865 with the Spring Valley Water Company (JRP and Caltrans 2000). These companies supplied San Francisco with its municipal water. Chabot was also involved in the development of pioneering municipal water systems for Vallejo, San Jose, and Oakland.

Edward E. Matteson operated a ground sluicing claim at American Hill near Nevada City with water supplied by the Rock Creek Water Company. At his claim he experimented with hydraulic mining in the early 1850s by running water through a rawhide hose down a 30-foot drop from a supply ditch that was attached to a brass nozzle at the end of the hose. This innovation dramatically improved Matteson’s ability to remove soils and recover gold. The advantages of what became known as hydraulic mining are a reduction of manual labor, an increase in the amount of soils and gravels excavated for gold extraction, and extension of mining operations to new locations away from rivers. Hydraulic mining could wash away an entire mountainside to expose gold-bearing strata with relative ease and without threatening mining crews because they could operate the nozzle or monitor used for spraying water at a distance from the soils being washed away.

Other early technological advances in water engineering were initiated during the 1850s and 1860s as a result of the development of hydraulic mining. For example, by the end of 1853 light sheet iron was introduced by R. R. Craig on American Hill, Nevada County to replace rawhide hoses originally used by Matteson (JRP and Caltrans 2000). Three years later, a San Francisco manufacturer began to produce wrought iron pipes to transmit water for hydraulic mining. By 1857, sheet iron pipe measuring up to 40-inches in diameter was being used in a conduit to cross a ravine at Timbuctoo in Yuba County. These innovations facilitated the expansion of hydraulic mining and the construction of water conveyance systems (i.e., ditches).

As hydraulic mining operations expanded there was a need to lengthen and/or enlarge existing water conveyance ditches/canals and/or flumes. The cost and effort necessary to construct a ditch could be high; consequently the need for larger ditches facilitated the formation of water companies that allowed miners to pool their money and labor in order to afford the cost of building of water ditches. Indeed, some of these companies eventually concentrated solely on selling water and not on mining.

3.3.2.2 Ditch Systems

As miners exhausted rich and shallow dry placer diggings close to rivers and streams, water ditches/canals were expanded to reach gold bearing deposits at greater distances from perennial water sources. During 1855, miners and water companies built more than 1,160 miles of mining ditches in California (JRP and Caltrans 2000). By 1857, there were approximately 4,400 miles of mining canals and ditches in operation across the state. The most extensive ditch systems were concentrated in the hydraulic mining regions where big companies had consolidated individual claims and invested substantial amounts of capital.

The ditch systems that delivered water to the main hydraulic mining districts of California were far more difficult and complicated to build than the small mining ditches expeditiously dug between a creek and claim in the early days of the Gold Rush. The earliest ditches were constructed in areas where digging was easy rather than with careful planning and design of the ditch to maximize its capacity and flow. On the contrary, ditches/canals with their storage reservoirs and extensive ditch systems necessary for successful hydraulic mining required skills and techniques (e.g., elaborate engineering that included flumes and permanent diversion works) of construction beyond the capability of most miners. Consequently, hydraulic mining companies enlisted engineers and other specialists to design and build ditches/canals to supply water to their operations.

One of the principal concerns of hydraulic mining companies was to have a sufficient water supply to allow operations to run through the dry summer months. To accomplish this, mining companies began to construct storage reservoirs in the mountains at elevations of 5,000 to 7,000 feet. Reservoir sites were constructed to store large amounts of water and to facilitate construction of ditches with the proper
hydraulic gradient to deliver water under sufficient pressure to mining sites. Consequently, reservoir and ditch systems had to be carefully surveyed and designed to maximize the use of available supplies of water and provide a profit to investors who funded the construction of a water conveyance system.

Regardless of their engineering or length, most water ditches/canals were excavated earthen channels. Soils removed during excavation were piled on the sides of a ditch to form a dirt berm. The flow of water in a ditch was influenced by factors including absorption, percolation, evaporation, and leakage. In some areas, dry-laid rock was used to line one or both walls of a ditch. For example dry-laid rock was used where the composition of the soil was conducive to erosion; where ditch lines transitioned to flumes, and the integrity of the connection was susceptible to damage from turbulence; where the material of the side hill was unstable and unsuited to ordinary forms of an earthen ditch; in hydraulic mining ditches/canals, which often had steep grades; and along curves in hydraulic mining canals to minimize erosion (JRP and Caltrans 2000).

Ditches could not span drainages or ravines to convey water; consequently wooden flumes on wooden trestles were often built to span these features. In addition to wooden flumes and trestles, other types of flumes were constructed in the late 1860s and early 1870s. For example, the Miocene Gold Mining Company constructed the Miocene Canal in Butte County, with a unique flume system. The ditch was designed and built with a hanging flume along the side wall of a steep canyon. Similarly, the El Dorado Canal in El Dorado County and the South Yuba Canal and Milton Ditch in Nevada County, which were constructed in the 1870s, employed many miles of bench flumes. A bench flume was an engineering design that required excavation of a shelf or bench along a steep hillside upon which a wooden flume was built. Engineers, however, attempted to avoid building flumes whenever possible because wooden flumes were expensive, subject to fire, and required substantial maintenance.

An alternative to wooden flumes was the use of iron pipe, which was not subject to fire and typically lasted longer than wooden flumes. Engineers began to use pipe in ditch construction as early as the mid-1850s and its use increased over time because of its low cost, adaptability to the topography, ease of relocation, and lightness compared to its tensile strength. Iron pipe was used by the La Grange Hydraulic Mining Company in Stanislaus County, the North Bloomfield Company in Nevada County, and San Francisco’s Spring Valley Water Company in the 1870s and 1880s (JRP and Caltrans 2000).

There were several hundred mining ditches in California by the end of the hydraulic mining era in 1882. Mining ditches generally fell into three functional types: main or trunk lines that diverted water from a creek or river; branch or lateral lines that took water from the main trunk to a mining operation; and finally waste channels that carried water away from various points on the individual mining claims (JRP and Caltrans 2000). One of the most prominent early placer and ground sluicing mining water systems was the Natoma Ditch in Placer and Sacramento counties (JRP and Caltrans 2000). The ditch was constructed by the Natoma Water and Mining Company in 1852-1853.

The Natoma Ditch diverted water from the left bank of the American River, 1.5 miles above Salmon Falls, and conveyed it to mines at Browns Hill, Red Bank, Richmond Hill, and Mormon Island, ending in a large storage reservoir 2 miles east of Folsom (JRP and Caltrans 2000). Water from the reservoir was also distributed by branch lines to mining claims owned by the Natoma Company in the area and mines at Bunker Hill, Folsom Flat, Alder Creek, and the Texas Hill in vicinity of Folsom. The main canal was 15 miles in length with an average grade of 3 feet per mile. The canal measured 8 feet across the top, 6 feet across the bottom, and was 4 feet 7 inches deep. There were four principal distribution ditches along the Natoma Ditch: the Mormon Island Branch, 2.5 miles long; the Bunker Hill Branch, 5 miles long; the Rhodes Branch, 12 miles long; and the Alder Creek Branch, 3.5 miles long (JRP and Caltrans 2000). In addition to these four ditches, there were numerous other smaller branch ditches that totaled approximately 12 miles in length. These distribution ditches measured approximately 2 feet in width and 1 foot 6 inches in depth.

Ditches serving hydraulic mines were the largest, ranging in carrying capacity from 500 miner’s inches (12.5 cubic feet per second [cfs]) to 7,000 miner’s inches (175 cfs). Relatively few ditches in California
could be classified as “large” mining ditches/canals (i.e., those carrying 2,000 miner’s inches [50 cfs] or more) (JRP and Caltrans 2000), but those ditches/canals totaled about 1,750 miles in length and represented capital investments of more than $11,500,000. These ditches/canals diverted water from the most of the principal streams that drain the west slope of the north-central Sierra Nevada such as the Feather, Yuba, Bear, American, Mokelumne, Cosumnes, Stanislaus, Tuolumne, and Trinity Rivers.

The ditch/canal systems across California varied greatly in length, with small ditch/canals ranging from 3 to 4 miles in length to complex systems totaling 250 miles in length (JRP and Caltrans 2000). The aggregate length of all water conveyance ditches for mining in California in 1882 is estimated at about 7,000 miles (JRP and Caltrans 2000). The cost of constructing the 7,000 miles of ditch/canal is estimated at $30 million (JRP and Caltrans 2000). The magnitude development and construction of water conveyance systems in California’s mining regions is not reached in any other mining area across the western United States.

3.3.3 Mining and Water Conveyance Systems in El Dorado, Placer, and Nevada Counties

Ditches constructed in the 1850s in the Project area were usually short, often less than 20 miles in length (cf., Meisenbach 1989). Meisenbach (1989) lists 34 ditches, most which were completed in the 1850s, in the San Juan Ridge mining district, located between the Middle and South Yuba rivers, where large hydraulic mining operations were located. Of the 34 ditches, only 6 were longer than 20 miles; 8 ditches were 11 to 20 miles in length; 15 ditches were 10 miles or shorter in length; and 5 ditches did not have an identified length. The longer ditches in the area were typically constructed by large mining companies, such as the North Bloomfield Gravel Mining Company and the Eureka Lake and Yuba Canal Company (Meisenbach 1989).

The North Bloomfield Gravel Mining Company was formed in 1866 by Lester L. Robinson and a group of San Francisco investors (JRP and Caltrans 2000). Assets of the company included the Malakoff Mine. Operations at the Malakoff Mine began in 1866 with water from the Eureka Lake and Yuba Canal Company. Mining operations required a large amount of water and the North Bloomfield Gravel Mining Company began to construct water conveyance systems to supply water to the mine. By 1880, the North Bloomfield Gravel Mining Company had a vast network of lakes, reservoirs, and ditches. Indeed, the 1880 Nevada County tax assessment for the North Bloomfield Company listed the Bowman Dam, 43 miles of ditch, claims to seven small lakes and reservoirs, and three other distributing reservoirs (JRP and Caltrans 2000). The North Bloomfield system eventually had an aggregate capacity in their reservoirs of 23,000 acre-feet.

The Eureka Lake Water Company incorporated in 1860 brought together many small mining ditches in the San Juan Ridge area, including the Miner’s Ditch. The Miner’s Ditch was completed in 1856 by a group of local miners who pooled their resources for its construction. The Miner’s Ditch conveyed water from the Middle Yuba River for a distance of 20 miles through a canal that measured 5 feet wide and 3 feet deep. In 1859, the Miner’s Ditch Company merged with the Eureka Lake Company (JRP and Caltrans 2000).

The Middle Yuba Canal Company began operations in 1853. By 1860 the company owned the Grizzly Ditch that distributed water to miners at and along the way to Columbia Hill. The Grizzly Ditch system was over 20 miles long and included wooden trestles and flumes, four reservoirs, and branch ditches from the reservoirs and main ditch to supply a number of mining operations (JRP and Caltrans 2000). The main channel of the ditch measured 7 feet wide at the top, 4 feet wide at the bottom, and 3 feet deep. The branch ditches leading off the main channel were smaller, measuring 4 feet across at the top, 2.5 feet wide at the bottom, and 2 feet in depth.

The South Yuba Water Company has its origins with the construction of the main South Yuba Canal in 1850 in Nevada County by the Snow Mountain Ditch Company. The Snow Mountain Ditch Company merged with two other companies and began construction of the South Yuba Canal under the name of the Rock Creek, Deer Creek, and South Yuba Canal Company (JRP and Caltrans 2000). The name of
the company was subsequently shortened to the South Yuba Water Company. By 1857, the company completed the South Yuba Canal from above Bear Valley (near Lake Spaulding) to Big Tunnel. The canal was 16 miles long before branching into smaller ditches/canals, and measures 8 feet wide at the top, 6 feet wide at the bottom, and 5 feet deep, with a capacity of 7,500 miner’s inches. By 1857, the South Yuba Water Company constructed distributing reservoirs along the canal and dammed 20 small headwater lakes to increase water storage.

The South Yuba Water Company continued to improve its operation through the 1850s and 1860s by acquiring smaller companies and building new ditches. By 1865, the South Yuba Water Company began inter-basin transfers of water between the Yuba and Bear River basins through the Yuba South Canal and its tributaries. During the peak period of hydraulic mining in California, the South Yuba Water Company emerged as the pre-eminent water ditch company in Placer and Nevada counties (JRP and Caltrans 2000).

A prominent figure in the development of water conveyance systems in El Dorado County is John Kirk. He was an engineering contractor who built navigation canals, roads, and railroad bridges in the eastern United States, before moving to Sacramento in the winter of 1849-1850 (JRP and Caltrans 2000). After arriving in Sacramento, Kirk was responsible for some of the major engineering works in the city, including the first municipal water works and planking of Sacramento’s principal commercial streets. In 1853 Kirk moved to Placerville, and a few years later, in partnership with Francis A. Bishop, organized the South Fork Canal Company to bring water to mining operations near Placerville.

Kirk proposed building a canal to convey water to mining operations in the Placerville area in 1856. The project stalled with the general depression in hydraulic mining during the early 1860s and in 1873 Kirk sold his holdings in the South Fork Canal Company, including water rights on the South Fork of the American River, to a group of San Francisco investors and Bishop (JRP and Caltrans 2000). Bishop and the investment group formed the El Dorado Water and Deep Gravel Mining Company and resurrected Kirk’s plan for a canal to deliver water to mining operations in the Placerville area (JRP and Caltrans 2000).

Bishop began construction on what became the El Dorado Canal in 1874 (JRP and Caltrans 2000). The canal was designed to deliver water from the South Fork of the American River to hydraulic mines in the vicinity of Placerville. The El Dorado Canal began on the South Fork of the American River near Kyburz. The canal system included 18 to 20 high Sierra reservoirs and had a capacity of 5,000 miner’s inches (JRP and Caltrans 2000). The El Dorado Water and Deep Gravel Mining Company anticipated that the canal would be completed in a year, but it was not completed until 1876. Construction of the El Dorado Canal was slow because of the vast amount of granite (i.e., approximately 200,000 cubic yards) that needed to cut or blasted away primarily for construction of bench flumes. Indeed, the canal consists of many long sections of bench flumes resting on dry-laid granite block and rubble bench walls that are 15 to 20 feet high (JRP and Caltrans 2000). The El Dorado Canal employed over 1,000 men and was the most expensive ditch, mile for mile, built in California during the hydraulic mining era (JRP and Caltrans 2000). The canal conveyed water to several mining operations in western El Dorado County, such as the Excelsior hydraulic mine, which was one of the largest operations in the region.

From the late 1850s through the mid-1860s, the output of gold from hydraulic mining in northern California decreased and correspondingly the profitability of the water conveyance systems supporting the mining operations declined. Consequently, many ditches/canals and reservoirs were sold or abandoned at this time. The overall decline in mining in California was the result of several factors including miners leaving the area for the Comstock Lode in Nevada and issues related to rights to use water and mineral resources on public lands. However, miners returned to the Mother Lode as the productivity of the Comstock Lode declined and issues related to water and mineral rights were resolved by the passage of the Mineral Act of 1866 and the California Water Code of 1872 (JRP and Caltrans 2000). As a result, the late 1860s witnessed an increase in investment in mining operations in California as capitalists were once again willing to fund hydraulic mining and ditch construction in the northern Sierra Nevada. This resurgence, however, was short lived due to the environmental effects of hydraulic mining.
3.3.4 **The Sawyer Decision**

Hydraulic mining had a dramatic effect on the landscapes surrounding mining sites and also on waterways and farms downstream of the mines in the Central Valley of California. The expansion of hydraulic mining in the late 1860s washed unprecedented amounts of soil and tailings directly into major tributaries of navigable rivers, causing tremendous damage to rivers and valley farms. Sacramento Valley farmers protested against hydraulic mining in 1862 when torrential rains washed mud, sand, and gravel tailings from hydraulic mines onto unprotected farms (JRP and Caltrans 2000). By 1868, mining debris had silted in the beds of the Yuba and Feather Rivers, raising the riverbeds higher than the town of Marysville (JRP and Caltrans 2000). This situation forced Marysville to invest hundreds of thousands of dollars in levee construction to control flooding around the city.

During the 1870s miners and farmers organized into groups, such as the Hydraulic Miners Association and the Anti-Debris Association of the Sacramento Valley, supporting or opposing hydraulic mining (JRP and Caltrans 2000). In addition, individuals and companies that used the Valley Rivers allied with the farmers because mining debris was clogging the rivers making navigation and travel along them very difficult. Eventually, farmers turned to the courts in an attempt to end hydraulic mining and the accumulation of debris in Valley Rivers.

In 1884, Ninth U. S. Circuit Court in San Francisco issued an injunction known as the Sawyer Decision that ended large-scale hydraulic mining in the Sierra Nevada (JRP and Caltrans 2000). In the case *Woodruff v. North Bloomfield*, Judge Lorenzo Sawyer ruled that hydraulic mining could be shut down on the grounds that dumping debris into rivers was injurious to the property of others. Not only were mining companies forbidden to allow any of their tailings to enter rivers, but ditch companies could not sell their water to hydraulic miners.

While the act did not affect other types of mining, it had a tremendous impact on California. It is estimated that during the first year after the Sawyer Decision, gold production in the state dropped by $10 million (JRP and Caltrans 2000). In certain areas, the value of mines, ditches, and other related property decreased dramatically. Some miners ignored the Sawyer Decision and continued hydraulic mining, while others looked for ways to operate a hydraulic mine within the limits of the decision. For example, a few companies constructed tailing storage dams and continued to operate. California legislators from the area of the Mother Lode attempted to restart hydraulic mining with the introduction of bills authorizing the construction of large debris dams (JRP and Caltrans 2000). In addition, in the late 1880s a federal commission, Briggs Commission, was set up to investigate the debris problem and the possibility of river reclamation. In 1891, the Briggs Commission recommended that hydraulic mining could resume if debris dams were constructed (JRP and Caltrans 2000). This and other commission recommendations were incorporated into a bill introduced to the U. S. House of Representatives by Anthony Caminetti in 1892 (JRP and Caltrans 2000).

Caminetti’s bill was signed into law in 1893 by President Grover Cleveland. The bill set up a three member California Debris Commission to oversee hydraulic mining in the area drained by the Sacramento and San Joaquin Rivers (JRP and Caltrans 2000). The commission had the authority to license hydraulic mining operations if it could be proven that mining would not affect farming or rivers. Regardless, the restrictions in the Caminetti bill ensured that hydraulic mining would not return to its previous levels of activity.

In the 1880s and 1890s, Sierra miners lobbied for a reduction in the Sawyer Decision’s restrictions. The most practical idea was the construction of impounding dams to keep tailings from entering rivers. A few of these dams were built in the 1910s and 1920s. For example, the California Debris Commission constructed small dams across the Yuba River, as well as protecting walls to guide the river through debris deposits in the 1920s (JRP and Caltrans 2000). A state investigation in the 1920s also determined that hydraulic mining could be resumed if impounding dams were constructed at strategic locations along major rivers, such as the American, Bear, and Yuba Rivers (JRP and Caltrans 2000). If dams were constructed, at an estimated cost of $2,405,000, hydraulic mining could be resumed in those areas (JRP
and Caltrans 2000). The Englebright Dam on the Yuba River, which was authorized by the U.S. Congress in 1935 as a hydraulic mining debris storage dam, is an example of one of these impounding dams (JRP and Caltrans 2000).

In summary, the Sawyer Decision had a negative effect on gold production in northern California, but mining continued in California and continued to require a large and reliable supply of water. The Sawyer Decision also caused mining ditch owners and operators to explore other uses of their supplies of water. One of these other uses was to provide water for agricultural and private customers. For example, the El Dorado Canal was used by irrigation, and municipal and domestic water users.

3.4 Water Companies and the El Dorado Irrigation District

Hydraulic mining increased the demand for water, which dramatically raised the price of water across the Mother Lode. The cost of building ditches and flumes for hydraulic mining operations could be enormous, but extremely lucrative as long as the demand for water was high. As early as 1850, water companies were forming in the Sierra Nevada to build ditches and flumes to bring water to mining operations. The water companies were typically joint stock companies formed by miners and local merchants to bring water to an area that had previously been dry. The companies used their pooled funds and resources to hire laborers to construct water conveyance systems. The high demand for labor to construct water supply systems was attractive to a large number of miners who abandoned their gold claims to work digging ditches and building flumes for water companies. Some of these early water companies that began by supplying water to mining operations subsequently developed into companies supplying water to expanding towns in the Sierra Nevada as gold mining decreased and other business enterprises and the general population expanded. One of these water companies is the El Dorado Irrigation District.

The El Dorado Irrigation District has been providing essential water services in El Dorado County since 1925 (Hildebrandt and Waechter 2003). In 1925, El Dorado County residents voted to form El Dorado Irrigation District to protect water filings, ensure a secure water supply, keep irrigation rates reasonable, and increase the value of agricultural lands. Indeed, by 1920 thousands of acres across El Dorado County were in crop production using water supplied primarily by old mining ditches and reservoirs that lacked storage and reliability necessary to sustain large scale agriculture. The focus of the District was to provide an adequate and reliable water supply for agricultural irrigation and domestic needs in the county.

In 1927, the District purchased the water storage and distribution system of the financially troubled El Dorado Water Corporation and its facilities (Hildebrandt and Waechter 2003). These facilities consisted of about 70 miles of main water ditches and laterals and Weber Reservoir. During the 1920s, the District was also interested in the El Dorado Canal and its large water storage and conveyance system that includes Lake Aloha; Echo, Silver, and Caples lakes; 22.3 miles of flumes and canals; Forebay Reservoir in Pollock Pines; and a powerhouse. However, the canal was owned by the Western States Gas and Electric Company (WSGEC).

WSGEC acquired ownership of the El Dorado Canal from the El Dorado Water and Deep Gravel Mining Company as part of an effort to develop and expand the generation of hydroelectric power (Hildebrandt and Waechter 2003). To facilitate the expansion of their hydroelectric power generation facilities WSGEC initiated a major rehabilitation of the El Dorado Canal in 1922. This work included more than doubling its capacity and replacing most of the original engineering features. The rehabilitation work included enlarging flumes and ditches along the canal’s entire 22 mile length, from the Cedar Rock diversion dam on the American River near Kyburz to the new forebay at Pollock Pines; lining long stretches of the canal with steel reinforced gunite shells; installing dry-laid and mortared rock lining and wood panels along the canal to improve efficiency and durability of the canal; and reconstructing/reconfiguring old rectangular box flumes with flared sides to increase their carrying capacity (Hildebrandt and Waechter 2003). Upon completion of the rehabilitation work in 1923, the El Dorado Canal was, for all intents and purposes, a new canal. The only remaining original features of the canal between the diversion dam and Forebay
consisted of the extensive rock bench foundation walls that supported the flumes on the ditch system and two tunnels.

Pacific Gas and Electric Company (PG&E) acquired WSEGC in 1928 (Hildebrandt and Waechter 2003). PG&E operated the El Dorado Canal until 1999 at which time PG&E conveyed the system to the District. The El Dorado Canal and its associated facilities are currently identified as Project 184. Project 184 delivers water to District customers and produces up to $10 million in hydroelectric power each year.

3.5 The El Dorado Canal

The El Dorado Canal was originally conceived by John Kirk to convey water to hydraulic mining operations near Placerville. The design of the canal was based on water filings of Kirk and Francis A. Bishop, but Kirk’s plans for construction of the canal were not implemented (Hildebrandt and Waechter 2003). The El Dorado Water and Deep Gravel Mining Company acquired the rights of Kirk and Bishop in 1873. At that time Kirk left the project because of his age, but Bishop became a member of the Board of Directors of the El Dorado Water and Deep Gravel Mining Company and supervising engineer for construction of the El Dorado Canal (Hildebrandt and Waechter 2003). The 26 mile long canal was built between 1874 and 1876 under the direction of Bishop at a cost of $650,000 or $25,000 per mile, which made the El Dorado Canal the most expensive canal built in California during the hydraulic mining period (Hildebrandt and Waechter 2003).

The El Dorado Canal itself (i.e., the water conveyance system from the point of diversion on the South Fork of the American River to Forebay) has been systematically recorded and evaluated by Caruso (1990), Glover et al. (1991), and Shoup (1990). Other features of the water conveyance system have been recorded and evaluated on a piecemeal basis.

The previous studies related to the El Dorado Canal is best discussed by dividing the canal system into three parts; the upper, middle, and lower sections of the system (i.e., current hydroelectric system). The upper section is composed primarily of the project water-storage facilities. The middle or "main canal" section covers facilities from the Intake Dam to Forebay. The lower section addresses Forebay and areas located below Forebay down to the El Dorado Powerhouse.

3.5.1 High-Elevation Storage Reservoirs

Since the 1990s cultural resources investigations were conducted for projects undertaken by PG&E and the District involving resources located in the upper segment of the El Dorado Canal and its associated hydroelectric facilities. In 1991, PAR (cf., Jackson and Maniery 1991) conducted investigations in the vicinity of Echo Lake. Their work included an evaluation of the significance of the Echo Lake storage and diversion dam and its conduit to the South Fork of the American River, a mini-hydro dam on Echo Creek, and several associated recreational facilities associated with the Echo Lake Chalet. PAR concluded, and the SHPO concurred, that none of these facilities were eligible for listing on the National Register of Historic Places (NRHP).

In 2002, King et al. inventoried the Echo Lake conduit rock walls, other previously unrecorded high-Sierra dams, and other resources related to hydroelectric power development. These resources include: the main dam and 11 auxiliary dams at Lake Aloha; the two dams and associated structures at Caples Lake; the lake tender's cabin complex at Caples Lake; the dam at Silver Lake; and the lake tender's cabin and associated outbuildings and structures at Silver Lake (King et al. 2002).

3.5.2 Main Canal Section: Intake to Forebay

A. Glenn Caruso and Laurence H. Shoup conducted inventory and evaluation studies of the El Dorado Canal in 1990. Caruso (1990) prepared the archaeological site record for CA-ELD-511-H and Shoup (1990) prepared the historic overview and NRHP eligibility determination for the canal. However, Caruso only recorded the major features of the El Dorado Canal system from the diversion dam on the South Fork of the American River to the end of the canal at Fourteen Mile Tunnel at its junction with El Dorado
Forebay. The upper storage reservoirs, Forebay itself, the conduit to the powerhouse, and the powerhouse were not included in his 1990 site survey. Similarly, Shoup focuses on the canal from the intake to Forebay and does not include the upper storage system or the power generation plant in his evaluation of the system.

Shoup (1990) determined that "the entire El Dorado Canal from the intake to the Forebay is one appropriate unit of analysis" and concluded that the El Dorado Canal system "as a whole" no longer retained sufficient integrity as related to its period of significance, 1922-1940. Therefore, Shoup determined that the El Dorado Canal was not eligible for listing on the NRHP. The State Historic Preservation Officer (SHPO) concurred with Shoup's finding. However, he also argued that the 1870s dry-laid granite rock walls along sections of the canal did possess both sufficient integrity and should be considered significant features of the canal at the local and statewide level. Shoup also recommended that the rock walls met the criteria for listing on the NRHP as a 'discontiguous district' associated with the Chinese and as an important example of late 19th century engineering. The SHPO disagreed with Shoup, but allowed that the rock walls may be eligible for inclusion on the NRHP under Criterion C, if it could be proved that there was something distinctively "Chinese" about the construction methods used in building the rock walls, or if the walls embodied "certain distinguishing attributes that define the property type and meet an appropriate level of integrity as well..."

Wee (1991) conducted investigations to determine whether the El Dorado Canal's 1870s rock walls were eligible for listing on the NRHP. After comparing the existing resources on the El Dorado Canal to the extant rock walls on thirteen other major hydraulic mining systems in the Sierra Nevada, Wee (1991) concluded that certain segments of the El Dorado Canal's extensive system of flume bench foundation walls and abutments possessed distinguishing attributes and sufficient integrity to warrant listing on the NRHP under Criterion C. These segments are: the rock bench walls located at Flume Nos. 8, 24-25, 41, 45, and 48, plus the rock retaining walls running up and down Alder Creek and Plum Creek canyons that were abandoned with the construction of siphons across the mouths of these canyons in 1924 (Glover et al. 1991). The SHPO concurred with these recommendations in 1993.

3.5.3 Lower Canal System: Forebay to Powerhouse

Since 1990, only a few cultural resources investigations have been conducted along the lower El Dorado Canal system, below the end of Fourteen Mile Tunnel, which is beyond the survey limits of the work conducted by Caruso (1990) and Shoup (1990). In 1995, PAR determined the NRHP eligibility of one of the last remaining sections of 68-inch wood-stave conduit associated with the El Dorado Canal located between Forebay and the El Dorado Powerhouse. The remaining redwood-stave pipe sections were eliminated from the canal system; consequently there are not any sections of the Forebay to powerhouse conduit that date to the historic period. PAR also evaluated the potential significance of the two governors within the El Dorado Powerhouse that were damaged in a 1993 equipment failure at the powerhouse. PAR recommended, and SHPO concurred, that the conduit and equipment were not eligible for inclusion on the NRHP, because the integrity of the resources is compromised, and other, better examples of these types of resources exist elsewhere in California.

In 1997, the El Dorado Powerhouse was severely damaged by flooding on the South Fork of the American River and was rendered inoperable. Cultural resources investigations conducted as part of the studies associated with repairing the powerhouse included of the District's access road to the powerhouse and a series of rock retaining walls located along the road in the vicinity of the powerhouse (cf., Wee 2001, 2002). Neither the rock walls nor the powerhouse were determined eligible for inclusion on the NRHP (JRP 2002; Wee 2001).

In 2002, King et al. completed an inventory for all of the buildings and structures related to hydroelectric power generation on the lower system that were not already recorded (King et al. 2002). These properties included the Forebay and associated buildings and structures; an isolated storage building at Moon Lane along the Forebay to powerhouse conduit; the complex of buildings and structures located at the interface
of the Forebay to powerhouse conduit and penstock; and the abandoned El Dorado Powerhouse operators' housing area. The eligibility of these resources for inclusion on the NRHP is not determined.

3.6 Summary

California's Gold Rush began in 1848 and attracted miners from around the world to the Mother Lode, the area between the Yuba River in northern California and Mariposa County in southern California. The earliest mining activity required water to wash lighter sands and gravels away from the heavier gold. From 1848 to 1850, miners could profitably work the easiest and most accessible diggings in or adjacent to water sources, along creeks, gulches, river bars, and river banks. During this early period, most miners worked independently and used relatively simple implements including pans, picks, shovels, rockers, long toms, and sluices.

Across California from the mid-1850s to the mid-1860s the era of the single miner working a successful placer operation came to an end as gold mining transitioned from small scale to large scale production away from rivers and easily accessible sources or water. Mining away from rivers required bringing water to a mining site. Consequently, miners began to convey water to their by building earthen ditches. The first ditches associated with mining activities were usually short and built with minimal effort in terms of design and construction.

As surface diggings produce smaller and smaller quantities of gold, miners turned to deeper auriferous beds and new mining techniques such as hydraulic mining that required large amounts and volumes of water. By the mid-1860s hydraulic mining was a common method of gold extraction in California, but it required large quantities of water. The large volumes of water necessary for hydraulic mining were delivered to mining sites from sources several miles away through the use of large scale systems that included reservoirs, ditches, tunnels, and flumes.

The 26 mile long El Dorado Canal is an example of a large scale water conveyance system designed to deliver water to hydraulic mining operations near Placerville. The canal was conceived by John Kirk and its construction between 1874 and 1876 was supervised by Francis A. Bishop. Following the Sawyer Decision, hydraulic mining dramatically declines and the need for water conveyance systems that support their operations. Consequently, many water ditches/canals are abandoned, but others are put to alternative uses such as providing water for irrigation, commercial and domestic use, and in some cases the generation of hydroelectric power.

The El Dorado Canal under the ownership of PG&E and the El Dorado Irrigation District successfully transitioned from providing water for hydraulic mining to providing water for irrigation, commercial and domestic use, and to generate hydroelectric power. Currently, the El Dorado Canal is owned and operated by the District and still provides water to a variety of users and its associated facilities generate hydroelectric power for commercial and residential consumption.
4 Results of Cultural Resources Investigations

Archaeological and historical investigations for the Project are complete. These investigations included: a record search at the North Central Information Center at California State University, Sacramento; archival research; a sacred lands search conducted by the Native American Heritage Commission; and pedestrian surface survey of the entire Project APE (i.e., the area around the El Dorado Canal/Main Ditch and Project staging areas). Archaeological and historical investigations identified that the Project APE is previously surveyed (cf., Snoke 1977; Gould 1993; Levy 1996; Allen 1999, 2003, 2003a; and Historic Resource Associates 2006); the El Dorado Canal, CA-ELD-511H/P-9-599 (also identified as the District’s Main Ditch) is within the Project APE; site P-9-3718-H is a previously recorded segment of the El Dorado Canal that extends toward the west for a short distance from Forebay Dam; site P-9-4147, a previously short segment of the El Dorado Canal is beyond, but near the Project APE; and site CA-ELD-2424-H/P-9-3717-H, a historic ranch, is located along the El Dorado Canal. There are no cultural resources associated with site CA-ELD-2424-H/P-9-3717-H within or near the Project APE (see site record in Appendix A). Therefore, implementation of the Project would not affect any cultural resources associated with the site and further discussion of the site is not warranted.

The purpose of this report is to document and determine the eligibility for inclusion on the NRHP and the California Register of Historical Resources (CRHR) of the approximately 3 mile long segment of the El Dorado Canal/Main Ditch from Forebay to RES 1. The eligibility of the site for inclusion on the NRHP and CRHR will be determined using the appropriate criteria and with regard to the canal’s historic context.

4.1 Site Characterization and Eligibility for the NRHP and CRHR

The Code of Federal Regulations (CFR) Title 36 CFR Part 60.4 [a-d] presents criteria for determining the significance and eligibility of sites for inclusion in the NRHP. The criteria at 36 CFR Part 60.4 [a-d] includes the following:

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

(a) that are associated with events that have made significant contributions to the broad patterns of our history; or

(b) that are associated with the lives of persons significant in our past; or

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

(d) that have yielded, or may likely yield, information important in prehistory or history.

CEQA also presents guidelines at §15064.5 and §21083.2 for the identification of historical resources and determining their historical significance. CEQA §15064.5(a) (3) presents the following eligibility criteria for inclusion of historical resources in the CRHR:

(1) Is associated with events that have made a significant contribution to the broad patterns of California’s history and cultural heritage;

(2) Is associated with the lives of persons important in our past;
(3) Embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual or possesses high artistic value; or

(4) Has yielded, or may yield, information important in prehistory or history.

In addition, CEQA requires consideration of effects of a project on unique archaeological resources. If an archaeological artifact, object, or site meets the definition of a unique archaeological resource, then the artifact, object, or site must be treated in accordance with the special provisions for such resources as presented at Public Resources Code 21083.2(e). Public Resources Code 21083.2(g) defines a unique archaeological resource as an archaeological artifact, object, or site that:

1) Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information.

2) Has a special and particular quality, such as being the oldest of its type or the best available example of its type.

3) Is associated with a scientifically recognized important prehistoric or historic person or event.

The California Code of Regulations (CCR), Title 14, Division 3, Chapter 11.5 § 4852 (c) states that integrity of historical resources should be considered when addressing their eligibility for inclusion in the CRHR. This section of the CCR describes integrity as the authenticity of an historical resource’s physical identity evidenced by the survival of characteristics that existed during the resource’s period of significance. Historical resources eligible for listing in the California Register must…retain enough of their historic character to be recognizable as historical resources and to convey the reasons for their significance.

Integrity is evaluated with regard to the retention of location, design, setting, materials, workmanship, feeling, and association.

4.2 El Dorado Canal

The El Dorado Canal was originally conceived by John Kirk and was designed based on water filings of Kirk and Francis A. Bishop (Hildebrandt and Waechter 2003). The purpose of the canal was to convey water to hydraulic mining operations near Placerville, but Kirk did not implement his plans to construct the El Dorado Canal. In 1873 the El Dorado Water and Deep Gravel Mining Company acquired the water rights of Kirk and Bishop (Hildebrandt and Waechter 2003). Bishop became a member of the Board of Directors of the El Dorado Water and Deep Gravel Mining Company and supervising engineer for construction of the El Dorado Canal (Hildebrandt and Waechter 2003). Construction on the 26 mile long canal began in 1874 and was completed in 1876 under the direction of Bishop (Hildebrandt and Waechter 2003).

WSGEC acquired ownership of the El Dorado Canal from the El Dorado Water and Deep Gravel Mining Company as part of an effort to develop and expand the generation of hydroelectric power (Hildebrandt and Waechter 2003). To facilitate the expansion of their hydroelectric power generation facilities WSGEC initiated a major rehabilitation of the El Dorado Canal in 1922. This work included more than doubling its capacity and replacing most of the original engineering features. The rehabilitation work included enlarging flumes and ditches along the canal’s entire 22 mile length, from the Cedar Rock diversion dam on the American River near Kyburz to the new forebay at Pollock Pines; lining long stretches of the canal with steel reinforced gunite shells; installing dry-laid and mortared rock lining and wood panels along the canal to improve efficiency and durability of the canal; and reconstructing/reconfiguring old rectangular box flumes with flared sides to increase their carrying capacity (Hildebrandt and Waechter 2003). Upon
completion of the rehabilitation work in 1923, the only remaining original features of the canal between the diversion dam and Forebay consisted of the extensive rock bench foundation walls that supported the flumes on the ditch system and two tunnels.

Pacific Gas and Electric Company (PG&E) acquired WSEGC in 1928 (Hildebrandt and Waechter 2003). PG&E operated the El Dorado Canal until 1999 at which time PG&E conveyed the system to the District. The El Dorado Canal and its associated facilities are currently identified as Project 184.

A. Glenn Caruso and Laurence H. Shoup conducted inventory and evaluation studies of the El Dorado Canal in 1990. Caruso (1990) prepared the archaeological site record for CA-ELD-511-H and Shoup (1990) prepared the historic overview and NRHP eligibility determination for the canal. Shoup (1990) determined that the El Dorado Canal no longer retained sufficient integrity as related to its period of significance, 1922-1940 and was not eligible for listing on the NRHP. The SHPO concurred with Shoup’s finding.

4.2.1 Eligibility of the El Dorado Canal between Forebay and RES 1 for the NRHP and CRHR

Current cultural resources investigations for the Project included archival research, survey of the segment of the Eldorado Canal/Main Ditch from Forebay to RES 1, and survey of the Project staging areas. Most of this section of the canal is not surveyed or appropriately recorded. Pedestrian surface survey for the Project did not identify any new or significant cultural resources or features associated with the canal, but did identify: previously recorded structures and features (e.g., a Valve House, Gauge House, and flow control structures) near the Forebay (see Appendix A, site record by Wee and Walters for Forebay and Associated Structures); that the El Dorado Canal/Main Ditch is crossed by bridges (i.e., five vehicular bridges) and pedestrian walkways (i.e., seven foot bridges); and that segments of the canal are bordered by private residences and landscaped areas (e.g., vegetation, rock walls, and sand bags) (Figures 3-8). The site record for the El Dorado Canal was updated as part of the Project to include the results of the survey along the section of the canal from Forebay to RES 1 (see Appendix A). Project related activities would not affect any of the previously recorded structures and features (e.g., a Valve House, Gauge House, and flow control structures) near the Forebay or the bridges and walkways that cross the El Dorado Canal; consequently their eligibility for inclusion on the NRHP and CRHR is not addressed in this report. Regardless, it does not appear that any of these features or structures would meet the eligibility criteria for inclusion on the NRHP or CRHR.

Under Criterion a and 1 a site may eligible for the NRHP or the CRHR if it is associated with events that have made a significant contribution to broad patterns of our history. Current research and previous research (cf., Caruso 1991 and Shoup 1991) identified that the El Dorado Canal was originally constructed between 1874 and 1876 and is still in use for water distribution. It is associated with the development of hydraulic mining, water conveyance systems, and hydroelectric power generation. However, the El Dorado Canal is only one of several ditches/canals constructed in the area during the 1860s and 1870s, is not the first canal constructed, is not directly instrumental in the construction of other water conveyance systems, and was completely rehabilitated in 1922. Other segments of the El Dorado Canal were previously determined to be ineligible for inclusion on the NRHP and similarly the segment associated with the Project does not meet the requirements of Criterion a for inclusion on the NRHP or Criterion 1 for inclusion on the CRHR because it does not appear that construction of the El Dorado Canal made a significant contribution to broad patterns of our history. On the contrary, the canal is one of many ditches/canals constructed in vicinity of the South Fork of the American River and was not instrumental in the development of hydraulic mining, design and/or construction of water conveyance systems, or the development hydroelectric power generation in El Dorado County.

Under Criterion b and 2 a site may eligible for the NRHP or the CRHR if it is associated with the lives of individuals significant in our past. John Kirk and Francis A. Bishop are associated with the planning and construction of the El Dorado Canal. Kirk was not directly involved with design or construction of the
Figure 3. View of segment of canal and Feature 4 (a flow control structure) facing west

Figure 4. View of segment of canal facing west; private residence on left of canal
Figure 5. View of segment of canal, bridge, and private residence facing east

Figure 6. View of segment of canal, bridge, and private residence facing west
Figure 7. View of segment of canal, flow control structure, and rock wall facing southwest

Figure 8. View of segment of canal and bridge facing west
canal and although Bishop was the supervising engineer for construction of the canal he does not appear to be a significant figure in El Dorado County or with the construction of other water conveyance systems in the region. Indeed, it appears that Bishop, upon completion of his role as supervising engineer, returned to his duties as a member of the Board of Directors of the El Dorado Water and Deep Gravel Mining Company. Other segments of the El Dorado Canal were previously determined to be ineligible for inclusion on the NRHP and similarly the segment associated with the Project does not meet the requirements of Criterion b for inclusion on the NRHP or Criterion 2 for inclusion on the CRHR because John Kirk did not participate in the actual design and construction of the El Dorado Canal and Francis A. Bishop does not appear to be a significant individual in the development of hydraulic mining, design and/or construction of water conveyance systems, or the development of hydroelectric power generation in El Dorado County.

Under Criterion c and 3 a site may eligible for the NRHP or the CRHR if it embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual or possesses high artistic value. The El Dorado Canal is an example of the construction of water conveyance systems in the 1870s, however, the canal was extensively rehabilitated in 1922 and Shoup (1991) determined the period of significance for the canal as 1922-1940. The segment of the El Dorado Canal between Forebay and RES 1 and its associated features (e.g., a Valve House, Gauge House, and flow control structures) do not reflect any unique elements of design or construction and similarly to other segments of the canal are not representative of its period of significance primarily due to modern improvements (e.g., lining of the canal and installation of other facilities). In addition, the integrity of design, workmanship, and materials is compromised for this segment of the El Dorado Canal because of maintenance activities, lining the canal, and the installation of other facilities along the canal. Other segments of the El Dorado Canal were previously determined to be ineligible for inclusion on the NRHP and similarly the segment associated with the Project does not meet the requirements of Criterion c for inclusion on the NRHP or Criterion 3 for inclusion on the CRHR because the integrity of design and workmanship of the segment is compromised.

Under Criterion d and 4 a site may eligible for the NRHP or the CRHR if it possesses the potential to yield information important in history. Prior research collected significant information regarding the El Dorado Canal (cf., Caruso 1991 and Shoup 1991). It appears that previous cultural resources investigations associated with the canal have exhausted its potential to yield any additional information important in history. Current research did not uncover any new information regarding the El Dorado Canal. Other segments of the El Dorado Canal were previously determined to be ineligible for inclusion on the NRHP and similarly the segment associated with the Project does not meet the requirements of Criterion d for inclusion on the NRHP or Criterion 4 for inclusion on the CRHR because the segment does not possess the potential to yield any significant information regarding the history, design, or construction of the El Dorado Canal or water conveyance systems.

In summary, other segments of the El Dorado Canal were previously determined to be ineligible for inclusion on the NRHP and the segment of El Dorado Canal within the Project APE does not appear to meet any of the eligibility requirements for inclusion on the NRHP or the CRHR. The construction of the segment of the El Dorado Canal associated with the Project does not appear to be directly associated with significant events in history or with individuals important in local history or the design and construction of other water conveyance systems. The El Dorado Canal is an example of a large scale water conveyance system, but it lacks integrity of setting, feeling, association, design, and workmanship because it is affected by maintenance, residential construction, installation of bridges/walkways, and installation of other facilities associated with modern use of the canal. Previous research regarding the El Dorado Canal was thorough and compiled sufficient information regarding design, construction, and use of the canal; consequently the segment of the El Dorado Canal associated with the current Project lacks the potential to yield additional significant information in related to the history of the canal or the development of water conveyance systems in El Dorado County.
4.3 Management Recommendations

The segment of site CA-ELD-511H/P-9-599 within the Project APE does not meet the eligibility requirements for inclusion on the NRHP or CRHR. The Project would improve water conveyance along the El Dorado Canal/Main Ditch by piping a segment of the El Dorado Canal between Forebay and RES 1. Implementation of the Project would not affect any historic properties or historical resources and a finding of "No Historic Properties Affected" appears appropriate for the Project. No additional archaeological or historical investigations are recommended prior to implementation of the Project.
5 Summary and Conclusions

The El Dorado Irrigation District is proposing to conduct evaluations and technical studies to support environmental review associated with piping a section of its Main Ditch, which is identified as the Main Ditch – Forebay to Reservoir 1 Water Treatment Plant Project. The Project would likely require approvals and permits from federal and state agencies and, as such, would be subject to the legal requirements of Section 106 of the National Historic Preservation Act (NHPA) 1966 and its implementing regulations, as amended, and the California Environmental Quality Act (CEQA) (Public Resources Code 21000 et seq.) 1970, as amended.

Cardno ENTRIX was contracted to conduct archaeological and historical investigations for the Project. These investigations identified previously recorded CA-ELD-511H/P-9-599 within the Project APE. Cardno ENTRIX cultural resources staff determined that the segment of site CA-ELD-511H/P-9-599 associated with the Project does not meet the eligibility requirements for inclusion on the NRHP or the CRHR. Consequently, implementation of the Project would not affect any historic properties or historical resources and a finding of “No Historic Properties Affected” appears appropriate for the Project.

Regardless of the Project findings, it is always possible to inadvertently uncover cultural resources or human remains during ground disturbing project activities. Therefore, if any cultural resources are uncovered during ground disturbing project activities it is recommended that all activity cease within 25 feet of the discovery and a professional archaeologist be retained to determine the significance of the discovery. If human remains are discovered, all work must stop in the immediate vicinity of the find and the County Coroner must be notified, according to Section 7050.5 of California’s Health and Safety Code. If the remains are determined to be Native American, the Native American Heritage Commission will be notified and procedures outlined in the CEQA Guidelines §15064.5(e) will be followed.
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APPENDIX

A

SITE RECORDS
**P1. **Other Identifier: El Dorado Irrigation District Main Ditch

*P2. Location: ☐Not for Publication ☐Unrestricted

* a. County: El Dorado

* b. USGS 7.5' Quad: Pollock Pines, Calif. Date: 1973 T 11N; R 12E; S & E 1/2 of Sec 35; M.D.B.M.

And N 1/4 of Sec 36

And S 1/2 of Sec 25

c. Address: N/A

d. UTM: Zone: 10S; 709641.78 mE; 429396.53 mN at east end of canal at Forebay 10S; 707639.20 mE; 4292251.85 mN at west end of canal at Reservoir 1

e. Other Locational Data: The canal can be accessed from the west at the Eldorado Irrigation District (District) Facility on Gilmore Road in Pollock Pines or from the east at the District's Forebay.

Elevation: 3700 ft amsl

*P3a. Description: The site consists of an approximately 3 mile long segment of the El Dorado Canal/Eldorado Irrigation District Main Ditch. The canal segment is located between Forebay and Reservoir 1. The canal is primarily an earthen ditch, but there are stretches along the canal that have concrete lining, concrete side walls, and gunite walls and bottom. There are previously recorded structures (e.g., Valve House, Gauge House, and flow control structures) near Forebay; the canal segment is crossed by 5 vehicular bridges and 7 pedestrian walkways; and there are modern stacked rock retaining walls, sandbags, concrete culverts, pipes, flow control structures, and flow measurement devices along the canal segment.

*P3b. Resource Attributes: HP20 Canal

*P4. Resources Present: ☐Building ☐Structure ☐Object ☐Site ☐District ☐Element of District ☐Other

*P5b. Description of Photo: Photo of canal facing west; photo taken 10/23/2012

*P6. Date Constructed/Age and Sources: ☐Historic ☐Prehistoric ☐Both

*P7. Owner and Address:

Eldorado Irrigation District

2890 Mosquito Road

Placerville, CA 95667

*P8. Recorded by: Ashley Hallock and Michelle Rossi

Cardno ENTRIX

701 University Ave. Suite 200

Sacramento, CA 95825

*P9. Date Recorded: 10/22/2012-10/23/2012

*P10. Survey Type: Intensive; 25 feet along both sides of the canal and across staging areas.

*P11. Report Citation: Cultural Resources Survey Report for the EID Main Ditch-Forebay to RES 1 Project, Cardno ENTRIX 2012

*Attachments: ☐NONE ☐Location Map ☐Sketch Map ☐Continuation Sheet ☐Building, Structure, and Object Record ☐Archaeological Record ☐District Record ☐Linear Feature Record ☐Milling Station Record ☐Rock Art Record ☐Artifact Record ☐Photograph Record ☐Other (List):

DPR 523A (1/95)

*Required information
**State of California — The Resources Agency**

**DEPARTMENT OF PARKS AND RECREATION**

**ARCHAEOLOGICAL SITE RECORD**

Page 2 of 12

*Resource Name or #:* El Dorado Canal

**A1. Dimensions:**
- **a. Length:** Approximately 3 miles
- **b. Width:** Varies from 11-20 feet

  **Method of Measurement:**
  - Paced
  - Taped
  - Visual estimate
  - Other: Topographic Map

  **Method of Determination:**
  - Artifacts
  - Features
  - Soil
  - Vegetation
  - Topography
  - Cut bank
  - Animal burrow
  - Excavation
  - Property boundary
  - Other:

  **Reliability of Determination:**
  - High
  - Medium
  - Low

  **Explain:** Eldorado Irrigation District’s Main Canal is depicted on a variety of maps and is documented in EID files.

  **Limitations:**
  - Restricted access
  - Paved/built over
  - Site limits incompletely defined
  - Other:

**A2. Depth:** The depth of the canal varies from 4-7 feet

**A3. Human Remains:**
- Present
- Absent
- Possible
- Unknown

  **Method of Determination:** Taped

**A4. Features:** There are previously recorded structures (e.g., Valve House, Gauge House, and flow control structures) near Forebay; the canal segment is crossed by 5 vehicular bridges and 7 pedestrian walkways; and there are modern stacked rock retaining walls, sandbags, concrete culverts, pipes, flow control structures, and flow measurement devices along the canal segment. This record addresses six features (e.g., concrete culverts, flow control structures, and flow measurement devices) along this segment of the El Dorado Canal/EID Main Ditch (see pages 5-10). This record does not address in detail the previously recorded structures near Forebay or the modern bridges and walkways that cross the canal. The bridges and walkways are not addressed in this record because they are not associated with the design, function, or use of the canal.

**A5. Cultural Constituents:** None

**A6. Were Specimens Collected?**
- No
- Yes

**A7. Site Condition:**
- Good
- Fair
- Poor

  The EID Main Canal is currently in use and generally in good condition.

**A8. Nearest Water:** There are several perennial streams near the canal and the North and South Fork of the American River are within a mile of the canal.

**A9. Elevation:** 3700 ft amsl

**A10. Environmental Setting:** The canal is located in a dispersed residential area along a northeast/southwest trending slope and is surrounded by pines, black oak, cedar, manzanita, and other brush.

**A11. Historical Information:** A prominent figure in the development of water conveyance systems in El Dorado County is John Kirk. He was an engineering contractor who built navigation canals, roads, and railroad bridges in the eastern United States, before moving to Sacramento in the winter of 1849-1850 (JRP and Caltrans 2000). After arriving in Sacramento, Kirk was responsible for some of the major engineering works in the city, including the first municipal water works and planking of Sacramento’s principal commercial streets. In 1853 Kirk moved to Placerville, and a few years later, with Francis A. Bishop, organized the South Fork Canal Company to bring water to the mines near Placerville.

Kirk proposed building a canal in 1856 to convey water to mining operations in the Placerville area. The project stalled with the general depression in hydraulic mining during the early 1860s and in 1873 Kirk sold his holdings in the South Fork Canal Company, including water rights on the South Fork of the American River, to a group of San Francisco investors. The investment group including Bishop formed the El Dorado Water and Deep Gravel Mining Company and resurrected Kirk’s plan for a canal to deliver water to mines in the Placerville area (JRP and Caltrans 2000).

Bishop became a member of the Board of Directors of the El Dorado Water and Deep Gravel Mining Company and supervising engineer for construction of the El Dorado Canal. The 26-mile long canal was built between 1874 and 1876 under the direction of DPR 523D-Test (12/93)
Bishop at a cost of $650,000 or $25,000 per mile, which made the El Dorado Canal the most expensive canal built in California during the hydraulic mining period (Far Western 2003). The canal was designed to deliver water from the South Fork of the American River to hydraulic mines in the vicinity of Placerville.

The El Dorado Canal began on the South Fork of the American River near Kyburz, included 18 to 20 high Sierra reservoirs, and had a capacity of 5,000 miner's inches of water. The El Dorado Water and Deep Gravel Mining Company anticipated that the canal would be completed in a year, but it was not completed until 1876. Construction of the El Dorado Canal was slow because of the vast amount of granite (approximately 200,000 cubic yards) that needed to be cut or blasted away for construction of the canal. The canal contains many long sections of bench flume resting on dry-laid granite block and rubble bench walls measuring 15 to 20 feet high. The El Dorado Canal employed over 1,000 men and was the most expensive ditch, mile for mile, built in California during the hydraulic mining era (JRP and Caltrans 2000). The canal conveyed water to several mining operations in western El Dorado County, such as the Excelsior hydraulic mine, which was one of the largest operations in the region.

In 1884, the Ninth U.S. Circuit Court in San Francisco issued an injunction known as the Sawyer Decision that ended large-scale hydraulic mining in the Sierra Nevada (JRP and Caltrans 2000). Following the Sawyer Decision, hydraulic mining dramatically declined and the need for water conveyance systems that support their operations. Consequently, many water ditches/canals are abandoned, but others are put to alternative uses such as providing water for irrigation, commercial and domestic use, and in some cases the generation of hydroelectric power. The El Dorado Canal under the ownership of PG&E and the El Dorado Irrigation District successfully transitioned from providing water for hydraulic mining to providing water for irrigation, commercial and domestic use, and to generate hydroelectric power. Currently, the El Dorado Canal is owned and operated by the District and still provides water to a variety of users and its associated facilities generate hydroelectric power for commercial and residential consumption.


A13. Interpretations: N/A

A14. Remarks: N/A


A16. Photographs: Original Media/Negatives Kept at: El Dorado Irrigation District

*A17. Form Prepared by: Michelle Rossi Affiliation and Address: Cardno ENTRIX, 701 University Avenue, Suite 200, Sacramento CA 95825 Date: 10/31/2012

*Required information
L1. Historic and/or Common Name: Eldorado Irrigation District Main Ditch

L2a. Portion Described: □ Entire Resource □ Segment □ Point Observation Designation:
   b. Location of point or segment: The canal segment extend from the EID Forebay to the Reservoir 1 Facility on Gilmore Road near Pollock Pines.

L3. Description: This segment of the El Dorado Canal/EID Main Ditch is approximately 3 miles long. The canal is primarily an earthen ditch but several sections along the canal segment are lined with concrete. There are concrete flow control structures, headgates, concrete culverts, and flow measurement devices along the canal. In addition, vehicular bridges and pedestrian walkways span the canal at various locations.

L4. Dimensions:
   a. Top Width: 20 feet at EID RES 1 Facility
   b. Bottom Width: 11.5 feet at Forebay
   c. Height or Depth: Varies from 4-7 feet
   d. Length of Segment: Approximately 3 miles

L5. Associated Resources: Concrete flow control structures, headgates, concrete culverts, and flow measurement devices.

L6. Setting: The canal is located in a dispersed residential area along a northeast/southwest trending slope and is surrounded by pines, black oak, cedar, manzanita, and other brush.

L7. Integrity Considerations: The integrity of design, setting, materials, workmanship, feeling, and association of the El Dorado Canal/EID Main Ditch is compromised because of maintenance activities associated with the canal to facilitate its current use as a water conveyance system providing water to a variety of users.

L8b. Description of Photo, Map, or Drawing: A view of a lined section of the canal facing west; a private residence is on the left in the photograph.

L9. Remarks: There are private residences around the canal, there is an access road along it, and it is crossed by vehicular bridges and pedestrian walkways.

L10. Form Prepared by: Michella Rossi,
     Cardno ENTRIX,
     701 University Avenue, Suite 200
     Sacramento CA 95825

L11. Date: 10/31/2012
Feature 1 is a two tiered abandoned concrete weir or flow control structure with metal screens and rebar visible on the lower tier. There is a small concrete foundation with a water pump directly east of the feature. Feature 1 is located on the south side of the canal near the concrete bridge at Blair Road. The walls of the top tier are 5 1/2 inches thick, 9 feet 4 inches in length, 9 feet 1 inch in width and 1 foot 9 inches in height; and the walls of the bottom tier are 5 1/2 inches thick, 9 feet 4 inches feet in length, 8 feet in width, 4 feet in height; and are spanned by 8 inch wide concrete beams.
Feature 2 consists of two concrete sidewalls located on the north and south sides of the canal. The sidewalls are 10 inches thick, 10 feet 9 inches in length, and 3 feet in height. The purpose of the walls is uncertain, but they may have been associated with a pedestrian walkway that was formerly located across the canal.

Photo 78: View of Feature 2 facing north

Feature 3 is a concrete side wall and or a fragmented foundation located on the north side of the canal behind 2281 Blair Rd. Feature is 4 inches thick, 6 feet 8 inches in length, 6 feet wide, and 3 feet in depth. The function of the wall/foundation is uncertain.

Photo 57: View of Feature 3 facing northwest
Feature 4 is a concrete block flow control structure with a wood plank at the edge of a concrete slab that is flanked by concrete and stacked tabular stone side walls held in place with mortar. The stone sidewall on the north side of the canal is 3 feet in length and 2 feet 5 inches in height; the concrete sidewall on the north side of the canal is 3 feet in length and 2 feet 5 inches in height; each concrete sidewall on the north and south side of the canal is 14 feet in length and 3 feet in height; the center beam crossing the canal is 8 feet in length, 2 feet in width, and 3 inches thick. Feature 4 is located at the east end of the canal near Forebay.

Photo 44: View of Feature 4 facing northeast

Photo 60: View of Feature 4 facing northwest
Feature 5 is a previously identified and recorded as a concrete block gauge box associated with a Gauge House that was constructed in 1922-1923 (JRP Historical 7/30/2002). Feature 5 is used for flow control. The feature is constructed with wood beams and concrete block sidewalls and 3 concrete support beams. The 3 center concrete beams are each 4 feet 4 inches in length, 10 inches in width, and 10 inches thick; the sidewalls are 6 feet 4 inches in length, 8 inches in width, and 10 inches thick. Wood beams frame the concrete sidewalls and head gate. The Gauge House is wood. The feature is located at the east end of the canal near Forebay.

Photo 19: View of Feature 5 facing east

Photo 20: View of Feature 5 facing east
Feature 6 is previously recorded as engineering structure A17 that was constructed in 1922-1923 (JRP Historical 7/30/2002). Feature 6 is a concrete block gate structure with metal screens, concrete support beams and a overhead metal pulley. Feature 6 is located at the east end of the canal near Forebay, and is associated with a wooden Valve House. The sidewalls are 18 feet in length total, 3 feet 4 inches in height, and 9 inches thick. There are 3 center beams connecting the sidewalls that are 8 feet long, 9 inches wide, and 1 foot 6 inches thick.

Photo 04: View of Sidewall of Feature 6 facing north

Photo 06: View of Feature 6, canal, and the Valve House facing east
*Map Name: Pollock Pines Calif.  *Scale: 1:24,000  *Date of Map: 1993

- Feature 1
- Feature 2
- Feature 3
- Feature 4
- Feature 5
- Feature 6
- Forebay
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The forebay for a hydroelectric power system is the large body of water located just above the conduit intake that supplies water to the powerhouse penstock. The Forebay of the El Dorado Powerhouse stores water delivered from the El Dorado Canal at a location on Forebay Road near the town of Pollock Pines. The Forebay area consists of many related structures and buildings: an earthen dam, a spillway channel, and an intake structure, as well as several engineering structures and related buildings, including a Valve House, Gauge House, Sump House, Pump House, weirs, and a steel pipe conduit. Several of the structures, including the Pump House, Valve House, Gauge House and associated engineering structures were constructed in 1922-23 along with the reservoir dam. The spillway channel was constructed in 1939. The original Sump House was torn (See Continuation Sheet)
P3a. Description (continued):

down reconstructed from salvage materials in the 1980s. Several other buildings that were built at the time of the Forebay's construction have been removed, including warehouses and a cottage.

The Forebay dam is a rolled earth dam 836 feet long and 91 feet in height. It has a crest width of 15 feet and a bottom width of 516 feet, with an upstream slope of 3:1 and a downstream slope of 2 1/2:1. The dam was constructed with a steel sheet piling cut-off trench in the core of the dam because it was constructed with fairly pervious materials. It was also built with a core wall, of less pervious material extending a slight distance below the original surface of the ground. The concrete intake gate is built into the base of the Forebay dam on its north side and the outflow into the 60 inch steel pipe conduit is controlled at the Butterfly Valve House located at the downstream toe of the dam opposite the intake gate.

The Forebay spillway channel, shown in Photograph 2, is located at the opposite, or south end, of the dam from the intake. Constructed in 1939, this channel begins as a 20 foot wide, eight-foot high box channel constructed of poured in place concrete. The concrete section extends for 30 feet where the channel becomes a gunite lined channel 203 feet long. At the end of the gunite-lined section the channel enters a 72-inch diameter steel pipe 64 feet in length, which empties into a 10 foot long concrete outlet channel from where water is released downstream. The staff gauge for the spillway is located on a wood pier north of the spillway channel opening.

A small Valve House is located north of the spillway channel at the top of the dam and is shown in Photograph 3. Water stored in the Forebay Reservoir is released through this valve house to supply water users downstream in the vicinity of Placerville with irrigation and domestic water. Constructed in 1922-23, this 8 x 12 foot wood frame building has a wood foundation and a gable roof clad in corrugated metal. The walls are clad in shiplap siding, except for the bottom one-foot portion, which is clad in replacement horizontal wood siding. There is a plank door with a Z-brace on the north side, a wood frame window opening on the south side boarded over with plywood and a window opening on the west side boarded over with lap siding. A

West of the valve house water is released through what is known as engineering structure A17 (Photograph 3). The concrete structure sits at the beginning of the canal that serves the El Dorado Irrigation District Main Canal and was also constructed in 1922-23. This concrete gate structure has walls approximately three feet high with a metal A-frame structure with an overhead pulley system mounted on top. This concrete structure has several slide gates, and is used to install and remove fish screens from the canal. East of structure A17 the canal is lined with gunite, which has been eroded away in places. At this location the canal widens to approximately 20 feet. There is a metal pipe on the north bank of the canal that drains water into the canal from a sump house located below the toe of the dam.

West of Structure A17, approximately 100 feet down the canal is a Gauge House and Gauge Box that measures flows delivered to the El Dorado Canal water users downstream. The wood frame Gauge House is square in plan and has a wood foundation and a gable roof with exposed rafters clad in corrugated metal. The walls are clad in horizontal wood siding. There is a wood door with a Z-brace on the north side, a wood frame window opening on the south side boarded over with plywood and a window opening on the west side boarded over with lap siding. A
P3a. Description (continued):

cement Gauge Box is located directly south of the Gauge House on the canal. This structure is approximately five feet wide and ten feet long and is constructed of board formed concrete. The metal spillway pipe crosses the canal approximately 30 feet downstream. At this location the canal is gunite lined, approximately 8 feet wide. The Gauge House and gauging box are shown in Photograph 4.

The Sump House, shown in Photograph 5, is located northwest of the valve house and Structure A-17, near the downstream toe of the dam. This 10 x 12 foot building has a wood foundation with an open floor and a gable roof with exposed rafters clad in composition roofing. The building is framed with 3 x 8 inch timbers and clad in plywood siding with battens. The building has no windows and has a wood door on the north side. The building was constructed of salvage materials in the 1980s. The function of this building is to collect and pump seepage water from the area below the toe of the Forebay Dam up into the El Dorado Canal.

There are five V-notch gauging weirs located below the toe of Forebay Dam. These weirs were constructed in the late 1970s and early 1980s to measure seepage flowing from beneath the toe of the dam. A typical weir, 17D, is located south of the Sump House and is shown in Photograph 6. This weir is constructed of concrete filled cinder blocks that channel water over a metal plate with a gauge and V-notch at the center. The channel drains into a pool with two pipes on the south side, and continues downstream.

The northernmost structure on the downstream side of the dam is the Upper Butterfly Pump House, shown in Photograph 7. The rectangular poured in place concrete structure was constructed in 1922-23, and houses a butterfly valve (riveted steel blowout valve), from which the welded steel conduit originates to carry water to the El Dorado Powerhouse. There is a wood frame shed roof extension clad in corrugated metal with a corrugated metal roof on the south side of the building. The building has a flat concrete roof with openings covered with wood planks. There is an opening in the west wall from which the conduit extends from the building. The opening surrounding the conduit is covered with corrugated metal. There is a personnel door on the west side of the building.

The 60" steel pipe conduit extends from the Upper Butterfly Pump House and runs northwest for approximately 2.3 miles to the Surge Tank. The final .6 miles to the El Dorado Powerhouse is covered with a thick gauged steel penstock capable of resisting the tremendous forces of the high velocity water delivered to the turbines below. The pipe is carried on steel saddles mounted on concrete sills. The conduit rests on an embankment bench that is generally 20 feet wide. This conduit replaced the original 60 inch wood stave pipe that ran from the Forebay to the Surge Tank and was constructed in 1922-1923 along with the Forebay and the El Dorado Powerhouse. The redwood stave conduit and its wood cradle were replaced in sections between the 1960s and 1977, except for a 785 foot section that was replaced in 1996. The newest sections of the conduit are composed of welded steel pipe, and the older replacement sections are constructed of riveted steel pipe.¹

Photographs

Photograph 2. Forebay Spillway Channel, camera facing southwest

Photograph 3. Valve House and Structure A17, camera facing southeast
Photographs

Photograph 4. Gauge House and Gauge Box, camera facing east
Photographs

Photograph 5. Sump House, camera facing southwest
Photographs

Photograph 8. Upper Butterfly Pump House, September 1923

Photograph 9. Panorama of the Forebay, September 1923
Photographs

Photograph 6. Typical Weir, camera facing north

Photograph 7. Upper Butterfly Pump House, camera facing north
Sketch Map
HISTORICAL OVERVIEW AND SIGNIFICANCE EVALUATION OF THE EL DORADO CANAL, EL DORADO COUNTY, CALIFORNIA

CONFIDENTIAL SITE RECORD
CA-Eld-511-H

VOLUME 2

A. GLENN CARUSO

CARUSO-CULTURAL RESOURCES MANAGEMENT
48 SAN FELIPE WAY
NOVATO, CALIFORNIA  94945

JUNE, 1990
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Evaluation of the El Dorado Canal, Eldorado County, California by Laurence H. Shoup, Archaeological/Historical Consultants

**Volume 2:** Confidential Site Record by A. Glenn Caruso, Caruso-Cultural Resources Management

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LEGEND

- AMERICAN RIVER GAUGING STATION
- ALARM STATION
- REMOTE AUTOMATIC SPILL GATE
- MANUAL SPILL GATE
- SEMI-AUTOMATIC SPILL GATE
- MILE POST MARK
- GOOD SPILLWAY - NO RESTRICTIONS
- POOR SPILLWAY - USE ONLY WHEN NECESSARY
- WOODEN FLUME
- INTAKES

A-DORADO CANAL

EL DORADO CANAL

A-Eld-511-H
ARCHAEOLOGICAL SITE RECORD

1. County: El Dorado

2. USGS Quad: Pollock Pines (7.5') X (15') Photorevised 1973
   USGS Quad: Riverton (7.5') X (15') Photorevised 1973
   USGS Quad: Kyburz (7.5') X (15') Photorevised 1973

3. UTM Coordinates: Zone 10
   Pollock Pines, 7.5':
   - End of Canal/Forebay; 710180E/4293675N
   - Canal due N. or Ditch Camp 5; 713120E/4293400N
   - Pacific House Tunnel, downstream end; 716005E/4292330N
   Riverton, 7.5':
   - Esmeralda Tunnel, downstream end; 718375E/4292925N
   - Plum Creek Siphon, downstream end; 722540E/4293265N
   - Alder Creek Siphon, downstream end; 727580E/4293540N
   Kyburz, 7.5':
   - Alder Creek Siphon, upstream end; 728140E/4293645N
   - Canal at junction of Carpenter Creek; 732640E/4293305N
   - Intake; 733040E/4293895N

4. Township 11N Range 12E ; section 25
   Township 11N Range 13E ; section 25,29,30,31,32,33,34,35,36
   Township 11N Range 14E ; section 25,26,27,28,29,30,31,32,35,36
   Township 11N Range 15E ; section 29,30,31,32
   Base(Mer.) Mt. Diablo

5. Map Coordinates: _______ mmS _______ mmS(from NW corner of map)

6. Elevation: 3900 - 3786' amsl

7. Location: Immediately south and adjacent to the South Fork of the American River and State Hwy. 50. The diversion dam is located 1.2 miles west of the town of Kyburz. The canal terminates at the El Dorado Forebay, near the town of Pollock Pines

8. Prehistoric____ Historic X____ Protohistoric____

9. Site Description: This site is a water conveyance system used for hydroelectric power and irrigation. Conceptualized by John Kirk in the late 1850's, full scale construction did not begin until 1868. The system was completed in 1873 by the El Dorado Water and Deep Gravel Mining Company. Western States Gas and Electric Company made major modifications to the system between 1922-1924, converting the system for use in hydroelectric generation. The system today is comprised of a diversion dam, open ditch (16.4 mi.), flume (3.75 mi.), tunnels (1.10 mi.), and pipes (.69 mi.). [See attached information.]
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10. Area: 21.93 miles (length)

11. Depth: NA cm Method of Determination: NA

12. Features: see attached

13. Artifacts: see attached

14. Non-Artifactual Constituents: NA

15. Date Recorded: December 20, 1987
16. Recorded by: A. Glenn Caruso

17. Affiliation and Address: PG&E, 77 Beale St., San Francisco, CA 94106

18. Human Remains: NA

19. Site Integrity: see Shoup 1988. Changes in this system have been continual and range from minor modification for maintenance purposes to major change such as the elimination of a stretch of canal with replacement by a siphon or tunnel.

20. Nearest Water: Type, distance and direction: site is a water conveyance system.

21. Largest Body of Water within 1 km (type, distance and direction): South Fork of American River; .1 to .5 km; south.

22. Vegetation Community (site vicinity): varies; Ponderosa Pine, Incense cedar, manzanita, cottonwood, cedar, black oak, dogwood, live oak, sugar pine, poison oak, grasses.

23. Vegetation Community (on site): same as above

24. Site Soil: mainly decomposing granite, friable, 7.5 YR hue, medium to coarse grain

25. Surrounding Soil: same as above

26. Geology: granitic bedrock underlies the soil; Sierra batholith

27. Landform: southern wall of South Fork American River canyon

28. Slope: 10-80 %
29. Exposure: north facing

30. Landowner (and/or tenant) and Address: PG&E, 77 Beale St., San Francisco, CA 94106; Eldorado National Forest, Placerville, CA.

Remarks: see attached.
### ARCHAEOLOGICAL SITE RECORD

| 34. Type of Investigation: | Resource evaluation. |
| 35. Site Accession Number: | NA Curated at: NA |
| 36. Photos: | yes; BW, rolls 1 - 7 Taken by: A. Glenn Caruso |
| 37. Photo Accession No.: | NA On file at: PG&E, San Francisco a |
Introduction

The supplemental information provided here is intended to elaborate on that which is provided on the standard site record. Information gathered during the course of the on-the-ground examination of the canal system was limited due to the complexity and size of this site. Additionally, the large volume of existing detailed drawings and historic, 1920’s era construction photographs greatly enhanced the field recordation.

For the purpose of this study, the El Dorado Canal is defined as the current working water conveyance system of PG&E’s El Dorado Hydroelectric Project (FERC 184). The canal system begins at a diversion dam on South Fork of the American River near the town of Kyburz (State Highway 50). The system ends 21.93 miles to the east (Pollock Pines) at the forebay to the El Dorado Powerhouse.

As an engineering feature, the El Dorado Canal is well documented. Engineering drawings exist for virtually every component of the canal and associated hydroelectric system since its reconstruction by Western States Gas and Electric (WSGE) in the 1920’s. Additionally, the PG&E archives hold four large volumes of photographs taken during construction by WSGE. A list of these photographs and records is on file at PG&E, San Francisco and at the Eldorado National Forest, Supervisor’s Office, Placerville.

As is the case with most hydroelectric systems, the El Dorado Canal has experienced nearly continual modification. These modifications are due, primarily, to maintenance and system upgrades. Both the physical location of the canal (on a steep mountain side subject to erosional slides) and severe winter weather have caused maintenance and modifications (both major and minor) to be a continual process.

Recordation Methodology

The entire length of the canal’s present configuration was walked by Glenn Caruso. The focus of the recordation was the operating system. Notes were taken on each of the various sections of ditch or flume with a microcassette recorder. Measurements were made with a small (3" diameter) wheeled (roll-a-tape) measuring device or were paced. Black and white photographs were taken of representative sections of standard flumes, rock walls, and ditches. Unique examples of flume, ditch, etc. were also photographed.
An attempt was made to locate the old ditch tenders camps and construction camps which had been located along the course of the existing system. In all instances, these camps have been demolished and little or no evidence remains.

The 1920's era reconstruction of the El Dorado canal included siphons at Alder and Plum creeks. These siphons eliminated long sections of the old flume and ditch (a total of approx. 15,000') as both creek canyons are quite deep. The access road into Camp 2, located at the Plum Creek Siphon, follows the course of the old canal. The rock walls along this route are spectacular due to their height (upwards of 30') and craftsmanship. The eastern side of this route was examined. The western side of the abandoned Alder Creek canal route was not examined as it is no longer a component of the current system.

The location of two ditch camps, camps 7 and 10 and the eastern side of the old canal route along Plum Creek, were examined by Larry Shoup and Suzanne Baker (November 1987). As with the other camps along the existing system, little remained at these camps. Camp 7 was difficult to relocate though early maps pinpointed its location. The probable location of this camp was found but no artifacts were located.

The flat where Camp 10 was located is about 20' wide and 100' long and at least a portion of it may have been cut out of the hillside. The flat is very grassy and overgrown, obscuring the ground surface. There appears to be either a spring flowing above the flat or a leak in the pipe buried in the ditch which has caused this area to be so overgrown. There are only a few artifacts visible; it is possible that the heavy vegetation covers other cultural materials. Observed artifacts include:

- a probable stove pipe fragment;
- a sanitary seal can;
- a burned vertical post (5 X 4"), with 10 cut nails and 11 wire nails visible;
- a burned vertical post (4 X 4") with 4 wire nails visible;
- three burned beams lying on the ground; and
- two pieces of light green bottle glass.

Flumes

A total of 43 flumes are utilized in the current system. These flumes can be characterized by the following types (or combinations) based on their means of support:

- Flumes founded on soil/natural ground
- Flumes founded on rock walls
- Flumes elevated on trestles
The shape of this system's flumes are unique because of their trapezoidal design (see drawing 8). The two side walls of the flumes slope inward. The purpose of this modification on a standard box flume is to facilitate the de-icing of the flume during winter. It was found (as previously constructed and operated between 1868 -1923), according to Dave Buel (1987), that the straight walls of a box flume were too difficult for the flume tenders to adequately and easily remove the ice which forms on their interior sides. In the newer trapezoidal design, as the water level rises, the winter ice tends to separate from the sides and float downstream.

The shape and method of construction of the flumes has changed little since the 1920's. Minor modifications have been made from time to time. An example is the walkway which now borders either side of the flumes. The original walkways were suspended over the middle of each flume. In addition to moving the walkways to the sides, handrails have been added for the safety of the flume tenders.

It appears that sections of flume are used when either soil instability or the steepness of slope are a factor. Flumes have also been used to replace old sections of ditch after a hillside slumped, often causing an outage in the system.

During the lifetime of a flume, repairs are made in order to provide it some longevity. Typically, the first series of repairs to a flume, in order to prevent major leakage, is to patch the seams of boards which are leaking. These repairs can be made with either a mastic and/or metal patch. At some point in time a flume may be so prone to leaks, although structurally sound, that either relining or adding an overlay lining to the entire flume or individual section becomes necessary. Marine plywood is now used for an overlay lining, extending the life of the flume 10 - 15 years. At a point where the effectiveness of the plywood is degrading, mastic is once again used to seal any place of leakage. The joints between sheets of plywood is a common problem area which often receives a seal. Often times the joints at the bottom of the flume in the corners (where the two sides and bottom portions join) are sealed with strips of sheet metal and mastic.

As was noted earlier, ice is a particular problem of flumes since air is able to circulate underneath. A recent attempt to solve this problem has been made. Complete lining of the flume with sheet metal has been tried. According to Dave Buel (1987), the sheet metal has not been a satisfactory solution because the high sand content in the water wears the sheet metal thin in only a few years. Also, metal conducts cold better than wood and thus more ice builds in these sections.
Other factors have been fatal to various sections of flume. One of the more interesting stories is a section of Flume No. 46 which was destroyed when a truck lost its load of logs on a road above the flume (Buel 1987).

[see drawings, pg. 46 - 56]

**Ditches**

Ditches vary greatly as to their size and type of construction. The various forms of ditch construction are as follows:

- gunite on the berm side (including approx. 2' on the bottom) with nothing placed over the up-slope side.
- fully gunite lined.
- preformed sections of gunite ditch lining.
- gunite on the berm side with boards on the up-slope side.
- gunite on the berm side with rock walls on the up-slope side.
- concrete "box" lining.
- concrete "L" walls.

At present, all but the last section of ditch (between the end of the Fourteen Mile Tunnel and the Forebay) have been sprayed with gunite (concrete) on the downslope or berm side. This last section has high embankments on both sides of the canal and has no potential for failure, a major reason to gunite an earthen ditch.

Of particular note is the preformed gunite ditch lining. Construction camps were established for the special purpose of manufacturing preformed gunite ditch linings. Gunite was sprayed on metal forms which were then brought to the canal and lowered in place by specially built derricks. The ends of the metal screen were left exposed at each end of the preform. These were then tied to the adjoining preformed sections and then the seam was sealed with cement.

Modifications to the various sections of ditch are numerous. Several sections of either sprayed in place gunite or preformed lining sections which have been removed, have been disposed of (usually buried) along side of the ditch. These sections were replaced for various reasons. Sections of preform have also been re-sprayed with gunite. Boarded sections, usually those on the berm side, have also been sprayed with gunite. Other modifications include the building up of the berm side lip of the ditch. This has been accomplished with concrete blocks, concrete bags, concrete, and gunite. Also, various coatings such as cement, epoxy, and fiberglass have been used to seal and preserve the life of the gunite.
The boarded sections of ditch (panel boards) were placed in areas where a lining was found to be necessary in order to prevent the water from eroding away a hillside. Panel boards are cheaper to install than gunite. The boards are overlapped much like a roof shingle with the downstream board being placed under the upstream board. The 1920's reconstruction utilized 1" square rebar to support the boards. According to Dave Buel (1987), the pre-1920's ditch utilized round pipe for that same purpose. [see drawings, pg. 57 - 59]

**Spillways**

Every major drainage along the system has a spillway for releasing water from the canal. Water is released in either emergency situations, a break in the system for instance, during a planned outages when the system is de-watered (to allow access), to relieve high water during heavy rains, or to remove ice and snow in the winter.

Spillways are quite varied throughout this system. In general, however, each one has from 1 to 3 release gates. These are either operated manually or automatically. Original 1920's era spillways were constructed with what was then called "automatic spillways." These spillway release gates were counterweighted so that the maximum flow did not open the gate. However, if additional water was to enter the system, the theory was that the weight of the water would open the gate. According to Dave Buel, old timers informed him that the system never worked very well.

Automatic spillways in the 1980's are opened hydraulically. Ten of these automatic spillways are radio controlled from the Vaca-Dixon Switching Center (Vacaville) on a 24 hour/day basis.

In addition to release gates, spillways often include sand traps. As the name implies, sand and small rock is trapped in a boxed depression in order 1) to keep sand and debris from entering the flumes and canals, 2) to keep the El Dorado Forebay from becoming filled with sediment, and 3) to prevent debris from entering the penstock and turbine.

Large, manually operated check dams are a part of several spillways. These check dams are lowered into either the flume or ditch in order to back-up the water to improve the discharge of water through the spill gates. In the winter, they are also used to raise the water level in a section of canal and help lift the ice from the sides.

Nearly every spillway includes a box flume chute. The purpose of this spillway chute is to prevent erosion in the natural drainage, especially near the canal where flume footings or a canal berm could be washed-out or undermined.

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Most spillways also include a shear board and removable spill boards. The sheer board lowers down into the top of the flume in order to deflect the freed ice to one side of the canal where it is spilled through an opening. This opening was created by removing portions of the flume called spillboards. Manually operated release gates have special sections on the top which can be opened separately from the entire release gate. Ice is then assisted out the gate by a flume tender.

Small housing structures have been constructed along the side of the canal to provide protection for the flume tenders during adverse weather. A wood stove and a supply of wood is kept with specialized tools (such as ice spades, pike poles, snow plows, spillboard pullers, and shovels) in these structures. [see drawings, pg. 48, 51, 55, 56, & 59]
The following is a description of the major features of the El Dorado Canal System. This description begins at the diversion dam on the South Fork of the American River and proceeds downstream to the end of the canal system at its juncture with the El Dorado Powerhouse Forebay.

**Diversion Dam**—a rock filled, timber crib structure which diverts water from the South Fork American River. The dam is located just downstream of the South Fork's confluence with the Silver Fork of the American River.
- The dam is covered with timber planks which appear to have been replaced recently. The crest length of this dam is 271' long. The dam is approximately 20' high. A cable suspension walk bridge spans the South Fork immediately downstream of the dam.
- [see drawings, pg. 42 & 44 for more detail.]

**Ditch Tender’s House**—a modern looking (built in 1964) house which is located on the north side of the river, adjacent to the dam and walkway. This structure is one of four now attended by PG&E employees.

**Intake structure**—a small house structure (concrete foundation, wood frame, metal siding) with slide gates and electronic control equipment for regulating water into the canal. This structure is located on the left abutment of the diversion dam. The metal control gates are at the canal level. The control valve equipment is housed above the gates.
- A fully automated spillway (No.1) is also integrated into this structure.
- [see drawings, pg. 44 for more detail.]

**Structure No. 1**—a board and baton structure measuring 32' long, 16' wide, and 12' high. The structure has a tin roof and is divided into two rooms. The structure has electricity, a wood burning stove, a refrigerator, and equipment for mixing and injecting copper sulfide into the canal for algae control. Snow shoes, bed frames, wood for the stove, and other tools are also found within the structure. The structure has been modified numerous times.

**Fish Screen**—the remains of this fish screen device are located approx. 40 yds. downstream of the intake structure. What remains of this structure is limited to the double-wide section of gunite.
lined ditch, 41' in length. A concrete pier is located in the middle of the ditch. A metal paddle-wheel-like device was placed in this location in an attempt to keep fish from entering the canal. Dave Buel (1987) was told by "old timers" that the fish trap never really worked.

- [see drawings, pg. 45]

**Flume No. 1** - a wooden flume 222' in length; last rebuilt in 1956. This flume sits, primarily, on the ground but a small trestle section was used over a small ephemeral drainage. This flume has been lined with marine plywood and has sheet metal strips covering the corners (at the junction of the two sides and bottom). This flume at one time had a chute to handle drain and leakage water. The spillway has been covered over (within the flume) but the box flume chute which dumps the water into the drainage still remains. In addition to the drainage, the flume crosses unstable soil which appears to have contributed to the decision to construct this flume (vs. using a ditch). [see drawings, pg. 49 for more detail of all flumes.]

**Flume No. 2** - a wooden flume 99' in length; last rebuilt in 1962. The flume crosses a small ephemeral drainage and is raised by trestle (3 - 5' high). This flume has been lined with marine plywood.

- A small box flume made of 2 X 12" boards feeds water from the Carpenter Creek drainage into the flume.
- A manual Spillway (No. 2) is located within this flume. The spillway leads to a typical timber flume chute structure.

- [see drawings, pg. 48]

**Spillway No. 3** - a concrete and metal, manually operated spillway. Two metal gates are located at the bottom of the spillway/flume. The gates are closed by concrete block counterweights. According to Dave Buel (1987), this type of spillway was designed to work automatically. The counterweight was set to allow for maximum flow. If the water level increased above maximum, thus increasing the weight on the gate, the gate was to open automatically. Dave stated that the "old timers" told him that the gates never worked well by themselves.

**Flume No. 2A** - a wooden flume 64' in length. The flume sits primarily on the ground. The flume was constructed in 1983 after heavy rains caused a slide to block the canal and damage the old gunite section. This flume crosses a seasonal drainage; water from the drainage can either be diverted into the canal or carried over the top of the flume and back into the drainage via a dam and small box flume and ditch. A gate on the small flume allows control of water to either the canal or back into the drainage.

- This flume replaced a section of ditch. Sections of concrete ditch lining which were removed are found adjacent to this flume. Unstable soil was probably the reason for the change from ditch to flume.
Flume No. 3- a small wooden flume, 109’ in length; last rebuilt in 1972. This flume sits on a short trestle.

Rock Wall within Ditch- just upstream of Flume No. 4 is an unusual rock wall which supports a section of ditch in an area of a drainage. It is also unusual in that it is a four layer, terraced/stepped rock wall and it is mortared. The rock wall is approx. 12’ in height and 32’ long. Each layer of this wall is made up of 3 courses of uncut rock. According to Shoup (1990), the 1870’s ditch was supported by numerous walls similar to this one.

Flume No. 4- a wooden flume, 399’ in length; last rebuilt in 1965. This flume is plywood lined. The flume is over an erosional area and over a large rock outcrop. A trestle (20-25’ high, 181’ long) is used in this rocky and erosional area. 

- Spillway No. 5 is manually operated and has an (freeboard screen) ice exit on the top 15" of the gates. The ice exit is a separate section which is covered with 3" wire mesh. The section has spillboards which can be removed for spilling water and ice if necessary. A small spillway chute, 3.5’ in length is attached to the gates.

- After a short distance on the ground, the flume resumes being supported by another trestle (6’ high, 85’ long). The remainder of the flume is on the ground.

Pipe- approx. 500’ downstream of Flume No. 4 is a 9’ high corrugated metal pipe. The pipe is 168’ in length and has a concrete cap. The pipe is in an area of a large earth slide. The pipe replaced a 52’ (linear feet[LF]) preformed ditch and 116’ LF flume. Both the bottom and sides of the pipe have been coated with gunite to assist in the free flow of water. The pipe was installed in 1983 and is designed to allow slide debris to pass over the top without affecting water flow.

Flume No. 5- this 313’ wooden flume, last rebuilt in 1968, sits mostly on the ground. A small section of trestle (3-4’ high) supports the flume over a small drainage.

Flume No. 6- this flume is 146’ in length; last rebuilt in 1966. The flume sits on the ground and is not plywood lined.

Flume No. 7- this 112’ long flume sits, except for a 30’ section of trestle, on the ground. It was last rebuilt in 1972.

Structure No. 2- this is a board and baton structure, 9.5’ X 14.5’ X 10’ high. The structure has a tin roof. Inside the building is a pot belly stove, tools, and wood for the stove. The floor is made of 2 X 12” planks nailed with round wire nails.

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Flume No. 8 & 9- this flume is 958' in length; last rebuilt in 1970. Two older flumes separated by ditch have been joined to form one continuous section.

-The flume begins on the ground but after 222' is supported by a section of dry-laid rock wall, 59' in length. The wall varies in height to a maximum of 6.5 feet. Seven courses of rock are needed for the 6.5' height. The first 21' of this wall is only one layer high.

-After a section of flume built on the ground, the flume is again supported by a rock wall. This rock wall is 51' in length and terminates at a large rock outcrop. This dry-laid rock wall reaches a height of 12-13' by use of 9 courses of large rock. The large rock is chinked with smaller rock.

-Spillway No. 7 is a manually operated with only one (3' wide) release gate. The gate has a section for ice removal on the top. This spillway begins 435' from the beginning of the flume.

-An excellent example of dry-laid rock wall begins just prior to Spillway No. 7. The wall is a maximum of 15' high (8 courses) and is 65' in length. [see drawings, pg. 60]

-Just beyond (116') the last rock wall is another rock wall 76' in length. This rock wall begins and ends at a rock outcrop. The wall has a section which is 11' high (7 courses) but is generally only 4.5' high (4 courses).

-The last 200' of flume are newly rebuilt (around 1970) in an area of a slide.

Spillway No. 8- this is a manually operated concrete spillway. The release gates are counterweighted with concrete block. The gates release water into a wooden spillway chute.

Flume No. 10- this flume is 954' in length and is plywood lined. Sections of the flume were last rebuilt in 1965, 1966, and 1973. Sika-Flex caulking has been used to seal the joints of the plywood overlay lining. Aluminum sheet metal has been used to patch several holes or areas of leaks.

-A dry-laid rock wall begins 423' beyond the beginning of the flume. This rock wall is not well built and is in poor condition. The wall is a maximum of 5' high (5 courses).

-Another dry-laid rock wall begins at 585' beyond the beginning of this flume. This wall is also poorly built. The rock used is a poor grade. The wall is 3' high (3-4 courses) and is 60' in length.

Concrete "L" Wall- approx. 500' beyond Flume No. 10 is a newly replaced section of ditch in an area of earth movement (slide). The "L" wall (or cantilever retaining wall), as it is called, is a 166' long and was built in 1983. The wall and ditch are made of steel reinforced concrete and resists the saturated earth pressure up-slope of the canal. The wall is so named because the interior or up slope side of the ditch is a vertical wall with an
attached bottom which supports the area of the slide. It also has a French drain under the floor to handle leakage from the canal and to reduce floor ground water originating from the hillside up-slope of the canal.

**Spillway No. 9**—a manually operated spillway similar in design and size to Spillway No. 8.

**Flume No. 11**—a wooden flume 307' in length; last rebuilt in 1970. The first 95' of this flume is supported on a large rock outcrop.
- The next 55' of flume sits on a pseudo-rock wall. The majority of the wall is only one course high with an occasional area having a second course. Within this 55' of wall, several gaps in the wall occur.
- Forty feet beyond the last rock wall is another rock wall 116' in length. This rock wall is not well built, this partially due to the poor and angular quality of the rock.

**Flume No. 12**—a wooden flume 104' in length. This flume is in relatively good shape and is not lined with plywood. The flume is in an area of a washout and sits on a short (2-4' high) trestle for its entire length. Originally built in 1971.

**Structure No. 3**—a recent wood framed, corrugated metal structure used to store a canal boat and equipment. This structure is 25' upstream of the beginning of Flume No. 13.

**Flume No. 13**—a wooden flume 324' in length.  
- **Spillway No. 10**—this is a fully automatic and remotely controlled spillway. The spillway sits on a trestle over a large creek gorge. This spillway is comprised of a metal canal check dam, a sand trap, double spill gates, an ice dam and associated release gate.  
- A **Standby Shack** is adjacent to the spillway. This structure is of board and baton construction with a metal roof. The upstream portion (6.5' X 8' X 9' high) of the structure is enclosed and contains a wood stove. Attached to this is a open structure (16' X 6.5') which allows the flume tender to work the various spillway equipment and stay out of the weather.  
- A dry-laid rock wall begins 105' beyond the beginning of the flume. The wall is 191' in length and is a maximum of 3.5' high (4 courses of rock).

**Alder Creek Siphon**—this siphon carries water over the large Alder Creek Gorge. The siphon replaced over a mile of flume and ditch. The old canal course can be readily seen from the siphon. This siphon was built during the 1920's reconstruction of the system. A board and baton structure houses the siphon opening and control equipment.

- [see drawings, pg. 62 for detail of old Alder Creek canal route]
Like the Plum Creek siphon, this siphon was originally a wood stave pipe (5’ diameter) on the down and up slope side. According to Dave Buel (1987), the wood stave pipe was replaced in the 1940’s with a 60” steel pipe which was buried. The span across the creek itself, according to Dave, has always been a riveted steel pipe. Because freezing of this span across the creek has always been a problem, the pipe has been recently insulated and wrapped in corrugated metal.

[Ditch Camp No. 1 is located on the north side of the canal. The house is a modest wood framed, aluminum siding structure which was built in 1971.

-A new buried steel overflow pipe (36” diameter) which runs parallel to the siphon on the north side and discharges into Alder Creek was built in 1987. This pipe replaced the old open channel spillway which caused some erosion damage by its use.

-A vehicle access ramp has been built at the outlet of this siphon. Small jeeps are used during an outage to service the canal.

Alder Creek Diversion Dam and Feeder- a cemented rock diversion dam with associated metal pipe (18” diameter) feeder. Water is diverted from approx. one mile up Alder Creek and is fed to the Alder Creek Siphon.

-The diversion dam has a crest length of 70’ and a maximum height of 9.5 feet. A 24” section of manual spill boards releases water into the feeder pipe. The central portion of the dam is approx. 4’ lower in height than the two side abutments. Each abutment has a groove for the placement of boards to raise the level of the dam to the height of the abutments. Repairs to the dam were made in 1986 following heavy rains and flooding which occurred in February. The repairs included replacing mortared rocks that were broken out on both the upstream and downstream faces of the dam with reinforced concrete. The downstream face was extended downstream for stability and was finished with rock placed on the outside face to recreate the original look. The grizzly and the gate operating mechanism were also replaced.

-The feeder pipe is an 18” steel pipe. The pipe follows the course of the old canal for most (75%) of its distance. The last section (nearest the dam) continues upstream of the old canal at a 10-15% grade. The steep hillside of this last section was minimally dug to provide a level surface for the pipe. It appears that the pipe was simply laid in the old ditch and flume way (predominantly on the up-slope side) of the 1870’s canal route. The pipe was then covered with dirt. In areas (30% of distance) a rubble rock wall (6” to 3’ high) was built to support the pipe. The walls are made of completely unmodified rock and are poorly constructed. The pipe is leaking badly in several dozen areas.
The 1870's canal route (east side of Alder Creek) appears to have been about 60% flume and 40% ditch. Only the unlined ditch banks and a few sections of rock wall remain. There are 5 sections of rock wall along the old canal route. The walls are:

1. -53' long, 3.5' high (3-4 courses), fair condition.
2. -43' long, 4-5' high (5-6 courses), interrupted by section of trestle, fair condition.
3. -326' total length;
   -35' long section, 2.5' high, fair condition.
   -116' long section, 4' high (2-3 courses of large rock), mostly fair condition, 13' is deteriorated badly.
   -175' long section, max. 16' high, poorly built, fair condition.
4. -53' long, 6-8' high, fair condition.
5. -148' total length;
   -100' long section, 6-8' high, fair condition.
   -48' long section, 3.5' high (2 courses), mostly collapsed.

The old crossing of Alder Creek was accomplished by using a flume elevated by a trestle. The flume crossing is approx. 40-50' above Alder Creek. Large rock walls (#1 above) were used on either side of Alder Creek to support the flume.

[see drawings, pg. 65 for more detail]

Flume No. 20- this wooden flume is completely lined with sheet metal and is 222' in length. Six sections of this flume were modified and rebuilt in 1984. The remaining sections were last rebuilt in 1949. The flume now leads into the new Slide Tunnel. A tall (approx. 25') rock wall supports a portion of the flume.

-[see Shoup and Salzman, 1983 for more detail of flume and rock wall prior to reconstruction]

Slide Tunnel- built in 1983-84 as a result of a massive landslide which created an unstable area along part of the old canal route. This tunnel is 3,619' long. The tunnel is 9' wide x 10' high and is horseshoe shaped. The tunnel is steel and concrete lined for about half of its length.

[see drawings, pg. 66 for more detail]

Flume No. 23- this flume is at the exit of Slide tunnel. A new portion (110' in length) of flume, rebuilt in 1984, connects with the older flume, rebuilt in 1949, which then crosses over Mill Creek. The flume is 569' in length.

-A large rock wall supports the flume at each side of Mill Creek. The upstream wall begins in the old canal course prior to joining the rebuilt flume. The wall varies in height, with a maximum height of 14 feet. A total of 133' of this rock wall are under the current configuration of this flume. The remainder of the wall follows the old canal course.

-[see Shoup and Salzman, 193 for more detail of flume and rock wall prior to reconstruction]
-Spillway No. 13 is a fully automatic spillway comprised of a metal check dam, hydraulically operated release gates and a removable spillboard section with ice release. This section of flume crosses Mill Creek and is supported by a trestle 12-15’ in height. This Spillway is operated from the Vaca-Dixon facility. Another rock wall is found at the end (downstream) of the trestle. This wall begins at a rock outcrop which has two courses of rock added to it. This poorly constructed wall reaches a maximum height of 4.5 feet. The last 80’ of this 138’ long wall is a single course of rock, approximately 12” in height.
-A small trestle 41’ in length begins at the end of the last rock wall. The trestle varies in height from 3-5’.

Flume No. 23A- this wooden flume is 137’ in length; rebuilt in 1949. The flume is in an area which is dug out. This dug out area gives one the impression that the flume has replaced a section of ditch. This flume sits entirely on the ground and is plywood lined.

Flume No. 23B- this flume (rebuilt in 1949) is 74’ in length and is plywood lined. The flume is built over an area of an ephemeral drainage. A trestle 1-3’ in height is used the entire length of this flume.

Flume No. 24 & 25- this wooden flume is 1401’ in length; rebuilt in 1949. Like Flume Nos. 8 & 9, this flume is an amalgamation of two older flumes which were probably separated by a section of ditch. The flume is plywood lined and has sheet metal strips placed over the two juctions of the sides and bottom.
-The first 36 feet of flume is on the ground and is followed by a trestle (3-5’ high) 59’ in length. This trestle is followed by a section of flume which is founded on the ground (115’ in length). This section of flume is then followed by a section of trestle which is 36’ in length and 3-5’ high.
-A one course layer, rock wall follows the trestle. The wall is 12-15” in height and is 95’ in length. Following the single course of wall, the rock wall then enlarges to 13-14’ maximum height (12-14 courses). This taller section of wall is only 14’ in length.
-After the rock wall, the flume is founded on the ground for a distance of 126 feet. This section is followed by a section of trestle 2-3’ high and 69’ long. The flume is then founded on the ground for an additional 29 feet.
-The next section of rock wall is 87’ in length and primarily 2-2.5’ (2 courses) in height. A small section in the middle of this wall reaches 8’ in height (7 courses). This section of wall is followed by a section of flume founded on the ground (93’ in length).

-26-
The next section of rock wall is an excellent example of fine workmanship. This wall is 352' in length. The first 192' of wall is 8-9' high (8 courses). The wall then tapers to 1-2 courses (1.5-2.5' high) for a distance of 58 feet. This section is followed by a section 3.5' high (4 courses - 52' long) which is followed by a section 4.5' high (5 courses - 50' long). This rock wall ends at a large rock outcrop.

The remainder of this flume is then founded on the ground.

Structure No. 4- a board and baton constructed building which measures 14' X 12' X 10' high. This structure is located approx. 750' downstream of the end of flume no. 24 & 25. The structure contains a wood stove and canal maintenance type tools. The building has been repaired several times with materials different than the original. This structure is in the location of old Camp S. This building was constructed in the early 20's. This was a site for building pre-form sections of gunite ditch.

Flume No. 26- this wooden flume is 218' in length; rebuilt in 1973. A manual spillway is located 60' from the beginning of this flume. The spillway has had sheet metal placed over the lower portion of the gate and does not appear to be functional. The top portion of the gate is an operational ice release gate. This spillway is not numbered.

Pipe- this pipe is 126' of corrugated metal, 9' in height. The pipe has a concrete cap. This pipe is in an area of an earth slide. The pipe is quite recent, 1984. The pipe was built so that the slide would go over the canal. There is a French Drain in this section. The pipe is identical to the pipe between Flumes 4 and 5.

Aluminum Arch Pipe- this corrugated pipe is 296' long. The pipe is 15'/7" wide and 10'/2" high. This pipe is also quite recent (1986) and in an area of a slide. This pipe was also constructed so that the slide would go over the canal. There is a French Drain in this section.

Flume No. 26A- this wooden flume is 144' long, is plywood lined, and was rebuilt in 1956. The joints of the plywood have been sealed with a black tar-like mastic. The flume sits on a trestle 2-5' in height.

Flume No. 27 & 28- this flume is 724' in length; last rebuilt in 1971. The flume is founded on rock wall, trestle and on the ground.

-Spillway No. 17 is a combination manual and automatic spillway. The first 6' is a set of manual spillboards with an attached wooden spillway chute (6' long). The automatic portion of this spillway has a metal check dam, sand trap, and two hydraulically
controlled release gates. The automatic portion can be radio controlled from the Vaca-Dixon facility.

-The first 375' of this flume are on the ground. This is followed by a section of 8' high trestle, 51' in length.

-At 507' from the beginning of the flume, a rock wall partially built on a natural rock outcrop supports the flume. The wall is a maximum of 3.5' high (4 courses). The remaining section of the flume is founded on the ground.

Rock Wall within Ditch- approx. 500' beyond the end of Flume No. 27 & 28 is a dry-laid rock wall on the up-slope side of the ditch. Rock walls used for interior ditch lining is quite unusual. This wall is 275' in length. The wall varies from 3-4.5' in height (4-6 courses).

Structure No. 5- this is a board and baton constructed building which measures 10' X 13' X 9' high. This structure is located 40' upstream from Flume 29. This building is currently used for maintenance purposes.

Flume No. 29- this flume, last rebuilt in 1950 and 1967, is 324' in length and has had plywood placed over the original lining. The joints of the plywood have been sealed with black tar/mastic. The flume sits on a short trestle (2-6' high) in an area of unstable soil.

Old Spillway- this abandoned spillway had, at one time, two counterweight release gates, a sand trap, a check dam, and a wooden spillway chute. The spillway has been sealed with gunite.

Flume No. 30- this unlined flume is 725' in length and is founded, primarily, on rock wall; last rebuilt in 1973.

- The first rock wall begins 59' from the beginning of the flume. The rock wall is 292'in length and 6-8' high (6 courses).

- Spillway No. 20 is located 283' from the beginning of the flume. This is a manual spillway with a single 4' wide release gate.

- At 339' past the beginning of the flume, a rock wall 7-7.5' high (large rock - 4 courses) supports a 4' high trestle. The rock wall is only 42' long at this height and is interrupted by a drainage for 12 feet. The wall continues an additional 45' as a single course (10-15" high).

Flume No. 31- this sheet metal lined (dated 9/24/85) flume is 312' in length. This flume is in an area of a major slide. The flume is founded on the ground. This flume was last rebuilt in 1969.

Flume No. 31A- this flume is 168' in length; last rebuilt in 1973. The flume is not lined and sits on a tall (18-20' high) trestle.
Spillway No. 20A—this is a fully automatic spillway just prior to the Plum Creek Siphon inlet. A check gate lowers into the canal causing water to backup and flow into a passive spillway. A recent wooden structure houses the control cabinet for this spillway. An attached "porch-like" structure provides the flume tenders with protection from the weather when operating the spillway. A sheer board for diverting ice and a manual spillgate are located adjacent to the structure.

Plum Creek Siphon—this siphon is similar in history and construction to the Alder Creek siphon. This siphon replaced a large section of ditch and flume which contoured around the Plum Creek drainage. The 5'5" redwood stave pipe has been replaced with a 60" steel pipe. The building over the siphon inlet is relatively recent as indicated by new lumber and corrugated metal siding and roofing.

- [see drawings, pg. 64 for more detail on siphon structure.]
- The old canal-way is used as an access road to this siphon and Ditch Camp No. 2. Large rock walls (some upward of 20-30' high) are found at a large portion of the access road. The rock walls are in excellent shape. It appears that most of the old canal which contoured around Plum Creek was flume, based on the amount of rock wall. Many long and tall rock walls can be seen on the other side of the Plum Creek canyon.
- The siphon pipe outlet is a concrete section of ditch. Metal lined slots over the mouth of the outlet are used to board-up the siphon if necessary during maintenance activities.
- Adjacent to the outlet is a gate which measures 6'(high) X 3' (wide). The gate frame is made of concrete and has metal guides for the 3 X 12" boards which form the gate. The gate, at present, is not functional and is filled with dirt. This gate was probably used for the old section while the siphon was under construction.

Ditch Camp No. 2 is located on the south side of the flume. The building is quite recent (2-3 yrs. old).
- [see Supernowicz 1985 for detailed recordation of the old structure which was removed from this camp.]
 [see drawings, pg. 76 for more detail].

Structure No. 6— a board and baton structure at the outlet of the Plum Creek Siphon. The structure measure 23' X 10' X 12' high. A 3' X 10' covered porch is attached. There are four windows in this structure. Inside the structure: wood stove, tools, bench. The structure has a metal corrugated roof. Plywood has been placed over the original planked flooring.

Old Spillway— this abandoned spillway is located 150 yards downstream of the Plum Creek Siphon outlet. This is a typical counterweighted release gate made of concrete and steel. Concrete or gunite has been placed over the old release gates.
Rock Wall within Ditch - this rock wall begins about 25 yards past the old spillway. The wall is approx. 5' high and 25' long. The rock is dry-laid and uncut rock. The wall prevents the cut slope from eroding into the ditch. The wall is in fair condition.

Rock Wall within Ditch - this rock wall begins approx. 300 yards downstream of the previous rock wall (500 yards downstream of the Plum Creek Siphon outlet). This wall is in good shape although there are some short sections which are deteriorating. The wall is 3.5-4.5' in height (4-5 courses of rock) and is 175' long. As with the previous wall, this wall prevents the hillside from eroding into the ditch. This wall ends at a seasonal drainage.

Flume No. 38 - this wooden flume is 202' long; last rebuilt in 1950. The flume has been plywood lined and the joints of the plywood have been sealed with the black tar/mastic. The flume is built in an erosional area and sits, predominantly, on a 3-5' high trestle.

Flume No. 39 & 40 - this wooden flume is 518' in length; last rebuilt in 1951 and 1961. The flume has been plywood lined and the joints of the plywood have been sealed with black tar/mastic.
- The first 50' of this flume are founded on a 6-8' high trestle then it continues on the ground. A second section of trestle is located 275' downstream of the beginning of the flume. This section of trestle is also 6-8' high and is approx. 120' long. The remaining sections of the flume sit on the ground.
- Spillway No. 22 is located on the second section of trestle. As with all spillways, this spillway is located at a drainage. This spillway has one section of manual spill boards with an attached wooden spillway chute. A 6" plastic pipe diverts water out of the drainage and empties into the flume at this location.

Concrete Box Section - this feature of the system is a 170' long, poured concrete section of open ditch. The down-slope wall of this feature is 7-8' high.

Flume No. 41 - a plywood line wooden flume 692' in length; last rebuilt in 1948. The plywood joints of this flume has been sealed with black tar/mastic.
- The first 210' of this flume sits on the ground.
- A rock wall then supports all (447' in length) but the last 35' of the flume. The wall is well built from uncut rock and is dry-laid. The majority of the wall is 6-8' in height.
- Spillway No. 23 is an automatic, radio controlled spillway. This spillway has two hydraulically controlled release gates at the bottom of the flume and a sand trap. Just prior to the automatic gates is a section of manual spill boards on the side of the flume.

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Rock Wall within Ditch - this dry-laid rock wall is located 75 yards downstream from the end Flume No. 41. The wall is 3.5-4' high (3-4 courses of rock) and is 410' in length.

Rock Crusher Boat House - this structure is located approx. 800' beyond the end of Flume No. 41. The structure is recent and is made entirely of corrugated metal (including roof). The structure is 8' X 15' X 12' high.

Old Platform - this is a wooden structure which appears to be a platform or foundation. This feature is located 450 yards downstream of the Rock Crusher Boat House. The structure rests on the berm of the ditch and measures 16' X 9' and is 8' high on the downslope side. The structure is made from 6 X 8" milled lumber. This platform was used during the reconstruction of Flume 42 and 43. Plywood was brought in and stock-piled.

Flume No. 42 & 43 - this is a plywood lined, wooden flume; last rebuilt in 1948. The flume is 432' in length. The joints of the plywood are sealed with black tar/mastic.
- The first 240' of the flume sit on the ground except for a 40' section of 4-5' high trestle.
- A rock wall begins at 240' from the upstream end of the flume. The wall is only 15' long and 2-3' high.
- The rock wall then joins a trestle which is 6-7' in height. This trestle is 67' in length.
- A rock wall supports the remainder of the flume. The wall is less than 12" high in most areas and is constructed of a single layer of large rock.

Flume No. 44 - this flume is plywood lined and 473' in length; last rebuilt in 1943 and 1948. The joints of the plywood have been sealed by black tar/mastic.
- The flume has three sections of trestle; the first section is 4' high and 100' long; the second section is 20' in an area of a slide and 200' long; the last section is 6-7' high and 50' long.

Flume No. 45 - this flume is 1942' in length; last rebuilt in 1948 and 1968. The flume is plywood lined and the joints of the plywood have been sealed with black tar/mastic. The flume is supported by various means:
- 0 to 42': flume on ground.
- 42 to 96': rock wall - well built; maximum of 4' high (5 courses); dry-laid, uncut rock.
- 96 to 160': flume on ground.
- 160 to 248': rock wall - well built dry-laid, large, uncut rock; 3.5 - 4' high (5 courses).
- 248 to 306': flume on ground.
- 306 to 565': rock wall-dry-laid, uncut rock; this wall is unusual in that it is 4-5' away from flume (vs. the usual 1-2'); the wall is 9-10' high and is made of large rock; wall tapers to 3' high at end.

- 565 to 616': rock wall-continuation of previous wall but is only 10-15" high (1 course).

- 616 to 735': trestle-on sloped ground; 6' high.

- 735 to 776': rock wall-single course of dry-laid rock; last 5' is 8-9" high (5 courses).

- 776 to 809': trestle-on sloped ground; 10-12' high.

- 809 to 1360': rock wall-dry-laid, uncut, large rock; 8' high at beginning, tapers to 2' high; height varies.

- 1360 to 1383': trestle-built to replace collapsed rock wall; trestle is scabbed-in.

- 1383 to 1449': rock wall-dry-laid, uncut, large rock; 2-3' high.

- 1449 to 1464': trestle-built to replace collapsed rock wall.

- 1464 to 1592': rock wall-dry-laid, uncut rock; maximum of 22' high; well built, excellent example.

- 1592 to 1942': trestle-varies in height from 4-8 feet.

- Spillway No. 25 is located at the end of the flume. This spillway is manually operated and includes a metal check dam, two release gates and a spillway chute (8-10'). The check dam has removed. A fire in 1987 destroyed this part of the flume and the check dam has not been replaced since.

Camp P- is located between Flumes 45 and 45A. A large rock wall along a wide spot in an access road is all that remains of this camp. The rock wall supporting this area is dry-laid of uncut rock. The wall is 15' high and is crumbling at the ends. The access road was built in the 1860's for wagons hauling material to and from Virginia City.

Flume No. 45A- a wooden flume 155' in length; last rebuilt in 1973. The flume is supported by a short trestle for 95% of its length. This flume is unusual in that the ditch just prior and after the flume is lined with flume board. In 1989, a fiberglass coating was applied over this flume.

Rock Wall within Ditch- this wall begins 200' downstream of Flume No. 45A. The wall is dry-laid and is not in very good shape. The ends of the wall, in particular, are deteriorating. The wall is 40' in length and 4' high.

Old Spillway- this spillway is typical of others which have been abandoned. The concrete spillway has been sealed with gunite. This spillway is located approx. one-half mile downstream of Flume No. 45A.
Flume No. 46—this is by far the largest and most complex flume of the El Dorado Canal system. The flume is 3,339' in length and is supported by several long rock walls and trestles. The majority of the Flume is plywood lined. The joints of the plywood are sealed.

-Camp 3 is located along Ogilby Creek and at the access road to this flume. Little remains of this camp. The camp was demolished by PG&E several years ago. What remains are two terraced areas; one area has two leveled pads and the other has only one leveled area. According to Dave Buel (1987) the upper area was the location of two bunk houses for the flume tenders. Some debris from these structures can be seen in three bulldozed piles. No trash scatters were located.

-A low rock retaining wall supports the pad closest to the flume. The pad closest to the flume and with the rock retaining wall measures 20 X 40' while the other pad measures 20 X 35 feet. These pads have been cut out of the steep hillside. Three large piles of bulldozed debris are located at the access road end of the pad closest to the flume.

-A smaller pad is located adjacent to the location of the main ditch tenders house. This pad is 10 X 25' and is supported by a wood retaining wall (flume boards) 4' high and 16' long. The area of the main ditch tenders house is now a wide spot in the access road to the flume. A wood picket-type fence and a 32' long retaining wall (6' high) is located adjacent to the house location in the last bend in the access road.

[see drawings, pg. 75 for more detail]

-The Ogilby Creek Diversion is unique in that a small ditch and flume system have been developed to feed the main system. A natural rock diversion dam was constructed up the creek and adjacent to Camp 3. The water is then carried in an unlined ditch (170' long) to a wooden diversion structure. This diversion structure allows water to be directed either back into Ogilby Creek or into the main system. The ditch continues an additional 65' until it reaches a box flume arrangement. The ditch varies in width between 3 - 10 feet. The box flume is 27' in length, plywood lined, and is 2'8" wide and 1’11” high. A portion of this flume is supported by a small trestle.

-Spillway No. 27 is a fully automatic spillway (which was rebuilt in 1989). The spillway sits on a tall trestle (20' high) over Ogilby Creek. Included in this spillway: metal check dam, two hydraulically operated release gates, ice sheer boards, two bays of manual spillboards with an ice release on top and a sand trap.

-A board and baton Flume Tender’s structure is located on the flume, adjacent to the spillway. This structure is 10’4" long, 7’6" wide and 10’5" high. The structure is open on the flume side. A wood stove, wood, and tools for de-icing the flume and operating the spillway are stored in this structure. The structure has a metal corrugated roof. The walkway along the flume passes through this structure. Rough cut (2 X 6") lumber
and round nails have been used to construct this station which
purpose is to provide shelter from the weather to the flume
tender while operating the spillway.

Flume No. 46 is supported by a series of rock walls and trestle
with intermingled sections of flume founded on the ground. The
following is a description of the rock walls and trestle
supported flume beginning at the upstream end:

- Rock wall: 45’ long, 3’ max. height; dry-laid, not well built
  and is deteriorating.
- Trestle: 73’ long, 8’ max. height; bank on downslope side of
  flume gives the impression that the area has been dug out.
- Rock wall: 495’ long, 4-8’ high; dry-laid, fair condition.
- Trestle: 100’ long, 20’ high; over Ogilby Creek, Spillway 27.
- Trestle: 123’ long, 8’ max. height.
- Rock wall: 210’ long, 6-8’ high; dry-laid, fair condition.
- Trestle: 33’ long, 6-8’ high.
- Rock wall: 35’ long, 6-8’ high; dry-laid, fair condition.
- Trestle: 35’ long, 6-8’ high; replaces section of collapsed
  rock wall.
- Trestle: 10’ long, 6-8’ high; on top of partially collapsed
  rock wall.
- Rock wall: 115’ long, 6-10’ high; dry-laid, continuation of
  wall under the last section of trestle; fair condition.
- Rock wall: 110’ long, 4-6’ high; dry-laid, fair condition.
- Rock wall: 45’ long, 4-6’ high; dry-laid, poor condition.
- Trestle: 25’ long, 4-6’ high; dry-laid, poor condition;
  replaces section of collapsed rock wall. - Rock wall: 40’
  long, 3-5’ high; dry-laid, poor condition.
- Trestle: 10’ long, 3-5’ high; dry-laid, poor condition.
- Rock wall: 10’ long, 2-4’ high; dry-laid, poor condition.
- Trestle: 120’ long, 18-20’ high.
- Rock wall: 55’ long, 1.5-4’ high; dry-laid, poor condition.
- Trestle: 130’ long, 3-5’ high.
- Trestle: 28’ long, 3’ high; up-slope side on ground.
- Rock wall: 33’ long, 2.5-3’ high; dry-laid, fair condition.
- Rock wall: 35’ long, 3’ high; dry-laid, fair condition.

A recent boat house is located at the beginning of this flume.
It is made of corrugated metal. A small iron beam extends out of
the boat house and over the flume to facilitate movement
of a boat into the canal.

**NOTE:** Since the time of the field recordation of this flume,
the entire flume has been rebuilt during a three year period,

Esmeralda Tunnel- a 1520’ long tunnel built in 1930 by Swedish
workers. This tunnel replaced a section of canal (ditch/flume)
probably because of unstable soil conditions. The tunnel is
partially lined at both ends on the bottom and partially up both
walls (3-3.5’) with the same boards used for flumes. The middle
one-fourth of the tunnel is unsupported. The remainder of the
tunnel is supported. The supports, called sets, are comprised of two side support "posts," a "header," and a "kicker." The sets are notched so that the kicker keeps the set together. The tracks used during construction remain in the tunnel.

Esmeralda Creek- a recently reconstructed (1986) diversion dam and "Lennon" style feeder flume. Small concrete dam and 4' wide, curved (half-round) metal "Lennon" flume (approx. 130' long) directs water either into the main canal or over the top of the canal and back into the natural drainage. Water can be directed into the canal via 2 sections of manual spill boards on the dam or 2 sections of manual spill boards in the metal flume.

Spillway No. 30- an old spillway which is now used for emergency use only. The spillway once contained a metal check dam which has since been removed. This spillway has a sand trap and large box flume chute spillway which exits released water into Esmeralda creek. Three hinged metal release gates are located on the vertical wall of the canal/spillway. These gates were once operated by a counterweight system that has been removed.

Old Camp 5- a ditch tender's camp. Nothing remains of this camp except for a cleared and bulldozed area. The site of the camp is at the southeast corner of the junction of the Hazel Creek road and the canal. This location was a camp during the initial period of the canal's use. A new camp downstream (Camp 4) was built to replace this aging camp. Informant Floyd Poole was born here.

-According to Dave Buel (1987), Swedish miners who dug the Esmeralda tunnel camped across the road from Camp 5. No evidence of this camp was found.
[see drawings, pg. 75 for more detail]

Old Spillway- an abandoned spillway is located 100' downstream from the Hazel Creek road crossing. The spillway is a concrete structure which has been covered over with gunite. It appears that this spillway had two release gates controlled by counterweights.

Camp 4/Spillway No. 32- little remains of this ditch tender's camp except for 2 terraces where structures once stood. A section of flume board, held up by 1" square rebar stabilizes the soil for each of the terraces. Spillway No. 32 is fully automatic. This spillway has a set of hydraulically operated (counterweights replaced) release gates, a metal check dam, and a spillway chute.

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**Flume 46A** - a short flume, 128' in length; last rebuilt in 1966. This flume is not plywood lined but does have a sheet metal strip over the bottom inside joints. This flume sits mostly on the ground and there is a small section of trestle.

**Spillway No. 33** - an older manual spillway with separate boards which are removed to operate the release gate. A box flume chute directs the released water into a drainage. This spillway once had the typical counter-weighted release gates.

**Old Spillway** - an abandoned spillway between Alarm Station 15 and John Roy's Boat House. This spillway has been boarded up and has had gunite shot over the boards.

**John Roy’s Boat House** - a recent building (16’X 8’X 10’h) of corrugated steel which is founded on concrete blocks/pillars.

**Flume 47A** - an older flume, last rebuilt in 1947, which has had marine plywood placed over the original boards. This flume is 201' long. The joints of the plywood have been repaired with black tar/mastic (roofing cement). The bottom inside joints have had aluminum sheet metal placed over them. This flume is in an area of an earth slide. The flume sits on a low trestle for half its distance.

-This flume has a peculiar feature. Two six inch diameter pipes come up and out of the flume and then bend 180 degrees. The pipes then proceed down a drainage. These pipes were used to siphon the water out of the canal when it reached a certain flow (165 cfs.). The siphon no longer works.

**Spillway No. 35** - a manual spillway with a diversion dam/gate, sand trap, and two release gates (only 1 is functional). The release gates are operated by counterweights. A box flume chute channels the water out into a small drainage.

**Pacific House Tunnel** - a small tunnel, 176’ in length. The tunnel is board lined on the sides and is supported by timber sets at the entrance and exit. The tunnel is lined with 1” X 12” boards for flow enhancement. The tunnel is approximately six feet wide and five and one-half feet high. This tunnel must have been built with the original 1870’s canal as there is no indication that the canal went around the small ridge which the tunnel by-passes.

**Flume No. 47B** - this flume is 128’ in length; last rebuilt in 1947. The flume is plywood lined. Sheet metal has been placed over the bottom joints of the flume. The joints of the plywood have been sealed with black tar/mastic. Except for a short trestle in the middle, this flume sits on the ground.
Old Spillway - a short distance (300’) downstream of Flume No. 47B is an abandoned spillway. This was a manually operated spillway with counterweighted release gates.

Spillway No. 37 - a fully automated spillway with hydraulically operated release gates (counterweights replaced) and a sand trap. A wooden spillway chute prevents erosion during release. A recent storage shed is adjacent to this spillway. The shed sits on concrete blocks and is made out of corrugated metal (roof and sides).

Spillway No. 39 - a small, older manual concrete spillway. The counterweighted release gates have been replaced with boards.

Spillway No. 40 - a manually operated spillway with two counterweighted release gates. Also a part of this spillway are a sand trap and a box chute spillway.

Flume No. 47 - a wooden flume 110’ in length; last rebuilt in 1945. The middle half of this flume is founded on a trestle 6-7’ high. The flume is plywood lined and has had the joints of the plywood sealed with black tar/mastic. A small box flume (24” wide X 12” high) is built into the side of the main flume. The small flume gathers water from a small tertiary drainage on the hillside.

Old Spillway - an abandoned concrete spillway is located 200’ upstream of Alarm station No. 17, near Old Carson Road. Gunite has been placed over the spillway to render it useless.

Flume No. 48 - this is a spectacular flume, last rebuilt in 1970, because it is on a steep hill which overlooks the South Fork American River Canyon. The flume, which is 448’ in length, is almost entirely supported by rock wall. Old highway 50 crossed the upstream end of this flume. The highway bed and a supporting rock wall still remain.

-Rock wall supports all but one section of this flume. The majority of wall is 7.5-8’ high (6 large courses of rock). Several short sections of wall are 12-14’ in height. These walls are dry-laid and chinked with small rock. Most of the wall is well made and in very good shape.

-A 48’ trestle (12-14’ high) is located at the downstream end of the flume.

-Spillway No. 42 is located at the downstream end of this flume. This concrete spillway has three hydraulically controlled release gates. A wooden spillway chute directs water out of the flume. A sand trap is adjacent to the release gates. This spillway also has a metal check dam and an ice sheer board and associated segment of manual spill boards. A recent board and baton style
flume tender's structure with metal corrugated roof is situated over the ice release gate.
-[see drawings, pg. 56 for more detail on this spillway.]

Ditch Camp No. 5- this is the current operational headquarters for this system. The camp consists of several offices, garages, sheds for equipment and supplies, a residence, and a heliport.

Old Spillway- an old abandoned concrete spillway is located adjacent to Ditch Camp No. 5. The spillway has been sealed with gunite.

Flume No. 49 & 50- this wooden flume is 1443' in length; last rebuilt in 1961, 1965, and 1971. The flume has been lined with aluminum sheet metal, except for the last 200 feet. The flume is founded (upstream end) as follows:

0 to 597': flume on ground.
597 to 630': trestle, 8' high.
630 to 711': flume on ground.
711 to 733': trestle, 8-10' high.
733 to 847': flume on ground.
847 to 900': trestle, 20-25' high.
900 to 915': flume on ground.
915 to 1025': rock wall; dry-laid, 3' max. height (1-3 courses); fair condition.
1025 to 1175': flume on ground.
1175 to 1195': Spillway No. 44
1195 to 1202': flume on ground; flume no longer lined.
1202 to 1301': flume on ground.
1301 to 1321': rock wall; poorly built wall, 4.5' high (6 courses); in a drainage.
1321 to 1336': rock wall; continuation of previous wall; trestle is supported by a dry-laid rock wall.
1336 to 1442': flume on ground.

-Spillway No. 44 is manually operated. This spillway has three release gates and a sand trap.

Flume No. 51- this wooden flume is unlined and 502' in length; last rebuilt in 1970.
-This flume has a section of rock wall which is 60' in length and varies in height from 4.5 to 7 feet.
-This flume is also supported by several sections of trestle which vary in height from 3.5 to 9 feet.
-A section of manual spill boards with box chute spillway is located at the downstream end of the flume.

Concrete "L" Wall- flume no. 51a was replaced (between 11/85 and 1/86) by a 300' section of "L" wall ditch. The whole area has been subjected to a landslide. The area has been bulldozed and planted.

-38-
Flume No. 52- this wooden flume is plywood lined and 180' in length; last rebuilt in 1947 and 1952. The bottom joints of the flume have been sealed with strips of sheet metal. Two sections of flume are supported on trestle, with the remainder being founded on the ground.
-One section of trestle is 17' in length and 3' high. The other section is 55 'long and 20' high.

Spillway No. 45- this is manually operated spillway. The release gates were once operated by counterweights, but they no longer function. There is a sand trap located adjacent to the gates. A box chute spillway conveys the water into a drainage.

Spillway No. 46- this is a section of manual spill boards which is designated for emergency use only. The release gates are now closed by boards but were once operated by counterweights. A sand trap adjacent to the release gates was recently (1987) shot with gunite. A box chute spillway conveys the water into a drainage.

Flume No. 52A- this wooden flume is 377' in length and was rebuilt in 1953. The flume sits entirely on the ground. The flume is plywood lined and the joints of the plywood have been sealed.
-Flume No. 47C is at the downstream end of this flume. It is a fully automatic, radio-controlled spillway. Two hydraulically operated gates (each 3' wide) are adjacent to a manually (boarded) release gate (6' wide). All three gates release into a single (21' wide), large box chute spillway. A modern, metal check dam is located downstream of the release gates. A recent flume tenders' structure is located adjacent to the spillway. The structure is 20 X 10 X 10' high. The last 4' of the length of this structure is an open area for wood storage. The structure has 3 metal corrugated sides and a metal corrugated roof. The side of the structure facing the flume is made of wood.

Fourteen Mile Tunnel- this tunnel is 477' in length and is 6.5' high and 6.5' wide. This tunnel was built with the original 1870's canal system. The tunnel is unlined except for the last 50' which is completely concrete lined. The upstream end of the tunnel has a grizzly (2" pipe grate) placed over it.
-At the downstream end of the tunnel, partially exposed timbers were noted in the stream bed. These may timbers used for a rail system used during the excavation of the tunnel. Dave Buel (1987) believes that the timbers were from a header box built to carry water around the forebay when it was built in 1922.

The last section of this canal system which leads directly into the El Dorado Forebay is completely unlined. The section appears to be a natural drainage; 25' max. height and 20' max. width.
REFERENCES CITED

Buel, Dave
1987 Personal communication.

Shoup, Laurence

Shoup, L. and S. Salzman

Supernowicz, Dana
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DIVERSION DAM EL DORADO CANAL
EL DORADO PROJECT
PACIFIC GAS AND ELECTRIC CO.
PLAN

PROFILE OF SPILLWAY PIPE

SIDE CHANNEL SPILLWAY AND PIPE

PLAN

SECTION C - C

SECTION B - B

OUTLET STRUCTURE

SECTION A - A

INLET STRUCTURE

PROFILE OF PLUM CREEK SIPHON

EXHIBIT L-10

PLUM CREEK SIPHON
EL DORADO PROJECT
PACIFIC GAS AND ELECTRIC CO.
TYPICAL SECTIONS OF UNLINED CANAL

TYPICAL SECTIONS OF LINED CANAL

TYPICAL SECTION OF COVERED CANAL

TYPICAL TUNNEL SECTIONS BETWEEN ALDER CREEK AND MILL CREEK

TYPICAL TRESTLE FRAMING

TUNNEL SECTIONS

FLUME SECTION

SECTION IN EARTH

SECTION IN ROCK

EXHIBIT L-8
EL DORADO CANAL - TYPICAL SECTIONS
EL DORADO PROJECT
PACIFIC GAS AND ELECTRIC CO.
### Archaeological Site Survey Record

**Site:** Plum Creek temp. # 8  
**Map:** Riverton CA 7.5'  
**County:** El Dorado  
** Township:**  
**Township:** J1N  
**Range:** 14E  
**South 1/2:**  
**UTM Grid:**  
**_zone:**  
**UTM Grid or Long & Lat.:**  
**Location:** Along and above both sides of Plum Creek canyon, between the P.G. & E flume/siphon and the road to ditch camp # 2.  
**Contour Elevation:** 3800'  
**Owner:** Eldorado National Forest  
**Address:** 100 Forni Road, Placerville, CA 95667  
**Present Tenant:** same  
**Description of Site:** This is a historic rock wall flume which runs approximately parallel to the So. Fork of the American River from Kyburz to Placerville. The flume is constructed of unmortared native rocks. It is approx. 7 ft. wide and (SEE CONT. 8)  
**Area Approx.:** 1 mile along both sides of Plum Creek  
**Depth average:** 10 to 20'  
**Vegetation:** Mixed conifer, scattered oak, manzanita  
**Nearest Water:** Plum Creek below, varying distances  
**Soil of Site:** N/A  
**Surrounding soil type:** geomorphic type: granitic canyon land  
**Previous Excavation:** unknown  
**Cultivation-Logging:** most wood has been "salvaged" and removed  
**Erosion:** unnumbered roads give access to either end of rock wall flume  
**Erosion light:**  
**Possibility of destruction:** uncertain. E.I.D. has mentioned plans for using the flume for a pipeline to carry water  
**Features (burials, house pits, etc.):** unmortared rock wall flumes, still standing wooden trestle (north side) over steep granite slope  
**Artifacts:** square and round nails, old cedar timbers may be found atop south side flume  
**Remarks:** This flume is an outstanding example of early construction technique using unmortared rocks and wooden trestles. The site is amenable to visitor interpretation, though some restoration, research, and maintenance are needed.  
**Published references:** unknown  
**Sketch map:** not yet  
**Photos:** yes, roll # 27  
**Recorded by:** Jim Heale & Jim Woodward  
**Date:** 6 Oct 1977  
**Continuation Sheet:** Yes  

---

*Revised, L. Goddard, 12/4/84*
<table>
<thead>
<tr>
<th>Item No.</th>
<th>CONTINUATION</th>
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<tbody>
<tr>
<td>23</td>
<td>from the proposed reservoir to a powerhouse or the PG &amp; E canal.</td>
</tr>
<tr>
<td>26</td>
<td>would be necessary to properly enhance this site as a self-guiding interpretive trail. At the southeast end of the rock wall flume some type of bridge must have existed connecting both sides of the flume. Both flumes terminate at about the same place. An impressive abutment rises (about 30 feet?) above the creek at the terminus of the flume on the north side. Again, this record should be regarded as only an initial cursory attempt at inventory.</td>
</tr>
<tr>
<td>12</td>
<td>3 ft. high. Flume gradient is less than .5%. In places, trestles bridge the flume over drainages. ***</td>
</tr>
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</table>

Recorded by Jim Heale & Jim Woodward

Date 6 Oct 1978

***Revised, L. Goddard, 12/4/84

R5-2700-31a (iss. 6/72)
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<td>Esmeralda Tunnel, downstream end</td>
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<td></td>
<td>2</td>
<td>AM</td>
<td>Spillway No. 30, chute</td>
<td>East</td>
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<td>Spillway No. 30</td>
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<tr>
<td></td>
<td>4</td>
<td>AM</td>
<td>Typical section of ditch, full gunite.</td>
<td>&quot;</td>
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<tr>
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<td>AM</td>
<td>Old Camp 5 location</td>
<td>South</td>
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<tr>
<td></td>
<td>6</td>
<td>AM</td>
<td>Old spillway across from Old Camp 5.</td>
<td>Downstream</td>
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<tr>
<td></td>
<td>7</td>
<td>AM</td>
<td>Section of boarded ditch lining</td>
<td>&quot;</td>
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<tr>
<td></td>
<td>8</td>
<td>AM</td>
<td>Boarded ditch lining showing</td>
<td>Upstream</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>AM</td>
<td>Overlapped boards</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>AM</td>
<td>Old mile post?</td>
<td>&quot;</td>
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<td>Spillway No. 32, Old Camp 4</td>
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<td>12</td>
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<td>Spillway No. 32</td>
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<td>13</td>
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<td>Old Camp 4 location</td>
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<td>14</td>
<td>PM</td>
<td>Flume 46A; underside</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>PM</td>
<td>New concrete ditch section</td>
<td>Upstream</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>PM</td>
<td>Old Spillway near John Roy's</td>
<td>&quot;</td>
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<tr>
<td></td>
<td>17</td>
<td>PM</td>
<td>John Roy's boat house</td>
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<td></td>
<td>18</td>
<td>PM</td>
<td>Flume 47A; pipes?</td>
<td>&quot;</td>
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<td></td>
<td>19</td>
<td>PM</td>
<td>Ladder for use of ice-boats</td>
<td>&quot;</td>
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<td>20</td>
<td>PM</td>
<td>Spillway No. 39; iron release gate</td>
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<td></td>
<td>21</td>
<td>PM</td>
<td>Flume 47; small box flume from feeder.</td>
<td>&quot;</td>
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<td>22</td>
<td>PM</td>
<td>Flume 47; board lined ditch</td>
<td>&quot;</td>
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<tr>
<td>11/21/87</td>
<td>23</td>
<td>AM</td>
<td>Sly Creek Rd.; County bridge</td>
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<td>24</td>
<td>AM</td>
<td>Highway 50 overpass</td>
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<td>AM</td>
<td>Concrete &quot;L&quot; wall connecting ditch</td>
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<td></td>
<td>26</td>
<td>AM</td>
<td>Flume 48; rock wall; trestle</td>
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<td>27</td>
<td>AM</td>
<td>Flume 48; rock wall; trestle replacing</td>
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<td>28</td>
<td>AM</td>
<td>Concrete &quot;L&quot; wall connecting ditch</td>
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<td>29</td>
<td>AM</td>
<td>Rock wall for Old Hwy. 50</td>
<td>West</td>
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<td>30</td>
<td>AM</td>
<td>Flume 48; upstream end; Old Hwy. 50</td>
<td>Upstream</td>
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<tr>
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<td>31</td>
<td>AM</td>
<td>Rock wall for Old Highway 50</td>
<td>West</td>
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<td>32</td>
<td>AM</td>
<td>Rock wall for Old Highway 50</td>
<td>West</td>
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<td>33</td>
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<td>Spillway No. 42; check dam and ice dam.</td>
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<td></td>
<td>34</td>
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<td>Recently rebuilt bridge 1/4 mile</td>
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<td></td>
<td></td>
<td></td>
<td>downstream of Camp 5.</td>
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### Archaeological Photograph Record

**Site #:** El Dorado Canal  
**Roll #:** 3

- **Camera:** Minolta SRT 101  
- **Lens:** 50 mm.

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<td>AM</td>
<td>Typical section of ditch</td>
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<td></td>
<td>36</td>
<td>AM</td>
<td>Stack of 6 tubs used during construction; Camp 5.</td>
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<td>37</td>
<td>PM</td>
<td>4 Mile House Tunnel, exit</td>
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## ARCHAEOLOGICAL PHOTOGRAPHIC RECORD

**SITE #: El Dorado Canal**

**ROLL #: 4**

**Camera** Minolta SRT 101  **Lens** 50 mm.

**Film Type** Plus-X Pan  **ASA** 125  **Page 1 of 1**

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<td>3</td>
<td>AM</td>
<td>Rock wall within ditch</td>
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<td>4</td>
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<td>Concrete box section of ditch, downstream of flume 39 &amp; 40.</td>
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<tr>
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<td>5</td>
<td>AM</td>
<td>Old platform?</td>
<td>East</td>
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<td></td>
<td>6</td>
<td>AM</td>
<td>Flume 45; rock wall</td>
<td>Downstream</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>AM</td>
<td>Flume 45; rock wall</td>
<td></td>
</tr>
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<td></td>
<td>8</td>
<td>AM</td>
<td>Flume 45; trestle scabbed-in at section of collapsed rock wall.</td>
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<tr>
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<td>AM</td>
<td>Flume 45; rock wall near Camp P</td>
<td></td>
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<td></td>
<td>10</td>
<td>AM</td>
<td>Camp P; rock wall supporting road</td>
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<td>PM</td>
<td>Flume 45A; board lined ditch</td>
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<td>12</td>
<td>PM</td>
<td>Rock wall within ditch, downstream of Flume 45A.</td>
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<td>Rock wall within ditch, used to protect bank from erosion.</td>
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<td>Plum Creek Siphon Inlet</td>
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<td>Spillway No. 20A</td>
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<td>Ditch Camp No. 2, new residence</td>
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<td>17</td>
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<td>Rock wall along access road to Ditch Camp No. 2, Plum Creek.</td>
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<td>Interior of Pacific House Tunnel</td>
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<td>PM</td>
<td>Section of ditch upstream of Pacific House Tunnel</td>
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<td>Canal Inlet Structure</td>
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<td>11</td>
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<td>North end of Diversion Dam</td>
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<td>Old Bridge footing in river</td>
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<td>Spillway No. 8; upstream side</td>
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<td>Preform canal joint</td>
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<td>Aluminum Arch pipe</td>
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<td>PM</td>
<td>Flume 27 &amp; 28</td>
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<td>Rock wall within ditch</td>
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**ARCHAEOLOGICAL PHOTOGRAPHIC RECORD**

**SITE #:** El Dorado Canal  
**ROLL #:** 7

**Camera:** Minolta SRT 101  
**Lens:** 50 mm.

**Film Type:** Plus-X Pan  
**ASA:** 125  
**Page:** 1 of 1

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<td>PM</td>
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**** FILM DESTROYED DURING DEVELOPING ****
ARCHEOLOGICAL SITE RECORD

Page 1 of

1. Permanent Trinomi: CA ELD - 511 - H

2. Common Name: El Dorado Ditch P-9-599-H

3. Forest Service No.: 05

4. Date Recorded: 6/28/83

5. Recorded By: Sally Salzman

6. Temp. No.: AC-55

7. USGS Quad: Riverton

8. Surveyed area: See attached

9. UTM Coordinates:
   - Zone: 10
   - Easting: SE ¼ of Sec. 27; SW¼ of Sec. 26; NE¼ of
   - Northing: NW4 of Sec. 35
   - Range: 14E
   - Township: 11N

10. Elevation: between 3840' and 3880'

11. Air Photo No.

12. Location:

    The portion of the ditch recorded during this survey runs west from
    the west end of the Alder Creek siphon (USGS-mapped in the NW¼ of
    the NE² of Sec. 35) along the contour of the steep north and northeast
    facing slope of the South Fork of the American River at about the 3860'
    elevation, for approximately one mile, to Mill Creek in Sec. 27. The
    ditch extends both westward and eastward for a number of miles and is
    shown on the USGS Riverton 7.5' quad as the El Dorado Ditch.

13. Site Description:

    A ditch and flume system, conveying water from the South Fork of the Amercian River westward,
    at approximately the 3860' elevation in the steep slope above the south
    side of the river. Ditch sections are splayed-U-shaped in cross-section, earthen, approximately 6' deep, 20' wide at top and 14' wide
    at base. Ditch is presently lined with gunnite for most of its ob-
    served length, but plank and/or masonite lining is also noted in some
    sections. Gunite lining was placed on top of original plank lining.
    The plank lining was comprised of milled 2x12s held horizontally in
    1 mile long x 25' wide (surveyed area); system is 22+ miles long.


15. Depth: __________ m Method of Determination: ________

16. Features:

    Feature 1: A small ditch running SE from near the west end of the Alder Creek siphon. It was traced SE
    at approximately the 3840' contour for about 750', out of the survey area.
    It is heavily overgrown and has been partially filled by slopewash and brush. Its greatest width at present varies from 6-10'. Depth is about
    4½'. The berm is approximately 8' wide at top. This may represent px

17. Artifacts:

    A few unidentified metal scraps and two square cut nails were
    noted along the ditch in the area surveyed, but no significant artifacts
    were recorded.

18. Non-Artifactual Constituents:

    Dry laid rock walls and timber structures as noted.
    Where flume support structure was not on rock wall, a rather level bed
    about 15' wide had been created for it.
ARCHEOLOGICAL SITE RECORD

1. Permanent Trinomial: CA ELD-511-H

3. Forest Service No: 05

5. Date Recorded: 6/28/83

6. By: Sally Salzman

Page 2 of _______

19. Human Remains: None

[ ]

20. Site Condition: System as a whole is essentially intact (as to route), although its function has altered from Gold Rush days. Ditch has been altered by addition of a succession of linings; flume and its structural supports have been repaired and [Excellent □ Good □ Fair □ Poor □] [X]

21. Water (Type, distance and direction): Mill Creek and Alder Creek, perennial creeks cross ditch system.

[ ]

22. Vegetation Community (on-site and vicinity; include reference): Yellow pine/oak community: black oak, white oak; doug fir; yellow pine, big-leaf maple, blackberry, huckleberry, alder, ceanothus, ferns, lupine. Yellow pine/oak community along ditch; ferns and grasses on berm of main ditch; alder, small firs, pines, white oak, blackberry, ferns in ditch feature 1.

(Storer and Ussinger, Sierra Nevada Natural History) _______ (Plant List □)

23. Soil (on-site and vicinity; include reference): Yellow brown, sandy loam of granitic origin

[ ]

24. Geology: granitic exposures

[ ]

25. Landform: Site along contour of steep (to 45 degree) slope

[ ]


29. Landowner(s) (and/or tenants) and address: El Dorado National Forest; Pacific Gas & Electric Co. is currently using ditch to supply water and generate power in conjunction with El Dorado Irrigation District.

[ ]

30. Remarks: This section of ditch was surveyed in assessing impacts to site of a proposed tunnel bypass of the section destroyed by slide, noted as Feature 5. A tunnel would be bored through the hill above the slide, [x]


[ ]

32. Name of Project: Highway 50 Slide Bypass, El Dorado Bitch

[ ]

33. Type of Investigation: Survey for impact assessment

[ ]

34. Artifact Accession No's: ____________________________ Curated at:

[ ]

35. Photos (Type): 1 roll, B & W _______ Taken by: S. Salzman

[ ]

Eldorado National Forest

[ ]
against the sides of the ditch with \( \frac{1}{4} \)" diameter vertical iron rods, spaced at 4' intervals. The earthen and rock berm of the ditch averages 10'-12' wide. Large angular cobbles from the ditch excavation form a talus slope down its outer edge. An earthen path along the top of the berm provides maintenance access to the ditch. The ditch is periodically bridged by a single or double 2x12" plank, railed in the same manner as the flumes described below, and set on 6" diameter round wooden pilings, one on each side of the ditch. The bridges are reached by two small wooden steps at each end.

As required to cross natural drainages and depressions in the contour, sections of flume occasionally alternate with ditch sections. These flume sections, set on trestles of varying heights, are commonly supported for part of their length by a drylaid stone "wall", also varying in height and length. Stones are roughly shaped angular blocks of native stone (a pale grey granite?), varying in size from 36x24" to 8x8". These are set in place without mortar, in irregular courses and chinked as necessary with small angular pieces of the same stone. These "walls" are as much as 15' thick.

Flume support structure commonly consists of two lines of horizontal 12x12" beams, running the length of the flume at the outer edges of either the rock wall or the flume bed. Surmounting these are 6x8" crossmembers, 13' long, spaced at 36" intervals. Standing on the crossmembers, one on each side of the flume, are 6' long, 4x6" beams, supporting the flume walls. The 4x6" beams are set in angled notches in the supporting 6x8" crossmembers to accommodate the outward cant of the flume walls. Supporting the angled 4x6s are additional diagonal 4x4s, extending from near the top of the flume to near the outer edge of each crossmember, on each side of the flume.

The flume itself is a trough-shaped structure, 160" across at the top, 78" across at the bottom and 73" high. It is constructed of horizontal 2 x 12" planks, laid parallel to the length of the flume. The 2 x 12" structure is faced, inside the flume, with sheets of \( \frac{1}{8} \)" plywood. These are fitted in two courses, the lower formed of 90x50" sections, the upper of 90x23" sections, with the long sides along the length of the flume. Joints are tar papered (?) and creosoted. Fasteners are round, galvanized nails.

A walkway of 2x12s placed end to end runs along the top of the flume at each side. This is supported by some of the 4x6" diagonal flume side supports, sometimes with the addition of short lengths of \( \frac{1}{4} \) x 3\( \frac{1}{2} \)" board, nailed upright to the 4x6s. A 3' high railing with two crossbars, supported by uprights at 10' intervals, is composed of additional \( \frac{1}{4} \) x 3\( \frac{1}{2} \) milled boards.

16. the route of the original ditch before the installation of the Alder Creek siphon. This "Old Ditch" is part of 1852-1873 South Fork Canal, a predecessor of the El Dorado Canal.

Feature 2: A dry laid rock wall and flume at the northwesternmost (Cont
creek mapped in Sec. 35. The wall varies from 6' to 15' high and is about 125' long. Stones are roughly shaped or naturally angular cobbles, presenting a fairly even face and a level top surface. Cobbles are set in place without mortar, in irregular courses and chinked with small, angular pieces of the same stone. The flume is typical section of flume throughout the surveyed area (described above) and walls are typical of those found along flume.

Feature 3 marked on map is a typical section of ditch as described in #13 above.

Feature 4: A short length of rock wall, supporting a flume over a small intermittent (unmapped) creek immediately NE of Mill Creek. The wall is 4-6' high and is pierced at its center by an opening 5½' wide for the passage of water from the drainage. This rock wall is approximately 100' long. The flume, on support structure as described above in #13, continued west to Mill Creek.

Feature 5: Trestle, flume, dry-laid rock wall. At Mill Creek the flume is carried over a deep rocky drainage by a rock wall 6'-10' high which supports a trestle approximately 12-24' high. The trestle structure evidences repair; members are weathered to various degrees. Diagonal supports are somewhat irregular in placement and are not consistently present. All lumber is milled; all fasteners are round nails.

somewhat altered over time; walls are probably as originally constructed.

One portal would be at Mill Creek and the other ca. 175 meters southeast of the southeast end of the slide in the SW¼ of the SW¼ of Sec. 26. It is proposed that the flume within this section be removed and the ditch be filled and resloped.

8. 1.) 726320 E 4294140 N
2.) 726420 E 4294050 N
3.) 726580 E 4294320 N
4.) 726920 E 4294170 N
5.) 727800 E 4293200 N
# ARCHEOLOGICAL PHOTOGRAPHIC RECORD

## Camera and Lens Types
- Pentax 1000-50mm lens

## Film Type and Speed
- B&W print, 35mm, ASA 125

## Year
- 1983

## Subject/Description

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<td></td>
<td></td>
<td>7</td>
<td>Feature 5: rock wall and trestle carrying flume over Mill Ck; from flume walkway</td>
<td>SW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>Feature 5: rock wall at W side Mill Ck.; from flume walkway</td>
<td>SW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9</td>
<td>Typical section of flume W of Feature 5</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>Section of high-quality wall below flume, W of Feature 5</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11</td>
<td>Another shot of above wall</td>
<td>SW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>Feature 5, from ground level</td>
<td>SW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13</td>
<td>Feature 5, from ground level</td>
<td>SW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14</td>
<td>Feature 5: trestle, from below</td>
<td>SW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15</td>
<td>Another shot of above</td>
<td>SW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>16</td>
<td>Feature 3A: original planking of inside of ditch</td>
<td>SE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td>Feature 2: dry laid rock wall carrying flume over creek</td>
<td>SE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>18</td>
<td>Feature 2: closeup</td>
<td>SE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>19</td>
<td>Feature 1: old ditch; passes under horizontal log in backgound; photo along ditch alignment</td>
<td>NE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20</td>
<td>Feature 1: old ditch to left, beam to right</td>
<td>W</td>
</tr>
</tbody>
</table>
El Dorado Canal
Feature 2
Typical Flume Section - Elevation

Schematic sketches not to scale

walkway and railing

flume side

rock wall or flume bed

Typical Flume Section - Cross Section

rock wall or flume bed
El Durado Canal
Feature 5
Mill Creek Trestle
cross section →
schematic sketch not to scale

Trestle elevation

This beam rests on rock wall or on additional trestle course, as necessary to obtain height

ground surface to rock wall
Project Area Map
(portion of USGS Riverton 7.5' quadrangle, 1950, revised 1973)

- tunnel portals
- features (2, 3, 3A, 4, 5; see p.8)
- old ditch (Feature 1)
- project area

① UTM Coordinate locations
**P1. Other Identifier:** Segment of the Sierra Ditch

**P2. Location:** ☑ Not for Publication ☐ Unrestricted  *a. County: El Dorado

* b. USGS Quad: Pollock Pines (1950; photorevised 1973); T11N R13E, S½ of SE¼ of Sec. 25; MDBM

c. Address:

d. UTM: Zone 10; 709640 mE/ 4293700 mN NAD27 East end 709940mE/ 4263680N

e. Other Locational Data:

From Pony Express Trail in Pollock Pines, take Forebay Road north 0.8 mile to picnic area parking lot north of the Forebay. Continue on foot 5W across Forebay dam past spillway. Ditch segment is approximately 100m from the spillway along the shore line approximately 10m south of high water mark.

**P3a. Description:**

This site consists of a short segment of the El Dorado Canal (a.k.a. Sierra Ditch), which was in use prior to the construction of the Forebay. According to Dave Buel from the El Dorado Irrigation District, the El Dorado Canal was constructed in 1876 as a water-conveyance system for downstream hydraulic mining activities. The ditch is 5 feet wide at the top, 3 feet wide at the bottom, and approximately 3 feet deep. The ditch is heavily overgrown with brush and trees. The Forebay levels never inundate the ditch.

**P3b. Resource Attributes:** AH6: Water Conveyance System

**P4. Resources Present:** ☑ Building ☑ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

**P5. Description of Photo:**
Sierra irrigation ditch. View facing southwest. Roll: FERC #1 Frame: 12

**P6. Date Constructed/Age & Sources:**

Historic ☑ Prehistoric ☐ Both

**P7. Owner and Address:**
El Dorado Irrigation District, 2890 Mosquito Road, Placerville, California, 95667

**P8. Recorded by:**
M. Darcangelo and N. Pagaling, Far Western, 2727 Del Rio Place, Suite A, Davis, Ca. 95616

**P9. Date Recorded:** 8/8/02

**P10. Survey Type:**
Surface Reconnaissance Survey


**Attachments:** ☐ None ☑ Location Map ☑ Sketch Map ☐ Continuation Sheet ☑ Building, Structure, and Object Record ☑ Archaeological Record ☑ District Record ☑ Linear Feature Record ☑ Milling Station Record ☑ Rock Art Record ☑ Artifact Record ☑ Photograph Record ☐ Other.

DPR523A (1/95)  

*Required Information
L1. Historic and/or Common Name: Sierra Ditch
L2a. Portion Described: □ Entire Resource  ✔ Segment  □ Point Observation  Designation:
L2b. Location of Point or Segment:
   South side of Forebay.

L3. Description:
   Earthen berm ditch is approximately 3 feet deep and 16 feet wide. Ditch segment has numerous trees growing in it. A lot of tree fall and duff are in ditch.

L4. Dimensions:
   a. Top Width: 6 feet
   b. Bottom Width: 3 feet
   c. Height or Depth: 3 feet
   d. Length of Segment: 200 feet

L5. Associated Resources:
   None noted

L6. Setting:
   North slope of hill, south of forebay. Vegetation is yellow pine forest.

L7. Integrity Considerations:

L8a. Photo or Drawing: none

L8b. Description of Photo, Map, or Drawing

L9. Remarks:

L10. Form Prepared By:
   M. Darcangelo

L11. Date: 8/8/02
Trinomial:
Agency Number:
Temporary Number: CA-8

A PORTION OF
POLLOCK PINES QUADRANGLE
7.5 MINUTE
1950, PHOTOREVISED 1973
Resource Name or #: (assigned by recorder) Segment of the Sierra Ditch

P1. Other Identifier: Site 4 for EID Forebay THP and FS #05 03 56 036-H.

P2. Location: a. County: El Dorado and (P2e, P2f, and P2g or P2d.
   b. USGS 7.5' Quad Pollock Pines, Calif. Date 1973, T 11N; R 12E; S1/4 SE1/4 Sec. 25; MDM, B.M.
   c. Address: Polaris Street, City: Pollock Pines, Zip: 95726
   d. UTM: (Give more than one for large and/or linear resources) Zone: 10.

P3a. Description (Describe its major elements. Include design, materials, condition, alterations, size and boundaries.)

Segments of Sierra Ditch: This site consists of two short segments of the Sierra Ditch which was in use prior to the construction of the Forebay. The ditch is 6 feet wide at the top, 3 feet wide at the bottom, and approximately 3 feet deep. The east segment is approximately 260 feet measured by pacing and the west segment is approximately 183 feet also measured by pacing. The missing segment inbetween was not measured. The ditch is heavily overgrown with brush and trees.

P3b. Resource Attributes: (List attributes and codes) HP20 Canal/Ditch

P4. Resources Present: _Building _Structure _Object _X Site _District _Element of District _Feature

P5a. Photograph or Drawing (Photograph required for buildings, structures and objects.)

P5b. Description of Photo: (view, date, accession #)

P6. Date Constructed/Age and Source: _Prehistoric _X Historic _Both

P7. Owner and Address: El Dorado Irrigation District, 2890 Mosquito Road, Placerville, CA. 95667

P8. Recorded by: (Name, affiliation and address) Robert W. Allen, 6221 Sly Park Road, Placerville, CA. 95667, RPF #2108 Consulting Forester

P9. Date Recorded: 04-13-2004

P10. Type of Survey: _X Intensive _ Reconnaissance _ Other Describe: THP Survey

P11. Report Citation (Provide full citation or enter "none"): Confidential Archaeological Addendum for EID Forebay THP (no number) and FS #05 03 56 036-H

Attachments: _NONE _Location Map _Continuation Sheet _Building, Structure, and Object Record _Linear Resource Record _Archaeological Record _District Record _Milling Station Record _Rock Art Record _Artifact Record _Photograph Record _Other: (List)
P1. Other Identifier: Segment of the Sierra Ditch

P2. Location: ☑ Not for Publication ☐ Unrestricted ☐ County: El Dorado
   *b. USGS Quad: Pollock Pines (1956; photorevised 1973); T11N R13E, S1/2 of SE1/4 of Sec. 25; MDBM
   c. Address:
   d. UTM: Zone 10; 709640 mE/4293700 mN NAD27 East end 709940mE/4293680N
   e. Other Locational Data:
   From Pony Express Trail in Pollock Pines, take Forebay Road north 0.8 mile to picnic area parking lot north of the Forebay. Continue on foot SW across Forebay dam past spillway. Ditch segment is approximately 100m from the spillway along the shore line approximately 10m south of high water mark.

P3a. Description:
This site consists of a short segment of the Sierra ditch which was in use prior to the construction of the Forebay. The ditch is 6 feet wide at the lip, 3 feet wide at the bottom, and approximately 3 feet deep. The ditch is heavily overgrown with brush and trees. The Forebay levels never inundated the ditch.

P3b. Resource Attributes: AH6: Water Conveyance System

P4. Resources Present: ☐ Building ☐ Structure ☐ Object ☑ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5a. Photo or Drawing: none

P5b. Description of Photo:

P6. Date Constructed/Age & Sources:
☑ Historic ☐ Prehistoric ☐ Both

P7. Owner and Address:
U.S.D.A., Forest Service, El Dorado National Forest, 100 Form Road, Placerville, CA 95667

P8. Recorded by:
M. Darcangelo and N. Pagaling, Far Western, P.O. Box 413, Davis CA 95617

P9. Date Recorded: 8/8/2002

P10. Survey Type:
Surface Reconnaissance Survey


*Attachments: ☐ None ☑ Location Map ☐ Sketch Map ☐ Continuation Sheet ☐ Building, Structure, and Object Record
   ☐ Archaeological Record ☐ District Record ☑ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record
   ☐ Artifact Record ☐ Photograph Record ☐ Other:

DPR523A (1/95)

*Required Information
Historic and/or Common Name: Sierra Ditch

Portion Described: Segment

Location of Point or Segment:
South side of Forebay. An El Dorado National Forest Sensitive Area Tag nailed to 12 dbh tree near east end of site.

Description:
Earthen beam ditch is approximately 3 feet deep and 16 feet wide. Ditch segment has numerous trees growing in it. A lot of tree fall and duff are in ditch.

Dimensions:
- Top Width: 6 feet
- Bottom Width: 3 feet
- Height or Depth: 3 feet
- Length of Segment: 200 feet

Associated Resources:
None noted

Setting:
North slope of hill, south of forebay. Vegetation is yellow pine forest.

Integrity Considerations:

Photo or Drawing: none

Description of Photo, Map, or Drawing

Remarks:

Form Prepared By:
M. Darcangelo

Date: 8/8/2002
<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Exp/Frame</th>
<th>Subject/Description</th>
<th>View Toward</th>
<th>Accession #</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/1/1982</td>
<td>1:40</td>
<td>12</td>
<td>Sierra Irrigation ditch.</td>
<td>230°</td>
<td></td>
</tr>
</tbody>
</table>
In April 2003, Robert W. Allen recorded the property, consisting of the Loomer’s Main House, a 16’ x 25’ outbuilding, cabin #1, cabin #2, a water tank, a water ditch, a water pipe and concrete spring box, and a dam/reservoir, as the Loomer Homestead, which presumably was the family who originally homesteaded the property (refer to Loomer Homestead Primary Record). All of these features were observed in September 2006, when the property was revisited, however, the condition of each property was more deteriorated. On the far eastern edge of the property is a segment of the El Dorado Canal, which dates to the 1870s, and was also recorded in April 2003 (refer to El Dorado Irrigation District Main Canal Primary Record). Official Maps of El Dorado County for 1895-1925 indicate the subject property was part of the Larsen Family Ranch. The subject property was owned in 1908 by Catherine Larsen. Previous to that date the property was owned by Emil Larsen, who owned approximately 520 acres along the present-day Pony Express Trail. By 1925, the property had passed on to M.B. Doutt. During the 1930s, the property was conveyed to the Loomer family, who owned the property until circa 1976 (personal communication: Gary Gould, October 2006). The Loomers constructed the log house on the property in the mid to late-1930s, and, while building the house, lived in a small cabin with an attached barn (personal communication: Gary Gould, October 2006). Margaret Smith acquired the property around 1976 and owned the property until 1998, when it was sold to the present owner, Cecil Wetsel, Jr. As reported by Robert W. Allen in 2003, the property was used as a Boy Scout Camp, perhaps as early as the late-1930s. The Boy Scouts presumably leased the property, perhaps when the Loomers owned it. The two cabins on the property are consistent with the design and construction methods used in the 1940s. The Main House, extensive landscaping, pond site, and several other structures seem consistent with construction techniques and materials from the 1930s. All the buildings on the property are in poor condition and have extensive deterioration and signs of vandalism. The property has subsequently been used by Cecil Wetsel, Jr. for logging.

In applying the Criteria of the California Register of Historic Resources (CRHR), a resource is considered “historically significant” under CEQA if the resource meets the criteria for listing in the CRHR. The CRHR is designed to be used by state and local agencies, private groups, and citizens to identify existing historical resources within the state and to indicate which of those resources should be protected, to the extent prudent and feasible, from substantial adverse change. The following criteria have been established for the CRHR (Public Resources Code §§5024.1, Title 14 CCR, Section 4852): A resource is considered significant if it (1) is associated with events that have made a significant contribution to the broad patterns of local or regional history, or the cultural heritage of California or the United States; (2) is associated with the lives of persons important to local, California, or national history; (3) embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of a master or possesses high artistic values; or (4) has yielded, or has the potential to yield, information important to the prehistory or history of the local area, California, or the nation.

In applying the California Register, the subject property was analyzed for its potential under all four Criteria. Historical documentation does not provide substantive proof that the subject property played an important role in local history as it relates to the Western El Dorado County in the area near Camino, Cedar Grove, and Pollock Pines. Similarly, no documentation has been found to suggest that the buildings’ builder, owner, and occupants, namely the Loomer family, played a significant role in the history of the County or the locale. Under Criterion 3, while the buildings and structures at the property reflect a rustic style of construction, collectively, they do not present important examples of that style of architecture, although the main house is of interest because of its use of logs. Finally, under Criterion 4, because of the age of the structures and the period in which the property was occupied (circa late-1930s through the 1960s), it is unlikely that if historic artifacts were to exist that they could provide scientific information consequential to our understanding of an event or events of significance. Therefore, the property does not appear to be a significant resource as per the California Register of Historic Resources.

7903

*Required information
Resource Name or #: (assigned by recorder) Loomer Homestead

P1. Other Identifier: Site 2 for D'Amico THP

P2. Location: a. County El Dorado and (P2c, P2b or P2d. Attach a Location Map as necessary)
   b. USGS 7.5' Quad Pollock Pines, Calif. Date: 1973 T 11N; R 12E; SW 1/4 Sec. 25; MDM B.M. T 11N; R 12E; NW 1/4 Sec. 36; MDM B.M.

   c. Address Blair Road __________ City Pollock Pines ______ Zip ___________

d. UTM: (Give more than one for large and/or linear resources) Zone 10 __________

Loomer Homestead

Main House: The main house is 34 feet by 32 feet. On the main floor are a kitchen, bathroom with the top of the bathtub at floor level, dining room, living room and bedroom. Also on the main floor is an enclosed porch that appears to be an add-on feature. Above the kitchen and dining room on the south side of the house are two small bedrooms in the upstairs loft, accessed by a narrow curved stairway. Below the main floor is a 3/4 basement. The walls of the house are made of white fir cants, 6 inches thick, with bark left on. The foundation is made of concrete and stone. Concrete steps near the northeast corner of the house lead to open air as the deck that used to surround the north and west sides of the house have been removed many years ago. Concrete and stone landscaping surrounds the house, including a barbecue.

Outbuilding: This building is 25 feet by 16 feet, has a peaked roof covered with corrugated galvanized metal material. The framing material is of poles and beams with rough sawn boards as siding. There is room for two vehicles with a side room for a shop.

Cabin #1: The cabin closest to the main house is 18 feet by 18.5 feet, also with a peaked roof, but with aluminum roofing material. There is one room with a loft. A wood stove was used for heat and possibly cooking.

Cabin #2: The cabin to the north is approximately 20 feet square, also with aluminum peaked roof. This building has three(3) rooms.

County records show that the Boy Scouts used these cabins from the mid 1960s, possibly earlier, to the mid 1970s.

Water Tank: This covered water storage tank is made with redwood staves. The height is 8 feet with a diameter of 11 feet. The foundation is made of 2 x 12 sawn boards. This tank was gravity fed by the El Dorado Irrigation District Main Canal in order to supply the main house, outbuildings and yard.

County records show that the Boy Scouts used these cabins from the mid 1960s, possibly earlier, to the mid 1970s.
Water Ditch: This hand dug ditch used to transport water originates at the class II watercourse approximately 500 feet east of the west property line. The ditch flowed northwest along the watercourse, turning north behind the main house to what appears to have been a water feature in the landscape. The ditch continued north toward Blair Road to a square concrete box where the water was diverted under Blair Road. It is unknown where the outlet is and where the flow of water continued from opposite side of Blair Road. The ditch has filled in in places to look like a trail, but other segments are still have the "U" shape. The ditch was approximately 3 feet wide and 1 foot deep with a berm. The length of this ditch is approximately 750 feet.

Water Pipe/Concrete Spring Box: This pipe is approximately 2 inches in diameter and is made of metal. The pipe originates at the start of the class II watercourse at a square approximately 3 feet by 3 feet concrete box. The length of the pipe is approximately 750 feet and is located either on top or buried down the center of the watercourse. The lower end of the pipe is located near the start of the ditch that runs along the north side of the watercourse in a northwest direction.

Dam/Reservoir: An earthen dam was constructed on the class II watercourse creating a small reservoir. This dam is located west of the main house approximately 50 feet east of Blair Road. The reservoir is drained by a 10 inch concrete pipe that is located near the center of the dam at the bottom of the reservoir. The dam stretches approximately 160 feet across the watercourse and is approximately 8 to 10 feet wide at the top, tapering to a wider base. In the early 1990s, the landowner had a bypass channel dug around the dam with a backhoe. This channel was too relieve pressure on the dam when water levels reached near the half full stage.

P3b. Resource Attributes: (List attributes and codes) HP2 Single Family Property Ancillary Building AH11 AH13 Landscaping AH16 Water conveyance system AH18 Dam HP39 Water Tank

P4. Resources Present: X Building Structure Object Site District Element of District Feature

P5a. Photograph or Drawing (Photograph required for buildings, structures and objects) P5b. Description of Photo: (view, date, accession)

P6. Date Constructed/Age and Source: Prehistoric Historic Both

P7. Owner and Address: Cecil Wetzel, Jr and Judith D'Amico P.O. Box 5530, El Dorado Hills, CA 95762

P8. Recorded by: Owner, affiliation and address Robert W. Allen, 5221 Sylvan Road, Placerville, CA 95667, RPF 5210 Consulting Forester

P9. Date Recorded: 04-10-2003

P10. Type of Survey: X Intensive Reconnaissance Other Describe: THP Survey

P11. Report Citation (Provide full citation or enter "none"). Confidential Archaeological Addendum for D'Amico THP (no number).
Pollock Pines, Calif. 7.5' Quad
Portion Secs. 25 and 36 T11N R12E MDM

Legend:
- THP Boundary
- Entire THP Area Surveyed
- Site 2: Loomer Homestead
- Main House
- Outbuilding
- Cabin #1
- Cabin #2
- Water Tank
- Water Ditch
- Water Pipe/Concrete Spring Box
- Dam/Reservoir

Scale 1" = 2,000 Feet

by the Geological Survey
by multiplex methods
old check 1950
mean datum
coordinate system,
site location
crown
sector grid ticks,

UTM GRID AND 1973 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

CONTOUR INTERVAL 40 FEET
NATIONAL GEOUGraphic VERTICAL DATUM OF 1927

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY
Site 2: Cabin #2 looking NW (4/03)

Site 2: Outbuilding SE of Main House looking SSW (4/03)
Site 2: Cabin #1 (4/03)
looking NW

Site 2: Cabin #1 looking S (4/03)
B10. Significance (Continued): The subject property consists of a segment of the El Dorado Irrigation District Main Canal, previously recorded by Robert W. Allen on April 10, 2003 (refer to El Dorado Irrigation District Main Canal Primary Record). The canal flows from Forebay Reservoir to storage reservoirs to the west. The property line for the Wetsel property appears to be largely conforming to the alignment of the canal. The canal on average measures 17 feet wide by 5 feet deep with a berm approximately 7 feet wide. The canal observed in September 2006 looks markedly the same as when it was observed in April 2003 by Robert W. Allen. The canal may date to the 1850s, with the upper canal segment along the South Fork of the American River dating to circa 1874. The upper canal was constructed with the use of Chinese laborers and is documented in a ledger, once owned by the Pacific Gas & Electric Company. Based upon the General Land Office Survey plat maps, the headwaters of Iowa and Long Creek or Canyon included a handful of ditches, including the Anderson Ditch, South Fork "old" and "new" Canal, the Iowa Ditch, and Kirk’s "new ditch." Collectively, all of these canals appear to begin in Sections 35 and 36, taking water west towards present-day Camino and, ultimately, Placerville and beyond. Kirk’s "new ditch" seems to roughly correspond with the El Dorado Irrigation District Main Canal, which borders the property on the east. Based upon the size and shape of the current canal, it is apparent it was improved numerous times and enlarged, perhaps in the 1920s to accommodate larger flows of water.

In applying the Criteria of the California Register of Historic Resources (CRHR), a resource is considered "historically significant" under CEQA if the resource meets the criteria for listing in the CRHR. The CRHR is designed to be used by state and local agencies, private groups, and citizens to identify existing historical resources within the state and to indicate which of those resources should be protected, to the extent prudent and feasible, from substantial adverse change. The following criteria have been established for the CRHR (Public Resources Code §§5024.1, Title 14 CCR, Section 4852): A resource is considered significant if it (1) is associated with events that have made a significant contribution to the broad patterns of local or regional history, or the cultural heritage of California or the United States; (2) is associated with the lives of persons important to local, California, or national history; (3) embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of a master or possesses high artistic values; or (4) has yielded, or has the potential to yield, information important to the prehistory or history of the local area, California, or the nation.

The El Dorado Canal, or what is referred to as the El Dorado Irrigation District Main Canal, appears to be a significant resource for listing on the California Register of Historic Resources under Criteria 1 and 3. Although the segment of the El Dorado Irrigation District Main Canal may have been built at the turn of the century, the canal retains good integrity and appears to be a significant contributing resource for listing on the California Register under Criterion 1 for its association with the historic development of a large and reliable water transport system to the western foothills of El Dorado County, and under Criterion 3 for its engineering design.
*Resource Name or # (Assigned by recorder): El Dorado Irrigation District Main Canal

*Recorded by: Dana E. Supernowicz

*Date: September 2006

View of the El Dorado Irrigation District Main Canal looking south 0
Primar# P-9-3718
HRI# 
Trinomial 
NRHP Status Code 

Resource Name or #: (assigned by recorder) El Dorado Irrigation District Main Canal

P1. Other Identifier: Site 2 for EID Forebay THP, Site 1 for THP #4-03-29/ELD-18.

P2. Location: County El Dorado and (P2c, P2e, and P2b or P2d. Attach a Location Map as necessary.)
   a. USGS 7.5' Quad Pollock Pines, Calif. Date 1973. T 11N; R 12E; NW1/4, SE 1/4 Sec. 25; MDM B.M.
   b. Address Blair Road City Pollock Pines Zip 95726
   c. Address Blair Road -
   d. UTM: (Give more than one for large and/or linear resources) Zone 10: El Dorado Irrigation District Main Canal 709685 mE/ 4293968 mN 709401 mE/ 4293932 mN
   e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate) Elevation: 3770 feet.

P3a. Description (Describe its major elements. Include design, materials, condition, alterations, size and boundaries.) El Dorado Irrigation District Main Canal: This canal flows from Forebay Lake, manmade, to lower elevation storage reservoirs and supplies a few customers along the way. The canal averages approximately 17 feet wide by 5 feet deep with a berm approximately 7 feet wide.

P3b. Resource Attributes: (List attributes and codes) HP20 Canal

P4. Resources Present: Building Structure Object District Element of District Feature

P5a. Photograph or Drawing (Photograph required for buildings, structures and objects.) P5b. Description of Photo: (view, date, accession #)

P6. Date Constructed/Age and Source Prehistoric X Historic X Both

P7. Owner and Address El Dorado Irrigation District. 2890 Mosquito Road, Placerville, CA. 95667

P8. Recorded by (Name, affiliation and address) Robert W. Allen, 6221 Sly Park Road, Placerville, CA. 95667. RPF #2108 Consulting Forester

P9. Date Recorded: 04-13-2004

P10. Type of Survey: X Intensive X Reconnaissance X Other Describe: THP Survey

P11. Report Citation (Provide full citation or enter "none"): Confidential Archaeological Addendum for EID Forebay THP (no number). Site 1 for THP #4-03-29/ELD-18.

Attachments: _NONE X Location Map _ Continuation Sheet _ Building, Structure, and Object Record _ Linear Resource Record _ Archaeological Record _ District Record _ Milling Station Record _ Rock Art Record _ Artifact Record _ Photograph Record _ Other: (List)

EID Forebay THP 61
Resource Name or #: (assigned by recorder) El Dorado Irrigation District Main Canal

P1. Other Identifier: Site 1 for D'Amico THP.

P2. Location: a. County El Dorado and (P2c, P2e, and P2b or P2d. Attach a Location Map as necessary)
   b. USGS 7.5' Quad Pollock Pines, Calif. Date 1973. T.11N, R 12E, SW 1/4 Sec. 25; MDM, B.M.
      T.11N; R 12E, NW 1/4 Sec. 36; MDM, B.M.

c. Address Blair Road

d. UTM: (Give more than one for large and/or linear resources) Zone 10
   El Dorado Irrigation District Main Canal
      709158 mE/4293579 mN
      709371 mE/4293153 mN
      709341 mE/4292980 mN
      708853 mE/4293153 mN

e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate) Elevation: 3760 feet

P3a. Description (Describe its major elements. Include design, materials, condition, alterations, size and boundaries.)
El Dorado Irrigation District Main Canal: This canal flows from Forebay Lake, manmade, to lower elevation storage reservoirs and supplies a few customers along the way. The majority of the east and south property lines are formed by the canal. The canal averages approximately 17 feet wide by 5 feet deep with a berm approximately 7 feet wide.

P3b. Resource Attributes: (List attributes and codes) HP20 Cannot

P4. Resources Present: _Building ___Structure ___Object X Site ___District ___Element of District ___Feature

P5a. Photograph or Drawing (Photograph required for buildings, structures and objects.)
P5b. Description of Photo: (View, date, accession #)

P6. Date Constructed/Age and Source _ Prehistoric _X Historic _Both

P7. Owner and Address Cecil Wetsel, Jr. and Judith D’Amico, P.O. Box 5530, El Dorado Hills, CA 95762

P8. Recorded by (Name, affiliation and address) Robert W. Allen, 2221 Sny Park Road, Placerville, CA. 95667, KDF #2108 Consulting Forester

P9. Date Recorded: 04-10-2003

P10. Type of Survey: _X_ Intensive _ Reconnaissance _ Other Describe: THP Survey

P11. Report Citation (Provide full citation or enter "none") Confidential Archaeological Addendum for D’Amico THP (no number).

Attachments: _NONE X Location Map Continuation Sheet Building, Structure, and Object Record Linear Resource Record Archaeological Record District Record Mating Station Record Rock Art Record Artifact Record Photograph Record Other: (List)

DPR 523A (1/95) 8783

D’Amico THP 47
**Resource Name or #** (Assigned by recorder) Alder Creek Canyon Bench Walls

**P1. Other Identifier:** Alder Creek Canyon Bench Walls

**P2. Location:**
- Not for Publication [X] Unrestricted
- USGS 7.5' Quad Riverton, 1950: Kyburz 1952 (1973) T11N: R 14E: ¼ of Sec 35; MD B.M.

**P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
The Alder Creek Canyon flume bench walls are located along an abandoned section of the El Dorado Canal on either side of Alder Creek Canyon, which is located on the south side of the American River. The rock walls at Alder Creek Canyon were constructed in 1874-1875 to support the flume bench for this section of the El Dorado Canal. The canal originally ran down the east side of the canyon along a hydraulic gradient from the current location of Ditch Camp 1, to a point approximately 100 meters from the Alder Creek Diversion Dam, where it crossed to the west side of the canyon on a trestle. On the west side of the canyon, the canal picked up water from a feeder flume that ran down the canyon from the Alder Creek Diversion Dam, before continuing up the west side of the canyon. The trestle abutments on either side of the canyon are still intact, but the trestle has been removed. (See Continuation Sheet)

**P3b. Resource Attributes:** (List attributes and codes) HP11 (Engineering Structure)

**P4. Resources Present:**
- Building [X]
- Structure [X]
- Object
- Site
- District
- Element of District
- Other (Isolates, etc.)

**P5b. Description of Photo:** (View, date, accession #)
Photograph 1, East abutment for Alder Creek Trestle, camera facing southwest

**P6. Data Constructed/Age and Sources:**
- Historic [X]
- Prehistoric
- Both ca. 1874-1875

**P7. Owner and Address:**
El Dorado Irrigation District
2890 Mosquito Road,
Placerville, CA 95667

**P8. Recorded by:** (Name, affiliation, address)
Stephen Wee and Andrew Walters
JRP Historical Consulting Services,
1490 Drew Ave, Suite 110, Davis,
CA 95616

**P9. Date Recorded:** November 5, 2002

**P10. Survey Type:** (Describe) Intensive

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*Required Information*
P3a. Description (continued):

This portion of the El Dorado Canal was abandoned in the 1920s when the Alder Creek Siphon was constructed across the mouth of the canyon. The construction of the siphon also included construction of a steel pipe conduit that runs approximately one mile down the east side of the canyon from the Alder Creek diversion to the Siphon House at Ditch Camp 1. At that time, this pipe was buried along the old canal alignment, and in the 1940s a new above ground conduit was constructed on top of the old one. The flume bench walls on the east side of the canyon currently support this above ground conduit, which has been repaired in places over the years. The former canal route along the west side of the canyon, containing alternating sections of flume bench with supporting rock walls and open canal, remains abandoned.

Some of the existing flume bench walls on both sides of the canyon were documented as sections of 1870s era rock wall located along the El Dorado Canal between the Intake and Forebay in the 1991 inventory and evaluation, "Archeological Survey and Historic Research Report on the El Dorado Canal, El Dorado County, California." This study found the Alder Creek Canyon bench walls to be one of seven locations of stone masonry walls that appeared eligible for listing in the National Register of Historic Places as part of a discontinuous historic district. The State Office of Historic Preservation concurred with this recommendation in 1993.

The 1991 evaluation included rock walls on the east side of the canyon, and on the west side in the vicinity of Screech Owl Canyon. However, none of these resources were formally recorded on a DPR 523 form. During the present inventory and evaluation, JRP staff walked the west side of the canyon in order to fully record resources located there that were inaccessible at the time of the 1991 study, and revisited the walls on the east side of the canyon to determine their current condition. During the field investigation, additional rock wall locations were identified on the west side of the canyon. These new sections of rock wall are included on this DPR 523 form, along with an update on the condition of the rock walls on the east side of the canyon previously identified in the 1991 study.

In 1991, the rock walls on the east side of the canyon were recorded as five segments. These segments were, from north to south, 53, 43, 326, 53, and 148 feet in length. Although the current study noted no significant change in the condition of these rock walls, a discrepancy in the two surveys was noted. In the 1991 survey, the northernmost rock wall was documented as 148 feet in length, but no wall of that length was found at that location during the present investigation. However, a segment of wall approximately 148 feet in length was found approximately 500 feet to the north along the bench and was recorded as Segment 2 on this DPR 523 form. It is the conclusion of the current investigation then, that the northernmost segment of rock wall recorded in the 1991 study is actually located further north along the bench. These five sections of rock wall are recorded on attached linear feature records as Segments 1 through 5, and references are given on the recordation forms for corresponding segments in the 1991 study.

The abandoned section of canal on the west side of the canyon consists of the feeder flume bench that runs from the Alder Creek diversion dam to the west trestle abutment, and alternating sections of open canal and flume bench with rock retaining walls from the trestle to the main canal. Along the bench portions of the canal on the west side of the canyon are four sections of rock retaining wall: two segments between the diversion dam and Screech Owl Canyon, at Screech Owl Canyon, and one segment north of Screech Owl Canyon. There are also rock walls and abutments for the crossing of the canal at an unnamed tributary to...
P3a. Description (continued):

Alder Creek at the northern end of the canyon. There is an additional section of rock wall located above the access road to the west end of the Alder Creek Siphon. This wall was recorded and evaluated recently as part of the environmental documentation for EID's tunnel construction project.

The above ground pipeline constructed in the 1940s and repaired in sections since that time, extends from the dam along the bench on the east side of the canyon to the Siphon House at Ditch Camp 1. The bench is generally 10 feet wide. The former metal pipe conduit, constructed during the 1920s, is buried shallow in the bench beneath the newer conduit, and is visible in places. The pipe conveys water diverted at Alder Creek diversion dam to the main canal and replaced in function the older 1870s feeder flume on the west side of the canyon. On either side of the canyon, approximately 100 meters downstream from the dam is an abutment for the former trestle crossing of the El Dorado Canal. The trestle abutments are approximately 20 feet in height, and project from the mountainside at a 90 degree angle. The abutments are constructed of roughly coursed dry laid cut stone blocks and rubble.

The rock walls along Alder Creek Canyon can generally be described as constructed of dry laid and roughly coursed granite blocks and rubble. Individual segments are recorded on the attached forms. As noted in the 1991 study, the quality of workmanship varies from fair on the walls on the east side of the canyon, to high on the abutment. The walls near Screech Owl Creek also possess distinguishing engineering features such as elegant curves and openings through the stone walls in the stone that function as culverts for drainage of side creeks.

The following linear feature records record the Alder Creek rock walls beginning south of the Ditch Camp 1 Siphon House, along the east side of the canyon to the diversion dam, and then up the west side of the canyon to its mouth and the vicinity of the west end of the Alder Creek Siphon. The recordation forms from the 1991 study are also attached.
Resource Name or # (Assigned by recorder): Rock Walls on the El Dorado Canal at Alder Creek Canyon

L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Alder Creek Canyon

L2a. Portion Described: ☐ Entire Resource Segment ☑ Point Observation Designation: Segment 1

*b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

Approximately 100 meters south of Ditch Camp 1 siphon house.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The rock wall at this location is approximately 53 feet long and reaches a height of four feet. The flume bench at this location is approximately 10 feet wide. The wall is constructed of uncut and un-coursed dry laid granite stones. This segment corresponds to Segment 1 in 1991 study.

L4. Dimensions: (in feet for historic features and meters for prehistoric features)

a. Top Width: 10 feet
b. Bottom Width: unknown
c. Height or Depth: 4 feet
d. Length of Segment: 53 feet

L5. Associated Resources:
Metal conduit with wood supports

L4e. Sketch of Cross-Section (Include scale) Facing: South

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting of this segment is typical of the length of the conduit and rock walls. The bench overlooks Alder Creek Canyon, and has steep hill-sides above and below, both covered with large boulders and dense vegetation. North of this point hillside is less steep and the natural beach is much wider.

L7. Integrity Considerations:

L8b. Description of Photo, Map, or Drawing:
Photograph 2, Camera facing south

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters
JRP Historical Consulting Services, 1490 Drew Ave, Suite 110, Davis, CA 95616

L11. Date: November 12, 2002

*Required Information
Resource Name or # (Assigned by recorder): Rock Walls on the El Dorado Canal at Alder Creek Canyon

L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Alder Creek Canyon

L2a. Portion Described: [ ] Entire Resource Segment [ ] Point Observation Designation: Segment 2

L2b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This section of rock wall is located 50 feet south of Segment 1.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The rock wall at this location is 148 feet long and reaches a height of 8 feet at its southern end. Some portions of the wall are obscured by vegetation and may also indicate breaks, or natural outcroppings incorporated into the wall. The old metal conduit is visible at this location. The wall is constructed of uncut and un-coursed dry laid granite stones. This segment corresponds to Segment 5 in the 1991 study.

L4. Dimensions: (in feet for historic features and meters for prehistoric features)

- e. Top Width 10-12 feet
- f. Bottom Width unknown
- g. Height or Depth 8 feet
- h. Length of Segment 148 feet

L5. Associated Resources:

Metal conduit and wood supports

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting of this segment is typical of the length of the conduit and rock walls. The bench overlooks Alder Creek Canyon, and has steep hillsides above and below. The pitch of the hillside at this point is steeper than at other locations.

L7. Integrity Considerations:

L8a. Photograph, Map, or Drawing:

L8b. Description of Photo, Map, or Drawing:

Photograph 3. Camera facing south

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters

JRP Historical Consulting Services,
1490 Drew Ave, Suite 110,
Davis, CA 95616

L11. Date: November 12, 2002
Resource Name or # (Assigned by recorder): Rock Walls on the El Dorado Canal at Alder Creek Canyon

L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Alder Creek Canyon

L2a. Portion Described: • Entire Resource Segment • Point Observation Designation: Segment 3

*b Location of point or segment (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This section of rock wall is located about 30 feet south of Segment 2.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The wall at this location is 25 feet long and two feet in height. The wall is constructed of uncut and un-coursed dry laid granite stones. This segment corresponds to Segment 2 in the 1991 study.

L4. Dimensions: (in feet for historic features and meters for prehistoric features)

i. Top Width 10 feet
j. Bottom Width unknown
k. Height or Depth 2 feet
l. Length of Segment 25 feet

L5. Associated Resources:

Metal conduit and wood supports

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting of this segment is typical of the length of the conduit and rock walls. The bench overlooks Alder Creek Canyon, and has steep hillsides above and below. The downhill slope is relatively flat for approximately 10 feet on the downhill side of the wall.

L7. Integrity Considerations:

L8a. Photograph, Map, or Drawing:

L8b. Description of Photo, Map, or Drawing:

Photograph 4, Camera facing north

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters

JRP Historical Consulting Services,

1490 Drew Ave, Suite 110,

Davis, CA 95616

L11. Date: November 12, 2002

*Required Information
**Resource Name or #** (Assigned by recorder) Rock Walls on the El Dorado Canal at Alder Creek Canyon

**Historic and/or Common Name:** Rock Walls on the El Dorado Canal at Alder Creek Canyon

**L2a. Portion Described:** □ Entire Resource Segment  □ Point Observation  **Designation:** Segment 4

**L2b. Location of point or segment:** (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This segment is located 50 feet south of Segment 3. The wall begins at a curve in the mountainside.

**L3. Description:** (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The wall at this point is 326 feet long and up to six feet high at the south end. The wall is constructed of cut and roughly coursed dry laid granite. The bench is wide at the southern end of the wall and contains what appears to be a second rock wall that is severely deteriorated. This wall is 25 feet long, one to two feet high, and is constructed of rubble. This segment corresponds to Segment 3 in the 1991 study.

**L4. Dimensions:** (In feet for historic features and meters for prehistoric features)

- **m. Top Width:** 10 feet
- **n. Bottom Width:** unknown
- **o. Height or Depth:** 6 feet
- **p. Length of Segment:** 326 feet

**L5. Associated Resources:** Metal conduit and wood supports

**L6. Setting:** (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting of this segment is typical of the length of the conduit and rock walls. The bench overlooks Alder Creek Canyon, and has steep hillsides above and below covered with trees and vegetation.

**L7. Integrity Considerations:**

**L8b. Description of Photo, Map, or Drawing:** Photograph 5, Camera facing south

**L9. Remarks:**

**L10. Form prepared by:** (Name, affiliation, address) Stephen Wee and Andrew Walters

JRP Historical Consulting Services,
1490 Drew Ave, Suite 110,
Davis, CA 95616

**L11. Date:** November 12, 2002

*Required Information*
Rock Walls on the El Dorado Canal at Alder Creek Canyon

L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Alder Creek Canyon

L2a. Portion Described: □ Entire Resource Segment □ Point Observation Designation: Segment 5

L2b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This recordation point is located just north of the trestle abutment for the former Alder Creek crossing.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The wall at this point is 53 feet long and up to five feet in height. The wall is constructed of cut and roughly coursed dry laid granite. The bench is at this location is 10 feet wide. This segment corresponds to Segment 4 in the 1991 study. At the north end of this segment of rock wall the old metal conduit is visible and is sheltered by a low rock wall, shown in Photograph 7.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

q. Top Width 10 feet
r. Bottom Width unknown
s. Height or Depth 2-5 feet
t. Length of Segment 53 feet

L5. Associated Resources:
Metal conduit and wood supports

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting of this segment is typical of the length of the conduit and rock walls. However, the pitch of the hillside below is less steep in the vicinity.

L7. Integrity Considerations:

L8a. Description of Photo, Map, or Drawing:
Photograph 6, camera facing southeast

L8b. Description of Photo, Map, or Drawing:
Photograph 6, camera facing southeast

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters
JRP Historical Consulting Services, 1490 Drew Ave, Suite 110, Davis, CA 95616

L11. Date: November 12, 2002
Photographs

Photograph 7. Old conduit and rock wall at north end of segment 5, camera facing southeast
L.1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Alder Creek Canyon

L.2a. Portion Described: Entire Resource Segment

L.2b. Location of point or segments: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

The abutment on the east side of the canyon is located just south of Segment 5, and approximately 100 meters from the Alder Creek Diversion Dam.

L.3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The trestle abutment for the former Alder Creek crossing is constructed of roughly coursed dry laid granite blocks and rubble. It is 19.5 feet in height, and projects from the mountainside at a 90 degree angle. The southeast facing side is approximately 10 feet long, and the southwest facing side is approximately 15 feet long.

L.4. Dimensions: (in feet for historic features and meters for prehistoric features)

u. Top Width 10 feet
v. Bottom Width unknown
w. Height or Depth See Description
x. Length of Segment 25 feet

L.5. Associated Resources:

L.6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The hillside at this location is steep, and covered with trees, except for a clearing at the location of the abutment.

L.7. Integrity Considerations:

L.8a. Description of Photo, Map, or Drawing:
Photograph 8, camera facing east

L.9. Remarks:

L.10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters
JRIP Historical Consulting Services, 1490 Drew Ave, Suite 110, Davis, CA 95616

L.11. Date: November 12, 2002
1. Historic and/or Common Name: Alder Creek Diversion Dam

L2a. Portion Described: □ Entire Resource Segment  □ Point Observation  Designation: Segment 7

*b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

The Alder Creek Diversion Dam is located approximately one mile from Ditch Camp 1, at the bottom of Alder Creek Canyon.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The Alder Creek Dam is a stone masonry structure, constructed of stone and mortar. It is constructed between two rock outcrops that serve as natural abutments, and has two approximate 45 degree angles in its length. It is approximately 70 feet long, and consists of a 30 foot long masonry wall on the north end with a 45 degree angle in the middle, a 30 foot spillway section in the middle, and another 10 foot long masonry wall on the southeast end set at a 45 degree angle to the spillway. (See Continuation Sheet)

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

x. Top Width 4 feet

z. Bottom Width unknown

aa. Height or Depth 10 feet

bb. Length of Segment 70 feet

L5. Associated Resources:

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The dam is located at the bottom of the canyon, bridging Alder Creek. The canyon has steep hillside with trees and underbrush, and granite boulder outcroppings on either side.

L7. Integrity Considerations:

L8b. Description of Photo, Map, or Drawing: Photograph 9, camera facing east

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters

JRP Historical Consulting Services

1490 Drew Ave, Suite 110

Davis, CA 95616

L11. Date: November 12, 2002
L3. Description: (Continued)

The wall on the north side of the dam is battered, approximately 10 feet in height and four feet wide. There is an approximately two by two foot opening with an outlet gate in the northern side of the wall to release water into the natural creek bed downstream. North of this opening, the 18 inch diameter metal pipe conduit exits the dam. The overflow spillway section is approximately four feet lower than the crest of the dam, and is battered on the downstream face. There are slots for flashboards on the adjoining masonry walls. The masonry wall on the southeast end is approximately two feet wide and four feet in height.

Photograph 10. Spillway and southeast end of dam, camera facing southeast
Page 13 of 22

Resource Name or # (Assigned by recorder) Rock Walls on the El Dorado Canal at Alder Creek Canyon

L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Alder Creek Canyon

L2a. Portion Described: ☐ Entire Resource Segment ☑ Point Observation Designation: Segment 8

L2b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This section of rock wall is the southeastern most of two retaining walls located southeast of Screech Owl Canyon, and northwest of the Alder Creek Diversion Dam. Located upstream of the old trestle crossing, this section of rock wall must have served as a bench for the old Alder Creek feeder flume.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The bench at this location is 8 feet wide and is heavily overgrown. Its retaining wall is constructed of dry laid roughly coursed granite blocks and rubble. The wall is 50 feet in length and has an average height between two and five feet.

L4. Dimensions: (in feet for historic features and meters for prehistoric features)
   cc. Top Width 8 feet
   dd. Bottom Width unknown
   ee. Height or Depth 2-6 feet
   ff. Length of Segment 50 feet

L5. Associated Resources:

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The hillside at this location has a gradual pitch and is heavily overgrown with vegetation.

L7. Integrity Considerations:

L8a. Photograph, Map, or Drawing.

No Photograph Available

L8b. Description of Photo, Map, or Drawing:

No Photograph available

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters

JRP Historical Consulting Services, 1490 Drew Ave, Suite 110, Davis, CA 95616

L11. Date: November 12, 2002

*Required Information
**Resource Name or # (Assigned by reorder):** Rock Walls on the El Dorado Canal at Alder Creek Canyon

**L1. Historic and/or Common Name:** Rock Walls on the El Dorado Canal at Alder Creek Canyon

**L2a. Portion Described:** □ Entire Resource Segment  □ Point Observation  **Designation:** Segment 9

**L2b. Location of point or segment:** (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This section of rock wall is the northwestern most of two retaining walls located southeast of Screech Owl Canyon, and northwest of the Alder Creek Diversion Dam. Located upstream of the old trestle crossing, this section of rock wall must have served as a bench for the old Alder Creek feeder flume.

**L3. Description:** (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The bench at this location is 8 feet wide and is heavily overgrown. Its retaining wall is constructed of dry laid roughly coursed granite blocks and rubble. The wall is 40 feet in length and reaches a height of 15 feet.

**L4. Dimensions:** (in feet for historic features and meters for prehistoric features)

- **gg. Top Width:** 8 feet
- **hh. Bottom Width:** unknown
- **ii. Height or Depth:** 15 feet
- **jj. Length of Segment:** 40 feet

**L5. Associated Resources:**

**L6. Setting:** (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The hillside at this location has a gradual pitch and is heavily overgrown with vegetation.

**L7. Integrity Considerations:**

**L8a. Photograph, Map, or Drawing.**

No Photograph Available

**L8b. Description of Photo, Map, or Drawing:**

No Photograph available

**L9. Remarks:**

**L10. Form prepared by:** (Name, affiliation, address) Stephen Wee and Andrew Walters

JRPI Historical Consulting Services, 1490 Drew Ave, Suite 110, Davis, CA 95616

**L11. Date:** November 12, 2002

*Required Information*
Historic and/or Common Name: Rock Walls on the El Dorado Canal at Alder Creek Canyon

**Portion Described:** Entire Resource Segment

**Location of point or segment:** (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

The abutment on the west side of the canyon is located southeast of Screech Owl Canyon, and northwest of the Alder Creek Diversion Dam.

**Description:** (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The trestle abutment for the former Alder Creek crossing is constructed of roughly coursed dry laid granite blocks and rubble. It is 19.5 feet in height, and projects from the mountainside at a 90 degree angle. The northeast facing side is approximately 10 feet long, and the northwest facing side is approximately 15 feet long.

**Dimensions:** (in feet for historic features and meters for prehistoric features)

- **Top Width**: 10 feet
- **Bottom Width**: unknown
- **Height or Depth**: See Description
- **Length of Segment**: 25 feet

**Setting:** (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The hillside at this location is steep, and covered with trees, except for a clearing at the location of the abutment.

**Integrity Considerations:**

**Description of Photo, Map, or Drawing:**

Photograph 11, camera facing south

**Remarks:**

**Form prepared by:** Stephen Wee and Andrew Walters

**Date:** November 12, 2002
**Historic and/or Common Name:** Rock Walls on the El Dorado Canal at Alder Creek Canyon

**Portion Described:**
- **Entire Resource Segment**
- **Point Observation**

The rock wall at this location is approximately 50 feet southeast of Screech Owl Creek.

**Description:**
This curving rock wall at this location is 40 feet long, and up to 15 feet in height at its center. There is a one and one half by three foot rectangular drainage opening in the wall. The bench is overgrown.

**Dimensions:**
- **Top Width:** 6 feet
- **Bottom Width:** unknown
- **Height or Depth:** 15
- **Length of Segment:** 40 feet

**Setting:**
The hillside at this location has a gradual pitch and is heavily overgrown with vegetation.

**Integrity Considerations:**

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**Photograph:**
Photograph 12. Camera facing southeast.

**Remarks:**

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**Prepared by:**
Stephen Wee and Andrew Walters
JRP Historical Consulting Services,
1490 Drew Ave, Suite 110,
Davis, CA 95616

**Date:** November 12, 2002
Resource Name or # (Assigned by recorder) Rock Walls on the El Dorado Canal at Alder Creek Canyon

L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Alder Creek Canyon

L2a. Portion Described: [ ] Entire Resource Segment  [Χ] Point Observation  Designation: Segment 12

*Lb. Location of point or segment (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This section of rock wall is located at Screech Owl Canyon, on the mountainside above where Screech Owl Creek joins Alder Creek.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The rock wall at Screech Owl Creek spans this tributary to Alder Creek and is approximately 200 feet long and up to 15 high at its southern end. It is constructed of dry laid roughly coursed granite blocks and rubble. At the south end of the wall at Screech Owl Creek, there is a rectangular drainage opening for the creek to flow through the rock wall. The opening is two by four feet in size. The bench at this point is heavily overgrown. The north end of the wall is shown in Photograph 14, and averages four feet in height.

L4. Dimensions: (in feet for historic features and meters for prehistoric features)

- ss. Top Width  6 feet
- tt. Bottom Width  unknown
- uu. Height or Depth  15 feet
- vv. Length of Segment  200 feet

L5. Associated Resources:

L4e. Sketch of Cross-Section (include scale) Facing: Northwest

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The hillside at this location has a gradual pitch and is heavily overgrown with vegetation.

L7. Integrity Considerations:

L8a. Photograph, Map, or Drawing:

L8b. Description of Photo, Map, or Drawing: Photograph 13, Camera facing northwest

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters

JRP Historical Consulting Services,

1490 Drew Ave, Suite 110,

Davis, CA 95616

L11. Date: November 12, 2002

*Required Information
Photographs

Photograph 14. North end of Segment 12, camera facing northwest
Rock Walls on the El Dorado Canal at Alder Creek Canyon

L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Alder Creek Canyon

L2a. Portion Described: [ ] Entire Resource Segment  [ ] Point Observation Designation: Segment 13

* Required Information

L2b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This segment of rock wall is located on either side of the creek bed for the northernmost tributary to Alder Creek. Approximately one quarter mile south of the west end of the Alder Creek siphon.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

At this point there are the remains of rock wall sections on either side of the creek bed crossing that likely functioned as trestle abutments for a trestle that crossed the creek bed. The wall on the north side of the crossing is approximately 10 feet long and six feet in height (Photograph 16), and the wall on the south side is approximately 20 feet long and 12 feet high at its north end (Photograph 17). The walls support a narrow bench, and there is a cut for the canal above the rock wall on the south side of the crossing where the open canal resumes. The cut is roughly a five wide and four feet high.

L4. Dimensions: (in feet for historic features and meters for prehistoric features)

uu. Top Width See Description
xx. Bottom Width unknown
yy. Height or Depth See Description
zz. Length of Segment See Description

L5. Associated Resources:
Cut for canal

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The area is heavily overgrown, and the hillside is steep on either side of the creek bed.

L7. Integrity Considerations:

L8b. Description of Photo, Map, or Drawing:

Photograph 15. Camera facing southeast, canal embankment (right) and rock wall (left)

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters
JRPHistorical Consulting Services,
1490 Drew Ave, Suite 110,
Davis, CA 95616

L11. Date: November 12, 2002
Photographs

Photograph 16 and 17. Walls on the north (left) and south (right) sides of northerly unnamed creek crossing (Segment 10)
Resource Name or # (Assigned by recorder): Rock Walls on the El Dorado Canal at Alder Creek Canyon

**L1. Historic and/or Common Name:** Rock Walls on the El Dorado Canal at Alder Creek Canyon

**L2a. Portion Described:** Entire Resource Segment  □  Point Observation  

**Designation:** Segment 14

**L2b. Location of point or segment:** Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.

This segment is typical of the open canal portions of the abandoned section of the El Dorado Canal on the west side of Alder Creek Canyon. This segment is located at the north end of the canyon, beginning south of the Alder Creek Siphon, and running one quarter mile to the northernmost unnamed tributary to Alder Creek.

**L3. Description:** Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.

The open ditch is roughly parabolic, and has a bottom width of approximately two feet, a top width of 10 feet and is six feet deep.

**L4. Dimensions:** (in feet for historic features and meters for prehistoric features)

<table>
<thead>
<tr>
<th>Description</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Width</td>
<td>10 feet</td>
</tr>
<tr>
<td>Bottom Width</td>
<td>2 feet</td>
</tr>
<tr>
<td>Height or Depth</td>
<td>five feet</td>
</tr>
<tr>
<td>Length of Segment</td>
<td>¼ mile</td>
</tr>
</tbody>
</table>

**L5. Associated Resources:**

**L4a. Sketch of Cross-Section (include scale) Facing: South**

```
10'  8
5'
2'
```

**L6. Setting:** Describe natural features, landscape characteristics, slope, etc., as appropriate.

The canal is located on a gently sloping mountainside that is characterized by many standing and fallen trees.

**L7. Integrity Considerations:**

**L8b. Description of Photo, Map, or Drawing:** Photograph 18. Camera facing south

**L9. Remarks:**

**L10. Form prepared by:** (Name, affiliation, address) Stephen Wee and Andrew Walters  
JRP Historical Consulting Services,  
1490 Drew Ave, Suite 110,  
Davis, CA 95616

**L11. Date:** November 12, 2002

*Required Information*
Sketch Map
The Plum Creek flume bench walls are located along the mountainside on the east and west sides of Plum Creek, a northerly flowing tributary to the South Fork of the American River. The creek runs through a steep canyon with a deep, gaping mouth that proved to be a formidable barrier to the canal builders of the 1870s. The rock walls constructed in 1874-1875 on the steep slopes of Plum Creek maintain the hydraulic gradient necessary to convey water at high elevation in flumes around the canyon. To support the flume, rock bench foundation walls were erected on the steep mountain slopes along this section of the El Dorado Canal. The flume was abandoned as a water conveyance facility in 1924 after the construction of the Plum Creek siphon, which carried water across the mouth of the canyon. The rock bench wall on the east side of the canyon currently functions as a retaining wall for the access road to Ditch Camp 2. (See Continuation Sheet)

*P3b. Resource Attributes: (List attributes and codes) HP11 (Engineering Structure)

*P4. Resources Present: □ Building □ Structure □ Object □ Site □ District □ Element of District □ Other (Isolates, etc.)

*P5b. Description of Photo: (View, date, accession #) Photograph 1, general view of rock walls on east side of canyon, camera facing northeast

*P6. Date Constructed/Age and Sources: □ Historic □ Prehistoric □ Both 1874-1875

*P7. Owner and Address: El Dorado Irrigation District 2890 Mosquito Road, Placerville, CA 95667

*P8. Recorded by: (Name, affiliation, address) Stephen Wee and Andrew Walters JRP Historical Consulting Services, 1490 Drew Ave, Suite 110, Davis, CA 95616

*P9. Date Recorded: October 2, 2002

*P10. Survey Type: (Describe) Intensive


*Attachments: NONE □ Location Map □ Sketch Map □ Continuation Sheet □ Building, Structure, and Object Record □ Archaeological Record □ District Record □ Linear Feature Record □ Milling Station Record □ Rock Art Record □ Artifact Record □ Photograph Record □ Other (list) DPR 523A (1/95)

*Required Information
P3a. Description (continued):

The trestle that once bridged the canyon has long ago been destroyed. The remaining evidence of the El Dorado Canal on the west side of the canyon is extensive, consisting of alternating sections of open canal and flume bench with rock retaining walls. The conveyance system on this side of the canyon, however, has been abandoned since the 1920s. The El Dorado Canal originally included a feeder flume that ran up from the trestle crossing on the west side of the canyon to the Plum Creek diversion dam. Water was diverted into the feeder flume which joined the main canal at the trestle junction on the west side of the canyon.

The extensive flume bench wall sections in Plum Creek Canyon were one of 28 sections of rock wall located along the El Dorado Canal between the Intake and Forebay that were inventoried and evaluated in 1991 in the study "Archeological Survey and Historic Research Report on the El Dorado Canal, El Dorado County, California." This study found the Plum Creek Canyon flume bench walls to be one of seven sections of stone masonry walls that were eligible for listing in the National Register of Historic Places as part of a discontiguous historic district. The State Office of Historic Preservation concurred with this determination in 1993.

Although only the rock walls on the east side of the canyon were formally recorded in 1991, it was the intent of that study to include all of the rock masonry engineering features in Plum Creek Canyon that dated to the 1870s period as among the National Register Eligible properties enumerated generally as the "Plum Creek" rock walls. The Plum Creek Diversion Dam, feeder flume bench walls and the remaining walls along the abandoned section of the El Dorado Canal on the west side of the canyon were not formally recorded in 1990 or 1991 because they were abandoned, and therefore, were considered as outside of the PG&E defined study area for those cultural studies. In addition, the flume bench walls on the east side of the canyon were recorded on a resource description sheet unique to that study, and not on DPR 523 Primary Record or BSO forms. For the current study JRP staff formally recorded the resources on the west side of the canyon for the first time, and revisited the walls on the east side of the canyon to record their current condition. The results of these findings were combined and presented on this DPR 523 form.

The Plum Creek Canyon flume bench wall on the east side of the canyon was found to have changed little since the 1991 survey. At that time, five primary segments of rock wall along the east side of the canyon were recorded, measuring 35, 104, 177, 272, and 166 feet in length, and ranging between three and twenty feet in height. The old flume bench formed behind the rock retaining wall now serves as a canal access road; the bench is approximately 12 feet in average width. During the current survey, JRP staff found sections of rock wall that corresponded generally to the dimensions of the segments as recorded in the 1991 survey. The wall segments are constructed of dry laid masonry using granite blocks and rubble laid in irregular courses. The massive stone abutments that once anchored the Plum Creek trestle at its canyon crossing and the stone walls along the old Plum Creek feeder line remain intact. The earth surfaced road that the retaining wall now supports has been graded recently, uncovering parts of the rock rubble fill that extends back from the exposed granite blocks on the outer facing of the rock wall. The rock walls on the east side of the canyon were recorded in 1991 as Segments 1 through 5, and are so noted in this description.

The abandoned section of the El Dorado Canal on the west side of the canyon consists of the feeder flume bench that runs from the diversion dam on Plum Creek approximately 300 feet downstream to a point where it meets with the main canal at the west trestle abutment. On the west side of the canyon, the El Dorado Canal of the
P3a. Description (continued):

1870s to 1920s ran in alternating sections of excavated ditch, ditch formed behind built-up outer walls, and flume bench, maintaining a hydraulic gradient along the steep canyon slopes and emerged from the canyon at the location where the west end of the Plum Creek Siphon now discharges into the canal. The remains of the Plum Creek Diversion Dam, shown in Photograph 9, consist of only deteriorated remnants of the rock abutment walls on either side of the creek. Approximately 20 feet west of the diversion dam is a section of the feeder flume bench wall. It is constructed of dry laid rock, and is approximately 4-5 feet high and 15 feet long. The feeder flume bench walls continue intermittently downstream from the diversion dam to a spillway at the junction of the feeder flume and the El Dorado Canal. The bench is generally about 8-10 feet wide and 5-6 feet high. The feeder flume bench walls were recorded in this survey as Segments 6 and 7.

The feeder flume spillway is located downstream from the junction of the main canal flume at the trestle crossing and the feeder flume, west of the trestle abutment. There is a two stepped rock wall approximately nine feet high on the south side of the spillway channel, and a two stepped wall on the north side that is approximately four feet high. This junction point of the feeder flume and main El Dorado Canal was recorded as Segment 8.

North of the spillway and abutment, intermittent sections of canal and flume bench continue for a distance of approximately one mile until the canal meets with the west end of the Plum Creek Siphon. The area near the creek crossing is strewn with deteriorated timbers, likely from the extensive flume and trestle structures that once existed in this area. On the northwest side of the spillway is an open canal section that runs for several hundred feet before it transitions back to a flume bench. Beyond this section of ditch there are four discernable sections of rock wall, recorded as Segments 9, 10, 12 and 13. The bench at this location is approximately eight to ten feet wide, and its supporting rock walls generally average three to five feet in height, and reach ten feet in height at places. A typical section of open canal is included as Segment 11.
Resource Name or # (Assigned by recorder): Rock Walls on the El Dorado Canal at Plum Creek Canyon

L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Plum Creek Canyon

L2a. Portion Described: □ Entire Resource Segment  □ Point Observation  Designation: Segment 1

L2b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This section of wall is located .2 miles southeast of Ditch Camp 2.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The rock wall at this location is approximately 35 feet long and reaches a height of 11 feet. The flume bench at this location is approximately 12 feet wide. The wall is constructed of local granite rocks and blocks blasted from natural outcroppings and boulders prevalent in the region. The granite is dry-laid and set randomly without any courses. The interstices between large granite blocks are filled with smaller stones and the walls are backed with rubble fill.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)
   a. Top Width 12 feet
   b. Bottom Width unknown
   c. Height or Depth 11 feet
   d. Length of Segment 35 feet

L5. Associated Resources:

L4c. Sketch of Cross-Section (include scale)  Facing: Northwest

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting at this location is typical of the east side of the canyon. The bench overlooks Plum Creek Canyon, and has steep hillsides covered with trees and boulders above and below.

L7. Integrity Considerations:

The access road has been recently graded, exposing the rock wall in places.

L8b. Description of Photo, Map, or Drawing:

Photograph 2, Camera facing northwest

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters

JRP Historical Consulting Services, 1490 Drew Ave, Suite 110, Davis, CA 95616

L11. Date: October 2, 2002

*Required Information
L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Plum Creek Canyon

L2a. Portion Described: □ Entire Resource Segment  □ Point Observation  Designation: Segment 2

L2b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This section of wall is located .3 miles southeast of Ditch Camp 2.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The rock wall at this location is approximately 104 feet long and reaches a height of three to four feet. The flume bench at this location is approximately 12 feet wide. The wall is constructed of local granite rocks and blocks blasted from natural outcroppings and boulders prevalent in the region. The granite is dry-laid and set randomly without any courses. The interstices between large granite blocks are filled with smaller stones and the walls are backed with rubble fill.

L4. Dimensions: (in feet for historic features and meters for prehistoric features)
   e. Top Width 12 feet
   f. Bottom Width unknown
   g. Height or Depth 3-4 feet
   h. Length of Segment 104 feet

L5. Associated Resources:

L4e. Sketch of Cross-Section (Include scale)  Facing: Northwest

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting at this location is typical of the east side of the canyon. The bench overlooks Plum Creek Canyon, and has steep hillsides covered with trees and boulders above and below.

L7. Integrity Considerations:

The access road has been recently graded, exposing the rock wall in places.

L8b. Description of Photo, Map, or Drawing:
Photograph 3, Camera facing northwest

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters
JRP Historical Consulting Services,
1490 Drew Ave, Suite 110,
Davis, CA 95616

L11. Date: October 2, 2002

*Required Information
Resource Name or # (Assigned by recorder) Rock Walls on the El Dorado Canal at Plum Creek Canyon

1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Plum Creek Canyon

2a. Portion Described: □ Entire Resource Segment  □ Point Observation  Designation: Segment 3

2b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This section of wall is located .4 miles southeast of Ditch Camp 2, northwest of the bridge.

3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The rock wall at this location is approximately 177 feet long and reaches a height of 20 feet at its southern end. The flume bench at this location is approximately 12 feet wide. The wall is constructed of local granite rocks and blocks blasted from natural outcroppings and boulders prevalent in the region. The granite is dry-laid and set randomly without any courses. The interstices between large granite blocks are filled with smaller stones and the walls are backed with rubble fill.

4. Dimensions: (in feet for historic features and meters for prehistoric features)
   i. Top Width: 12 feet
   j. Bottom Width: unknown
   k. Height or Depth: 20 feet
   l. Length of Segment: 177 feet

5. Associated Resources:
   Wood trestle bridge

6a. Sketch of Cross-Section (include scale) Facing: Northwest

6b. Description of Photo, Map, or Drawing: Photograph 4, Camera facing east

6c. Photograph, Map, or Drawing

7. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting at this location is typical of the east side of the canyon. The bench overlooks Plum Creek Canyon, and has steep hillsides covered with trees and boulders above and below.

8. Integrity Considerations:

The access road has been recently graded, exposing the rock wall in places. The bridge, located approximately .5 miles from Ditch Camp 2 was being repaired at the time of recordation in October 2002.

9. Remarks:

10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters
   JRP Historical Consulting Services, 1490 Drew Ave, Suite 110, Davis, CA 95616

11. Date: October 2, 2002

*Required Information
L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Plum Creek Canyon

L2a. Portion Described: □ Entire Resource Segment  □ Point Observation  Designation: Segment 4

L2b. Location of Point or Segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This section of wall is located .5 miles southeast of Ditch Camp 2, southeast of the bridge.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The rock wall at this location is approximately 270 feet long and reaches a height of 12 feet. The flume bench at this location is approximately 15 feet wide. The wall is constructed of local granite rocks and blocks blasted from natural outcroppings and boulders prevalent in the region. The granite is dry-laid and set randomly without any courses. The interstices between large granite blocks are filled with smaller stones and the walls are backed with rubble fill.

L4a. Sketch of Cross-Section (Include scale) Facing: Northwest

L4b. Dimensions: (In feet for historic features and meters for prehistoric features)

m. Top Width 15 feet
n. Bottom Width unknown
o. Height or Depth 12 feet
p. Length of Segment 270 feet

L5. Associated Resources:
Wood trestle bridge

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting at this location is typical of the east side of the canyon. The bench overlooks Plum Creek Canyon, and has steep hillsides covered with trees and boulders above and below.

L7. Integrity Considerations:

The access road has been recently graded, exposing the rock wall in places. The bridge, located approximately .5 miles from Ditch Camp 2 was being repaired at the time of recordation in October 2002.

L8b. Description of Photo, Map, or Drawing:
Photograph 5, Camera facing east

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters
JRP Historical Consulting Services, 1490 Drew Ave, Suite 110, Davis, CA 95616

L11. Date: October 2, 2002
L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Plum Creek Canyon

L2a. Portion Described: [] Entire Resource Segment  [ ] Point Observation  Designation: Segment 5

L2b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This section of wall is located .6 miles southeast of Ditch Camp 2, southeast of the bridge.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The rock wall at this location is approximately 160 feet long and reaches a height of 10 feet. The flume bench at this location is approximately 15 feet wide. The wall is constructed of local granite rocks and blocks blasted from natural outcroppings and boulders prevalent in the region. The granite is dry-laid and set randomly without any courses. The interstices between large granite blocks are filled with smaller stones and the walls are backed with rubble fill. The wall ends near the former site of Camp 7, near the abutment for the trestle that once crossed the canyon. The abutment is shown in Photograph 7.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

q. Top Width 15 feet
r. Bottom Width unknown
s. Height or Depth 10 feet
t. Length of Segment 160 feet

L5. Associated Resources:

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting at this location is typical of the east side of the canyon. The bench overlooks Plum Creek Canyon, and has steep hillsides covered with trees and boulders above and below.

L7. Integrity Considerations:

The access road has been recently graded, exposing the rock wall in places.

L8a. Photograph, Map, or Drawing:

L8b. Description of Photo, Map, or Drawing:
Photograph 6. Camera facing east

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters
JRP Historical Consulting Services, 1490 Drew Ave, Suite 110, Davis, CA 95616

L11. Date: October 2, 2002
Photographs

Photograph 7. Trestle abutment on east side of Plum Creek Canyon camera facing south.
L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Plum Creek Canyon

L2a. Portion Described: □ Entire Resource Segment  ☑ Point Observation  Designation: Segment 6

*b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This section of wall is located 20 feet west of the diversion dam.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The rock wall at this location once supported the Plum Creek feeder flume that ran from the diversion dam to a spillway at the trestle crossing of the El Dorado Canal. It is approximately 15 feet long and reaches a height of four to five feet. The flume bench at this location is approximately 8 feet wide. The wall is constructed of local granite rocks and blocks blasted from natural outcroppings and boulders prevalent in the region. The granite is dry-laid and set randomly without any courses. The interstices between large granite blocks are filled with smaller stones and the walls are backed with rubble fill. The diversion dam is shown in Photograph 9.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

u. Top Width  8 feet
v. Bottom Width  unknown
w. Height or Depth  4-5 feet
x. Length of Segment  15 feet

L5. Associated Resources:

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting at this location is typical of the west side of the canyon. The bench runs through a heavily wooded area, with a gradually pitched hillside above and below.

L7. Integrity Considerations:

L8b. Description of Photo, Map, or Drawing: Photograph 8, Camera facing southeast

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters

JRP Historical Consulting Services,
1490 Drew Ave, Suite 110,
Davis, CA 95616

L11. Date: October 2, 2002

*Required Information
Photograph 9. Remains of the Plum Creek Diversion Dam, camera facing east
L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Plum Creek Canyon

L2a. Portion Described: Entire Resource Segment  
Point Observation  
Designation: Segment 7

*Location of point or segments* (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This section of feeder flume bench wall is located northwest of the diversion dam, and southeast of the trestle abutment and spillway.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The feeder flume bench wall continues intermittently downstream from the diversion dam. This section of rock wall is approximately 30 feet long and reaches a height of three to four feet. The flume bench at this location is approximately 8 feet wide. The wall is constructed of local granite rocks and blocks blasted from natural outcroppings and boulders prevalent in the region. The granite is dry-laid and set randomly without any courses. The interstices between large granite blocks are filled with smaller stones and the walls are backed with rubble fill.

L4. Dimensions: (in feet for historic features and meters for prehistoric features)

1. Top Width: 8 feet
2. Bottom Width: unknown
3. Height or Depth: 3-4 feet
4. Length of Segment: 30 feet

L5. Associated Resources:

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting at this location is typical of the west side of the canyon. The bench runs through a heavily wooded area, with a gradually pitched hillside above and below.

L7. Integrity Considerations:

L8a. Photograph, Map, or Drawing:

L8b. Description of Photo, Map, or Drawing:

Photograph 10. Camera facing northwest

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address)  
Stephen Wee and Andrew Walters  
JRP Historical Consulting Services,  
1490 Drew Ave, Suite 110,  
Davis, CA 95616

L11. Date: October 2, 2002

*Required Information*
L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Plum Creek Canyon

L2a. Portion Described: Entire Resource Segment

L2b. Location of point or segments: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This recordation point is located where the feeder flume meets the abandoned section of the El Dorado Canal, approximately one quarter mile from the diversion dam.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The feeder flume bench ends at the south side of a spillway channel. The trestle abutment for the El Dorado Canal is located west of the channel. The spillway has two stepped rock walls that are nine feet in height on the south side, and four feet high on the north side. The trestle abutment is approximately six feet in height, and eight six feet wide. The end of the feeder flume bench at the spillway is shown in Photograph 12, and the abutment is shown in Photograph 13.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

cc. Top Width: See Description

dd. Bottom Width: unknown

ee. Height or Depth: See Description

ff. Length of Segment: See Description

L5. Associated Resources:

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting at this location is typical of the west side of the canyon. The bench runs through a heavily wooded area, with a gradually pitched hillside above and below.

L7. Integrity Considerations:

L8b. Description of Photo, Map, or Drawing:

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters

JRP Historical Consulting Services,
1490 Drew Ave, Suite 110,
Davis, CA 95616

L11. Date: October 2, 2002

Photograph 11. Looking across Plum Creek Canyon at the end of the feeder flume, and trestle abutment. Camera facing southwest.
Photographs

Photograph 12. End of feeder flume at spillway, camera facing east

Photograph 13. Trestle abutment on the west side of Plum Creek Canyon, camera facing northwest
Resource Name or # (Assigned by recorder) Rock Walls on the El Dorado Canal at Plum Creek Canyon

L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Plum Creek Canyon

L2a. Portion Described: □ Entire Resource □ Segment □ Point Observation Designation: Segment 9

L2b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This section of flume bench wall is located several hundred feet northwest of the trestle abutment and spillway.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The flume bench wall continues intermittently downstream from the spillway and trestle abutment. This section of rock wall is approximately 180 feet long and varies in height between three to five feet. The flume bench at this location is approximately eight feet wide and ends at a granite outcropping with drilled blasting holes. The wall is constructed of local granite rocks and blocks blasted from natural outcroppings and boulders prevalent in the region. The granite is dry-laid and set randomly without any courses. The interstices between large granite blocks are filled with smaller stones and the walls are backed with rubble fill.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>gg. Top Width</td>
<td>8 feet</td>
</tr>
<tr>
<td>hh. Bottom Width</td>
<td>unknown</td>
</tr>
<tr>
<td>ii. Height or Depth</td>
<td>3-5 feet</td>
</tr>
<tr>
<td>jj. Length of Segment</td>
<td>180 feet</td>
</tr>
</tbody>
</table>

L5. Associated Resources:

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting at this location is typical of the west side of the canyon. The bench runs through a heavily wooded area, with a gradually pitched hillside above and below.

L7. Integrity Considerations:

L8a. Photograph, Map, or Drawings:

L8b. Description of Photo, Map, or Drawing: Photograph 14, Camera facing northwest

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters

JRP Historical Consulting Services,
1490 Drew Ave, Suite 110,
Davis, CA 95616

L11. Date: October 2, 2002

*Required Information
Resource Name or #: Rock Walls on the El Dorado Canal at Plum Creek Canyon

L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Plum Creek Canyon


*b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This section of flume bench wall is located northwest of the trestle abutment and spillway.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

This section of rock wall is approximately 65 feet long and reaches a height of 10 feet at its northern end. The flume bench at this location is approximately 8 feet wide. The wall is constructed of local granite rocks and blocks blasted from natural outcroppings and boulders prevalent in the region. The granite is dry-laid and set randomly without any courses. The interstices between large granite blocks are filled with smaller stones and the walls are backed with rubble fill.

L4. Dimensions: (in feet for historic features and meters for prehistoric features)

kk. Top Width: 8 feet
ll. Bottom Width: unknown
mm. Height or Depth: 10 feet
nn. Length of Segment: 65 feet

L5. Associated Resources:

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting at this location is typical of the west side of the canyon. The bench runs through a heavily wooded area, with a gradually pitched hillside above and below.

L7. Integrity Considerations:

L8a. Photograph, Map, or Drawing:

Photograph 15, Camera facing southeast

L8b. Description of Photo, Map, or Drawing:

Photograph 15, Camera facing southeast

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters
JR P Historical Consulting Services,
1490 Drew Ave, Suite 110,
Davis, CA 95616

L11. Date: October 2, 2002
**Resource Name or # (Assigned by recorder): Rock Walls on the El Dorado Canal at Plum Creek Canyon**

**L1. Historic and/or Common Name:** Rock Walls on the El Dorado Canal at Plum Creek Canyon

**L2a. Portion Described:** □ Entire Resource Segment  □ Point Observation  **Designation:** Segment 11

**b. Location of point or segment:** (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This location is representative of the open canal sections of the abandoned section of the El Dorado Canal, and is located midway between the spillway and abutment and the west end of the Plum Creek siphon.

**L3. Description:** (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

This open canal section is built into the hillside and has a berm on the northeast side (downhill slope). The canal is approximately 12 feet wide and five feet deep. The berm is approximately six feet wide.

**L4. Dimensions:** (in feet for historic features and meters for prehistoric features)

- **oo. Top Width** 12 feet
- **pp. Bottom Width** 4 feet
- **qq. Height or Depth** 200 feet
- **rr. Length of Segment** 30 feet

**L5. Associated Resources:**

**L4e. Sketch of Cross-Section (include scale) Facing:** Northwest

![Sketch of Cross-Section](image)

**L6. Setting:** (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting at this location is typical of the west side of the canyon. The bench runs through a heavily wooded area, with a gradually pitched hillside above and below.

**L7. Integrity Considerations:**

**L8b. Description of Photo, Map, or Drawing:**

Photograph 16, Camera facing southeast

**L9. Remarks:**

**L10. Form prepared by:** (Name, affiliation, address) Stephen Wee and Andrew Walters

JRP Historical Consulting Services,
1490 Drew Ave, Suite 110,
Davis, CA 95616

**L11. Date:** October 2, 2002

*Required Information*
Page 18 of 20

Resource Name or # (Assigned by recorder): Rock Walls on the El Dorado Canal at Plum Creek Canyon

L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Plum Creek Canyon

L2a. Portion Described: □ Entire Resource Segment □ Point Observation Designation: Segment 12

*b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This section of flume bench wall is located northwest of the trestle abutment and spillway, across the canyon from the bridge.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

This section of rock wall is approximately 100 feet long and varies in height between five and eight feet, and is taller at the northern end. The flume bench at this location is approximately 8 feet wide. The wall is constructed of local granite rocks and blocks blasted from natural outcroppings and boulders prevalent in the region. The granite is dry-laid and set randomly without any courses. The interstices between large granite blocks are filled with smaller stones and the walls are backed with rubble fill.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

ss. Top Width 8 feet
tt. Bottom Width unknown
uu. Height or Depth 5-8 feet
vv. Length of Segment 100 feet

L5. Associated Resources:

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting at this location is typical of the west side of the canyon. The bench runs through a heavily wooded area, with a gradually pitched hillside above and below.

L7. Integrity Considerations:

L8b. Description of Photo, Map, or Drawing:

Photograph 17, Camera facing northwest

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Stephen Wee and Andrew Walters

JRP Historical Consulting Services, 1490 Drew Ave, Suite 110, Davis, CA 95616

L11. Date: October 2, 2002

*Required Information
**Resource Name or #** (Assigned by recorder): Rock Walls on the El Dorado Canal at Plum Creek Canyon

**L1. Historic and/or Common Name:** Rock Walls on the El Dorado Canal at Plum Creek Canyon

**L2a. Portion Described:** Entire Resource Segment

**L2b. Location of point or segment:** (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This section of flume bench wall is the most northerly along the abandoned section of the El Dorado Canal located approximately 100 meters from the west end of the Plume Creek siphon.

**L3. Description:** (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

This section of rock wall is approximately 45 feet long and reaches a height of 10 feet. The flume bench at this location is approximately 10-12 feet wide. The wall is constructed of local granite rocks and blocks blasted from natural outcroppings and boulders prevalent in the region. The granite is dry-laid and set randomly without any courses. The interstices between large granite blocks are filled with smaller stones and the walls are backed with rubble fill.

**L4. Dimensions:** (in feet for historic features and meters for prehistoric features)

- **ww. Top Width:** 10-12 feet
- **xx. Bottom Width:** unknown
- **yy. Height or Depth:** 10 feet
- **zz. Length of Segment:** 45 feet

**L5. Associated Resources:**

**L4e. Sketch of Cross-Section (include scale) Facing:** Northwest

**L6. Setting:** (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting at this location is typical of the west side of the canyon. The bench runs through a heavily wooded area, with a gradually pitched hillside above and below.

**L7. Integrity Considerations:**

**L8b. Description of Photo, Map, or Drawing:** Photograph 18, Camera facing northwest

**L9. Remarks:**

**L10. Form prepared by:** (Name, affiliation, address) Stephen Wee and Andrew Walters
JRP Historical Consulting Services
1490 Drew Ave, Suite 110
Davis, CA 95616

**L11. Date:** October 2, 2002

*Required Information*
*Resource Name or # (Assigned by recorder): Rock Walls on the El Dorado Canal at Plum Creek Canyon

*Recorded by: Stephen Wee and Andrew Walters  *Date: October 2, 2002

Sketch Map
The rock walls along the Echo Lake conduit are located along a mountainside south and east of Echo Lake, between Lower Echo Lake and Highway 50. The Echo Lake conduit runs 1.16 miles from Lower Echo Lake to the South Fork of the American River, and includes a .55 mile metal conduit section, 100 feet of which is supported by a wood trestle, a .17 mile open canal section, and a .2 mile tunnel section which empties into a natural drainage channel tributary to the South Fork of the American River. The flume bench walls inventoried on this DPR523 Form support the metal pipe section of the conduit. (See Continuation Sheet)
**Resource Name or #**: Rock Walls on the El Dorado Canal at Echo Lake Conduit

**Historic and/or Common Name**: Rock Walls on the El Dorado Canal at Echo Lake Conduit

**Portion Described**: Entire Resource Segment

**Designation**: Segment 1

Segment 1 is the first section of flume bench wall along the conduit, located .23 miles southwest of the beginning of the conduit at Echo Lake Dam. UTM: 10 / 756983 / 4302356

**Description**: This segment is constructed of dry laid uncoursed rough cut granite stones with a mix of small and large uncut stones acting as infill. The wall faces north. Natural granite outcroppings have also been incorporated into the wall in several places, and in some areas cut granite stones form the bench wall above low outcroppings of granite boulders. (see also Photographs 7 and 8).

**Dimensions**: a. Top Width 5 feet  
   b. Bottom Width unknown  
   c. Height or Depth 2-5 feet  
   d. Length of Segment 45 feet

**Associated Resources**: Metal conduit with wood supports

**Setting**: At this location the pitch of the mountainside is less steep than at other rock wall locations. The uphill slope is characterized by trees and thick vegetation, and the downhill slope is covered in bushes and strewn with rocks and boulders.

**Integrity Considerations**: Some portions of the rock wall have been recently built up.

**Description of Photo, Map, or Drawing**: Photograph 2, Segment 1, Camera facing east

**Remarks**: 

**Form prepared by**: Chris McMorris and Andrew Walters  
JRP Historical Consulting Services,  
1490 Drew Ave, Suite 110,  
Davis, CA 95616

**Date**: August 27, 2002
**Resource Name or # (Assigned by recorder)** Rock Walls on the El Dorado Canal at Echo Lake Conduit

L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Echo Lake Conduit

L2a. Portion Described: ☐ Entire Resource Segment ☐ Point Observation  
**Designation:** Segment 2

*Location of point or segment:* (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

Segment 2 is located 10-20 feet southeast of Segment 1. UTM: 10 / 757060 / 4302328

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

Segment 2 runs on a northeastern course and is constructed of roughly coursed dry laid granite, with small stones acting as infill. Large cut and uncut stones, and natural outcroppings are integrated into the wall. It is generally three to five feet in height, with portions as high as 17 feet. South of the conduit is a small retaining wall (Photograph 9) constructed of small dry laid stones that retains a large boulder on the uphill slope. This smaller retaining wall is approximately two feet in length and one and one half feet in height.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)
   
   e. Top Width 8 feet  
   f. Bottom Width unknown  
   g. Height or Depth 2-17 feet  
   h. Length of Segment 112 feet

L5. Associated Resources:  
Metal conduit with wood supports

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The setting of this segment is typical of the length of the conduit and rock walls. The bench overlooks Highway 50 and has steep hillsides above and below: the hillside above is covered with large boulders and dense vegetation, and the hillside below is strewn with large rocks and downed trees.

L7. Integrity Considerations:

L8a. Photograph, Map, or Drawing: Photograph 3, Segment 2, camera facing south

L8b. Description of Photo, Map, or Drawing:  
Photograph 3, Segment 2, camera facing south

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Chris McMorris and Andrew Walters  
JRP Historical Consulting Services,  
1490 Drew Ave, Suite 110,  
Davis, CA 95616

L11. Date: August 27, 2002
**Resource Name or # (Assigned by recorder)** Rock Walls on the El Dorado Canal at Echo Lake Conduit

**Historic and/or Common Name:** Rock Walls on the El Dorado Canal at Echo Lake Conduit

**Portion Described:**
- **Entire Resource Segment**

**Designation:** Segment 3

**Location of point or segment:** (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

This segment is located 20-30 feet southeast of Segment 2, and ends where the mountainside curves to the south.

**UTM:** 10 / 757142 / 4302288

**Description:**

Segment 3 is constructed of roughly coursed cut and uncut dry laid granite, with small stones chinked into the wall to infill small voids. The wall faces northeast, and is generally ten feet in height with portions as low as one foot in height. This segment is 105 feet in length and the bench at this location is twelve feet wide, and ends at a large natural rock outcropping on the east end. Segment 2 is shown in Photograph 1 and Photograph 4.

**Dimensions:**
- **Top Width:** 12 feet
- **Bottom Width:** unknown
- **Height or Depth:** 1-10 feet
- **Length of Segment:** 105 feet

**Associated Resources:**

Metal conduit with wood supports

**Setting:**

The setting of this segment is typical of the length of the conduit and rock walls. The bench overlooks Highway 50 and has steep hillsides above and below covered with dense vegetation and strewn with large rocks and boulders.

**Integrity Considerations:**

**Description of Photo, Map, or Drawing:**

Photograph 4, Segment 3, camera facing southeast

**Remarks:**

Form prepared by: Chris McMorris and Andrew Walters

JRP Historical Consulting Services

1490 Drew Ave, Suite 110

Davis, CA 95616

Date August 27, 2002
L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Echo Lake Conduit

L2a. Portion Described: □ Entire Resource Segment □ Point Observation Designation: Segment 4

*b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map.)

Segment 4 is located about 400 feet south of Segment 3, and ends at the trestle section of the conduit. UTM: 1075768 / 4302055

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

This segment of rock wall is 200 feet long and between three and five feet in height. The bench is approximately six feet wide at this location, and faces northwest. The wall is constructed of roughly coursed and cut dry laid granite with some natural rock outcroppings integrated into the wall in places. The wall is narrow at this point and the bench is set back from the wall.

L4. Dimensions: (in feet for historic features and meters for prehistoric features)

n. Top Width 6 feet
o. Bottom Width unknown
p. Height or Depth 3-5 feet
q. Length of Segment 200 feet

L5. Associated Resources:

Metal conduit with wood supports

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

The slope above the bench is characterized by vegetation and large rocks, while the downhill slope is obscured by dense vegetation.

L7. Integrity Considerations:

L8a. Photograph, Map, or Drawing.

L8b. Description of Photo, Map, or Drawing:
Photograph 5, Segment 4, camera facing northwest

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Chris McMorris and Andrew Walters

JBP Historical Consulting Services,
1490 Drew Ave, Suite 110,
Davis, CA 95616

L11. Date: August 27, 2002

*Required Information
L1. Historic and/or Common Name: Rock Walls on the El Dorado Canal at Echo Lake Conduit

L2a. Portion Described: ☐ Entire Resource Segment ☑ Point Observation  Designation: Segment 5

*Required Information

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)
The rock wall at Segment 5 supports a narrow section of the bench and faces east. It is located between two natural rock outcroppings, and is constructed of roughly coursed and roughly cut dry laid granite.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)
- Top Width: 5 feet
- Bottom Width: unknown
- Height or Depth: 2-3 feet
- Length of Segment: 50 feet

L5. Associated Resources:
- Metal conduit with wood supports

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
At this location the uphill slope consists of a large natural wall of granite, and the downhill slope is less steep than at other locations and covered with dense vegetation. A group of cabins is located south of this segment.

L7. Integrity Considerations:

L8a. Photograph, Map, or Drawing:
Photograph 6, Segment 5, camera facing south

L8b. Description of Photo, Map, or Drawing:
Photograph 6, Segment 5, camera facing south

L9. Remarks:

L10. Form prepared by: (Name, affiliation, address) Chris McMorris and Andrew Walters
JRPHistorical Consulting Services, 1490 Drew Ave, Suite 110, Davis, CA 95616

L11. Date: August 27, 2002
P3a. Description (continued):

The walls begin about .23 miles southeast of the Echo Lake Dam, and continue intermittently in discontinuous segments for approximately .3 miles south and east, ending approximately .17 miles north of the tunnel section of the Echo Lake conduit near Berkeley Camp. The rock wall segments were originally constructed in 1873-1974 as support for a hydraulic mining flume, and were incorporated into the Western States Gas and Electric Company's hydroelectric power operation during the 1920s.

There are twelve distinct rock wall segments along the Echo Lake conduit. These segments are generally concentrated in three groups. The individual segments have 10 to 50 foot gaps between them, while the wall groups have larger gaps between them or distinct breaks. The first group encountered from northwest to southeast along the conduit is a group of four segments which comprises the longest discontinuous section of rock walls, with segments measuring 45, 112, 105, and 89 feet, totaling 351 feet in length. This group ends at a curve in the mountainside. Southeast of this first group of walls are sections that may have been walls but are now disintegrated or under heavy undergrowth. The second group of five segments, located approximately 250 feet south from the first, measure 56, 13, 10, 13 and 200 feet, for a total length of 292 feet, and end at the trestle section of conduit. The third group begins at the east end of the trestle and has three segments, measuring 50, 37 and 50 feet, totaling 137 feet in total length. This last segment of rock wall ends approximately 100 feet from the end of the metal pipe section of the conduit. Five pint locations on these three segments are inventoried here on attached Linear Feature Records as best representing the character of the walls.

The walls are constructed of un-coursed or roughly coursed dry laid native granite, a mix of rough cut and large and small uncut stones and rubble. The walls vary in length from ten to 200 feet, and in height between one and 17 feet. These walls were constructed as flume bench walls and support a bench that descends gently in elevation at a gradual hydraulic gradient. The bench formed by the rock retaining walls varies between five and twelve feet in width. In many areas, large natural outcroppings were incorporated into the wall, and other sections have begun to disintegrate due to landslides or erosion. Some sections of rock wall, mainly at the south end of the metal conduit were overgrown with vegetation, making it difficult to discern with accuracy the full vertical height of the rock walls.

There are 28 other documented locations of rock walls located along the current El Dorado Canal, between the Intake Dam and the Forebay in Pollock Pines. These rock wall segments were of three types—flume bench walls and associated abutments, canal embankment retaining walls, and canal lining walls—of which flume bench walls are the most numerous. These wall segments were inventoried in 1991 and seven of the sections of 1870s flume bench wall were found eligible for listing in the National Register of Historic Places as part of a discontinuous historic district. The rock walls on the El Dorado Canal at Echo Lake Conduit were not included in the 1991 study and are inventoried and evaluated for the first time on this DPR523 Form.
Photograph 7. Beginning of rock wall section along conduit (left), camera facing east

Photograph 8. Segment 1, rock buildup over rock outcropping, camera facing southeast
Rock Walls on the El Dorado Canal at Echo Lake Conduit

Recorded by Christopher McMorris and Andrew Walters

Date August 27, 2002

Sketch Map

Echo Lake
Segment 1
Segment 2
Segment 3
Segment 4
Segment 5
Trestle
Echo Conduit
Tunnel
Resource Name or # (Assigned by recorder) Flume 8 Bench Wall

P1. Other Identifier: Flume 8 Bench Wall

P2. Location: □ Not for Publication □ Unrestricted
   □ County El Dorado
   □ Other Identifier
   □ USGS 7.5' Quad Kyburz Date 1952 (1973) T14E, R 11N; SE 1/4 of Sec 25; MD B M.
   □ Address
   □ UTM: (give more than one for large and/or linear resources) Zone 10; 729818mE/ 429371OmN
   □ Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

P3a. Description: (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
The Flume 8 bench wall is located along the mountainside on the south side of Highway 50, and one mile east of Ditch Camp 1. This rock wall was constructed in 1874-1875 to support the flume bench for this section of the El Dorado Canal. The flume bench wall at this location was one of 28 sections of rock wall located along the El Dorado Canal between the Intake and Forebay that were inventoried and evaluated in 1991 in the study, “Archeological Survey and Historic Research Report on the El Dorado Canal, El Dorado County, California.” This study found the Flume 8 bench wall to be one of seven sections of stone masonry walls that were eligible for listing in the National Register of Historic Places as part of a discontinuous historic district. The State Office of Historic Preservation concurred with this determination in 1993. (See Continuation Sheet)

P3b. Resource Attributes: (List attributes and codes) HP11 (Engineering Structure)

P4. Resources Present: □ Building □ Structure □ Object □ Site □ District □ Element of District □ Other (Isolates, etc.)

P5a. Photos of Drawing: (Photos required for buildings, structures, and objects)

P5b. Description of Photo: (View, date, accession #) Photograph 1. Camera facing southwest

P6. Data Constructed/Age and Sources: □ Historic □ Prehistoric □ Both
   1874-1875

P7. Owner and Address:
   El Dorado Irrigation District
   2890 Mosquito Road,
   Placerville, CA 95667

P8. Recorded by: (Name, affiliation, address)
   Stephen Wee and Andrew Walters
   JRP Historical Consulting Services
   1490 Drew Ave, Suite 110
   Davis, CA 95616

P9. Data Recorded: November 6, 2002

P10. Survey Type: (Describe) Intensive


*Attachments: NONE □ Location Map □ Sketch Map □ Continuation Sheet □ Building, Structure, and Object Record □ Archaeological Record
 □ District Record □ Linear Feature Record □ Milling Station Record □ Rock Art Record □ Artifact Record □ Photograph Record
 □ Other (list)

DPR 523A (1/95)
P3a. Description (continued):

The Flume 8 bench wall was revisited for the current study. A forest fire in the late 1990s destroyed the timber flume that rested on this bench wall. That timber flume was not part of the original construction, but may have dated to the 1920s enlargement of the canal system. It was replaced with the current pre-cast concrete and steel flume structure. This new flume, rather than resting on wooden sills set atop the bench, was integrated into the wall structure through sinking poured concrete footings into the top of the bench wall. Photograph 3. When the flume structure was replaced, the old wooden spillway on Flume 8 was removed and it was replaced by the steel outlet structure shown above the rock outcropping in Photograph 3. This metal spillway disrupts the continuity of the rock wall, as well as its former seamless integration with the natural granite outcropping that is typical of the 1870s rock wall construction on this canal. Other than these two factors (the concrete footings and steel spillway), the flume replacement project of the late 1990s did not affect the integrity of the massive rock bench foundation wall located along the alignment of Flume 8.

This dry laid rock wall utilizes varying sizes of cut granite blocks and granite rubble and is laid in irregular courses. The wall measures 59 feet in length and has a maximum height of 11 feet. There is a drainage opening near the center of an 11-foot high portion of the wall that measures seven feet high, three feet wide and is 20 feet deep. This wide drainage opening provides one of the few opportunities to see the full extent of these massive engineering structures as the true width of the extensive rock work that went into these rubble backed walls is not always apparent when viewed from the top of the bench. There are several large granite outcroppings incorporated into the wall, one of which is located at the spillway.
Photographs

Photograph 2. Close up of cut in rock wall, camera facing east

Photograph 3. Spillway constructed on outcropping in between sections of rock wall
Sketch Map
The Flume 24-25 bench wall was constructed in 1874-1875 to support the flume bench for this section of the El Dorado Canal. EID plans to abandon this section of the canal upon completion of the Mill to Bull Tunnel. The flume bench wall at this location was one of 28 sections of rock wall located along the El Dorado Canal between the Intake and Forebay that were inventoried and evaluated in 1991 in the study "Archeological Survey and Historic Research Report on the El Dorado Canal, El Dorado County, California." This study found the Flume 24-25 bench wall to be one of seven sections of stone masonry walls that were eligible for listing in the National Register of Historic Places as part of a discontiguous historic district. The State Office of Historic Preservation concurred with this determination in 1993.

*Resource Name or # (Assigned by recorder) Flume 24-25 Bench Wall

**P3a. Description** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)

The Flume 24-25 bench wall is located along the mountainside on the south side of the South Fork of the American River. This rock wall was constructed in 1874-1875 to support the flume bench for this section of the El Dorado Canal. EID plans to abandon this section of the canal upon completion of the Mill to Bull Tunnel. The flume bench wall at this location was one of 28 sections of rock wall located along the El Dorado Canal between the Intake and Forebay that were inventoried and evaluated in 1991 in the study "Archeological Survey and Historic Research Report on the El Dorado Canal, El Dorado County, California." This study found the Flume 24-25 bench wall to be one of seven sections of stone masonry walls that were eligible for listing in the National Register of Historic Places as part of a discontiguous historic district. The State Office of Historic Preservation concurred with this determination in 1993. (See Continuation Sheet)
The Flume 24-25 bench wall was revisited for the current study, and no observable change could be detected from the conditions as they existed at the time of the 1991 evaluation. The flume that rests on the wall has been replaced with a pre-fabricated concrete flume with steel walkways and rails. The new flume was attached to the bench wall with poured in place concrete footings that are integrated into the fabric of the top of the rock wall bench. The wall is constructed of dry laid granite blocks and rubble. It consists of eight segments 938 total feet in length, with a maximum height of 24 feet. The segment furthest to the east is 154 feet in length and for its first 95 feet is two to three feet in height, but increases to 24 feet in height at its west end. This highest portion of the wall contains an opening to allow for drainage. The next segment is 86 feet long, and only two to four feet in height, but contains an unusual two stepped rock wall along a 56 foot long portion of the wall. The next segment is 127 feet in length and has a maximum height of eight feet. This section is followed to the west by a 135 foot long section, averaging in height between six and nine feet. The next two segments are approximately 180 feet in length, and each segment reaches a height of 12 feet, with one notable section containing an elegant arch. These sections are followed by a 30 foot long segment with one course, and a 20 foot long wall with a maximum height of 10 feet.
**Resource Name or #** (Assigned by recorder) Flume 24-25 Bench Wall

*Recorded by* Stephen Wee and Andrew Walters  *Date* October 2, 2002  ✔ Continuation  □ Update

Sketch Map

---

DPR 523L (1/95)  Required Information
*Resource Name or # (Assigned by recorder) Flume 41 Bench Wall

P1. Other Identifier: Flume 41 Bench Wall

P2. Location: ☐ Not for Publication ☑ Unrestricted and (P2b and P2c or P2d. Attach a Location Map as necessary.)

P3a. Description: (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)

The Flume 41 bench wall is located along the mountainside on the south side of the South Fork of the American River and west of Plum Creek Canyon. This rock wall was constructed in 1874-1875 to support the flume bench for this section of the El Dorado Canal. The flume bench wall at this location was one of 28 sections of rock wall located along the El Dorado Canal between the Intake and Forebay that were inventoried and evaluated in 1991 in the study “Archeological Survey and Historic Research Report on the El Dorado Canal, El Dorado County, California.” This study found the Flume 41 bench wall to be one of seven sections of stone masonry walls that were eligible for listing in the National Register of Historic Places as part of a discontinuous historic district. The State Office of Historic Preservation concurred with this determination in 1993. (See Continuation Sheet)

P3b. Resource Attributes: (List attributes and codes) HP11 (Engineering Structure)

P4. Resources Present: ☐ Building ☑ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5a. Photo of Drawing (Photo required for buildings, structures, and objects.)

P5b. Description of Photo: (View, date, accession #) See Continuation Sheet

P6. Data Constructed/Age and Sources:

☐ Historic ☐ Prehistoric ☐ Both
1874-1875

P7. Owner and Address:
El Dorado Irrigation District
2890 Mosquito Road
Placerville, CA 95667

P8. Recorded by: (Name, affiliation, address)
Stephen Wee and Andrew Walters
JRP Historical Consulting Services
1490 Drew Ave, Suite 110, Davis, CA 95616

P9. Date Recorded: July 30, 2002

P10. Survey Type: (Describe) Intensive


*Required Information
P3a. Description (continued):

The Flume 41 bench wall was revisited for the current study, and no observable changes in its condition could be detected since the 1991 evaluation. The wall is constructed of dry laid granite blocks and rubble and has elegant curves. It is 202 feet long, and has a maximum height of 12 feet.
Photographs

Photograph 1. Flume 41 Bench Wall, Camera facing southeast
Sketch Map
The Flume 45 bench wall is located on a bench constructed along the steep mountainside on the southern slope of the South Fork of the American River Canyon, and approximately one mile west of Plum Creek Canyon. The Flume 45 rock wall was constructed in 1874-1875 to support the flume bench for this section of the El Dorado Canal. This was one of 28 sections of rock wall dating from the 1870s through the 1920s located along the El Dorado Canal between the Intake and Forebay that were inventoried and evaluated in 1991 in the study, "Archeological Survey and Historic Research Report on the El Dorado Canal, El Dorado County, California." This study found the Flume 45 bench foundation wall to be one of seven sections of stone masonry walls that appeared eligible for listing in the National Register of Historic Places as part of a discontinuous historic district.
P3a. Description (continued):

The State Office of Historic Preservation concurred with this recommendation in 1993.

There are eight segments of rock masonry bench foundation walls that support Flume 45, with a total length of 1,238 feet. The segments are 54, 88, 259, 51, 41, 551, 66, and 128 feet in length, with the highest portions reaching 22 feet in height. All of the wall segments are constructed of roughly coursed or uncoursed dry-laid granite blocks and rubble backed by rubble fill. The wall possesses elegant curves in places, as shown in Photograph 1, constructed of well-fitted granite blocks. One segment of Flume 45 has been altered since the resource was recorded in 1991. A portion of the Ogilby Road rock retaining wall located above the flume failed and washed out a short section of the flume that rests on the Flume 45 bench wall. The flume bench wall itself was not directly affected by the washout. However, the National Register eligible rock wall is now protected from future washouts by a protective ceiling constructed of galvanized steel I-beams that extend outward from the top of the bench wall, supported by steel posts with concrete block footings located beneath the foot of the bench wall (Photograph 2). While this protective steel structure and the shielding wall erected on Ogilby Road above the flume have impinged on the forest setting, and therefore on the integrity of the setting to the historic period, they otherwise do not affect the overall integrity of the eligible rock walls beneath the flume, and therefore, the rock walls appear to retain sufficient integrity to remain eligible for listing in the National Register.
Photographs

Photograph 2. Galvanized steel support for flume, camera facing, southeast
Photographs

Photograph 3. End of rock wall section 100 meters from east end of Flume 45, camera facing northeast
*Resource Name or # (Assigned by recorder) Flume 48 Bench Wall

P1. Other Identifier: Flume 48 Bench Wall
P2. Location: □ Nut for Publication □ Unrestricted
and (P2b and P2c or P2d. Attach a Location Map as necessary.)

*P2a. County El Dorado

*P2b. USGS 7.5' Quad Pollock Pines
Date 1950 T13E R 11N NW % of Sec 33; MD B.M.

c. Address

Address: City, Zip

d. UTM: (give more than one for large and/or linear resources)
Zone; latitude/longitude

*P2c. Location Map

*P2d. Unrestricted

(P1b. Other Identifier: Flume 48 Bench Wall)

*P3a. Description: (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)

The Flume 48 bench wall is located along the mountainside on the north side of Highway 50, and east of Ditch Camp 5. This rock wall was constructed in 1874-1875 to support the flume bench for this section of the El Dorado Canal. The flume bench wall at this location was one of 28 sections of rock wall located along the El Dorado Canal between the Intake and Forebay that were inventoried and evaluated in 1991 in the study "Archeological Survey and Historic Research Report on the El Dorado Canal, El Dorado County, California." This study found the Flume 48 bench wall to be one of seven sections of stone masonry walls that were eligible for listing in the National Register of Historic Places as part of a discontiguous historic district. The State Office of Historic Preservation concurred with this determination in 1993. (See Continuation Sheet)

*P3b. Resource Attributes: (list attributes and codes) HP11 (Engineering Structure)

*P4. Resources Present: □ Building □ Structure □ Object □ Site □ District □ Element of District □ Other (Isolates, etc.)

*P5a. Photo of Drawing (Photo required for buildings, structures, and objects.)

See Continuation Sheet

*P5b. Description of Photo: (View, date, accession #) See Continuation Sheet

*P5c. Date Constructed/Age and Sources: □ Historic □ Prehistoric □ Both

1874-1875

*P7. Owner and Address:
El Dorado Irrigation District
2890 Mosquito Road,
Placerville, CA 95667

*P8. Recorded by: (Name, affiliation, address)
Stephen Wee and Andrew Walters
JRP Historical Consulting Services,
1490 Drew Ave, Suite 110, Davis,
CA 95616

*P9. Date Recorded: July 30, 2002

*P10. Survey Type: (Describe) Intensive


*Attachments: NONE □ Location Map □ Sketch Map □ Continuation Sheet □ Building, Structure, and Object Record □ Archaeological Record □ District Record □ Linear Feature Record □ Milling Station Record □ Rock Art Record □ Artifact Record □ Photograph Record

DPR 523A (1/95)

*Required Information
P3a. Description (continued):

The Flume 48 bench wall was revisited for the current study, and no observable change could be detected from the conditions as they existed at the time of the 1991 evaluation. This wall is 304 feet long and has a maximum height of 15 feet. It is constructed of dry laid granite blocks and rubble. Upslope at the east end of the wall is another dry laid granite rock wall supporting old Highway 50 road grade.
Photographs

Photograph 1. Flume 48 Bench Wall, Camera facing east
Resource Name or # (Assigned by recorder): Flume 48 Bench Wall

Recorded by Stephen Wee and Andrew Walters
Date: October 2, 2002
Continuation 
Update

Sketch Map
The EID Intake Area consists of a modern concrete dam and canal intake structure constructed within the last two years and a modern brick air compressor building next to the intake dam, a modern patrolman's residence, a historic period storage building, and a 1950s pumphouse. The latter two resources are described and evaluated in this form. The other resources are non-historic having all been constructed in the past few years in association with the dam replacement project undertaken by El Dorado Irrigation District in 2000-2001. The two historic buildings evaluated in this form were not evaluated in the March 2000 study undertaken for the intake dam replacement project. (See Continuation Sheet)
P3a. Description (continued):

The storage building is located west of the intake structure on the south side of the American River adjacent the El Dorado Canal. This wood frame building, shown in Photograph 1, was constructed around 1922 and measures 32 x 16 feet. It rests on a wood foundation, has board and batten siding, and a gable roof clad in corrugated metal. There are rectangular openings beneath the gable ends of the building: the opening on the west side is boarded over, and the opening on the east side is open. On the south side of the building is a pair of side-hinged wood doors. East of the doors is a boarded over wood frame window opening. There are no openings on the north side of the building.

A small pumphouse dating from the 1950s is located on the north side of the American River and is shown in Photograph 2. This 5.5 x 5 foot wood frame shed is clad in corrugated metal and has a corrugated metal clad shed roof. There is a corrugated metal clad door on the south side of the building.
Photographs

Photograph 2. Corrugated metal pumphouse, camera facing west.
Intake Area Storage Building and Pumphouse

Sketch Map

DPR 523L (1/95)

*Required Information
The EID Surge Tank, Valve House and Tram House are all located in close proximity to each other on the top of a mountainside approximately 2/3 mile uphill from the El Dorado Power House. The Surge Tank, its accompanying Valve House and the Forebay-Powerhouse Conduit are integrated facilities. The Tram House located immediately to the west of these facilities was used to construct and then later maintain the penstock which emerges from the Valve House. All of these facilities were constructed between 1922-1923 when the El Dorado Powerhouse was built. The base of the Surge Tank, Valve House, penstock, the Tram House and its railway with a tram car present are all shown in Photograph 1. (See Continuation Sheet)
P3a. Description (continued):

Water-hammer pressure is created in long closed power conduits by sudden opening and closure of turbine gates at the hydroelectric power plant. The violent fluctuations in the conduit may seriously interfere with proper turbine regulation. One of the means of eliminating this problem is to install a surge tank at the lower end of the conduit and virtually all long closed conduit systems have a surge tank. In general, water flows into the tank when rejected by the closed system, as water rises in the tank, a retarding head is created, which decreases the conduit velocity. Conversely when velocity in the conduit is demanded, the water in the tank starts to fall with the consequent acceleration of head, which increases flow in the conduit. The tank must be sufficiently large and elevated to prevent spillover. The base of the Surge Tank for the El Dorado Powerhouse is shown in Photograph 1 and the whole structure appears in Photograph 2.

The Surge Tank was manufactured by Minneapolis Steel and Machinery Company. It is composed of a narrow cylindrical tank and support frame that is 243 feet in total height. The steel pipe conduit that runs from the Forebay to the El Dorado Powerhouse passes beneath the tank and is connected to it by a 54 inch diameter riser. The Tank is 138 feet in height and is supported by a 105 foot high, four legged, riveted steel frame with cross girders. The legs of the frame are 50 feet apart at ground level, and are encased in concrete footings buried ten feet beneath the ground. The surge tank is tapered at the bottom and top. There is a six-foot diameter opening in the top, and two platforms at the bottom of the tank. At the center of the base of the tank is a smaller cross receiver tank and related machinery mounted on a raised concrete pad located beside the penstock. The 54 inch diameter metal riser extends from the penstock through the cross receiver to the base of the Surge Tank. To the east (rear) of the Surge Tank, a 20 foot section of the penstock is anchored in concrete.

The Valve House is located to the west of the Surge Tank, or downstream on the conduit, and is shown in Photograph 3. This rectangular building is constructed of board formed concrete and sits on a raised concrete foundation. It has a gable roof clad in corrugated metal, with corrugated metal on the walls beneath the gable ends. The steel pipe conduit passes into the building through the east (rear) wall, which houses a butterfly valve that controls water flows from the conduit into the penstock. A corrugated metal clad roof extension shelters a metal personnel door located on the west side of the building next to the penstock. The south wall of the building extends out on the east side to shelter equipment located on a concrete pad on the east side of the building.

The butterfly valve is essentially a disk mounted to an arm that can be adjusted to create deflection within a pipe or to close flows altogether. The housing of the valve must be designed to be sufficiently rigid to retain its circular form, or the valve cannot be made tight. Most hydroelectric plants have valves located at the upper end of the penstock so that it is possible to dewater the turbines without having to empty the long pipe conduit on the system and the surge tank.

The pipe conduit on the El Dorado Powerhouse system extends from the Upper Butterfly Pump House at the Forebay and runs northwest for approximately 2.3 miles to the Surge Tank and Valve House. The conduit is a 60 inch diameter steel pipe resting on steel saddles with concrete sills. It is carried on an embankment bench that is generally 20 feet wide. This conduit replaced the original 60 inch wood stave pipe that ran from the Forebay to the Surge Tank and was constructed in 1922-1923 at the same time as the Forebay and the El Dorado Powerhouse. The redwood stave conduit and its timber cradles were replaced in sections between the 1960s and 1977, except
P3a. Description (continued):

for a 785 foot section that was replaced in 1996. The newest sections of the penstock are composed of welded steel pipe, and the older replacement sections are constructed of riveted steel pipe.¹

The Tram House is located west of the Surge Tank, and was constructed in 1922. It houses the equipment necessary to operate the tram that is employed to inspect and maintain the penstock. This rectangular wood frame building sits on a raised concrete foundation, has walls clad in corrugated metal and a corrugated metal gable roof with overhanging eaves and exposed rafters. There is a wood personnel door and an exterior hinged wood plank door on the east side of the building. On the South side of the building is an exterior hinged door mounted high on the side of the building with no stairs. There is a centrally located rectangular opening for the tram cable covered in corrugated metal on the west side of the building. Iron tram tracks with wood ties extend from the west side of the building and parallel the penstock down slope to the El Dorado Powerhouse. The Tram House is shown in Photograph 1.

*Resource Name or # (Assigned by recorder) Surge Tank, Valve and Tram Houses

*Recorded by Stephen Wee and Andrew Walters  *Date July 30, 2002  ☑ Continuation  ☐ Update

Photographs

Photograph 2. Surge Tank, camera facing northeast
Photographs

Photograph 3. Close-up of Valve House, camera facing northeast

Photograph 4. Surge Tank after construction, 1923
Resource Name or # (Assigned by recorder) Surge Tank, Valve and Tram Houses

Recorded by Stephen Wee and Andrew Walters  Date July 30, 2002  Continuation  Update

Sketch Map
This addendum to the original site record for the El Dorado Canal (CA-Elk-511H) is completed to document a newly identified resource along the Canal. The resource is a dry-laid granite boulder retaining wall that supports a section of the El Dorado Canal along a steep slope. The wall supports the downhill and northern side of the canal.

The wall is east of Ditch Camp 5 and approximately 2.5 miles east of Pullock Pines in El Dorado County, California. The resource was identified on March 31, 2005 during the cultural resources survey conducted for the Ditch Camp 5 Waterline Replacement Project proposed by the El Dorado Irrigation District.

Cleaver et al. (1991) inventoried and evaluated 29 sections of rock wall along the El Dorado Canal between the intake and Forebay as part of the study entitled "Archaeological Survey and Historic Research Report on the El Dorado Canal, El Dorado County, California." The rock wall east of Ditch Camp 5 was not evaluated as part of this study.

This Addendum includes a Building, Structure, Object Record to evaluate the resource for its eligibility for listing in the National Register of Historical Places.

Recorded by: T. Fernandez and K. Quidachay  Date: March 31, 2005
**Resource Name or #** Rock wall east of Ditch Camp 5

**NRHP Status Code** P-9-599-H

**B1. Historic Name:** N/A  
**B2. Common Name:** N/A  
**B3. Original Use:** Rock retaining wall  
**B4. Present Use:** Same  

**B5. Architectural Style:** Vernacular

**B6. Construction History:**  
The rock retaining wall was constructed as part of the El Dorado Canal (CA-EI-611/H), completed in 1876. No alterations are evident.

**B7. Moved?** ☐ No ☐ Yes ☐ Unknown  
**Date:** Original Location: N/A

**B8. Related Features:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Architect</th>
<th>Builder</th>
<th>Area</th>
<th>Period of Significance</th>
<th>Property Type</th>
<th>Applicable Criteria</th>
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<tbody>
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<td>El Dorado Water and Deep Gravel Mining Company</td>
<td>Francis B. Bishop (Engineer)</td>
<td>El Dorado Water and Deep Gravel Mining Company</td>
<td>California</td>
<td>1874-1922</td>
<td>Canal</td>
<td>C</td>
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</table>

**B10. Significance Theme:** Hydraulic Mining Era, Canal Building  
**Area:** California  
**References:**

**Property Type:** Canal  
**Type:** Canal  
**Location:** California

The El Dorado Canal was constructed in 1876 to bring water to hydraulic mining workings near Placerville. The remaining evidence of the El Dorado Canal is extensive, consisting of standing sections of open canal and flume bench with rock bench foundation walls. The El Dorado Canal was converted to hydroelectric power use in the early 1920s.

The El Dorado Canal from its intake near Kyburz to the powerhouse below Potrock Pines has been inventoried and evaluated for NRHP eligibility (Caruso and Shoup 1990; Glover et al. 1991). The El Dorado Canal as a single unit was found ineligible for listing in the NRHP through a consensus determination between the El Dorado National Forest and the SHPO in 1991. However, the SHPO agreed that some rock wall features of the canal system represent a discontinuous historic district and possesses distinguishing attributes and sufficient integrity to warrant listing in the NRHP under Criterion C, as examples of applying engineering and construction methods available at the time of construction (1873-1876) to the very difficult task of building and maintaining a canal down the west slope of the Sierra Nevada in extremely unfavorable terrain for canal building, (Glover et al. 1991, section 4B8).

The rock retaining wall in the Camp 5 Waterline APE is an ancillary feature of the gunite-lined eastern canal section extending east of Camp 5. Though it most likely dates to the hydraulic mining era period of construction for the El Dorado Canal (1873-1876), it is one of hundreds of minor rock retaining walls found along the canal and throughout the Sierra Nevada and is in no way distinguishable as one of the more advanced or significant engineering components of the El Dorado Canal. As such, it lacks sufficient integrity to convey the El Dorado Canal's period and theme of significance (stated in the previous paragraph). As a result, the rock retaining wall west of Frame 4B does not appear eligible for the NRHP either individually or as part of the established discontinuous district.

**B11. Additional Resource Attributes:** HP29, Canal/Apexdect

**B12. References:**


**B13. Remarks:**

**B14. Evaluator:** Leslie Fryman and Trish Fernandez

**Date of Evaluation:** May 29, 2005

(This space reserved for official comments.)

(Sketch Map with north arrow required.)
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<th>Time</th>
<th>Exp/Frame</th>
<th>Subject/Description</th>
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<th>Accession #</th>
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<td>March</td>
<td>31</td>
<td>1000</td>
<td>01</td>
<td>Close-up view of rock retaining wall. Photo taken from western edge of the rock wall.</td>
<td>SE</td>
<td>1:01</td>
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<tr>
<td>March</td>
<td>31</td>
<td>1300</td>
<td>02</td>
<td>Close-up view of the southwestern edge of the rock wall. Note that the rocks are covered with green moss.</td>
<td>E</td>
<td>1:02</td>
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<tr>
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<td>31</td>
<td>1700</td>
<td>03</td>
<td>View across the rock wall with the El Dorado Canal in background.</td>
<td>W</td>
<td>1:03</td>
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<td>31</td>
<td>1110</td>
<td>04</td>
<td>Overview of rock wall showing the sharp curve in El Dorado Canal in the background.</td>
<td>SW</td>
<td>1:04</td>
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<td>1110</td>
<td>05</td>
<td>Close-up view showing system sidewall. Photo taken from downhill side of the rock wall.</td>
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<td>1:05</td>
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<td>06</td>
<td>Close-up view of headwall with trees in foreground.</td>
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<td>1:06</td>
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<tr>
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<td>31</td>
<td>1710</td>
<td>07</td>
<td>View toward corner (L shape) of the rock wall. Photo taken from western bank.</td>
<td>S</td>
<td>1:07</td>
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<tr>
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<td>31</td>
<td>1115</td>
<td>08</td>
<td>View from headwall looking toward drainages showing the size of the unnamed drainage.</td>
<td>SW</td>
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### P1. Resource Name:
CA-ELD-511-H (El Dorado Canal)- update

### P2. Location:
**X. Confidential _ Unrestricted**
- **County:** El Dorado
- **USGS Quad:** Pollock Pines 7.5'
- **Map Date:** 1950 Rev. 1973
- **UTM Zone:** Zone 10
  - **Canal North end:** 713957 mE, 4292546 mN
  - **Canal South end:** 713971 mE, 4292309 mN

### Legal Location:
T11N R13E Por of NW ¼ of SW ¼ of Section 33 MDB&M

### Directions:
Located 2 miles East of the town of Pollock Pines, off of Old Carson Rd.

### P3. Description:
- **a.** This site consists of a cement lined, earthen canal which is still in use for domestic and agricultural water supplies. The canal includes a 100 foot section of wooden flume, lined with metal sheeting. The canal is approximately 12 feet wide by 5 feet deep. The Ditch is located at the 3780 foot contour level.
- **b.** Resource attributes: AH6 Water Conveyance System

### P4. Resources Present:
- ( ) Building
- (X) Structure
- ( ) Object
- (X) Site
- ( ) District
- ( ) Element of District
- ( ) Other

### P5. Photograph or Drawing:
No Photo

### P6. Date Constructed/Age:
- ( ) Prehistoric
- (X) Historic
- ( ) Both
- Early to Mid 1900s

### P7. Landowner and Address:
Jeff & Rebekah Boatman
P.O. Box 58
Pollock Pines, CA 95726

### P8. Recorded by:
Mark Stewart, RPF #2308
4655 Tulip Ct
Placerville, CA 95667

### P9. Date Recorded:
March 18, 2005

### P10. Type of Survey:
- ( ) Intensive
- (X) Reconnaissance
- ( ) Other

### P11. Report Citation:

### P12. Attachments:
- ( ) None
- (X) Location Map
- ( ) Site map
- ( ) Continuation Sheets
- ( ) Building, Structure, and Object Record
- ( ) Archaeological Record
- ( ) District Record
- ( ) Linear Resource Record
- ( ) Milling Station Record
- ( ) Rock Art Record
- ( ) Artifact Record
- ( ) Photographic Record
- ( ) Other (List)

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MAR 21 2005
CALIF. DEPARTMENT OF FORESTRY
SIERRA SOUTH HEADQUARTERS

3-18-05
8752
State of California — Dept of Forestry
PROGRESSIVE FORESTRY

PRIMARY RECORD

Page 1 of 2

Review Code Reviewer Date

--------- --------- ---------
P1. Resource Name: CA-ELD-S11-H (El Dorado Canal) - update
P2. Location: 
   County: El Dorado
   USGS Quad: Pollock Pines 7.5'
   UTM Zone: Zone 10, Westernmost: 714160 mE / 4292370 mN; Easternmost: 714430 mE / 4292500 mN
   Legal Location: N3, Section 33, T11N, R13E, MDB&M
   Directions: From Pollock Pines, CA, travel east on highway 50 approximately 3 miles. The site of Fresh Pond lies to the south or right hand side of highway 50 and is evidenced by a sign that reads "Fresh Pond Cafeteria". Continue west on the frontage road until you reach a driveway with the name "Cloud" on a sign. The canal defines the majority of the southern project boundary.

P3. a. Description: This site consists of an earthen canal that is used for domestic water uses today. The canal is operated by the El Dorado Irrigation District. The canal features a associated wooden flume and a release valve that is still in use today.

b. Resource attributes: AH6, Water conveyance system

P4. Resources Present: ( ) Building ( ) Structure ( ) Object ( ) Site ( ) District ( ) Element of District ( ) Other

P5. Photograph or Drawing: No

P6. Data Constructed/Age: ( ) Prehistoric ( ✔ ) Historic ( ) Both Early to mid-20th Century

P7. Landowner and Address: Sierra Pacific Industries
   P.O. Box 680
   Camino, CA 95709
   Phone #: (530) 644-2311

P8. Recorded by: James J. Kral
   P.O. Box 928
   Pollock Pines, CA 95627

P9. Date Recorded: August 1, 2003

P10. Type of Survey: ( ) Intensive ( ) Reconnaissance ( ✔ ) Portion of Other

   This was a survey designed and conducted by James Kral during the course of preparing a Timber Harvest Plan.

P11. Report Citation: Archaeological survey of the Fresh Pond THP Amendment by James J. Kral. An archaeological survey report shall be filed by CDF with the North Central Information Center at CSU Sacramento upon plan approval.

P12. ATTACHMENTS: ( ) None ( ✔ ) Location Map ( ) Site map ( ✔ ) Continuation Sheets ( ) Building, Structure, and Object Record ( ) Archaeological Record ( ) District Record ( ) Linear Resource Record ( ) Milling Station Record ( ) Rock Art Record ( ) Artifact Record ( ) Photographic Record ( ) Other (List) ( ) Sketch Map
CA-ELD-511-H (El Dorado Canal) - Update

County: El Dorado
USGS Quad: Pollock Pines 7.5' Map Date: 1950, Photo inspected 1973
UTM Zone: Zone 10, Westernmost: 714010 mE/4292600 mN; Easternmost: 714490 mE/4292500 mN
Legal Location: N34 Section 33, T11N, R13E, MDB&M
Directions: From Pollock Pines, CA, travel east on highway 50 approximately 3 miles. The site of Fresh Pond lies to the south or right hand side of highway 50 and is evidenced by a sign that reads "Fresh Pond Cafeteria". Continue west on the frontage road until you reach a driveway with the name "Cloud" on a sign. The canal defines the majority of the southern project boundary.

P3 a. Description: This site consists of an earthen canal that is used for domestic water uses today. The canal is operated by the El Dorado Irrigation District. Though not on this project, the canal features wooden and steel flumes, gauging stations, weirs, penstocks and a road that is used for maintenance.


P4. Resources Present: () Building () Structure () Object () Site () District () Element of District () Other

P5. Photograph or Drawing: No

P6. Date Constructed/Age: ( ) Prehistoric (✓) Historic ( ) Both Early to mid-20th Century

P7. Landowner and Address: Thomas & Reba Cloud
3061 Forest Road
Pollock Pines, CA 95726
530.644.4043

P8. Recorded by: James J. Kral
P.O. Box 928
Pollock Pines, CA 95627

P9. Date Recorded: December 3, 2002

P10. Type of Survey: ( ) Intensive (✓) Reconnaissance ( ) Portion of Other

This was a survey designed and conducted by James Kral during the course of preparing a Timber Harvest Plan.

P11. Report Citation: Archeological survey of the Fresh Pond THP Amendment by James J. Kral. An archeological survey report shall be filed with CDF with the North Central Information Center at CSU Sacramento upon plan approval.

P12. ATTACHMENTS: ( ) None (✓) Location Map (✓) Site map (✓) Continuation Sheets ( ) Building, Structure, and Object Record ( ) Archaeological Record ( ) District Record ( ) Linear Resource Record ( ) Milling Station Record
( ) Rock Art Record ( ) Artifact Record ( ) Photographic Record ( ) Other (List) ( ) Sketch Map
Page 2 of 2 Resource Name or # (Assigned by recorder) CA-ELD-511-H El Dorado Canal - Update
Map Name: Pollock Pines Calif. 7.5' USGS Quad
Scale: 1:24,000
Date of Map: 1950
**P1. Resource Name:** Fong THP Site - Historic Canal (CA-ELD-511H)

**P2. Location:**
- **County:** El Dorado
- **USGS Quad:** Pollock Pines, CA 7.5'
- **UTM Zone:** Zone 10, westernmost - 4293540 mN, 712020 mE, easternmost - 4293610 mN, 712240 mE
- **Legal Location:** SW1/4, Section 29, T7N, R13E, MDB&M
- **Directions:** Located approximately 500 feet north of Pony Express Trail at the point where the County maintained portion ends. The canal is located on the 3820 foot contour.

**P3 a. Description:** This site is known as the El Dorado Canal. The canal provides raw domestic water to users located throughout El Dorado County. The canal was once an earthen ditch with wooden flumes which has been improved to reduce maintenance and repairs. The canal has been lined with gunite to help reduce leakage and the wooden flumes have been replaced with steel to protect the water resource in the event of a wildfire. The canal runs from it's intake at Kyburz to a number of storage and treatment facilities in Pollock Pines. It measures approximately 12 feet wide (at the widest point) by 6 feet deep.

**P3 b. Resource attributes:** HP20 - Canal/aqueduct

**P4. Resources Present:**
- Building
- Structure
- Object
- Site
- District
- Element of District
- Other

**P5. Photograph or Drawing:** No

**P6. Date Constructed/Age:**
- Prehistoric
- Historic
- Both

**P7. Landowner and Address:** William & Geraldine Fong
- P.O. Box 502
- Pollock Pines, CA 95726

**P8. Recorded by:** James J. Kral, RPF #2588
- Kral's Progressive Forestry
- PO Box 928
- Pollock Pines, CA 95726

**P9. Date Recorded:** September 4, 2002

**P10. Type of Survey:**
- Intensive
- Reconnaissance
- Other

This was a survey designed and conducted by James Kral during the course of preparing a Timber Harvest Plan.

**P11. Report Citation:** Archeological survey of the Fong THP by James Kral. An archeological survey report shall be filed by CDF with the North Central Information Center at CSU Sacramento upon plan approval.

**P12. ATTACHMENTS:**
- Location Map
- Site map
- Continuation Sheets
- Building, Structure, and Object Record
- Archeological Record
- District Record
- Linear Resource Record
- Milling Station Record
- Rock Art Record
- Artifact Record
- Photographic Record
- Other

RESOURCE MANAGEMENT

SEP 06 2002
CALIF. DEPARTMENT OF FORESTRY
SIERRA SOUTH HEADQUARTERS
P1. Location: a. County El Dorado
   and (Address and/or UTM Coordinates Attach Location Map as required)
   b. Address:
      City: ___________________________ State: ___________________________
      Zip: ___________________________ 713700 mE 4293200 mN

P2. Description: (Describe resource and its major elements. Include design, materials, condition, alterations, size, settings, and boundaries)
   Site #1, The El Dorado Canal. This is a wide, deep, high-banked earthen ditch. This is a historic linear feature currently in use and well maintained by PG&E. The canal is a water and electricity generating source and flows into "Forbay" in Pollock Pines. A section of Flume #48 as well as canal as it crosses from east to west through the southwest corner of the subject property is identified in great detail in CA-ELD-511-H.
   The west most coordinates given above and the coordinates for the east are 713700 mE and 4293200 mN.

P3. Resources Present: Building  Structure  Object  Site  District  Element of District
P4. Photograph or Drawing (Photograph required for buildings, structures, and objects.)

P5. Date Constructed/Age
   Prehistoric  Historic  Both

P6. Owner and Address:
   Larry Carleton
   PO Box 688
   Camino, CA 95709

P7. Recorded by:
   David Levy
   PO Box 1797
   Nevada City, CA 95659

P8. Date Recorded: 11/7/94

P9. Type of Survey:
   Intensive  Reconnaissance  Other

P10. Report Citation: Confidential Archaeological, Historical Resources and Survey Assessment Report for Landowner on 11/7/94 by David Levy IC File # ELD 94-132

Attachments: Location Map  Continuation Sheet  Building, Structure and Object Record
             Archaeological Record  District Record  Milling Station Record  Rock Art Record  Artifact Record
             Photograph Record  Other (List)
CARLETON - HWY. 50 THP

LEGEND

Watercourses
Class III: --------------
Class II
Spring: ●
Class IV: --------------

Archaeological Area
Archeological Site ONE:
(Historical Ditch)

Boundary

Property Boundary:

Existing Roads

Permanent:
(HWY. 50)

El Dorado County
13 Acre THP

Contour Interval 40'

ARCHAEOLOGICAL SITE MAP

POLLOCK PINES
USGS Quadrangle

7.5 Min.
Section 33,
T11N, R13E, MDM
El Dorado County
13 Acre THP

Contour Interval 40'
November 20, 2012

Michella Rossi
Cardno ENTRIX
701 University Avenue
Sacramento, CA 95825

Sent by 916-923-6251
Number of Pages: 2

Re: EID Main Ditch Project, El Dorado County

Dear Ms. Rossi:

A search of the Native American Heritage Commission (NAHC) Sacred Lands File was completed for the area of potential project effect (APE) referenced above. Please note that the absence of specific site information in the Sacred Lands File does not indicate the absence of Native American traditional cultural places or cultural landscapes in any APE. While in this case, a search of the NAHC Sacred Lands File did not indicate the presence of any sites within the APE you provided, a Native American tribe or individual may be the only source for the presence of traditional cultural places. For that reason, enclosed is a list of Native American individuals/organizations who may have knowledge of traditional cultural places in your project area. This list should provide a starting place in locating any areas of potential adverse impact.

The NAHC makes no recommendation or preference of any single individual, or group over another. All of those on the list should be contacted, if they cannot supply information, they might recommend others with specific knowledge. By contacting all those listed, your organization will be better able to respond to claims of failure to consult with the appropriate tribe or group. If a response has not been received within two weeks of notification, the NAHC requests that you follow-up with a telephone call to ensure that the project information has been received.

If you receive notification of change of addresses and phone numbers from any of these individuals or groups, please notify me. With your assistance we are able to assure that our lists contain current information. If you have any questions or need additional information, please contact me at my email address: rw_nahc@pacbell.net

Sincerely,

[Signature]
Rob Wood
Associate Government Program Analyst
Native American Contact List
El Dorado County
November 20, 2012

Shingle Springs Band of Miwok Indians
Sam Daniels, Vice Chairperson
P.O. Box 1340
Shingle Springs, CA 95682
(530) 676-8010
(530) 676-8033 Fax

Buena Vista Rancheria
Rhonda Morningstar Pope, Chairperson
1418 20th Street, Suite 200
Sacramento, CA 95811
rhonda@buenavistatrib.com
916 491-0011
916 491-0012 Fax

Wilton Rancheria
Andrew Franklin, Chairperson
9300 W. Stockton, Suite 200
Elk Grove, CA 95758
916-683-6000
916-683-6015

T si-Akim Maidu
Eileen Moon, Vice Chairperson
1239 East Main St.
Grass Valley, CA 95945
(530) 477-0711

United Auburn Indian Community of the Auburn Rancheria
David Keyser, Chairperson
10720 Indian Hill Road
Auburn, CA 95602

Ione Band of Miwok Indians
Pamela Baumgartner, Tribal Administrator
PO Box 699
Ione, CA 95640
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THIS MAP IS NOT A SURVEY. It is prepared by the El Dorado County Assessors office for assessment purposes only. Area calculations and measurements are not guaranteed. Users should verify items such as dimensions and acreage.

Acreages Are Estimates

Revised: July 12, 2006

Assessor's Map Bk. 101,
Pg. 03
County of El Dorado, CA

The parcel numbers shown in circles are parcel numbers shown in circles; these should be verified. The parcel numbers shown in ellipses are parcel numbers shown in ellipses. Parcel boundaries shown in ellipses are not guaranteed. Areas, dimensions, and measurements are not guaranteed.
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<td>GILMORE RD</td>
<td>294245</td>
<td>18</td>
<td>067884-001</td>
<td>SFRESP</td>
<td></td>
</tr>
</tbody>
</table>
## Ditch Accounts

<table>
<thead>
<tr>
<th>Name</th>
<th>Account</th>
<th>Ditch</th>
<th>Service Address</th>
<th>Phone</th>
<th>Parcel No.</th>
<th>Weir Size / Miner's Inches</th>
<th>Consumption (af)</th>
<th>Active</th>
<th>Zone</th>
<th>Potable Raw</th>
<th>Frequency</th>
<th>Flow Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hurnes, Charles</td>
<td>069166-001</td>
<td>Main</td>
<td>2421 Forebay Rd</td>
<td>530-644-2392</td>
<td>101-330-10</td>
<td>Landscape Irrig</td>
<td>Metered</td>
<td>A</td>
<td>13</td>
<td>R</td>
<td>Year Round</td>
<td>Landscape Irrig</td>
</tr>
<tr>
<td>Magness, Judy &amp; Charles</td>
<td>069186-001</td>
<td>Main</td>
<td>2410 Forebay Rd</td>
<td>530-647-9059</td>
<td>110-330-20</td>
<td>1</td>
<td>1</td>
<td>A</td>
<td>13</td>
<td>R</td>
<td>Year Round</td>
<td>Flat</td>
</tr>
<tr>
<td>Whelden, Dave</td>
<td>068308-001</td>
<td>Main</td>
<td>101-220-01</td>
<td>530-644-2038</td>
<td>101-220-01</td>
<td>Landscape Irrig</td>
<td>Metered</td>
<td>A</td>
<td>13</td>
<td>R</td>
<td>Year Round</td>
<td>Landscape Irrig</td>
</tr>
</tbody>
</table>
Appendix F

Opinion of Probable Construction Costs
## Table F1 Alignment #1 - Preferred Alignment
### July 2014

<table>
<thead>
<tr>
<th>Element Description</th>
<th>Estimated Quantity</th>
<th>Units</th>
<th>Unit Price</th>
<th>Estimated Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobilization/Demolition</td>
<td>1</td>
<td>LS</td>
<td>$62,890</td>
<td>$62,890</td>
</tr>
<tr>
<td>Erosion Control &amp; Sediment Plan Compliance (SWPPP)</td>
<td>1</td>
<td>LS</td>
<td>$43,000</td>
<td>$43,000</td>
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<tr>
<td>Project Safety, Trench Safety, and Traffic Control</td>
<td>1</td>
<td>LS</td>
<td>$47,168</td>
<td>$47,168</td>
</tr>
</tbody>
</table>

### Mainline Construction

- **Connection to Valve House at Forebay Reservoir**: 1 LS $21,000 $21,000
- **36" PVC (DR51)**: 8,400 LF $90 $756,000
- **42" PVC (DR51)**: 7,000 LF $116 $812,000
- **Air Vaccum Release Valve**: 16 EA $5,000 $80,000
- **Blow-off Valves**: 7 EA $3,500 $24,500
- **Trench Cut Off Wall**: 16 EA $750 $12,000
- **Earthwork - Cut**: 1,900 CY $10 $19,000
- **Earthwork - Fill**: 36,000 CY $20 $720,000
- **Pipe Trench Class 2 AB Backfill**: 9,700 CY $45 $436,500
- **Tree Removal**: 1 LS $67,500 $67,500
- **Gnite Removal (Crush and placed in fill)**: 1 LS $2,000 $2,000
- **Outlet Structure (Concrete Vault, 1 BFV, 1 BOV, screen)**: 1 LS $71,000 $71,000
- **Raw Water Service (36" saddle, meter strainer, box, etc.)**: 3 EA $2,500 $7,500
- **Site Restoration**: 1 LS $115,500 $115,500
- **Contractor Overhead and Profit**: 12% LS $396,000
- **Construction Contingency**: 25% LS $824,000

**Construction Subtotal =** $4,517,600

### Non-Construction Costs

- **Temporary Easement Acquisition**: 3.8 AC $5,000 $19,000
- **Permenant Easement Acquisition**: 0.5 AC $40,000 $20,000
- **Title Search Service**: 1 LS $100,000 $100,000
- **Design/Engineering/Surveying**: 7% LS $316,000
- **Construction Administration/Overhead**: 8% LS $361,000
- **General Conditions, Taxes, Miscellaneous Items**: 15% LS $678,000

**Other Costs Subtotal =** $1,494,000

**TOTAL COST =** $6,012,000
### Table F2 Alignment #2 - Cross Country Alignment

**July 2014**

<table>
<thead>
<tr>
<th>Element Description</th>
<th>Estimated Quantity</th>
<th>Units</th>
<th>Unit Price</th>
<th>Estimated Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mobilization/Demolition</strong></td>
<td>1</td>
<td>LS</td>
<td>$60,225</td>
<td>$60,225</td>
</tr>
<tr>
<td><strong>Erosion Control &amp; Sediment Plan Compliance (SWPPP)</strong></td>
<td>1</td>
<td>LS</td>
<td>$58,000</td>
<td>$58,000</td>
</tr>
<tr>
<td><strong>Project Safety, Trench Safety, and Traffic Control</strong></td>
<td>1</td>
<td>LS</td>
<td>$45,169</td>
<td>$45,169</td>
</tr>
<tr>
<td><strong>Mainline Construction</strong></td>
<td>1</td>
<td>LS</td>
<td>$21,000</td>
<td>$21,000</td>
</tr>
<tr>
<td>36&quot; PVC (DR51)</td>
<td>5,900</td>
<td>LF</td>
<td>$90</td>
<td>$531,000</td>
</tr>
<tr>
<td>36&quot; PVC (DR41)</td>
<td>400</td>
<td>LF</td>
<td>$105</td>
<td>$42,000</td>
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<tr>
<td>42&quot; PVC (DR51)</td>
<td>7,000</td>
<td>LF</td>
<td>$116</td>
<td>$812,000</td>
</tr>
<tr>
<td>Creek Crossing</td>
<td>50</td>
<td>LF</td>
<td>$250</td>
<td>$12,500</td>
</tr>
<tr>
<td>Air Vacumm Release Valve</td>
<td>13</td>
<td>EA</td>
<td>$5,000</td>
<td>$65,000</td>
</tr>
<tr>
<td>Blow-off Valves</td>
<td>7</td>
<td>EA</td>
<td>$3,500</td>
<td>$24,500</td>
</tr>
<tr>
<td>Trench Cut Off Wall</td>
<td>13</td>
<td>EA</td>
<td>$750</td>
<td>$9,750</td>
</tr>
<tr>
<td>Earthwork - Cut</td>
<td>4,500</td>
<td>CY</td>
<td>$10</td>
<td>$45,000</td>
</tr>
<tr>
<td>Earthwork - Fill</td>
<td>37,500</td>
<td>CY</td>
<td>$20</td>
<td>$750,000</td>
</tr>
<tr>
<td>Trench Class 2 AB Backfill</td>
<td>8,700</td>
<td>CY</td>
<td>$45</td>
<td>$391,500</td>
</tr>
<tr>
<td>Tree Removal</td>
<td>1</td>
<td>LS</td>
<td>$97,500</td>
<td>$97,500</td>
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<tr>
<td>Gunite Removal (Crush and placed in fill)</td>
<td>1</td>
<td>LS</td>
<td>$2,000</td>
<td>$2,000</td>
</tr>
<tr>
<td>Outlet Structure (Concrete Vault, 1 BFV, 1 BOV, screen)</td>
<td>1</td>
<td>LS</td>
<td>$71,000</td>
<td>$71,000</td>
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<tr>
<td>Raw Water Service (36&quot; saddle, meter strainer, box, etc.)</td>
<td>3</td>
<td>EA</td>
<td>$2,500</td>
<td>$7,500</td>
</tr>
<tr>
<td>Site Restoration</td>
<td>1</td>
<td>LS</td>
<td>$129,000</td>
<td>$129,000</td>
</tr>
<tr>
<td>Contractor Overhead and Profit</td>
<td>12%</td>
<td>LS</td>
<td></td>
<td>$381,000</td>
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<tr>
<td>Construction Contingency</td>
<td>25%</td>
<td>LS</td>
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<td>$794,000</td>
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</table>

**Construction Subtotal** = $4,349,644

<table>
<thead>
<tr>
<th><strong>Non-Construction Costs</strong></th>
<th><strong>Estimated Quantity</strong></th>
<th><strong>Units</strong></th>
<th><strong>Unit Price</strong></th>
<th><strong>Estimated Amount</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporary Easement Acquisition</td>
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<td>AC</td>
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<td>$17,500</td>
</tr>
<tr>
<td>Permanent Easement Acquisition</td>
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<td>AC</td>
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<td>$225,000</td>
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<td>Title Search Service</td>
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<td>LS</td>
<td>$100,000</td>
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<tr>
<td>Design/Engineering/Surveying</td>
<td>7%</td>
<td>LS</td>
<td></td>
<td>$304,000</td>
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<tr>
<td>Construction Administration/Overhead</td>
<td>8%</td>
<td>LS</td>
<td></td>
<td>$348,000</td>
</tr>
<tr>
<td>General Conditions, Taxes, Miscellaneous Items</td>
<td>15%</td>
<td>LS</td>
<td></td>
<td>$652,000</td>
</tr>
</tbody>
</table>

**Other Costs Subtotal** = $1,646,500

**TOTAL COST** = $5,997,000
Table F3 Alignment #3 - Blair Road Alignment
July 2014

<table>
<thead>
<tr>
<th>Element Description</th>
<th>Estimated Quantity</th>
<th>Units</th>
<th>Unit Price</th>
<th>Estimated Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobilization/Demolition</td>
<td>1</td>
<td>LS</td>
<td>$69,899</td>
<td>$69,899</td>
</tr>
<tr>
<td>Erosion Control &amp; Sediment Plan Compliance (SWPPP)</td>
<td>1</td>
<td>LS</td>
<td>$43,000</td>
<td>$43,000</td>
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<tr>
<td>Project Safety, Trench Safety, and Traffic Control</td>
<td>1</td>
<td>LS</td>
<td>$69,899</td>
<td>$69,899</td>
</tr>
</tbody>
</table>

**Mainline Construction**

- Connection to Valve House at Forebay Reservoir: 1 LS @ $21,000 = $21,000
- 36" PVC (DR51): 4,400 LF @ $90 = $396,000
- 36" PVC (DR41): 1,500 LF @ $105 = $157,500
- 42" PVC (DR51): 7,000 LF @ $116 = $812,000
- Air Vacum Release Valve: 13 EA @ $5,000 = $65,000
- Blow-off Valves: 6 EA @ $3,500 = $21,000
- Trench Cut Off Wall: 13 EA @ $750 = $9,750
- Earthwork - Cut: 11,300 CY @ $10 = $113,000
- Earthwork - Fill: 34,900 CY @ $20 = $698,000
- Trench Class 2 AB Backfill: 10,900 CY @ $45 = $490,500
- Tree Removal: 1 LS @ $67,500 = $67,500
- Gunite Removal (Crush and placed in fill): 1 LS @ $2,000 = $2,000
- Outlet Structure (Concrete Vault, 1 BFV, 1 BOV, screen): 1 LS @ $71,000 = $71,000
- Raw Water Service (36" saddle, meter strainer, box, etc.): 3 EA @ $2,500 = $7,500
- Site Restoration: 1 LS @ $122,300 = $122,300
- Type II Slurry Seal (12’ 1/2 Road Width): 81,600 SF @ $1.50 = $122,400
- 3"AC/8"Class 2 AB Replacement: 49,000 SF @ $6.50 = $318,500
- Contractor Overhead and Profit: 12% LS @ $441,000 = $441,000
- Construction Contingency: 25% LS @ $919,000 = $919,000

**Construction Subtotal =** $5,037,800

**Non-Construction Costs**

- Temporary Easement Acquisition: 2.7 AC @ $5,000 = $13,500
- Permanent Easement Acquisition: 0.3 AC @ $40,000 = $12,000
- Title Search Service: 1 LS @ $100,000 = $100,000
- Design/Engineering/Surveying: 7% LS @ $353,000 = $353,000
- Construction Administration/Overhead: 8% LS @ $403,000 = $403,000
- General Conditions, Taxes, Miscellaneous Items: 15% LS @ $756,000 = $756,000

**Other Costs Subtotal =** $1,637,500

**TOTAL COST =** $6,676,000
Appendix B Engineering Studies

B.2 DOMENICHIELLI AND ASSOCIATES FINAL UPPER MAIN DITCH BASIS OF DESIGN REPORT UPDATES TECHNICAL MEMORANDUM (JANUARY 29, 2016)
BODR UPDATES

The purpose of this memo is to provide an update to the 2014 Upper Main Ditch Piping Basis of Design Report (BODR) that reflects updated costs and alignment considerations. This memo will provide recommendations for EID to consider in their final decisions.

BACKGROUND UPDATE

Existing Ditch Water Loss Confirmation – As a follow up to the estimated annual water loss in the existing Upper Main Ditch presented in the 2014 BODR, SAGE Engineers has performed field tests to measure percolation losses of ditch water. Attachment E is a technical memorandum prepared by SAGE that summarizes their findings. The results confirm previous flow measurements are within the range of what would be expected based on soil type and permeability.

HYDRAULIC ANALYSIS UPDATE

The hydraulic analysis included in the BODR was based on the best available information at the time. An update of the analysis was performed using the final survey data provided by EID and adjusting the Manning’s N-value for plastic pipe from 0.010 to a more conservative value of 0.012 to account for air entrainment, sediment loading and other unknowns. The results of the hydraulic analysis are provided below. Additional calculations are provided in Attachment 1.

### Table 1. Hydraulic Analysis Results (for 42-inch PVC with 42.65-inch ID)

<table>
<thead>
<tr>
<th>Forebay Reservoir HGL (ft)</th>
<th>Design Flow</th>
<th>Total Loss (ft)</th>
<th>HGL required at the Forebay (ft)</th>
<th>Excess Available Head at Forebay (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3799 Maximum</td>
<td>40 cfs Maximum</td>
<td>26</td>
<td>3782</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>7 cfs Minimum</td>
<td>6</td>
<td>3763</td>
<td>34</td>
</tr>
<tr>
<td>3786 Minimum</td>
<td>40 cfs Maximum</td>
<td>26</td>
<td>3782</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>7 cfs Minimum</td>
<td>6</td>
<td>3763</td>
<td>21</td>
</tr>
</tbody>
</table>

(1) Water Surface Elevation at Inlet to Res 1 WTP = approximately 3758 ft, pipe invert of 3754.5 ft and 3.5 ft of water depth (NAVD 88).

### Table 2. Hydraulic Analysis Results (for 48-inch HDPE pipe with 44.08-inch ID)

<table>
<thead>
<tr>
<th>Forebay Reservoir HGL (ft)</th>
<th>Design Flow</th>
<th>Total Loss (ft)</th>
<th>HGL required at the Forebay (ft)</th>
<th>Excess Available Head at Forebay (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3799 Maximum</td>
<td>40 cfs Maximum</td>
<td>22</td>
<td>3778</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>7 cfs Minimum</td>
<td>6</td>
<td>3763</td>
<td>35</td>
</tr>
<tr>
<td>3786 Minimum</td>
<td>40 cfs Maximum</td>
<td>22</td>
<td>3778</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>7 cfs Minimum</td>
<td>6</td>
<td>3763</td>
<td>22</td>
</tr>
</tbody>
</table>

(2) Water Surface Elevation at Inlet to Res 1 WTP = approximately 3758 ft, pipe invert of 3754.5 ft and 3.5 ft of water depth (NAVD 88).
The results show that a minimum pipe size of 42-inches nominal diameter for PVC is required for the new pipeline and a minimum 48-inch nominal diameter if HDPE is used. The difference in pipe size requirements is due to available pipe sizes and the variation in wall thickness between PVC and HDPE. DI pipe and welded steel pipe have a comparable inside diameter to PVC, though their n-value is slightly higher resulting in no excess head available at the maximum flow with the minimum Forebay elevation scenario for 42-inch diameter DI or steel pipe. Calculations using 36-inch PVC showed that even with PVC pipe, a 36-inch diameter pipe cannot convey the 40cfs under low Forebay elevation conditions. Additional discussion on the hydraulic differences in the pipelines is provided in the Pipe Material section of this TM.

**DESIGN CRITERIA UPDATES**

EID has requested that the design criteria for pipeline alignment and material type selection be updated with current costs and address any design and/or constructability issues that may be associated with the alternatives. The following sections describe each of the alternatives under consideration.

**ALIGNMENT**

The original BODR considered three alignments:

1. **Alignment 1** – Existing Ditch Alignment
2. **Alignment 2** – South Fork of Long Canyon Creek Cross Country Alignment
3. **Alignment 3** – Blair Road Alignment

The existing ditch alignment was selected based on costs and ease of construction. EID has requested that the Blair Road alignment (Alignment #3) be reconsidered based on the following:

1. **Construction Timeline** – The portion along Blair Road could be constructed during the spring/summer and is not dependent on the outage and would make the second outage window unneeded. This would reduce pumping cost by $35,000 – $100,000, depending on the length of the outage, associated with supplying water from Reservoir 2 via the Moose Hall Pump Station to the Pollock Pines Service area. Additionally, this alignment has approximately 2,500-feet less pipeline than the existing ditch alignment.

2. **Forebay Construction Requirements** – Raising of the Forebay Dam will require dewatering of the reservoir for approximately 2-weeks during the second ditch outage and a continuous groundwater dewatering of approximately ½cfs throughout construction. Additionally, up to 1cfs of storm water from the watershed above the Forebay must be managed. This water will be required to discharge down the Main Ditch and must be handled during construction of the proposed pipeline. This is a cost not originally considered in the BODR.

Figure 1 provides an overview of the two alignments being considered along with their approximate lengths. The following briefly compares the two alignments and estimates costs associated with differences identified. The intent of the discussion is to focus on the specific components of the two alignments that would create a cost difference between the two. A table is also provided to summarize the considerations for a final alignment selection.
ALIGNMENT #1 – EXISTING MAIN DITCH – 15,400 FEET

Additional Length of Pipe – The alignment in the existing ditch requires approximately 2,500 feet more pipe than the Blair Road Alignment. This is a significant amount of pipe and added cost to this alignment.

- Approximate Added Cost = based on an installed unit cost of $180/foot = $450,000

Additional mobilization/demobilization – Due to the limited outage of the ditch for the construction season (October 1 to March 1) it is anticipated that a two season construction period will be required. This cost difference approximates the added cost for the contractor to demobilize and remobilize the following fall.

- Approximate Added Cost = estimated at $120,000 (approximately 2% of the total cost)

Additional Tree Removal Required – The ditch alignment will require removal of trees that could be avoided if the Blair Road alignment is selected.

- Approximate Added Cost = estimated at $45,000 (approximately 150 trees at $300/tree)

Dewatering and Storm Water Bypass Required for Forebay Project – As mentioned above the piping project will be required to handle dewatering and any storm water flows from the site for the duration of the project. It is anticipated that this water will be handled by creating a temporary dam along the ditch to pond the water and pumping the water around the section of the ditch under construction.

- Approximate Added Cost = estimated at $80,000 (approximately two thirds of the total estimated cost of $120,000 based on 1,000-feet of 6-inch pipeline and pump rental for approximately 8 months total)

Additional Storm Water Pollution Prevention Plan (SWPPP) Implementation – The ditch alignment is expected to create a significant amount of disturbed area. Depending on the number and duration of storms over the season, the costs to stabilize the disturbed area prior to each storm and monitor the site could be significant. Cost for monitoring will be reduced if storm water is allowed to stay in the ditch and continue down stream.

- Approximate Added Cost = estimated at $50,000

Additional Pumping Costs – The Reservoir 1 WTP is normally offline October 1st to mid-December each year during the Project 184 outage. During this time, water is pumped from Reservoir 2 to the Pollock Pines Service Area at an estimated cost of approximately $20,000/month. In order to construct Alignment 1, 2-four month outage periods are needed. Alignment 3 (Blair Road) eliminates approximately 9,300 lf of pipeline within the existing ditch. The remaining 6,100 lf that would be built in the existing alignment can be built in one extended outage of approximately 3 months. As a result, 5 months or approximately $100,000 in power costs can be saved.

- Approximate Added Cost = estimated at $100,000

ALIGNMENT #3 – BLAIR ROAD – 12,900 FEET

Road Restoration Required – El Dorado County was contacted regarding the required road restoration for the project. They indicated minimum road restoration requirements will include replacement of the road section for the half of the road where the pipe is placed and a chip seal
over the entire roadway. The road is approximately 24-feet in width. The costs estimated below are based on recent bids received for similar work for EID.

- **Approximate Added Costs = $775,200** (based on 163,200SF of chip seal and striping at $150/SF and 81,600SF of 3”AC/8”AB at $6.50/SF)

**Traffic Control Required** – Construction along the roadway will require significant traffic control during construction. The limited amount of detours available in the area will require the contractor to keep the road open for residents and some through traffic (with anticipated delays).

- **Approximate Added Cost = $60,000**

**Additional Trench Safety** – The trenches along the roadway will need to be minimized in width in order to minimize impacts. The depth of the trench required for the pipe will require trench safety equipment including shoring and trench plates.

- **Approximate Added Cost = $68,000** (based on $10/foot over 6,800 feet of pipe)

**Additional fittings and Culvert crossings required** – Existing drainage along Blair Road includes multiple culverts that will need to be crossed by the pipeline. Added cost for these crossings will result due to deeper trenching to pass under the culverts and the need for additional air relief and blowoffs. It is estimated that an additional three blowoffs and four ARV’s are required for this alignment.

- **Approximate Added Cost = $30,000**

**Main Ditch Restoration Required** – The existing main ditch section that is not piped will require some restoration including partially filling sections to reduce liability and trash accumulation.

- **Approximate Added Cost = $200,000** (based on filling approximately 2-feet in depth over the 9,300 feet of pipeline at $15/CY)

**Reconnection to existing services** – There are two existing raw water services off of the main ditch that would require reconnection and new easements. It is estimated that approximately 800-ft of 2-inch service line would be required and 500-feet of 4-inch service line. Easements would include 20-feet over the length of the pipelines for a total of approximately 0.6 acres. The estimated costs for new easements are $40,000 per acre.

- **Approximate Added Cost = $89,000** (based on $50/feet of pipeline installation and 0.6 acres of new easement required)

**DRAINAGE FOR BOTH ALIGNMENTS:**

The existing main ditch intercepts off-site drainage from the upstream watershed. Currently all of that drainage is conveyed through the ditch downstream where it infiltrates. Piping the ditch will require that drainage either be diverted to the County drainage system or a road side ditch along the new pipeline. The drainage issue will need to be addressed regardless of the alignment selected and is discussed in more detail in a separate section.

**ENVIRONMENTAL AND RIGHT-OF-WAY:**

The main ditch alignment (#1) will have additional environmental impacts including removal of trees. The environmental impacts will be reduced by utilizing the Blair Road alignment (#3). This alignment is in an existing road way that would be considered previously impacted.
The existing main ditch alignment (#1) will require additional right-of-way acquisition due to the change from an open ditch to a pipeline. This will require the District to obtain a new easement at each property and then quit claim the existing federal patents. This process can be time consuming and potentially add costs that are not currently accounted for. The Blair Road alignment (#3) will avoid those issues where the pipeline is in Blair Road, and place the pipeline (for this segment) in the existing County Right-Of-Way. Acquisition of easements across third party parcels for restoration of service will however, be required and for areas where the pipe is installed in the ditch near the Forebay or Reservoir 1.

**ESTIMATED COST DIFFERENCE AND CONSIDERATIONS**

**Table 3. Summary of Alignment Considerations**

<table>
<thead>
<tr>
<th>Alignment #</th>
<th>Estimated Cost Difference total</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| #1 – Existing Main Ditch | $845,000 | Within existing EID ROW  
Minimized impact to community  
Minimal traffic impacts | 2,500-ft longer  
Multiple construction seasons  
Requires handling water from Forebay for two construction seasons  
Additional ROW required  
Additional environmental impacts  
Added pumping cost | |
| #3 – Blair Road | $1,222,200 | Can be constructed during the spring/summer  
Shorter Alignment  
Easier maintenance access  
Lower maintenance cost  
Minimized environmental impact | Major traffic impacts  
Additional agency coordination  
Road restoration required  
Potential utility crossings  
Service easements required  
Reduced Forebay water handling | |

Cost Difference = $377,200

Based on the analysis above, the two alignments are approximately $400,000 difference in cost. This difference in costs is considered significant. It is recommended that the final alignment be placed along the existing ditch.
PIPE MATERIAL TYPE
The BODR considered multiple types of pipeline materials for use on the project. The use of PVC was selected based on cost, constructability and District preference at the time. The District has requested that the use of HDPE, Ductile Iron, and Welded Steel pipe be reconsidered. The following briefly describes the considerations for each pipe type. Pipe cost information and data sheets for HDPE, PVC, and Welded Steel are provided in Attachment B.

DUCTILE IRON (DI):

Material Cost – At large diameters ductile iron pipe is more expensive than both HDPE, PVC, and welded steel pipe. At 42-inch diameter ductile iron pipe cost delivered is approximately $172 per foot. That is almost twice the cost of PVC.

Constructability – DI Pipe at this size is also more difficult to handle and install due to the pipe weight. Aggregate base (AB) and controlled density fill (CDF) material would both be acceptable backfill materials and protection against buoyancy. Additional advantages of CDF are that the trench width could be narrowed to minimize impacting the working area, ensure compaction around the pipe, serve to stabilize the bank from potential erosion, and potentially increase backfill production rates.

Corrosion Potential – Ductile Iron has the potential to corrode if not properly protected.

STEEL:

Material Cost – 42” welded steel pipe with concrete mortar lining and coating cost between $88 and $98 per foot depending on the selected pipe joint (i.e. lap weld joint v. gasket joint), which is comparable to PVC pipe.

Constructability – Carnegie gasket bell and spigot connections with 20-foot pipe lengths are recommended over single welded joints and typical 40-foot pipe. Though this causes more joints, the Contractor can utilize smaller equipment resulting from the confined work area to maneuver and install the heavier pipe sections and maintain higher installation production rates as joints would not be welded. Either AB or CDF would be acceptable backfill materials as described above.

Corrosion Potential – Steel pipe has the potential to corrode if not properly protected. All exposed steel (e.g. interior and exterior joints) would be grouted after installation. Furthermore, the CDF backfill would buffer the pipe from potential corrosion.

HIGH DENSITY POLYETHYLENE (HDPE)

Hydraulic Capacity – Typical inside diameter dimensions for an HDPE 42-inch nominal diameter pipeline is 38.58-inches. Based on the hydraulic analysis this inside diameter would not be adequate to convey the maximum flow of 40cfs. The next size available is a 48-inch nominal diameter with an inside diameter of 44.08-inches. In order to achieve the desired hydraulic capacity using HDPE the 48-inch diameter pipe was selected.

Material Cost – 48-inch HDPE costs approximately $110 per foot, which is 22% higher than PVC pipe.

Installation Costs – Fusing of HDPE requires a skilled technician and specialty equipment. Fusion equipment at this size do not include internal generators therefore a separate generator must be provided. The following summarizes the average costs for HDPE fusion.
• Fusion Machine Daily $1,200/Weekly $4,800/Monthly $16,000
• Datalogger Daily $200/Weekly $800/Monthly $2400
• Generator Daily $250/Weekly $1,000/Monthly $3,000
• Tech Daily $700 + travel expenses & per diem (estimate $1,000 total).

For a project duration of four months each construction season the total cost for fusion of the pipe is approximately $145,600 over one season. This equates to approximately $20 per foot over the length of the pipeline.

**Constructability** – The main construction advantage of HDPE is its flexibility and durability allowing for the number of fittings to be reduced. However, at this size of pipe the pipe wall thickness causes the material to be more ridged reducing the allowable turning radius. While the HDPE will require less fittings than the PVC pipe the difference is not significant at this size. Additionally, the pipe material will behave differently depending on the weather conditions. During cold weather winter construction, the material will be more rigid which will make it difficult to work with. HDPE is also approximately 30lbs per foot heavier than PVC. This added weight can be significant over the length of the project. This along with the added time required to fuse the pipe could extend project construction or require the use of multiple crews increasing the overall project costs.

**Connections** – A significant advantage for HDPE is that the fusing process will allow the final product to be one continuous pipeline without joints. In the project area, root intrusion can be a concern. Fused joints will eliminate this concern. Custom fittings can be fabricated for the turns and connections to eliminate the need for multiple fittings to be installed.

**POLYVINYL CHLORIDE (PVC)**

**Material and Installation Cost** – 42-inch PVC costs approximately $90 per foot. Installation of PVC is anticipated to be performed using standard construction methods.

**Constructability** – PVC construction would utilize typical bell and spigot connections and fittings. Typical PVC pipe installation utilizes smaller lengths of pipe (18-20 foot sticks) versus HDPE pipe which can go up to 50-feet in length. While the smaller lengths create more joints this also enables the contractor to move around lighter pipe. This along with push-on joints allows for faster construction with smaller equipment. For bends, standard mechanical joint fittings with megalug restraints would be used.

**Connections** – The main disadvantage to PVC is the number of joints required along the pipeline. When properly installed joints should be watertight and not allow root intrusion. However, even small leaks can become a problem with the large trees in the area. Inspection during project construction will be essential to ensure a proper installation. Additionally, the District should consider the use of some root deterrent at the joints to minimize this concern.

**ESTIMATED COST DIFFERENCE**

It is anticipated that the earthwork costs associated with all pipe types will be similar depending on the alignment selected. To compare costs only the delivered material cost and added installation costs are included in the table below.
Table 4. Pipe Material and Installation Cost Comparison

<table>
<thead>
<tr>
<th>Pipe Material</th>
<th>Cost per foot</th>
<th>Total cost (using 15,400-feet)</th>
<th>Difference from PVC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ductile Iron</td>
<td>$344</td>
<td>$5,297,600</td>
<td>+$1,278,200</td>
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<tr>
<td>Steel</td>
<td>$278</td>
<td>$4,281,200</td>
<td>+$261,800</td>
</tr>
<tr>
<td>HDPE</td>
<td>$283</td>
<td>$4,358,200</td>
<td>+$338,800</td>
</tr>
<tr>
<td>PVC</td>
<td>$260</td>
<td>$4,019,400</td>
<td>N/A</td>
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</table>

While the cost difference between HDPE, DI, Steel and PVC is significant each pipe has advantages and disadvantages that should be considered. All pipe types were determined to be feasible alternatives for the project.

PIPE BUOYANCY ISSUES

Pipeline buoyancy will be a design concern regardless of the pipeline type selected. This is mainly due to the collection of storm water (discussed further in the Drainage section below). Storm water will collect above the pipeline as it does in the ditch under current conditions. The recommended solution to manage the storm water will be to provide conveyance capacity above the pipeline backfill by maintaining the existing berm. Under this condition, maximum buoyancy forces will occur when storm water saturates the pipe trench and the pipe is empty.

Buoyancy calculations are provided in Attachment A for the various pipe and backfill conditions. In order to overcome these forces, alternatives were analyzed based on costs and final product reliability. The following alternatives for backfill were analyzed:

- **Aggregate Base Backfill** – For steel pipe backfill with aggregate base (AB) material will be adequate if compacted correctly. For both PVC and HDPE pipe aggregate base material would also be feasible, however cover must be maintained greater than 2.2 feet. If cover is lost over time or the backfill material and compaction do not meet specifications, the pipeline integrity could be compromised.

- **Controlled Density Fill** – Another option would be to use controlled density fill (CDF) for backfill material. This would provide greater protection from buoyancy and can help with production rates for construction as mentioned previously.

DRAINAGE

One of the major design components of the project discussed in the BODR is off-site drainage. Currently the main ditch intercepts drainage from the watershed above the ditch. Once the ditch is piped this drainage must either be conveyed in an alternative drainage system or allowed to continue downslope of the ditch. The following drainage analysis provides an estimate of the expected flows and recommendations for final drainage improvements.

UPPER MAIN DITCH ANALYSIS

WATERSHED DESCRIPTION AND METHOD OF ANALYSIS

The Upper Main Ditch from Forebay to Reservoir 1 WTP traverses the side slope of the upper Long Canyon watershed for approximately 3 miles. This reach of ditch is proposed for
conversion from an open water supply canal to a closed pipeline conveyance system. Runoff up-slope from the Upper Main Ditch is intercepted by the ditch along this project reach. Figure D-1 (Attachment D) shows the drainage sheds tributary to the ditch, along with points along the ditch where runoff flows have been estimated by hydrologic modeling.

Larger storm events generally occur during the winter months a portion of which occurs during the ditch outage. During the outage conveyance of storm flow is allowed through the Upper Main Ditch, past Reservoir 1 into the Lower Main Ditch eventually lost to infiltration. If a major storm is anticipated during normal raw water conveyance operations, the flows from Forebay would be reduced to allow for added runoff inflow. Runoff overflows the ditch at several locations identified following the survey.

Runoff modeling was performed using the US Army Corps of Engineers, HEC-HMS computer modeling software. Rainfall and runoff parameters are taken from the El Dorado County Drainage Manual. This analysis provides estimates of runoff into the ditch under existing conditions and discusses options for safely managing this runoff after completion of the pipeline project. Additional modeling results and figures are provided in Attachment D.

EXISTING CONDITIONS INFLOW TO DITCH

The following Table 5 summarizes the existing conditions runoff characteristics for sub-basins tributary to the ditch (see Figure D-1). Runoff parameters used in the modeling include rainfall, soil type, cover type, percent impervious area (roads, roofs, patios, etc.) and overland flow routing. The resulting sub-basin flows are relatively low due to pervious soils with dense forest cover and very little impervious areas. For small tributary areas resulting in mostly nuisance level flood flows, the design storm frequency used is a 10-year storm event. Any improvements should be sized to convey the 10-year flows with added capacity to contain larger events without causing measurable property damage.

Table 5. 10-year Design Storm

<table>
<thead>
<tr>
<th>Sub-basin</th>
<th>Drainage Area (Acres)</th>
<th>Sub-basin 10-year runoff (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>27</td>
<td>6.1</td>
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<tr>
<td>10</td>
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<td>9</td>
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<td>1.9</td>
</tr>
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<td>2</td>
<td>6</td>
<td>2.4</td>
</tr>
<tr>
<td>1</td>
<td>37</td>
<td>13.3</td>
</tr>
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</table>

Table 6 provides cumulative flows in the ditch at several locations (junctions) traversing downstream along the project reach. The ditch junctions are designated from J11 near the Forebay to J0 at Reservoir 1 WTP as seen on Figure D-1. The resulting flows below are
tabulated at several locations of interest. A detailed listing of flow results can be found in Attachment D, HEC-HMS Results.

**Table 6. 10-year Design Peak Flows**

<table>
<thead>
<tr>
<th>Ditch Location (Junction)</th>
<th>Description</th>
<th>Cumulative Drainage Area (Acres)</th>
<th>Peak 10-year Flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>J11</td>
<td>Initial basin</td>
<td>27</td>
<td>6.1</td>
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<tr>
<td>J9</td>
<td>Long Canyon Creek xing</td>
<td>178</td>
<td>41.3</td>
</tr>
<tr>
<td>J7</td>
<td>minor swale</td>
<td>200</td>
<td>43.5</td>
</tr>
<tr>
<td>J5</td>
<td>Large swale before Blair Rd -xing</td>
<td>272</td>
<td>57.2</td>
</tr>
<tr>
<td>J3</td>
<td>Blair Rd Crossing</td>
<td>305</td>
<td>63.4</td>
</tr>
<tr>
<td>J1</td>
<td>Large swale before WTP</td>
<td>348</td>
<td>72.2</td>
</tr>
<tr>
<td>J0</td>
<td>Res 1 WTP</td>
<td>348</td>
<td>71.8</td>
</tr>
</tbody>
</table>

A review of the Upper Main Ditch capacity was conducted using the channel topographic survey and a HEC-RAS hydraulic model of the ditch. This review found that the ditch has capacity when flowing nearly full to convey approximately 40 cfs in the upper reaches, 60 cfs at the Blair Rd crossing and nearly 70 cfs closer to Reservoir 1. Based on the flows in Table 6, the ditch can convey approximately a 10-year storm event.

**PROPOSED CONDITIONS DRAINAGE OPTIONS**

The project proposes to replace the ditch with a pipeline, either within the entire reach or a portion thereof. One alignment alternative would put a large portion of the pipe in Blair Road. Figure 1 shows the two alternative alignments. In either case, drainage currently flowing into the ditch must be addressed.

**Drainage for Alignment #1 – Pipe in Ditch entire reach** – With the pipe in the ditch, the up-slope runoff can be handled in three different ways as follows:

- **Option 1** – Fill the ditch completely and allow flows (in Table 5) to continue down-slope to adjacent properties.
- **Option 2** – Partially fill the ditch containing runoff within the ditch (above the new pipe) and discharge flow at swales indicated in Table 6.
- **Option 3** – Partially fill the ditch containing runoff within the ditch above the pipe and convey all flow past Reservoir 1 to the Lower Main Ditch up to the 10 year storm event flow and discharge excess flow at swales.

Option 1 is not recommended due to the fact that there are many down-slope residents that would be impacted by new runoff introduced to their properties. In addition, completely filling the ditch would require either using the entire embankment as fill or importing fill material. Both fill scenarios would be costly and due to the number of large trees in the embankment, it will be difficult to use much of that soil.

Option 2 is also problematic in that the flows (shown in Table 6) are large enough to impact properties adjacent to these swales and impact existing culvert crossings on Blair Road.
Option 3 requires the ditch to convey all runoff past Reservoir 1 as it does under existing conditions. As described above, this can be achieved for flows up to a 10-year storm event. Flows greater than the 10yr level would overtop the ditch banks. Providing overflow weirs at the existing swales to control the overtopping flows is recommended.

Figure 2 below is a typical section of the proposed ditch partially filled, with a 12-foot roadway surface and a roadside ditch to convey more frequent storm runoff to the swales. By only partially filling the ditch and leaving the embankment, large storm events can still be conveyed in the roadside ditch with overflow on the access surface. The capacity of this system with 1 foot of freeboard is between 50cfs to 95cfs. This will adequately convey the 10-year flows shown in Table 7.

Figure 2. Typical cross section proposed

**Drainage for Alignment #3 – Pipe in Blair Road and Ditch**

As seen in Figure 1, a large portion of the pipeline could follow Blair Road. This option would leave a large portion of the ditch to convey and potentially store storm water. For this Alternative, handling storm water and dewatering flows during construction would be simplified. However, at least partially filling of the ditch is still desirable for liability reasons and to avoid creating a trash or mosquito breeding nuisance. Therefore, a similar cross-section to Figure 2 would be necessary, with the exception of the need for a roadside ditch. Conveyance of the storm water downstream of the Blair Road crossing would still be necessary, therefore this alignment alternative provides only limited drainage advantages (mostly SWPPP conditions during construction) over the pipeline in the ditch alignment.

**EL DORADO COUNTY INPUT**

A meeting with El Dorado County drainage staff on January 26, 2016 discussed drainage issues on the project and proposed solutions. While the County does not have jurisdiction to dictate how drainage is handled, their input and knowledge of issues in the area is important to
developing a solution. Based on the meeting it is recommended to design the drainage system to contain the 10-year flow rates as calculated previously. Flows exceeding the 10-year will be allowed to overflow at key locations identified.

**ADDITIONAL DESIGN CONSIDERATIONS**

**PLACEMENT OF PIPELINE AT EXISTING DITCH ELEVATION**

This alternative would allow the pipeline to be built within the ditch alignment placing the pipe at or near the ditch invert, rather than completely below the invert as shown in the typical cross-section (above) for Option #4. By placing the pipe on the ditch bottom or partially below the invert, the ditch could be back-filled with the existing berm material, leaving a flat bench above the pipe. No import would be required other than the pipe zone material similar to Option #4. This option also requires less excavation into native earth below the ditch than shown above in the typical cross-section (Option #4).

Reasons that this option was not considered for further investigation are as follows:

- In order to assure proper bedding and pipe zone material placement, the ditch would have to be filled and compacted prior to trenching for the pipe. The need for this operation removes any trenching advantage.

- A disadvantage of this option would be the need to remove all trees and root systems from the berm. There are several hundred large trees growing within the berm cross-section with roots extending across to the ditch. Costs of removal of the trees and roots to obtain suitable fill material would be excessive.

- Environmental impacts and drainage impacts of removing the added trees and eliminating a portion of the ditch drainage conveyance would make this option difficult to permit.

**SHOTCRETE LINING OF DITCH**

An alternative to concrete line the Upper Main Ditch was considered in this basis of design update. This alternative could potentially address some of the concerns associated with piping the ditch and possibly result in a cost saving solution. If the ditch remains open with the lining, collection and conveyance of drainage runoff would not be changed and would no longer be an issue. This alternative would also reduce the impact to residents that would like the open flowing ditch to remain.

Ditch lining costs will vary significantly relative to desired water loss and expected life of the lining. A simple 4-inch thick lining reinforced with welded wire fabric that basically follows the existing contours will be less expensive than a lining capable of supporting maintenance equipment with a low leak rate requiring minimal long term maintenance and repair. Cost of recent similar projects for reinforcing and shotcrete application have ranged from $14 per square-foot for a minimal lining to $18 per square-foot for a more waterproof robust system with re-bar reinforcement on the walls and channel invert. For the purposes of this report, a value of $15 per square foot was used, assuming added thickness and reinforcing for the channel bottom to support equipment and reduce leakage.

Given the unit cost established above, the lining alternative would be approximately 10% less expensive to construct than the pipeline options (see Attachment B for relative cost estimates).
However, this savings relative to the cost to maintain and repair the lining make it a less attractive alternative. Cracking will occur and increase over time resulting in increased leakage and potential lining failure. Repair and complete section replacements should be anticipated and budgeted for every 10 years.

In any case, debris removal will continue to be a significant maintenance cost and will be difficult with the limited access along much of the ditch alignment. Ditch plugging and overflow concerns will still be an issues as they are under existing conditions. Water loss with a lining system as described above will continue to be an issue as the project ages. Cost to provide a water tight lining on the order of $7,500,000 with relatively low maintenance and a life cycle similar to a pipeline would make the ditch lining the highest construction cost alternative by a significant margin.

Continued water loss issues, relatively high maintenance and repair costs, debris loading and overflow potential are all disadvantages to the lining option, and we recommend this option not be pursued.

BACKFILL MATERIAL

Caltrans identified two available backfill material sites, Piney Point and Bullion Bend, which are located within a 6-mile radius (and 4-miles of one another) east of the Main Ditch site along the Highway 50 corridor. Both sites are used by Caltrans to stockpile materials (i.e. soil, rock, debris) from landslide and highway maintenance operations. It is expected that EID could take as much material from either site as need at no cost, though agreements/permits with both USFS and/or Caltrans would be required. EID would be responsible for all costs associated with processing and hauling the material, and erosion sediment control measures. Vehicle access and staging area at both sites are adequate, though traffic control measures are anticipated to ensure public safety.

PINEY POINT SITE

The Piney Point site is owned by the U.S. Forrest Service (USFS) and permitted to Caltrans; though Caltrans’ permit expires at the end of 2015 and is not anticipated to be renewed. The Site is approximately 2-acres and was a portion of the old Highway 50 alignment. Material samples at the surface were collected by a geotechnical consultant and are being analyzed. Based on field observation the material make-up of the stockpile is expected to vary, but comprised mostly of native materials cut from previous Highway 50 alignment work. Lower levels of the stockpile are unknown, but anticipated to consist of the original highway material. The site has not been used by Caltrans in many years, and is currently densely compacted and covered with Starthisle. See Figure 3 for a photo of the available material at the site.
BULLION BEND SITE

The Bullion Bend site, approximately 9.5-acres, is owned by Caltrans and located approximately ½-mile east of the Sly Park Road exit. Caltrans established the site to stockpile materials collected from the 1997 Whitehall landslide along Highway 50. This site remains Caltrans primary site for stockpiling materials collected from their Highway 50 maintenance activities. Material samples at the surface were collected by a geotechnical consultant and the results of the analysis are included in Attachment E. Based on field observation, the material make-up is expected to vary throughout the site with the upper layers having more trash and debris from Highway maintenance operations, and the lower levels having more uniform material with rock from the landslide. Residential homes border the site’s southwest boundary, so noise ordinance requirements are expected to be enforced. See Figure 4 for a photo of the available material at the site.
Figure 4. View of stockpiled material at Bullion Bend site

The material does not appear suitable without some significant processing. Additional costs would include site restoration and BMPs during and after construction.

RIGHT-OF-WAY

The existing right-of-way along the ditch is a 100-foot patent measured 50-feet from the marginal limit of the ditch (top) on either side. This right-of-way is larger than estimated in the original BODR. Based on the existing rights there is sufficient right-of-way to place the new pipeline in the ditch and provide a drainage ditch (as previously recommended). The District plans to establish a new reduced easement width in exchange for quit claiming the existing federal patent. All right-of-way work will be coordinated through the District’s land consultant.

PROPERTY OWNER COMMENTS

A number of comments were received from property owners following an initial public informational meeting. A majority of the comments are objections to the project from an aesthetics and inconvenience perspective. Most of the concerns including loss of home value will not be addressed in the design. There were two concerns that were expressed by multiple property owners that can be addressed with the design. These include:

- **Drainage** – Multiple homeowners expressed concern over how storm drainage would be handled. As mentioned previously this will be addressed in the final design by selecting an acceptable conveyance option presented in this TM.

- **Fire Safety** – It was pointed out that currently the fire department utilizes the ditch as a source of water if a fire occurs in the area. It is recommended that the final design
include access points for the fire department to the new pipeline at key access points along the ditch.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based on the analysis provided in the original BODR and updates provided in this TM.

ALIGNMENT OPTIONS

The two basic alignment options require either a portion of or all of the pipeline to be installed within the Main Ditch. The Blair Road Alignment will require 6,100 feet of pipeline be installed in the Ditch and 6,800 within the roadway. The Main Ditch Alignment would have the entire pipeline within the Ditch at a length of 15,400 lineal feet. Although the Main Ditch Alignment requires 2,500 feet of additional pipeline, the estimated cost of this alignment is approximately $500,000 less than the Blair Road Alignment in initial capital costs. This is due to factors such as added traffic control, roadway restoration and shoring costs not associated with the Main Ditch Alignment.

Based on the costs to construct the pipeline and other issues associated with the alignments, the existing Main Ditch Alignment is recommended for this project.

PIPE MATERIAL

Based on cost of material and installation, PVC C905 pipe material is recommended for this project. At an additional cost of approximately $200,000 to 350,000, HDPE and welded steel pipe would provide essentially an almost seamless pipeline which may be preferable to the District, if the added cost is acceptable. Ductile iron pipe cost at this size would be on the order of approximately $1,200,000 more than PVC pipe. The durability of the metal pipe may not be warranted for this low pressure system at the added costs anticipated.

DRAINAGE MANAGEMENT

Management of drainage currently entering the Main Ditch from watersheds up-slope from the ditch, must be addressed with this project. Allowing the runoff to pass unimpeded to down-slope properties is not recommended. Using the Main Ditch to convey the runoff either completely as it does under current conditions or partially to major swale locations will have a better chance to gain the approval of the local residents and the County. Providing capacity in the ditch above the buried pipe to carry runoff is recommended and can be accommodated given the required fill and available ditch cross-sectional area. We recommend that the District propose diversion of a portion of the runoff into three swale crossings of the Ditch Alignment for flows exceeding the 10-year event. It is our opinion that diverting all of the flow at these locations would cause adverse impact to downstream properties due to the volume of added flow.

OTHER DESIGN CONSIDERATION

- Use of Caltrans Fill Material – This option is not recommended due to the condition of the Caltrans material and fact that between the trench excavation and fill available from the existing (ditch) berm, no import material should be necessary.
• **Two Pipe Option** – An option to install two pipes in the ditch was discussed. A smaller pipe could be installed first that could pass low WTP demand flows to extend the construction window. A second pipe to convey the balance of design flow would be installed afterwards. Although this could significantly extend the construction window, the two pipes installed would add approximately $1,000,000 to the project costs over the recommended design. This is due to the need for an initial 24-inch pipe and a second 36-inch pipe compared to a single 42-inch pipe to convey the final design flow. This option would also require the operation and maintenance of two pipes. For these reasons, this option is not recommended.

**UPDATED ESTIMATE OF PROBABLE COSTS**

The following provides an updated cost estimate for the project based on the recommended alignment and pipe material.
### Element Description

<table>
<thead>
<tr>
<th>Element Description</th>
<th>Estimated Quantity</th>
<th>Units</th>
<th>Unit Price</th>
<th>Estimated Amount</th>
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<td>$547,500</td>
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<tr>
<td>Pipe Trench Backfill (CDF)</td>
<td>8,800</td>
<td>CY</td>
<td>$100</td>
<td>$880,000</td>
</tr>
<tr>
<td>AB Road Surface and drainage ditch</td>
<td>3,400</td>
<td>CY</td>
<td>$55</td>
<td>$187,000</td>
</tr>
<tr>
<td>Tree Removal</td>
<td>1</td>
<td>LS</td>
<td>$67,500</td>
<td>$67,500</td>
</tr>
<tr>
<td>Gunite Removal (Crush and placed in fill)</td>
<td>1</td>
<td>LS</td>
<td>$5,000</td>
<td>$5,000</td>
</tr>
<tr>
<td>Outlet Structure (Concrete Vault, 1 BFV, 1 BOV, screen, 1 Full Bore Mag Meter)</td>
<td>1</td>
<td>LS</td>
<td>$120,000</td>
<td>$120,000</td>
</tr>
<tr>
<td>Raw Water Service (42” saddle, meter strainer, box, etc.)</td>
<td>4</td>
<td>EA</td>
<td>$2,500</td>
<td>$10,000</td>
</tr>
<tr>
<td>Site Restoration</td>
<td>1</td>
<td>LS</td>
<td>$115,500</td>
<td>$115,500</td>
</tr>
<tr>
<td>Construction Contingency</td>
<td>20%</td>
<td>LS</td>
<td>$1,180,080</td>
<td></td>
</tr>
</tbody>
</table>

**CONSTRUCTION COST = $7,080,500**

**Non-Construction Costs**

<table>
<thead>
<tr>
<th>Element Description</th>
<th>Estimated Quantity</th>
<th>Units</th>
<th>Unit Price</th>
<th>Estimated Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design/Engineering/Surveying</td>
<td>7%</td>
<td>LS</td>
<td></td>
<td>$496,000</td>
</tr>
<tr>
<td>Construction Administration/Overhead</td>
<td>8%</td>
<td>LS</td>
<td></td>
<td>$566,000</td>
</tr>
<tr>
<td>Title Research and Easement Acquisition</td>
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<td>LS</td>
<td>$255,000</td>
<td>$255,000</td>
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<tr>
<td>Environmental</td>
<td>1</td>
<td>LS</td>
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<td>$250,000</td>
</tr>
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**Other Costs Subtotal = $1,667,000**

**TOTAL COST = $8,748,000**
ATTACHMENT A – HYDRAULIC ANALYSIS AND BOUANCY CALCULATIONS
<table>
<thead>
<tr>
<th>Nominal Dia (in)</th>
<th>Inside Pipe Dia (in)</th>
<th>Material</th>
<th>Manning &quot;n&quot;</th>
<th>Pipe Friction系数 (K)</th>
<th>Pipe FR Loss (ft)</th>
<th>Pipe Friction Loss from Head Loss (ft)</th>
<th>HGL change (ft)</th>
<th>Total Loss (ft)</th>
<th>Total HR (ft)</th>
<th>Remaining Available Head within the Forebay Reservoir</th>
</tr>
</thead>
<tbody>
<tr>
<td>36.0</td>
<td>35.71</td>
<td>PVC</td>
<td>0.012</td>
<td>0.76</td>
<td>0.0027</td>
<td>42.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>5.4 Max Normal</td>
</tr>
<tr>
<td>36.0</td>
<td>36.71</td>
<td>PVC</td>
<td>0.012</td>
<td>0.76</td>
<td>0.0027</td>
<td>42.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>5.4 Max Normal</td>
</tr>
<tr>
<td>42.0</td>
<td>42.65</td>
<td>PVC</td>
<td>0.012</td>
<td>0.89</td>
<td>0.0027</td>
<td>42.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>5.4 Max Normal</td>
</tr>
<tr>
<td>42.0</td>
<td>42.65</td>
<td>PVC</td>
<td>0.012</td>
<td>0.89</td>
<td>0.0027</td>
<td>42.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>5.4 Max Normal</td>
</tr>
<tr>
<td>48.0</td>
<td>48.00</td>
<td>HDPE</td>
<td>0.012</td>
<td>0.58</td>
<td>0.0027</td>
<td>38.576</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>5.4 Max Normal</td>
</tr>
<tr>
<td>48.0</td>
<td>48.00</td>
<td>HDPE</td>
<td>0.012</td>
<td>0.58</td>
<td>0.0027</td>
<td>38.576</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>5.4 Max Normal</td>
</tr>
<tr>
<td>48.0</td>
<td>48.00</td>
<td>HDPE</td>
<td>0.012</td>
<td>0.58</td>
<td>0.0027</td>
<td>38.576</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>5.4 Max Normal</td>
</tr>
<tr>
<td>48.0</td>
<td>48.00</td>
<td>HDPE</td>
<td>0.012</td>
<td>0.58</td>
<td>0.0027</td>
<td>38.576</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>5.4 Max Normal</td>
</tr>
</tbody>
</table>

Minimum Flow:

<table>
<thead>
<tr>
<th>Nominal Dia (in)</th>
<th>Inside Pipe Dia (in)</th>
<th>Material</th>
<th>Manning &quot;n&quot;</th>
<th>Pipe Friction系数 (K)</th>
<th>Pipe FR Loss (ft)</th>
<th>Pipe Friction Loss from Head Loss (ft)</th>
<th>HGL change (ft)</th>
<th>Total Loss (ft)</th>
<th>Total HR (ft)</th>
<th>Remaining Available Head within the Forebay Reservoir</th>
</tr>
</thead>
<tbody>
<tr>
<td>36.0</td>
<td>35.71</td>
<td>PVC</td>
<td>0.012</td>
<td>0.76</td>
<td>0.0001</td>
<td>1.3</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.7 Max Normal</td>
</tr>
<tr>
<td>36.0</td>
<td>36.71</td>
<td>PVC</td>
<td>0.012</td>
<td>0.76</td>
<td>0.0001</td>
<td>1.3</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.7 Max Normal</td>
</tr>
<tr>
<td>42.0</td>
<td>42.65</td>
<td>PVC</td>
<td>0.012</td>
<td>0.89</td>
<td>0.0000</td>
<td>0.6</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.5 Max Normal</td>
</tr>
<tr>
<td>42.0</td>
<td>42.65</td>
<td>PVC</td>
<td>0.012</td>
<td>0.89</td>
<td>0.0000</td>
<td>0.6</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.5 Max Normal</td>
</tr>
<tr>
<td>48.0</td>
<td>48.00</td>
<td>HDPE</td>
<td>0.012</td>
<td>0.58</td>
<td>0.0000</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.4 Max Normal</td>
</tr>
<tr>
<td>48.0</td>
<td>48.00</td>
<td>HDPE</td>
<td>0.012</td>
<td>0.58</td>
<td>0.0000</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.4 Max Normal</td>
</tr>
<tr>
<td>48.0</td>
<td>48.00</td>
<td>HDPE</td>
<td>0.012</td>
<td>0.58</td>
<td>0.0000</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.4 Max Normal</td>
</tr>
</tbody>
</table>
### Pipeline Buoyancy Calculations

#### AB Backfill

**Given:**
- Backfill dry density (lbs/cf) \(140\) AB material
- Backfill Specific Gravity \(2.65\)
- Pipe Depth of Cover (ft) \(2\)
- Water Level Above Pipe (ft) \(2\)
- Factor of Safety \(1.3\)

**Results:**

<table>
<thead>
<tr>
<th>Material Type</th>
<th>HDPE</th>
<th>PVC</th>
<th>DIP</th>
<th>Steel Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe Size</td>
<td>IPS 42&quot;</td>
<td>IPS 48&quot;</td>
<td>DIPS 42&quot;</td>
<td>36&quot;</td>
</tr>
<tr>
<td></td>
<td>DR32.5</td>
<td>DR32.5</td>
<td>DR17</td>
<td>80 PSI</td>
</tr>
<tr>
<td></td>
<td>DR17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe Rating</td>
<td>DR32.5</td>
<td>DR32.5</td>
<td>DR17</td>
<td>80 PSI</td>
</tr>
<tr>
<td></td>
<td>DR17</td>
<td>DR17</td>
<td>DR17</td>
<td>80 PSI</td>
</tr>
<tr>
<td></td>
<td>DR17</td>
<td>DR17</td>
<td>DR17</td>
<td>80 PSI</td>
</tr>
<tr>
<td></td>
<td>DR17</td>
<td>DR17</td>
<td>DR17</td>
<td>80 PSI</td>
</tr>
<tr>
<td></td>
<td>DR17</td>
<td>DR17</td>
<td>DR17</td>
<td>80 PSI</td>
</tr>
<tr>
<td>Pipe Weight (lbs/ft)</td>
<td>72.77</td>
<td>94.9</td>
<td>151.37</td>
<td>64.32</td>
</tr>
<tr>
<td>Outside Diameter (in)</td>
<td>42</td>
<td>48</td>
<td>44.5</td>
<td>38.3</td>
</tr>
<tr>
<td>Displaced Water Weight (lbs/lf)</td>
<td>-600.3</td>
<td>-784.1</td>
<td>-673.9</td>
<td>-499.2</td>
</tr>
<tr>
<td>Summation of Forces (lbs/lf) = (Pipe Weight+Displaced Water)</td>
<td>-527.6</td>
<td>-689.2</td>
<td>-522.6</td>
<td>-434.9</td>
</tr>
<tr>
<td>Average unit weight of inundated Backfill Density (lbs/cf)</td>
<td>87.2</td>
<td>87.2</td>
<td>87.2</td>
<td>87.2</td>
</tr>
<tr>
<td>Weight of inundated backfill (lbs/lf)</td>
<td>724.8</td>
<td>847.0</td>
<td>775.1</td>
<td>651.7</td>
</tr>
<tr>
<td>Weight of backfill above water level (lbs/lf)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total Weight of Backfill (lbs/lf)</td>
<td>724.8</td>
<td>847.0</td>
<td>775.1</td>
<td>651.7</td>
</tr>
<tr>
<td>Total Weight of Backfill with Factor of Safety (lbs/lf)</td>
<td>557.5</td>
<td>651.5</td>
<td>596.3</td>
<td>501.3</td>
</tr>
<tr>
<td>Net Total Displacement (lbs/lf) (+Will not float, -Will float)</td>
<td>29.9</td>
<td>-37.7</td>
<td>73.7</td>
<td>66.4</td>
</tr>
</tbody>
</table>

**Will not float** | **Will Float** | **Will not float** | **Will float** | **Will not float** | **Will float** | **Will not float** | **Will float** | **Will not float** | **Will float**
# Pipeline Buoyancy Calculations

## CDF Backfill

### Given:

<table>
<thead>
<tr>
<th>Given</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backfill above trench density (lbs/cf)</td>
<td>110</td>
</tr>
<tr>
<td>Backfill Specific Gravity</td>
<td>2.65</td>
</tr>
<tr>
<td>CDF Backfill (density)</td>
<td>150</td>
</tr>
<tr>
<td>Pipe Depth of Cover (ft)</td>
<td>3</td>
</tr>
<tr>
<td>Water Level Above Pipe (ft)</td>
<td>3</td>
</tr>
<tr>
<td>Factor of Safety</td>
<td>1.5</td>
</tr>
<tr>
<td>Displaced Volume of CDF &amp; Pipe (assume 5x5ft trench) (cf/ft)</td>
<td>25</td>
</tr>
</tbody>
</table>

### Results:

<table>
<thead>
<tr>
<th>Material Type</th>
<th>HDPE</th>
<th>PVC</th>
<th>DIP</th>
<th>Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe Size</td>
<td>IPS 48&quot;</td>
<td>42&quot;</td>
<td>42&quot;</td>
<td>42&quot;</td>
</tr>
<tr>
<td>Pipe Rating</td>
<td>DR32.5</td>
<td>80 PSI</td>
<td>Class 150</td>
<td>3/16&quot;</td>
</tr>
<tr>
<td>Pipe Weight (lbs/ ft)</td>
<td>94.9</td>
<td>88.1</td>
<td>173.8</td>
<td>139.7</td>
</tr>
<tr>
<td>Outside Diameter (in)</td>
<td>48</td>
<td>44.5</td>
<td>44.5</td>
<td>42.5</td>
</tr>
<tr>
<td>CDF Backfill Weight (lbs)</td>
<td>1866</td>
<td>2131</td>
<td>2131</td>
<td>2282</td>
</tr>
</tbody>
</table>

| Displaced Water Weight (lbs/lf)             | -1560.0| -1560.0| -1560.0| -1560.0|
| Summation of Forces (lbs/lf) = (Pipe Weight+Displaced Water)         | 400.9  | 658.8  | 744.5  | 861.4  |
| Average unit weight of Inundated Backfill Density (lbs/cf)            | 68.5   | 68.5   | 68.5   | 68.5   |
| Weight of inundated backfill (lbs/lf)      | 939.5  | 863.0  | 863.0  | 817.2  |
| Weight of backfill above water level (lbs/lf) | 0.0    | 0.0    | 0.0    | 0.0    |
| Total Weight of Backfill (lbs/lf)          | 939.5  | 863.0  | 863.0  | 817.2  |
| Total Weight of Backfill with Factor of Safety (lbs/lf)               | 626.3  | 575.3  | 575.3  | 544.8  |
| Net Total Displacement (lbs/lf) (+Will not Float, -Will Float)        | 1027.2 | 1234.2 | 1319.9 | 1406.2 |

**Will not float** | **Will not float** | **Will not float** | **Will not float**
ATTACHMENT B – BACK-UP COST DATA AND ESTIMATES OF PROBABLE COSTS FOR EACH ALTERNATIVE
<table>
<thead>
<tr>
<th>Seq#</th>
<th>Qty</th>
<th>Description</th>
<th>Units</th>
<th>Price</th>
<th>Ext. Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>15,400</td>
<td>42 DR51 80PSI PVC C095</td>
<td>FT</td>
<td>90.24</td>
<td>1,389,696.00</td>
</tr>
<tr>
<td>30</td>
<td>25</td>
<td>42 MJ 45 BEND L/ACC DI CL</td>
<td>EA</td>
<td>3,035.20</td>
<td>75,880.00</td>
</tr>
<tr>
<td>40</td>
<td>50</td>
<td>42 MJ ACC KIT</td>
<td>EA</td>
<td>483.47</td>
<td>24,173.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>SUBTOTAL C905 PVC</strong></td>
<td></td>
<td></td>
<td><strong>1,489,749.50</strong></td>
</tr>
<tr>
<td>80</td>
<td>15,400</td>
<td>48 DR32.5 63PSI HDPE FUSION</td>
<td>FT</td>
<td>109.35</td>
<td>1,683,990.00</td>
</tr>
<tr>
<td>90</td>
<td>25</td>
<td>48 DR32.5 HDPE 45 BEND</td>
<td>EA</td>
<td>1,690.59</td>
<td>42,264.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>SUBTOTAL HDPE</strong></td>
<td></td>
<td></td>
<td><strong>1,726,254.75</strong></td>
</tr>
<tr>
<td>110</td>
<td>15,400</td>
<td>42 FST PR150 DI PIPE C/L</td>
<td>FT</td>
<td>172.22</td>
<td>2,652,188.00</td>
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<tr>
<td></td>
<td></td>
<td><strong>Sub Total</strong></td>
<td></td>
<td></td>
<td><strong>$5,868,192.25</strong></td>
</tr>
</tbody>
</table>

**Bid Totals**

| Bid Total | $5,868,192.25 |
## Iron Pipe Size (IPS) and Dimension Data

**DriscoPlex® Pipe for Municipal and Industrial Applications**

Pressure Ratings are calculated using 0.63 design factor for HDS at 73°F as listed in PPI TR-4 for PE 4710 materials. HDPE can accommodate up to 1.5 times the pipe pressure rating for a recurring surge and up to 2.0 times the pipe pressure rating for an occasional surge. Temperature, Chemical, and Environmental use considerations may require use of additional design factors.

<table>
<thead>
<tr>
<th>Pressure Rating</th>
<th>355 psi DR 7.0</th>
<th>250 psi DR 9.0</th>
<th>200 psi DR 11.0</th>
<th>160 psi DR 13.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Pipe Size</td>
<td>Minimum</td>
<td>Average</td>
<td>Weight (lbs/ft)</td>
<td>Minimum</td>
</tr>
</tbody>
</table>
| 1 1/4" | 1.660 | 0.237 | 1.158 | 0.46 | 0.184 | 1.270 | 0.37 | 0.151 | 1.340 | 0.31 | 0.123 | 1.399 | 0.26 | 1 1/4"
| 1 1/2" | 1.900 | 0.271 | 1.325 | 0.61 | 0.211 | 1.453 | 0.49 | 0.173 | 1.533 | 0.41 | 0.141 | 1.601 | 0.34 | 1 1/2"
| 2" | 2.375 | 0.339 | 1.656 | 0.95 | 0.264 | 1.815 | 0.77 | 0.216 | 1.917 | 0.64 | 0.176 | 2.002 | 0.53 | 2"
| 3" | 3.500 | 0.500 | 2.440 | 2.06 | 0.389 | 2.675 | 1.66 | 0.318 | 2.826 | 1.39 | 0.259 | 2.951 | 1.16 | 3"
| 4" | 4.500 | 0.643 | 3.137 | 3.40 | 0.500 | 3.440 | 2.75 | 0.409 | 3.633 | 2.31 | 0.333 | 3.794 | 1.92 | 4"
| 6" | 6.625 | 0.948 | 4.619 | 7.37 | 0.736 | 5.085 | 5.96 | 0.602 | 5.349 | 5.00 | 0.491 | 5.854 | 4.15 | 6"
| 8" | 8.625 | 1.232 | 6.013 | 12.50 | 0.958 | 6.594 | 10.11 | 0.784 | 6.963 | 8.47 | 0.639 | 7.270 | 7.04 | 8"
| 10" | 10.750 | 1.536 | 7.494 | 19.42 | 1.194 | 8.219 | 15.70 | 0.977 | 8.679 | 13.16 | 0.796 | 9.062 | 10.93 | 10"
| 12" | 12.750 | 1.821 | 8.889 | 27.31 | 1.417 | 9.746 | 22.08 | 1.159 | 10.293 | 18.61 | 0.944 | 10.749 | 15.38 | 12"
| 14" | 14.000 | 2.000 | 9.700 | 32.93 | 1.550 | 10.701 | 26.03 | 1.273 | 11.301 | 22.32 | 1.037 | 11.802 | 18.54 | 14"
| 16" | 16.000 | 2.286 | 11.154 | 43.03 | 1.778 | 12.231 | 34.78 | 1.465 | 12.615 | 28.15 | 1.185 | 13.488 | 24.22 | 16"
| 18" | 18.000 | 2.571 | 12.549 | 54.43 | 2.000 | 13.760 | 44.02 | 1.636 | 14.532 | 36.69 | 1.333 | 15.174 | 30.65 | 18"
| 20" | 20.000 | 2.857 | 13.943 | 67.20 | 2.222 | 15.289 | 54.34 | 1.818 | 16.146 | 45.54 | 1.481 | 16.860 | 37.94 | 20"
| 22" | 22.000 | 3.143 | 15.337 | 81.32 | 2.444 | 16.819 | 65.75 | 2.000 | 17.760 | 55.10 | 1.630 | 18.544 | 45.79 | 22"
| 24" | 24.000 | 3.429 | 16.731 | 96.77 | 2.667 | 18.346 | 78.25 | 2.182 | 19.374 | 65.58 | 1.778 | 20.231 | 54.49 | 24"
| 26" | 26.000 | 3.717 | 18.080 | 113.12 | 2.889 | 19.875 | 91.84 | 2.364 | 20.988 | 76.96 | 1.920 | 21.917 | 63.95 | 26"
| 28" | 28.000 | 4.000 | 21.405 | 126.51 | 3.111 | 21.405 | 106.51 | 2.545 | 22.605 | 89.26 | 2.074 | 23.603 | 74.17 | 28"
| 30" | 30.000 | 4.286 | 22.934 | 140.27 | 3.333 | 23.934 | 122.27 | 2.727 | 24.219 | 102.47 | 2.222 | 25.289 | 85.14 | 30"
| 34" | 34.000 | 4.857 | 25.991 | 167.67 | 3.778 | 25.991 | 157.05 | 3.091 | 27.447 | 131.61 | 2.519 | 28.660 | 109.36 | 34"
| 36" | 36.000 | 5.143 | 27.520 | 181.43 | 4.000 | 27.520 | 176.07 | 3.273 | 29.061 | 147.55 | 2.667 | 30.346 | 122.60 | 36"
| 42" | 42.000 | 5.911 | 31.250 | 214.29 | 4.286 | 31.250 | 190.86 | 3.511 | 33.906 | 200.84 | 3.818 | 35.405 | 166.88 | 42"
| 48" | 48.000 | 6.685 | 34.980 | 247.15 | 4.571 | 34.980 | 214.29 | 3.818 | 33.906 | 200.84 | 4.011 | 36.370 | 191.12 | 48"

This size and dimension chart is intended for reference purposes. It should not be used in place of the advice from a licensed Professional Engineer. Pipe weights are calculated in accordance with PPI TR-7. Average inside diameter is calculated using IPS OD and Minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary. When designing components to fit the pipe ID, refer to pipe dimension and tolerances in the applicable pipe manufacturing specification.

Visit www.performancepipe.com for the most current literature.
# Iron Pipe Size (IPS) and Dimension Data

## DriscoPlex® Pipe for Municipal and Industrial Applications

Pressure Ratings are calculated using 0.63 design factor for HDS at 73°F as listed in PPI TR-4 for PE-4710 materials. HDPE can accommodate up to 1.5 times the pipe pressure rating for a recurring surge and up to 2.0 times the pipe pressure rating for an occasional surge. Temperature, Chemical, and Environmental use considerations may require use of additional design factors.

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This size and dimension chart is intended for reference purposes. It should not be used in place of the advice from a licensed Professional Engineer. Pipe weights are calculated in accordance with PPI TR-7. Average inside diameter is calculated using IPS OD and Minimum wall plus 5% for use in estimating fluid flows. Actual ID will vary. When designing components to fit the pipe ID, refer to pipe dimension and tolerances in the applicable pipe manufacturing specification.

Visit [www.performancepipe.com](http://www.performancepipe.com) for the most current literature.
APPLICATIONS

JM Eagle’s Big Blue C905 pipe is suitable for use in distribution pipelines of potable water, as well as gravity and/or force main sewer and water reclamation projects.

DESCRIPTION

JM Eagle Big Blue is available in blue, white, purple and green, in standard laying lengths of 20 feet. Non-hydrotested pipe is available upon request in lengths of 14 feet.

The pipe conforms to cast-iron ODs and is available in DR 18 (235 psi) for sizes 14 to 30 inches in diameter; DR 21 (200 psi) for sizes 14 to 36 inches in diameter; DR 25 (165 psi), DR 32.5 (125 psi), and DR 41 (100 psi) for sizes 14 to 48 inches in diameter; and DR 51 (80 psi) for sizes 18 to 48 inches in diameter.

Big Blue water pipe has the long-term hydrostatic strength to meet the accepted high safety requirements of municipal water systems. It carries approval of ANSI/NSF Standard 61 and UL 1285 (up to 24").

BENEFITS

JM Eagle Big Blue 905 large-diameter pipe is the safe, long-lasting and stable solution for a modern infrastructure. Big Blue:

- Maintains performance against tuberculation, corrosion and external galvanic soil conditions without lining wrapping, coating or cathodic protection.
- Keeps its smooth interior over long years of service with virtually no loss in carrying capacity, allowing for savings in pumping costs, as well as savings on the size of the pipe required.
- Can be field-cut with a power saw or ordinary handsaw and be beveled without the use of expensive or complicated machinery.

PLEASE CONTACT YOUR JM EAGLE REPRESENTATIVE OR VISIT WWW.JMEAGLE.COM FOR MORE INFORMATION.
Sara Rogers

From: Tom Dugan <tomd@daengineering.net>
Sent: Monday, February 1, 2016 3:21 PM
To: Sara Miller Rogers
Subject: FW: EID Budget Number

Sara,

See $ below. These were adjusted as follows:

Base cost x 15% for special pieces (45s, 22.5, etc) x taxes 8%

Takes may be low, is it 8.5%

Tom Dugan, P.E., QSD, D1
DOMENICHELLI & ASSOCIATES
1101 Investment Blvd., Suite 115
El Dorado Hills, CA  95762
Phone: (916) 933-1997
Cell: (916) 837-7978
Fax: (916)-933-4778
tomd@daengineering.net
www.daengineering.net

From: Benitez, Edgar A [mailto:Edgar.Benitez@nov.com]
Sent: Thursday, January 28, 2016 4:34 PM
To: Tom Dugan <tomd@daengineering.net>
Subject: EID Budget Number

Hi Tom,

Shown below are the budget numbers.

- 42” w/ Carnegie Gasket Joint = $79/FT
- 42” w/ Lapweld joint = $71/FT

Per our conversation, I used 0.175” cylinder thickness per AWWA M11. The price includes delivery to El Dorado Irrigation District area and for pipe cement mortar lined and coated in 40 foot lay lengths. Prices are for budget purpose only and do not include any taxes. Let me know if you need additional information.

Respectfully,

Edgar
(209) 836-5050 ext. 201
### El Dorado Irrigation District

**Main Ditch Basis of Design Report**  
*Engineer's 30% Opinion of Probable Costs*

**Ditch Only Alignment**  
January 2016

<table>
<thead>
<tr>
<th>Element Description</th>
<th>Estimated Quantity</th>
<th>Units</th>
<th>Unit Price</th>
<th>Estimated Amount</th>
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<td>Mobilization/Demolition</td>
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**Mainline Construction**

- **Connection to Valve House at Forebay Reservoir**
  - 1 LS $45,000 $45,000
- **42" Welded Steel Pipe**
  - 15,400 LF $208 $3,120,320
- **Service Line**
  - 1,300 LF $50 $65,000
- **Air Vacum Release Valve**
  - 16 EA $6,500 $104,000
- **Blow-off Valves**
  - 7 EA $4,500 $31,500
- **Trench Cut Off Wall**
  - 16 EA $1,200 $19,200
- **Earthwork - Cut and fill (native material)**
  - 36,500 CY $15 $547,500
- **Pipe Trench Backfill (CDF)**
  - 8,800 CY $100 $880,000
- **AB Road Surface and drainage ditch**
  - 3,400 CY $55 $187,000
- **Tree Removal**
  - 1 LS $67,500 $67,500
- **Gunite Removal (Crush and placed in fill)**
  - 1 LS $5,000 $5,000
- **Outlet Structure (Concrete Vault, 1 BFV, 1 BOV, screen, 1 Full Bore Mag Meter)**
  - 1 LS $120,000 $120,000
- **Raw Water Service (42" saddle, meter strainer, box, etc.)**
  - 4 EA $2,500 $10,000
- **Site Restoration**
  - 1 LS $115,500 $115,500
- **Construction Contingency**
  - 20% LS $1,180,080 $1,180,080

**CONSTRUCTION COST** = **$7,080,500**

**Non-Construction Costs**

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**Other Costs Subtotal** = **$1,667,000**

**TOTAL COST** = **$8,748,000**
### Upper Main Ditch BODR Update

**El Dorado Irrigation District**  
Main Ditch Basis of Design Report  
Engineer’s 30% Opinion of Probable Costs

### Shotcrete Lining  
January 2016

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<th>Element Description</th>
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### Mainline Construction

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**CONSTRUCTION COST = $ 6,276,000**

### Non-Construction Costs

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**Other Costs Subtotal = $ 1,446,000**

**TOTAL COST = $ 7,722,000**
ATTACHMENT C – TYPICAL CROSS SECTIONS
NOTE - FOR CROSS SECTION LOCATIONS SEE FIGURE D2

(ATTACHMENT D)
NOTE - FOR CROSS SECTION LOCATIONS SEE FIGURE D2

(ATTACHMENT D)

STA 42+00 CROSS SECTION

STA 48+27 CROSS SECTION

STA 55+36 CROSS SECTION

STA 63+00 CROSS SECTION
NOTE - FOR CROSS SECTION LOCATIONS SEE FIGURE D2

(ATTACHMENT D)
ATTACHMENT D – DRAINAGE MODEL OUTPUT AND CROSS SECTIONS
### PROPOSED

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### Existing Watershed Basins and Peak Discharge

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- 10-Yr storm depth = 6.111 inches (County of El Dorado, Drainage Manual, pages 2-35,37)
- Rainfall distribution (Type 1A) and Curve Numbers were determined by utilizing USDA's TR-55 manual (210-VI-TR-55, Second Ed., June 1986).
- Watershed areas were determined by analyzing the USGS Pollock Pines Quadrangle, 7.5 minute series map (2015).
- All soil type in project area is "Type B." Which was determined by USDA's web soil survey: <http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>
- Peak discharge corresponds to the 10-yr storm depth and was calculated using the SCS runoff curve number method within HEC-HMS 3.4
ATTACHMENT E – GEOTECHNICAL FINDINGS MEMO AND SEEPAGE ESTIMATE TECHNICAL MEMORANDUM – SAGE ENGINEERS
SAGE Engineers, Inc. (SAGE) is pleased to submit this memorandum presenting estimates of seepage loss from the approximately 3-mile-long Upper Main Ditch, in El Dorado County, California. This work was performed to assist El Dorado Irrigation District (EID) in securing water conservation grants for the Upper Main Ditch Piping project. The project consists of the construction of a new pipeline within portions of the unlined Upper Main Ditch (canal) alignment, which connects Forebay Reservoir to the Reservoir 1 Water Treatment Plant (WTP). The remaining pipe is proposed to be installed beneath Blair Road, which roughly parallels the existing canal alignment. The pipeline will eliminate approximately 3 miles of open ditch and is intended to reduce water loss between the facilities. Our findings indicate a minimum water loss of 2 to 11 percent due to seepage through the canal at flows of 40 cubic feet per second (cfs), and a 4 to 21 percent loss at flows of 20 cfs. These are likely minimum estimates because they do not include losses associated with animal burrows, areas of shallow and/or fractured rock, evapotranspiration, etc.

This memorandum describes our scope of work, and summarizes observations from a limited geologic reconnaissance, procedures used for percolation and permeability testing, seepage modelling, and estimated losses in the following sections.

**SCOPE OF WORK**

We performed a limited field exploration program in general accordance with the scope of services presented in our proposal dated November 6, 2015 and our Master Services Agreement with EID dated January 1, 2014. Specifically, our scope consisted of:

- Reviewing readily available geologic maps and reports, and an environmental assessment provided by EID. Based on our literature review and access along the canal, we identified locations suitable for limited field exploration (percolation and permeability testing).
- Performing five (5) percolation (perc) tests in shallow excavations in the canal bottom.
- Driving 3-inch diameter Shelby tubes with a 20 pound slide hammer to collect samples from the canal adjacent to each perc test.
• Laboratory testing of five (5) samples for permeability testing using ASTM method D5084.

• Reviewing the results of perc and permeability testing and modelling seepage from the canal using SEEP/W software for 2 soil/rock conditions at flow rates of 20 and 40 cfs.

• Reviewing literature for and estimating the amount of evapotranspiration along the canal.

• Preparing this memorandum, which summarizes geologic conditions, field procedures, test results, modeling, and seepage estimates.

PREVIOUS LOSS ESTIMATES

We reviewed the Environmental Assessment for the Proposed El Dorado Canal Pipeline Project (Jones and Stokes, 1977), which includes estimates of seepage and evapotranspiration losses based on flow measurements performed by Mr. E. M. Padjin (C.E.) and trained EID staff in July of 1977. They found that loss generally scaled with flow rate. Between Forebay Reservoir and the Blair Road crossing (STA 120+50 feet), they estimated losses of 0.8 cfs and 4 cfs (4 to 10 percent) at flow rates of 18 and 40 cfs, respectively (Attachment 1). When these loss estimates are extrapolated to the entire length of the canal that will be replaced (15,400 feet), the losses are estimated to be 1 cfs to 5.1 cfs (6 to 13 percent).

In 2012, EID performed additional flow measurements (EID, 2015a). They measured 8.51 cfs at the upstream end of the canal and 6.04 cfs just downstream of Patrick Lane, which equates to approximately 2.5 cfs (29 percent) water loss. Patrick Lane is approximately 1,800 feet upstream of the water treatment plant. They noted the presence of multiple animal burrows and voids in the canal, the larger of which were later filled with bentonite.

EID continuously measures flow at the Forebay Reservoir water rights reporting gauge A18 and at the Reservoir 1 WTP headworks. Review of flow monitoring data from 2009 through 2014 indicates annual water losses in the range of 10% and 23% (EID, 2015b).

GEOLOGIC RECONNAISSANCE

To provide geotechnical recommendations for a previous phase of the Upper Main Ditch piping project, we met with Domenichelli & Associates (D&A) on October 22, 2015 to perform a geologic reconnaissance of the upper approximate ½-mile-long reach of the canal from Forebay Reservoir (forebay) to the Pinewood Lane crossing. From STA 1+00 to STA 4+50, we observed fractured meta-sedimentary rock exposed in the bank excavation and locally in the canal bottom. The rock exposed in the bank is generally closely to moderately fractured (2” to 12” spacing), moderately hard, and moderately strong. Although we were not able to fully classify the rock in the canal bottom due to flowing water (<½ cfs), the rock is generally consistent with regional geologic mapping that show this portion of the canal underlain by Paleozoic-aged marine rocks (Wagner et al., 1981).

Farther downstream, from STA 4+50 to Pinewood Lane (STA 25+25), we observed reddish brown fine-grained soil exposed in the banks and berm. We observed similar fine-grained soil with occasional andesitic cobbles during a walkdown from Pinewood Lane to the water treatment plant (STA 158+84) with EID on the same date. The regional geologic map indicates that the portion of the canal downstream of

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1 Approximate stationing (STA) based on AutoCAD drawing received from Domenichelli & Associates on November 24, 2015
STA 4+50 is underlain by volcanic rocks of the Mehrten Formation, which commonly weather to material consistent with the observed soil.

**PERCOLATION TESTING**

**Procedures**

SAGE geologists Matt Buche and Zack Washburn met representatives of EID at Forebay Reservoir on November 18th and 19th, 2015 to perform perc testing at select locations on the Upper Main Ditch. Upon arrival, we observed flow in the bottom of the canal, at about the same rate as observed during our October reconnaissance, estimated to be approximately 0.10 cfs coming from intermittent flow from the Forebay Dam seepage pump station. After discussing possible effects of the water on the perc tests with EID, we elected to run the tests on topographic high spots in the canal bottom that were not inundated.

We used a post hole digger (clamshell) to create cylindrical excavations (test holes) in the canal bottom as shown on Attachment 1. The test holes were 6 inches in diameter and ranged from 12 to 18 inches in depth. We placed a folding stick ruler at the base of each test hole to measure water levels during testing. We also placed two inches of gravel in the bottom of the holes to protect from scouring when adding water for the tests. Typically test holes are presoaked to saturate the soil; however, the ground was still saturated by the minor flow in the canal. Accordingly, we did not presoak the test holes.

Each test hole was initially filled with water to a level of 6 inches of above the top of the gravel. We performed falling head tests by measuring the drop in the water level at 30 minute intervals. After each measurement, we added water to raise the water level to the starting elevation (6 inches above the gravel). Testing continued until three consecutive measurements differed by less than 1/8 inch.

**Percolation Test Results**

Table 1 shows the approximate stationing and measured percolation rates for each of the five tests performed. Flowing water was present at the upper two perc test locations and standing water was observed within 80 lineal feet of the third perc test, located at STA 86+50. The measured percolation rates at these locations may be minimums due to possible increased pore pressure around the test holes.

### Table 1 - Summary of Percolation Test Results

<table>
<thead>
<tr>
<th>Test Location</th>
<th>Material Type</th>
<th>Measured Percolation Rate (min/ft)</th>
<th>Estimated Hydraulic Conductivity (^2) (cm/day)</th>
<th>Estimated Hydraulic Conductivity (^3) (cm/day)</th>
<th>Estimated Hydraulic Conductivity (^4) (cm/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4+50</td>
<td>fine-grained soil</td>
<td>96</td>
<td>4</td>
<td>&lt;8.3</td>
<td>4.7</td>
</tr>
<tr>
<td>26+00</td>
<td>fine-grained soil</td>
<td>120</td>
<td>4</td>
<td>&lt;8.3</td>
<td>6.3</td>
</tr>
<tr>
<td>86+50</td>
<td>fine-grained soil</td>
<td>480</td>
<td>NA(^5)</td>
<td>&lt;8.3</td>
<td>1.5</td>
</tr>
<tr>
<td>130+00</td>
<td>coarse-grained soil</td>
<td>20</td>
<td>20</td>
<td>16(\frac{3}{4})</td>
<td>47</td>
</tr>
<tr>
<td>134+50</td>
<td>coarse-grained soil</td>
<td>8</td>
<td>50</td>
<td>&gt;50</td>
<td>NA</td>
</tr>
</tbody>
</table>

2 Based on Amoozegar, A., Comparison of saturated hydraulic conductivity and percolation rate: Implications for designing septic tank systems, 1997.
5 Not available because percolation rate is beyond the limits of the correlation.
The percolation rates range from 8 to 480 minutes per inch (MPI). Based on Soil Conservation Service (SCS) reports, the Environmental Assessment (Jones and Stokes, 1977) cites perc rates ranging from 0.2 to 6.3 inches per hour for the soil along the canal. Converting the SCS rates from inches per hour, yields rates of 9.5 to 300 MPI, similar to our measurements.

To compare the measured perc rates with the following permeability test results, we used 3 different methods to estimate hydraulic conductivity from the percolation rates, as indicated in Table 1. Note that the terms “hydraulic conductivity” and “permeability” are used interchangeably in practice and in this memorandum.

**PERMEABILITY TESTING**

We collected relatively undisturbed rock and soil samples from the bottom of the canal and berm using a 20 pound slide hammer to drive 3-inch diameter Shelby tubes adjacent to each perc test. We submitted four (4) samples collected from the canal bottom and one (1) from the berm for laboratory permeability testing using ASTM method D5084. Permeability is the measure of the ability of a material to allow fluid to pass through it. Test D5084 measures the rate at which water passes through a fully saturated sample and is usually reported in units of centimeters per second (cm/sec). The permeability test results are included with this memorandum as Appendix A and summarized in the Table 2. Note, the table also provides test results in more usable units of cm/day to allow for better comprehension of the data.

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Sample Location</th>
<th>Position in Canal</th>
<th>Lab Test Permeability (cm/sec)</th>
<th>Lab Test Permeability (cm/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perm 1</td>
<td>4+50</td>
<td>berm</td>
<td>1.78 e-4</td>
<td>15.38</td>
</tr>
<tr>
<td>Perm 2</td>
<td>26+00</td>
<td>bottom</td>
<td>3.83 e-6</td>
<td>0.33</td>
</tr>
<tr>
<td>Perm 3</td>
<td>86+50</td>
<td>bottom</td>
<td>2.87 e-7</td>
<td>0.02</td>
</tr>
<tr>
<td>Perm 4</td>
<td>130+00</td>
<td>bottom</td>
<td>1.19 e-6</td>
<td>0.10</td>
</tr>
<tr>
<td>Perm 5</td>
<td>134+50</td>
<td>bottom</td>
<td>1.45 e-4</td>
<td>12.53</td>
</tr>
</tbody>
</table>

**SEEPAGE MODELING**

**Procedures**

Based on the limited number of samples collected and the potential variability in permeability along the canal, we elected to average the permeabilities measured from the canal bottom samples in our model. We divided the canal into four equal length segments, each representing 3,971 feet of native canal bank and bottom. We used the permeability from sample Perm 1 to model the fill comprising the berm along the full length of the canal. Canal cross sections were established for modeling purposes from the 100-foot-cross sections cut in the Civil 3D file prepared by D&A (D&A, November 2015).

We analyzed the four canal cross sections using SEEP/W version 8.15.3.11339 by GEO-SLOPE, 2012. In our models, we assumed that the canal reaches steady state conditions, meaning that the canal runs at constant head sufficiently long so that the seepage velocities do not vary with time. Furthermore, we assumed that the canal runs constantly so that the soil becomes fully saturated. To help determine that these assumptions and others were appropriate, we ran sensitivity cases that varied the saturated/nonsaturated condition, groundwater table, preferential flow ratios, canal head, and impermeable boundary depth. We found that most of these assumptions did not have a large effect on
the seepage volume. See the Seepage Estimates section, below, for further discussion on the sensitivity cases.

The permeabilities used in our models were directly based on the lab-determined values presented in Tables 2 and 3. However, because the permeability values estimated from our percolation testing were generally an order of magnitude higher than the lab values (see Table 3 for comparison), we ran the models with the permeabilities increased by one order of magnitude to establish a potential range of seepage loss.

The models were analyzed assuming both 40 cfs and 20 cfs canal flows. Based on discussions with D&A, this results in approximate canal heads of 2.5 and 1.33 feet, respectively, above the bottom of the canal. The results of the seepage modeling are discussed below.

**TABLE 3 – COMPARISON OF LAB PERMEABILITIES WITH ESTIMATED RATES FROM PERC TESTING**

<table>
<thead>
<tr>
<th>Test Location</th>
<th>Lab Test Permeability (cm/sec)</th>
<th>Lab Test Permeability (cm/day)</th>
<th>Estimated Hydraulic Conductivity from Perc Test (cm/day)</th>
<th>Estimated Hydraulic Conductivity from Perc Test (cm/day)</th>
<th>Estimated Hydraulic Conductivity from Perc Test (cm/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4+50</td>
<td>1.78 e-4</td>
<td>15.38 (sample from berm)</td>
<td>4 (perc test from bottom)</td>
<td>&lt;8.3 (perc test from bottom)</td>
<td>4.7 (perc test from bottom)</td>
</tr>
<tr>
<td>26+00</td>
<td>3.83 e-6</td>
<td>0.33</td>
<td>4</td>
<td>&lt;8.3</td>
<td>6.3</td>
</tr>
<tr>
<td>86+50</td>
<td>2.87 e-7</td>
<td>0.02</td>
<td>NA</td>
<td>&lt;8.3</td>
<td>1.5</td>
</tr>
<tr>
<td>130+00</td>
<td>1.19 e-6</td>
<td>0.10</td>
<td>20</td>
<td>16 1/2</td>
<td>47</td>
</tr>
<tr>
<td>134+50</td>
<td>1.45 e-4</td>
<td>12.53</td>
<td>50</td>
<td>&gt;50</td>
<td>NA</td>
</tr>
</tbody>
</table>

**Seepage Estimates**

Based on the seepage modeling for 40 cfs canal flow, we estimate the seepage losses to range from about 0.8 to 4.5 cfs (2 to 11 percent). For the 20 cfs canal flow, we estimate seepage losses of about 0.8 to 4.2 cfs (4 to 21 percent). As previously mentioned, the range in the loss estimates is primarily due to the difference in conductivities measured from permeability testing (lower values) versus those estimated from percolation testing (higher values).

We found that the seepage models were sensitive to changes in preferential flow direction (horizontal vs. vertical) and depth to an impermeable layer. Bedded clay layers can have a preferential horizontal flow direction typically up to 4 times the vertical direction (ASDSO, 2014). Additionally, most seepage models assume an impermeable layer/boundary at depth. By varying the preferential flow ratio and impermeable boundary depth, we estimate the ranges of water loss presented above. Based on our experience with unlined canals, the uncertainty in the parameters established for the seepage models, the variability of the canal materials in areas not observed for this study, and the sensitivity of the calculated flow estimates to some of the key model parameters, we believe the upper end of our loss estimate range to be more likely than the lower end.

**OTHER SOURCES OF POSSIBLE WATER LOSS**

We reviewed readily available publications to estimate potential water loss from the canal due to evapotranspiration (sum of evaporation and transpiration from plants and trees). Although it is difficult to quantify evapotranspiration (ET), there are numerous models that attempt to do so. The models range from simple temperature and radiation-driven equations to more complex algorithms.
We reviewed a study that measured actual evapotranspiration using instruments on towers above the forest canopy at the Blodgett Research Station (Fisher et al., 2004). The research station is located about 10 miles north of the canal, underlain by the same soil type and geologic formation (Cohasset Series soil and Mehrten Formation), and covered with similar tree species (Ponderosa Pine, Douglas Fir, White Fir and Incense Cedar). The instruments measure flux and record up to 200 watts per square meter of evapotranspiration during the summer months. This amount equates to approximately 0.1 cfs or \( \frac{1}{4} \) percent of water loss from the canal due to ET.

We observed rodent burrows in the banks and berm during our reconnaissance and walkdown. It is likely that additional water loss, that is not included in our model, is occurring through burrows and other pathways, such as zones of shallow and/or fractured rock. The observation of seasonal springs that form during the dry summer months on the downhill side of the canal (Jones and Stokes, 1977) suggests that water flows through larger voids or at least areas of higher permeability are present that were not represented in our model.

**COMPARISON OF SEEPAGE ESTIMATES AND CONCLUSIONS**

The following chart presents water loss estimates from our modeling with those from flow meter measurements for comparison and discussion. At flows of 40 cfs, the high end of the modeled range is similar to the 1977 flow meter estimates. Conversely, at 20 cfs the low end of the modeled range generally coincides with the 1977 measurements. In general, the upper limit of the modeled seepage losses are within the range of Forebay/Reservoir 1 WTP flow metering data (EID, 2015b).

The water loss estimated by EID in 2012 is greater than both the estimates from 1977 data and our seepage. The reason for this is unknown, but may be due to other sources of potential water loss as discussed above, possibly degradation of the berm and resulting increased water loss, or imprecise measurements of the cross sectional area used in the flow meter estimates.
There are numerous factors that contribute to uncertainty in the water loss estimates, including: limited conductivity data with only 5 data points (permeability samples) for 3 miles of canal; and the possible increased pore pressure due to flowing water and resulting lower percolation rates. Also it is important to consider that conductivity values typically range a few orders of magnitude, even within the same soil or rock type. Based on the available data, it appears that at flows of 40 cfs on the order of 10 percent of the water that leaves the forebay is lost during travel to the treatment plant.

**LIMITATIONS**

This technical memorandum has been prepared for the sole use of El Dorado Irrigation District and its agents, specifically for design of the improvements described herein for the subject project. The seepage estimates presented in this technical memorandum are solely professional opinions based on limited percolation testing, limited permeability testing, SEEP/W modelling, and professional experience with similar projects. SAGE is not responsible for the data and methods presented by others.

The information provided in this technical memorandum is valid for a period of three (3) years from the date of issuance. Conditions may arise that were not apparent at the time of this design (e.g., changes in design geometries, soil design parameters, loadings, etc.). In addition, changes in applicable standard of practice can occur, whether from legislation or the broadening of knowledge. Accordingly, the information provided in this technical memorandum may be invalidated, wholly or partially, by changes outside of our control. Should changes occur that might affect the design presented herein, SAGE should be notified to evaluate the validity of this technical memorandum to those changes. This document may not be reproduced for any other reason than pertains to the project for which it was prepared.

Attachments:

Attachment 1 – Percolation and Flow Test Locations (prepared by D&A)
Appendix A - Sierra Testing Laboratories – Lab Test Results

References:


Association of State Dam Safety Officials (ASDSO), 2014, Dam Safety Technical Seminar, Seepage through Earth Dams, April 1–2, 2014.


Eldorado Irrigation District a, Conversation Record, Flow metering completed January 27, 2012 to identify losses along Main Ditch, December 2, 2015

Eldorado Irrigation District b, personal communication with EID staff, December 16, 2015.


PERCOLATION TEST @ BLAIR BRIDGE
PERCOLATION TEST @ STA 130+00
1977 FLOW METER @ BLAIR BRIDGE
PERCOLATION TEST @ STA 134+50
2012 FLOW METER LOCATION PATRICK LANE

LEGEND
MAIN DITCH
DRAINAGE FLOW LINE
TEST LOCATION

EL DORADO IRRIGATION DISTRICT
2980 MOSQUITO ROAD - P.O. BOX 1047
PLACERVILLE, CALIFORNIA 95667

LEGEND
MAIN DITCH
DRAINAGE FLOW LINE
TEST LOCATION
HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA
Sample Identification: Perm 1A Bern
Location: Roots & Weeds
Remarks:

Sample Depth, ft.: 0-18" Lab No.: 544504
Sample Type: Driven Liner

TEST RESULTS
Permeability, cm/sec.: 1.78E-04 Average Hydraulic Gradient: 2.9
Effective Confining Pressure, psi: 5

TEST SAMPLE DATA
Before Test
Specimen Height, cm: 6.73
Specimen Diameter, cm: 7.14
Dry Unit Weight, pcf: 72.0
Moisture Content, % 26.1

After Test
Specimen Height, cm: 6.73
Specimen Diameter, cm: 7.14
Dry Unit Weight, pcf: 74.3
Moisture Content, % 34.0

Test Method: ASTM D5984 Method C

PROJECT NUMBER: 15-120 November 19, 2015
HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA
Sample Identification: Perm 2 Bottom
Location: 0
Remarks:

Sample Depth, ft.: 0-8" Lab No.: S44505
Sample Type: Driven Liner

TEST RESULTS
Permeability, cm/sec.: 3.83E-06
Effective Confining Pressure, psi: 5
Average Hydraulic Gradient: 5.3

TEST SAMPLE DATA

Before Test
Specimen Height, cm: 7.11
Specimen Diameter, cm: 7.19
Dry Unit Weight,pcf: 80.6
Moisture Content, % 37.6

After Test
Specimen Height, cm: 7.11
Specimen Diameter, cm: 7.19
Dry Unit Weight,pcf: 78.7
Moisture Content, % 41.6

Test Method: ASTM D5984 Method C

PROJECT NUMBER: 15-120 November 19, 2015

SIERRA TESTING LABORATORIES, INC
485 Pierroz Rd, Unit D, Placerville, CA 95667
Ph 530-622-1101 Fax 530-622-1191

EID UMD
HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Perm 3 Bottom
Sample Depth, ft.: 0-9"
Location: 0
Sample Type: Driven Liner
Remarks:
Lab No.: S44506

TEST RESULTS

Permeability, cm/sec.: 2.61E-07
Effective Confining Pressure, psi: 5
Average Hydraulic Gradient: 7.7

TEST SAMPLE DATA

Before Test
Specimen Height, cm: 7.62
Specimen Diameter, cm: 7.19
Dry Unit Weight, pcf: 83.1
Moisture Content, % 37.2

After Test
Specimen Height, cm: 7.62
Specimen Diameter, cm: 7.19
Dry Unit Weight, pcf: 83.0
Moisture Content, % 39.8

Test Method: ASTM D5964 Method C
PROJECT NUMBER: 15-120
November 24, 2015
EID UMD
HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Penn 4 Bottom
Location: 0
Remarks:

Sample Depth, ft.: 0-9"  Lab No.: S44507
Sample Type: Driven Liner

TEST RESULTS

Permeability, cm/sec.: 1.19E-06
Effective Confining Pressure, psi: 5
Average Hydraulic Gradient: 6.1

TEST SAMPLE DATA

Before Test
Specimen Height, cm: 7.87
Specimen Diameter, cm: 7.14
Dry Unit Weight, pcf: 72.7
Moisture Content, % 50.8

After Test
Specimen Height, cm: 7.77
Specimen Diameter, cm: 7.14
Dry Unit Weight, pcf: 74.6
Moisture Content, % 49.7

Test Method: ASTM D5084 Method C

PROJECT NUMBER: 15-120
November 24, 2015

SIERRA TESTING LABORATORIES, INC.
GEOTECHNICAL AND MATERIALS TESTING SERVICES
485 Pierroz Rd, Unit D, Placerville, CA 95667
Ph 530-622-1101  Fax 530-622-1191
HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA
Sample Identification: Perm 5 Bottom
Sample Depth, ft.: 0-9"
Location: Broken, very weathered rock
Sample Type: Driven Liner
Lab No.: S44508
Remarks:

TEST RESULTS
Permeability, cm/sec.: 1.45E-04
Average Hydraulic Gradient: 4.8
Effective Confining Pressure, psi: 5

TEST SAMPLE DATA

Before Test
Specimen Height, cm: 7.62
Specimen Diameter, cm: 7.14
Dry Unit Weight, pcf: 60.6
Moisture Content, % 69.9

After Test
Specimen Height, cm: 7.62
Specimen Diameter, cm: 7.14
Dry Unit Weight, pcf: 64.7
Moisture Content, % 60.3

Test Method: ASTM D5084 Method C

PROJECT NUMBER: 15-120
November 19, 2015

SIERRA TESTING LABORATORIES, INC.
PHYSICAL AND MATERIAL TESTING SERVICES
485 Pierroz Rd, Unit D, Placerville, CA 95667
Ph 530-622-1101 Fax 530-622-1191
Appendix B Engineering Studies

B.3 DOMENICHELLI AND ASSOCIATES UPPER MAIN DITCH ALIGNMENT ALTERNATIVES (MARCH 9, 2018)
Alignment Description

Alignment #2, as shown on Attachment 1, includes approximately 8,200 feet of pipeline along Blair Road, 1,500 feet in the existing ditch and 2,600 feet through cross-country terrain, near the tie-in to the Reservoir 1 Water Treatment Plant.

Alignment #2 is approximately 12,300 feet in total length. With this alignment tree removal will be necessary for a portion of the ditch length and along the cross-country terrain, which is densely populated with trees. Approximately 100 trees will be removed for the construction of the new pipe along the cross-country section. Approximately 25 trees will be removed during construction within the ditch section of the alignment. The total tree removal for Alignment #2 is approximately 125 trees.

The Cross-Country Alignment (sub-option to Alignment #2) includes an alternative for a section of the Blair Road alignment (starting just downstream of Apple Creek Road and continuing cross-country and within the existing ditch). The Cross-Country Alignment is approximately 11,900 feet in total length. The alignment will follow Blair Road for approximately 3,200 feet, 4,000 feet through cross-country terrain, and 4,700 feet in the existing ditch. Approximately 175 trees will be removed for the cross-country alternative and approximately 100 trees will be removed from the existing ditch. The total tree removal for The Cross-Country Alignment is approximately 275 trees.

Drainage Considerations

The existing ditch will be unaffected except in areas where the new pipeline will enter the ditch from either the cross-country alignment or Blair Road. Due to the change in pipe elevation at these turnouts additional appurtenances will be required in the new pipeline. In areas where the pipeline is along the ditch alignment and in areas of transition a v-ditch will be maintained for drainage. The v-ditch will maintain the same invert (and drainage capacity) as the existing ditch in order to prevent ponding or any change in existing drainage conditions as shown in the attached cross section exhibit. Where the pipeline reenters the existing ditch alignment the existing 10-year storm event channel capacity will be maintained above the pipe as described in the FINAL Upper Main Ditch BODR Updates Technical Memorandum (Domenichelli and Associates, January 29, 2016). As with the existing conditions, flow exceeding the 10-year storm event capacity will overflow the ditch into natural drainages.

Pipeline Appurtenances

Blow off valves will be needed at the low points in the cross-country alignment and swale crossings. Should sediment enter the pipe system, it may deposit at the low point and periodic flushing will be required. This alignment will also require additional air relief valves at the high points of the alignment.
There are currently four existing El Dorado Irrigation District (EID) raw water customers served from the existing main ditch. Continuation of service to these customers will be required. New service lines will be required in Forebay and Blair Road, and in cross country terrain, for all alternatives. Meters will be installed at the new pipeline.

Advantages of Alignment #2 and Cross-Country Alternative

The following table summarizes the advantages and disadvantages to Alignment #2.

Table 1. Advantages/Disadvantages of Alignment #2

<table>
<thead>
<tr>
<th>Blair Road Alignment</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total pipe length = 12,300 feet – Shorter than original In Ditch Alignment</td>
<td>Additional appurtenances required which include additional maintenance</td>
</tr>
<tr>
<td></td>
<td>Requires fewer new permanent easements</td>
<td>Sediment may tend to deposit at low point</td>
</tr>
<tr>
<td></td>
<td>Access is available for long term maintenance in the roadway section</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minimizes section of cross-country pipeline where access is limited</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Advantages/Disadvantages of Cross-Country Alignment

<table>
<thead>
<tr>
<th>Blair Road Alignment with Cross-Country Alternatives</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total pipe length = 11,900 feet – Shorter than Alignment #2 and original In Ditch Alignment</td>
<td>Access to additional cross country sections may be difficult</td>
</tr>
<tr>
<td></td>
<td>Requires fewer new permanent easements</td>
<td>Sediment may tend to deposit at low point</td>
</tr>
<tr>
<td></td>
<td>Access is available for long term maintenance in the roadway section</td>
<td>Additional appurtenances required which include additional maintenance</td>
</tr>
</tbody>
</table>

Construction Timeline

**Blair Road Alignment:** The Blair Road Alignment will include significant work in the roadway, with associated traffic control, trench shoring and pavement restoration. These work components will add construction time relative to working within the existing Main Ditch. Considering these added activities, a daily production rate of approximately 80 lineal feet per day is used for the roadway reach. In-ditch and cross-country reaches are estimated at a rate of 100 lineal feet per day, similar to previous estimates. With most of the work in the roadway and only 1,500 lineal feet in the existing ditch, this alignment can be constructed continuously through the non-outage months, with only the in-ditch portion and tie-ins constructed during the outage. This can be accomplished in one construction season.

Other significant work items that are included in the overall project timeline include: mobilization; clearing and grubbing for in-ditch and cross-country reaches, tie-ins structures at the treatment plant and at the Forebay outlet; ditch dewatering and bypass components (if some work takes place the ditch during non-outage periods); final testing and closeout items.
A breakdown of the construction timeline is as follows:

- Mobilization: 1 month
- Clearing & Grubbing: 1 month
- Pipeline in Roadway: 5 months
- Cross-Country and In-Ditch Pipeline: 2 months
- Tie-Ins, Services and Other Appurtenances: 2 months
- Final Testing, Surface Restoration and Closeout: 2 months

The total construction schedule for Alignment #2, Blair Road Alignment would be approximately 13 months.

**Cross Country Alternative:** Given the same rates of production as described above, the pipeline construction breakdown would be as follows:

- Mobilization: 1 month
- Clearing and Grubbing: 1.5 months
- Pipeline in Roadway: 2 months
- Cross-Country and In-Ditch Pipeline: 4.5 months
- Tie-Ins, Services and Other Appurtenances: 2 months
- Final Testing, Surface Restoration and Closeout: 2 months

The total construction schedule for Alignment #2, Blair Road Alignment would be approximately 12 months.

Depending on the crews available, the contractor could perform some work simultaneously to slightly reduce the overall construction timeline for either alternative, however due to uncertainties in construction issues such as weather and rock excavation, the timeline should reflect a range from 12 months to 15 months for either alignment alternative.
Appendix B Engineering Studies

B.4 HYDROSCIENCE WATER QUALITY IMPACT ANALYSIS (DECEMBER 2016)
Purpose

The purpose of this technical memorandum is to serve as a supplement to the EIR for the Upper Main Ditch Pipeline Project for an assessment of the water quality impacts as they affect the Reservoir 1 water treatment plant (WTP.)

Summary

The El Dorado Irrigation District (District) owns and operates the Reservoir 1 WTP, which is a 26 million gallon per day (MGD) capacity water treatment facility located in Pollock Pines. It is supplied by a reservoir, the Long Canyon Forebay, via a 3.3 mile long open ditch (Main Ditch.) The District is in the process of permitting and designing a pipeline to replace the open ditch as a means of water delivery from the Forebay to the WTP. Please refer to the EIR for a detailed description of the project, maps and figures.

One of the primary drivers for the project is the protection of water quality to ensure reliability and effectiveness of the Reservoir 1 treatment technology. Due to the location and construction of the Main Ditch, it is susceptible to contamination by intercepted stormwater runoff, which causes high spikes in turbidity, organic loading, and microbiological activity including coliforms and giardia. These spikes cause operational difficulties with the WTP and threaten the plant’s ability to properly achieve multi-barrier treatment.

The impacts of the project with respect to water quality were analyzed by comparing key water quality parameters (turbidity, total coliform, E. coli, giardia and cryptosporidium) at the beginning of the Main Ditch as it leaves the Forebay, and at the end of the Main Ditch as it enters the WTP. The conclusion that was drawn is that since the Forebay constitutes a settled source of water, potentially harmful spiking, particularly with turbidity and organics, can be effectively controlled by the replacement of the Main Ditch with a closed pipeline.
Key Regulations

The following are selected Federal EPA and State water quality regulations under the Safe Drinking Water Act (SDWA) that are, or are potentially affected by the project:

**Total Coliform Rule (TCR)**

The TCR sets protocols for ensuring that coliform bacteria are absent from the distribution system. A reduction in organic loading to the plant will increase the initial disinfection effectiveness of the WTP, and/or alter the disinfection strategy, which could potentially have an impact on distribution system disinfection and microbiological control.

**Disinfectants and Disinfection Byproduct Rule (D/DBPR)**

The D/DBPR sets limits for total trihalomethanes (TTHMs) and specific haloacetic acids (HAA5s) and bromate, which are carcinogenic compounds formed when chlorine used as a disinfect reacts with organic compounds present in the water. Although organics are substantially removed by the treatment process, pre-chlorination (adding chlorine prior to filtration) is required to enable the plant to achieve its minimum regulatory disinfectant contact time. Currently, there are times during storm events when the pre-chlorination is overwhelmed or staff must cease operations in order to meet D/DBR limits. Current maximum contaminant levels (MCL's) are 0.08 mg/L for TTHMs, 0.06 mg/L for HAA5s, and 0.01 mg/L for bromine.

**Enhanced Surface Water Treatment Rule (ESWTR)**

ESWTR sets design and performance standards for surface water treatment plants for multi-barrier treatment of pathogens, and also sets requirements for water source protection and watershed management. The project implementation would be considered as a best management practice for source water protection. Additionally, there are provisions of the rule affected by the project. The Reservoir 1 WTP is a conventional treatment process as defined by the SWTR consisting of pre-disinfection, flocculation, sedimentation, mixed media gravity filtration, and post disinfection. The required removal performance for cryptosporidium is 2.0 log (99%) and the MCLG (maximum level at which there is considered no public health risk) is zero. One key provision of the ESWTR is for granting an additional 0.5 log credit for cryptosporidium removal for having an approved watershed control plan. Additionally, the mode for introduction of cryptosporidium into the WTP would be through the ditch through runoff, versus from the Forebay, which is a settled water source.
Water Quality Impacts

Turbidity and Organics

Figure 1 – Turbidity History

Figure 1 (above) depicts the history of turbidity measurements taken at the reservoir at the beginning of the Main Ditch, and at the WTP influent at the end of the Main Ditch. The black line, sampling point A18, represents the turbidity of the reservoir as it enters the ditch. This ranges from 0.10 NTU to 9.77 NTU, and averages 1.19 NTU. The red line, WTP Influent Turbidity, represents the turbidity at the end of the Main Ditch that has been picked up from both stormwater runoff, and from the ditch itself, which is of earthen construction. These values range from 0.29 NTU to 110 NTU, and average 4.34 NTU. As can be seen from the graph, a significant amount of solids are collected by the ditch, and runoff turbidity solids are largely organic.

It should be noted that the plant is seasonally taken out of service from October through December for water availability and system operational reasons, and there are corresponding
gaps in the turbidity measurements since turbidity is not monitored when the plant is off. Although the average turbidity of the raw water entering the plant is not excessively high, it is spiking events (such as the 110 NTU event recorded in February 2014) that cause operational problems, such as solids overloading and reduced disinfection performance caused by the need to stop pre-chlorination in order to avoid exceeding TTHM limits.

There are two significant observations that need to be reinforced with respect to the data presented in Figure 1:

1. The data shown has been collected from January 2014 through September 2016. Both 2015 and 2016 have been exceptionally dry years, and are not representative of typical rain years and hence corresponding turbidity levels due to runoff.

2. The gaps in the data represent plant shutdowns, which are typically in the winter months. Turbidity data was not recorded during the periods when the plant was shut down. The remaining data largely depicts dry weather conditions with the exception of 2014, when turbidities are expected to be at their lowest levels.

**Coliform Bacteria**

**Figure 2 – Total Coliform History**

![Total Coliform History chart](chart.png)

*Note: The chart illustrates the total coliform count per 100 ml over time, with data points clearly showing trends and exceptions.*
Figures 2 and 3 depict the amount of coliform organisms (total and fecal, e. coli) respectively added by transit through the main ditch. Figure 4 represents statistical values for the raw data. Although the contribution is not significantly higher, the plant’s ability to treat pathogens such as e. coli is significantly impacted by spikes in turbidity, including a degradation in disinfection caused by the inability to maintain effective pre-chlorination.
Cryptosporidium and Giardia

Figure 5 – Cryptosporidium and Giardia History

<table>
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<tr>
<th>Date</th>
<th>MPWS R1WTP-RW Cryptosporidium oocysts</th>
<th>MPWS R1WTP-RW Giardia cysts</th>
</tr>
</thead>
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</tr>
<tr>
<td>9/6/2016</td>
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<td>0</td>
</tr>
</tbody>
</table>

Figure 5 depicts measured counts of cryptosporidium oocysts, and giardia cysts respectively, measured at the WTP inlet. No data is available for the levels at the reservoir. Giardia is primarily transmitted through animal feces, and are not expected to be present in the reservoir source water in significant quantities due to the fact that it is a settled source. Animal activity in and around the Main Ditch is the likely sources of the giardia presence.

Conclusions

The Main Ditch constitutes a significant source of contamination by turbidity, organic loading, and pathogens, particularly during storm events. The replacement of the ditch with a closed pipeline from Reservoir 1 to the WTP would significantly enhance its ability to provide effective multi-barrier treatment during times of precipitation, and would in fact allow it to operate during times when it would otherwise have to be shut off to avoid solids overloading and disinfection system failure.
B.5 TULLY AND YOUNG MAIN DITCH WATER LOSS TECHNICAL MEMORANDUM (FEBRUARY 2017)
The purpose of this memorandum is to provide the results of an analysis performed by Tully & Young to understand and quantify the losses associated with water deliveries in the El Dorado Irrigation District’s Upper Main Ditch (Main Ditch). The document is intended to support EID’s CEQA document currently under preparation that will assess potential environmental impacts of the proposed pipeline to replace the Main Ditch (hereafter the “Project”).

This memo presents the detailed underlying data supporting the analysis, a general characterization of the physical operations of the Main Ditch, and the analysis method and results.

**Background and Summary**

The purpose of the Project is to improve water conservation by reducing system losses from the unlined ditch, and to improve water quality by piping the water delivered from the El Dorado Forebay (Forebay) to the Reservoir 1 Water Treatment Plant (WTP). Because the Main Ditch is uncovered and unlined, a portion of the water conveyed through the ditch is lost to seepage and evapotranspiration and the WTP has to contend with higher turbidity influent associated with sediment and water of unknown quality entering the ditch after water is released from Forebay. The U.S. Bureau of Reclamation has noted that losses from unlined earthen canals may be estimated to be one-third of the water conveyed or more. Studies done for other agencies in the area have indicated that losses from unlined earthen canals may be as high as fifty percent or more.

Past flow studies conducted by EID for the Main Ditch (Attachments 1 and 2) indicate losses from the canal due to seepage range from approximately 6% to 33% based on single measurements, depending on flow rate at the time of the measurement. The 1977 analysis
estimated that when conveying the full water right at 40 cfs, approximately 1,300 acre-feet would be lost.

Table 1 summarizes the results of estimated loss rates including recently completed analysis by EID in late 2016.

<table>
<thead>
<tr>
<th>Flow Study</th>
<th>Flow Rate/Quantity</th>
<th>Loss Estimate</th>
</tr>
</thead>
</table>
| 1977 Environmental Assessment – Ditch Flow Measurement¹ (Attachment 1) | 18 cfs  
40 cfs | 1 cfs (6%)  
5.1 (13%) |
| 2012 Ditch Flow Measurement (Attachment 2)² | 8.5 cfs | 2.8 cfs (33%) |
| EID 2016 Ditch Flow Measurement (Attachment 3) | 13.08 cfs  
20.76 cfs  
30.92 cfs | 2.25 cfs (17.2%)  
4.42 cfs (21.3%)  
4.5 cfs (14.6%) |
| EID 2016 Upper Main Ditch Annual Water Loss - Forebay to Reservoir 1 WTP (Attachment 4) | 5,296 af at varying rates full season  
3,464 af at 20 cfs  
July 7 – Sept 30 | 1,100 af (20.8%)  
full season  
617 ac-ft (17.8%)  
July 7 – Sept 30 |

**Approach**

Digital water meter data was available beginning in 2009 of recorded releases from Forebay into the Main Ditch and from the Main Ditch into the WTP inlet. The loss in this section of the ditch would typically be determined from the difference between these two values with a correction for backwash return flows ahead of the WTP inlet meter. However, this meter was found to be producing erroneous data between 2009 and 2015, which resulted in the prior WTP flow records being deemed unreliable. Prior to the start of 2016 deliveries, the WTP inlet flow meter was replaced and calibrated, assuring more reliable data going forward. With the improved data source, electronically recorded data (hereafter “SCADA data”) during 2016 became the best source for deriving loss estimates and was used for EID’s 2016 Upper Main Ditch Annual Water Loss analysis (Attachment 4). Separate single ditch flow measurements were also taken at various flow rates.  

¹ Losses between Forebay and Blair Road were estimated to be 0.8 cfs and 4 cfs (4 to 10 percent) at flow rates of 18 and 40 cfs, respectively. The length of the ditch between Forebay and the Reservoir 1 WTP is approximately 15,400 feet and Blair Road is approximately 3,200 feet upstream of Reservoir 1. When loss estimates are extrapolated to the entire length of the canal, the losses are estimated to be 1 cfs to 5.1 cfs (6 to 13 percent). (SAGE 2015).  
² The length of the ditch between Forebay and the Reservoir 1 WTP is approximately 15,400 feet and Patrick Lane is approximately 1,800 feet upstream of Reservoir 1. When loss estimates are extrapolated to the entire length of the canal, the losses are estimated to be 2.8 cfs from the originally measured 2.47 cfs.
rates over the season (Attachment 3) to supplement and calibrate, if necessary, the WTP inlet meter data.

Tully & Young obtained and analyzed the entirety of the SCADA data collected by EID during 2016, as well as recent soils testing and modeling completed in December 2015 by SAGE Engineers (Attachment 5). The 2016 data included recorded flows released from Forebay as well as flows entering the WTP. The difference between these two data sets, with consideration for backwash water returned ahead of the WTP meter, represents water lost during conveyance in the Main Ditch. The 2016 data included a limited flow range (13 cfs to 31 cfs) with most data being collected during a long duration of steady 20 cfs flows. Deriving a broader spectrum of estimated losses over varying flow rates required interpretations and extrapolations using data from the prior studies, professional understanding of hydraulics, and EID operator knowledge to develop relationships between flows rates and estimated losses. The results provide a basis that can be used for estimating historical losses, in lieu of prior erroneous meter data, and for projecting future losses.

The 2016 data also provided enough diurnal detail throughout the summer to understand the approximate portion of flow “lost” to evaporation and bankside vegetation, referred to here as ETc as shorthand for channel evapotranspiration. From this information, the effect of ETc during the summer on overall loss percentages compared to that during winter months was assessed, the results of which are represented in Table 2 below.

To derive losses for flow rates outside the range recorded during the 2016 operations, the following other factors were assessed. After discussions with EID staff and review of mathematical models developed using the 2016 data, ditch cross section geometry was assessed to help develop loss rates outside the 2016 empirical range. A topographic survey of the ditch completed by Domenichelli & Associates for pipeline design and stormwater modeling provided cross sectional geometry useful for understanding the relationship between flow and wetted perimeter.

**Analytic Results**

One key finding from assessing the full 2016 SCADA dataset was the percentage of flows lost while traveling between Forebay Reservoir and the WTP varied with the actual flow rate. Using the entire set of 2016 SCADA data in conjunction with data points from prior studies, a representative curve and equation were developed to correlate flow to the loss percentage. Figure 1 below demonstrates the derived representation of loss at varying flow rates. Also shown in Figure 1 are the single ditch flow measurements, separate from the SCADA dataset, taken during the 2016 season which closely correlate with the derived curve. This figure reflects the entirety of 2016 SCADA data for the A-18 gage measuring flows out of Forebay, using the recorded losses at approximately 20 cfs (occurring between July 6 through September 28, 2016), and a best-fit curve derived using the wetted perimeter analysis to reflect loss percentages at a range of flow rates.
greater and less than the 20 cfs estimate. The wetted perimeter analysis is depicted in Figure 2.

Figure 1 – Loss vs. CFS

It is important to note a few critical factors considered while developing the curve:

• Wetted perimeter data was used to model losses at flows greater and less than 20 cfs, which was determined by Tully & Young to be the most accurate source for estimating losses due to the prolonged SCADA data set recorded at that flow.

• The slope and channel configuration, as described in the Domenichelli & Associates topographic survey and accompanying data, shows that wetted perimeter expands rapidly at low flows, but increases much more slowly above 5 cfs. The resulting relation between average wetted perimeter and flow rate is presented in Figure 2.

• Based on available data and operational observation, flows below 5 cfs realize losses of a minimum of 33% and up to 100%. This factor helped establish a functional, polynomial curve to reflect significantly decreasing loss percentages until around 10 cfs, when losses begin to be more consistent. It is noted that the treatment plant typically avoids operating when flow rates are below 7 cfs due water quality considerations and operational efficiency.

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2 Since 2009, ditch customer water use between Forebay and the WTP has averaged approximately 28 acre-feet per year. This represents 0.5% of 2016 diversions and 0.2% for the full water right diversion of 15,080 acre-feet and is considered insignificant for this analysis.

3 33% minimum losses are tied to the 2012 measurement but are likely higher in this low flow range.
Comparing Study Results
Comparing the various study results to the modeled best-fit curve in Figure 1 demonstrates (1) the 1977 Study estimates higher losses at 40 cfs and lower losses at 18 cfs than the wetted perimeter analysis and the 2016 findings, (2) the SAGE analysis provides a broad theoretical range of loss that bounds the modeled curve, and (3) the 2012 and 2016 single measurement flow data deviates somewhat above and below the derived curve. These comparisons are all represented in Figure 3, which illustrates the derived curve under this analysis is a reasonable representation of likely losses.

Figure 2 – Wetted Perimeter vs. CFS

![Figure 2 – Wetted Perimeter vs. CFS](image)
Estimating Historic and Future Losses

Because the exact loss is not measurable at each increment of flow, the curve presented in Figure 1 was translated to a look-up table to reflect the approximate percentage of loss for each increasing 5 cfs increment from 5 cfs to 40 cfs (see Table 2). The table also separately represents loss percentages during the two primary delivery periods of October-March and April-September considering the ETc factors described above.  

<table>
<thead>
<tr>
<th>Table 2 – Seasonal Loss Percentages</th>
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<tr>
<td>Oct 1-Mar 31</td>
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<tr>
<td>5-10 cfs</td>
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<td>20.1-25 cfs</td>
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<td>25.1-30 cfs</td>
</tr>
<tr>
<td>30.1-35 cfs</td>
</tr>
<tr>
<td>35.1-40 cfs</td>
</tr>
</tbody>
</table>

Using the look-up table, losses can be estimated for the historical monthly flow records for 2009 through 2015 for releases from Forebay (referred to as Gage A-18). Table 3 below presents the resulting monthly and annual loss estimates. Note that although the flow records indicated flows from Forebay during the months October through December, the flows were approximately 1 cfs or less to provide ditch customers with water and were thus conservatively reflected as zero loss in the table. This tends to underestimate seepage losses and does not capture carriage losses that occur during this period.

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4 Loss estimates for the April-September period include a component that represents ETc. During the winter period, ETc was assumed to not occur, since channel evaporation is very limited and bank vegetation is essentially dormant.
Table 3 – Calculated Loss

<table>
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<td>8,663</td>
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<td>Percent Loss</td>
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<td>22%</td>
<td>18%</td>
<td>22%</td>
<td>25%</td>
<td>21%</td>
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</table>

The look up table allows losses to also be estimated for historic periods when EID routinely conveyed up to 15,080 acre-feet annually through the Main Ditch. These historic higher flows pre-date the monthly digital records and were therefore not readily available for inclusion in this memo.

**Conclusion**

Using a look-up table that reflects the varying percentage of loss under different flow conditions and different seasons provides a supportable basis for estimating historic losses, and will be useful for establishing a method to identify quantifiable savings associated with the Project. Based on 2009 to 2015 data, minimum savings of approximately 1,350 acre-feet per year and an average of nearly 1,800 acre-feet can be expected to result from piping the ditch.

**Attachments**

Attachment 1 – 1977 Ditch Flow Measurement

Attachment 2 – 2012 Ditch Flow Measurement

Attachment 3 – 2016 EID Ditch Flow Measurement

Attachment 4 – 2016 EID Upper Main Ditch Annual Water Loss

Attachment 5 – 2015 Sage Engineering Ditch Modeling
Attachment 1

Excerpt from

Environmental Assessment

Proposed El Dorado Main Canal Pipeline Project

El Dorado Irrigation District
In evaluating any of the proposed actions, it is useful to compare each to the project objectives to determine the degree to which each meets this set of objectives. This comparison is presented in the section on environmental impacts.

**Project Need**

The need for the project relates directly to each of the foregoing objectives. The purpose of this section is to describe the nature and extent of the need for some action by EID and to present all available information that substantiates and reinforces that need.

**Water Losses**

Various estimates of water losses from the ditch have been made, but until recently none was substantiated by actual field measurements or tests. On June 7, 1977, Mr. E. M. Padjen, a licensed civil engineer experienced in the measurement of surface flows, was retained by several property owners residing in the Blair Road area to quantify losses in the EID ditch. Mr. Padjen made one set of measurements using a current meter at Pine Wood Lane and another set at the Blair Road crossing of the EID canal. His figures indicate that, at a flow of approximately 15 cfs, losses from the ditch in that 1.7-mile stretch would equal approximately 3 percent of the flow, or slightly less than 0.5 cfs.

In June and July 1977, the EID staff was trained by the U. S. Bureau of Reclamation in the use of current meters to estimate the discharge in the canal. The EID staff took several sets of measurements on the ditch at locations immediately downstream from Forebay Reservoir, at the Pinewood Lane crossing of the ditch, and at the Blair Road crossing of the ditch. While there are some variations in the computed losses, the tests seem to show that at a discharge of 40 cfs that the ditch loses about 9 percent of its flow between Forebay and the Blair Road bridge (about 3.5 cfs). The figures further show that about two-thirds of this loss (6 percent of the ditch flow) is lost between Pinewood Lane and Blair Road at this flow. These figures indicate that at full deliveries to the ditch under the PG&E contract, losses would amount to about 1,260 acre-feet per year in this section. Appendix G further explains these loss estimates.

When considering the test results, it is important to note that the measurement of flowing water in an irregularly-shaped ditch using a current meter is subject to error. Each individual measurement may be off from 5 to 8 percent. It is
possible (although not probable) that errors in measuring could account for part or all of the indicated losses. It is also possible that the losses could be greater than those measured. However, it is known that discharges in downstream springs in the Blair Road area increase following an increase in flow in the ditch. This response of the springs is the reverse of the normal rainfall pattern in the area, thus indicating a strong relationship between these spring flows and flows in the ditch, as well as indicating that the seepage losses from the ditch do increase as the water level in the ditch increases.

Estimates of losses for the rest of the ditch are not presently available. Two series of flow measurements were made to evaluate losses downstream from the Blair Road crossing. However, during the days the measurements were made, PG&E changed the flows out of Forebay Reservoir several times. As a result, the measurements are not usable, although they do indicate that some losses may occur. Between Blair Road crossing and Reservoir No. 1, seepage is evident downhill from the canal. No seepage was observed downstream from Reservoir No. 1 along the canal.

As a result, the 1,260 acre-foot per year estimate does understate the losses, to an unknown degree.

Maximize Use of Available Water

During the severe 1977 drought year, EID has had to cut back total district-wide water use by approximately 42 percent. This is one of the greatest reductions in water supply that has had to be imposed in any area of California during the drought. Both domestic and agricultural uses have been cut back significantly. Most dramatic however, has been the effect on the non-commercial agricultural uses which have not been allocated any water whatsoever. Only property owners who are able to demonstrate a commercial and viable agricultural operation have been allocated water for agricultural purposes. This has been necessary to provide adequate water for domestic, commercial, agricultural and industrial endeavors in the district.

The situation is further pointed up by the fact that Sly Park Reservoir had an average annual inflow from 1960 to 1976 of about 35,000 acre-feet. At the end of last year, Sly Park contained only 7,675 acre-feet of water in its 41,000 acre-foot capacity. Inflow for the year amounted to only 3,167 acre-feet -- a new record low. As a result, the principal water supply for EID in 1977 is the flow from Forebay Reservoir through the main canal.
Flow measurements were made by E. M. Padjen on June 7, 1977 and by EID staff in June and July 1977. The Padjen measurements indicate a loss of 3 percent of the flow between Pinewood Lane and the Blair Road crossing at a flow of 18 cfs. The EID measurements indicate a loss of between 9 and 10 percent between Forebay and Blair Road crossing, with about a 6 percent loss in the reach measured by Padjen, at flows of 40 cfs.

By prorating Padjen's loss estimate back to Forebay, including the Forebay-Pinewood Lane reach which he did not measure, a total of 4.5 percent loss at 18 cfs flow could be postulated. It should then be possible to plot the losses, both by percent loss and by cfs loss, to extrapolate losses for this reach of the canal at any flow. These assumptions are plotted on the attached figures.

The data upon which these charts are based may be in error. The measured flows vary enough from actual flows to account for a good portion of the measured losses, or to substantially understate the losses. Since other evidence corroborates that seepage losses do occur, and that the degree of loss varies with the flow in the canal, the charts have been drawn up and are used as the best available data. They must be used cautiously, however, and accepted as a guide only, not as a definitive answer.

These charts were used to determine the losses used in the assessment, based on the following computations:

**Loss at full flow:**

May 15-Oct 15: 4 cfs x 1.98 acre-feet/cfs-day x 152 days = 1,200 acre-feet
Oct 15-May 15: 0.15 cfs x 1.98 acre-feet/cfs-day x 213 days = 63 acre-feet

Use 1,260 acre-feet

**Loss at 7 cfs flow year-around:**

0.15 cfs x 1.98 acre-feet/cfs-day x 365 days = 108 acre-feet

Use 110 acre-feet
FIGURE G1. APPROXIMATE SEEPAGE LOSSES IN EL DORADO MAIN CANAL, FOREBAY TO BLAIR ROAD CROSSING
APPENDIX H

Recorded discharge from Forebay Reservoir in the EID Main Canal for Calendar Year 1969.
Recorded discharge from Forebay Reservoir in the EID Main Canal for Calendar Year 1970
Recorded discharge from Forebay Reservoir in the EID Main Canal for Calendar Year 1971
Recorded discharge from Forebay Reservoir in the EID Main Canal for Calendar Year 1974
Recorded discharge from Forebay Reservoir in the EID Main Canal for Calendar Year 1975
Recorded discharge from Forebay Reservoir in the EID Main Canal for Calendar Year 1976

CFS (Cubic Feet per Second)
ERRATA SHEET
Environmental Assessment of Proposed
El Dorado Main Canal Pipeline Project
August 19, 1977

Page 7 under Maximize Use of Available Water, first paragraph, second line: "42 percent" should read "58 percent".

Page 19, bottom of page, last line: "Placer County" should read "El Dorado County".

Page 29, delete first sentence on page, add: "Bacteriological quality has been tested on a long-term basis. Additional, more intensive testing was performed for this report. The discussions in this assessment are based on these recent tests."

Page 37, below the table, add: "Source: Storer and Usinger, 1963."

Page 46, second paragraph, first indented line should read: "Water supply: Georgetown Divide Public Utilities District..."

Page 58, last paragraph, under Water Sources, the sixth sentence, beginning "The Coloma-Lotus Ditch diverts..." should be deleted. Add: "The district has rights to about 6,900 acre-feet per year from the Coloma-Lotus Ditch, and diverts about 600 acre-feet annually. The district also has rights to 1,300 acre-feet on Weber Creek."

Page 61, Table 15 excludes data for the Coloma-Lotus Ditch.

Page 62, Table 16, add to bottom of table: "Source: El Dorado Irrigation District, 1976".

Page 65, third full paragraph, seventh line: "Indian Hill Reservoir" should read "Union Hill Reservoir".

Page 141, in the left margin of the lower chart, the vertical axis "Seepage losses, %" should read "Seepage losses, cfs".

Pages 103-105, Bibliography, add:
EDCPD — see El Dorado County Planning Department.
Storer, Tracy I., and Robert L. Usinger...
Delete:
EID (additions to) El Dorado...
San Francisco Chronicle...
ENVIRONMENTAL SETTING OF THE PROJECT

Physical Environment

Soils

The soils in the project area are derived from metamorphic or volcanic conglomeratic rocks. The most common soils in the area are the Cohasset loams and the Aiken loams. Minor soils occurring in the project area are the Josephine very rocky or gravelly loams, the Mariposa-Josephine very rocky loam, and the McCarthy cobbly loam. These soils are described below and located on the soil map (Figure 1).

Cohasset Series. The Cohasset series are well drained soils underlain by weathered andesitic conglomerate at a depth of more than 40 inches. These soils are gently sloping to strongly sloping on smooth ridges or are moderately steep to steep on sides of ridges.

Vegetation is mainly coniferous forest and associated hardwoods.

In representative profile, the surface layer is brown and reddish brown, slightly acid cobbly loam about 14 inches thick. The subsoil is reddish-brown and yellowish red, medium acid cobbly heavy loam and cobbly clay loam about 32 inches thick. Parent rock is slightly weathered andesitic conglomerate at a depth of about 46 inches.

The Cohasset soils are a dominant soil type in the project area. The three Cohasset soils found here are: the Cohasset loam, 3-9 percent slope; Cohasset loam, 9-15 percent slope; and the Cohasset loam, 15-30 percent slope.

Aiken Series. The Aiken series are well drained soils underlain by deeply-weathered andesitic conglomerate at a depth of 4 feet or more. The soils are gently sloping to moderately steep on wide smooth ridges and the sides of ridges. Vegetation is mainly coniferous forest and associated hardwoods.

In representative profile, the surface layer is brown and reddish brown, medium acid loam and clay loam about 24 inches thick with subsoil red and yellowish red. Medium acid and strongly acid heavy clay loam and clay are found to a depth of more than 72 inches.
The soil supports woodland and deciduous fruit orchards.

The Aiken soils common in the project area are: Aiken loam, 3-9 percent slope eroded; Aiken loam, 9-15 percent; and the Aiken loam, 15-30 percent slope.

McCarthy Series. The McCarthy series are well drained soils underlain by volcanic conglomerate and Breccia at a depth of 24-40 inches. These soils are strongly sloping on ridges and are steep on side slopes. These soils mainly support coniferous forest and associated hardwoods with scattered areas of brush.

In representative profile, the surface layer is dark grayish brown and brown, slightly acid cobbly loam about 10 inches thick. The subsoil is strong brown, medium acid, very cobbly loam about 28 inches thick. This is underlain by weathered andesitic conglomerate.

The McCarthy soil found in the project area is the McCarthy cobbly loam, 9-50 percent slope.

Josephine Series. The Josephine series are well drained soils underlain by vertically-tilted schists, slates and contact metamorphic rocks at a depth of 40-60 inches. These soils are gently rolling to very steep on mountainous uplands. Vegetation is mainly coniferous forest and associated hardwoods with scattered areas of brush.

In representative profile, the surface layer is yellowish-brown and reddish-yellow, medium acid and strongly acid silt loam about 14 inches thick. The upper part of the subsoil is reddish-yellow, very strongly acid silty clay loam about 19 inches thick. The lower part of the subsoil is yellow, very strongly acid, very gravelly silt loam, and is underlain by slate at a depth of 50 inches.

The two Josephine soils found in the project area are: the Josephine very rocky loam, 15-50 percent slope; and the Josephine gravelly loam, 9-15 percent slope.

Mariposa Series. The Mariposa series are well drained soils underlain by vertically-tilted schists and slate which contact metamorphic rocks at a depth of 15-30 inches, and are restricted to sloping or rolling to very steep terrain on mountainous uplands. Vegetation is mainly mixed coniferous forest and associated hardwoods and brush.
FIGURE 1 SOILS ADJACENT TO EID MAIN CANAL
In representative profile, the surface layer is pink, medium acid, gravelly silt loam about 8 inches thick. The subsoil is reddish yellow, medium acid and strongly acid gravelly silt loam about 18 inches thick. This is underlain by schists or slate at a depth of about 26 inches.

The Mariposa-Josephine very rocky loam is found in the project area.

Soil Permeability and Canal Flows. The EID main canal is affected by the underlying soils in several ways.

First the ditch, as an earth lined channel, is subject to water losses in transit, through seepage. The soils are classified by the Soil Conservation Service (SCS) according to permeability which is a measure of how fast water will move through the soil, expressed in inches per hour. In the project area soil permeabilities are rated as moderate and moderately rapid to moderately slow. (See Table 2). That means the water moves at a rate somewhere between 0.2 and 6.3 inches per hour depending on local conditions. The range of permeabilities shows the soils can allow substantial amounts of water to percolate, where the more permeable soils exist.

The soils in the project area are all rated by SCS as having severe limitations on their suitability for use as septic tank filter fields. This limitation is due to slope which can be as much as 50 percent. The soil can be very permeable locally and transmit water at a rate up to 6.3 inches per hour.

Geology

The oldest rocks in the project area are Paleozoic gray-wackes and volcanics (Calaveras formation) laid down in shallow seas between 600 and 230 million years ago. One hundred forty to 70 million years ago these sediments were turned steeply on end, metamorphosed into hornfels, slates and schists and intruded by granitic rocks and gold-bearing quartz veins. These intrusive granitic rocks form the core of the present Sierra Nevada. A long period of erosion followed, wearing down the mountains and depositing gold-bearing gravels in the river beds. In the early Cenozoic (65 million years ago) volcanism on the east side of the Sierra deposited rhyolitic ash and flows (Valley Springs formation). The andesitic tuffs and mud flow breccias of the Mehrten formation were deposited in the middle Cenozoic (about 25 million years ago).
<table>
<thead>
<tr>
<th>Soil</th>
<th>Erosion Hazard</th>
<th>Permeability of Subsoil</th>
<th>Runoff</th>
<th>Septic Tank Filter Field Suitability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohasset loam</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CmB, 3-9% slope</td>
<td>Slight</td>
<td>Moderate</td>
<td>Slow to medium</td>
<td>Severe</td>
</tr>
<tr>
<td>CmC, 9-15% slope</td>
<td>Slight to moderate</td>
<td>Moderately rapid to moderately slow</td>
<td>Slow to medium</td>
<td>Severe</td>
</tr>
<tr>
<td>CmD, 15-30% slope</td>
<td>Slight to high</td>
<td>Moderately rapid to moderately slow</td>
<td>Slow to medium</td>
<td>Severe</td>
</tr>
<tr>
<td>Aiken loam</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Afb2, 3-9% slope, eroded</td>
<td>Slight</td>
<td>Moderate</td>
<td>Slow to medium</td>
<td>Severe</td>
</tr>
<tr>
<td>AfC, 9-15% slope</td>
<td>Slight to moderate</td>
<td>Moderately rapid to moderately slow</td>
<td>Slow to medium</td>
<td>Severe</td>
</tr>
<tr>
<td>AfD, 15-30% slope</td>
<td>Slight to high</td>
<td>Moderately rapid to moderately slow</td>
<td>Slow to medium</td>
<td>Severe</td>
</tr>
<tr>
<td>Josephine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jse, very rocky loam, 15-50% slope</td>
<td>Slight to high</td>
<td>Moderately rapid to moderately slow</td>
<td>Medium to rapid</td>
<td>Severe</td>
</tr>
<tr>
<td>JrC, gravelly loam, 9-15% slope</td>
<td>Slight to moderate</td>
<td>Moderately rapid to moderately slow</td>
<td>Slow to medium</td>
<td>Severe</td>
</tr>
<tr>
<td>McCarthy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MhE, cobbly loam, 9-50% slope</td>
<td>Moderate to high</td>
<td>Moderately rapid to moderately slow</td>
<td>Medium to rapid</td>
<td>Severe</td>
</tr>
<tr>
<td>Mariposa-Josephine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>McE, very rocky loam, 9-50% slope</td>
<td>Slight to high</td>
<td>Moderately rapid</td>
<td>Medium to rapid</td>
<td>Severe</td>
</tr>
</tbody>
</table>
During the Pliocene (3 million years ago) block faulting uplifted the eastern edge of the Sierra along a major fault. A new, west-flowing stream pattern was established, cutting deep canyons through the volcanic debris and tertiary river deposits into the granitic and meta-volcanic bedrock. The lava flows remain as remnants capping the ridges.

The project area is on the gently sloping west side of the Sierra Nevada block, on a west-trending ridge dividing the South Fork of the American River and Webber Creek.

There are no active faults in the project area. The foothill fault system has had no movement since the late Mesozoic (100 million years ago). Any earthquake shock which could affect the project area would originate in the Basin and Range province to the east. Shocks greater than intensity VI have not occurred in the last 100 years. Shocks of intensity VII to VIII should be anticipated, however, during the next few centuries from very strong earthquakes in the Basin and Range Tectonic province (United States Bureau of Reclamation, 1974).

Surface Water Hydrology and Quality

El Dorado County contains 4 major and 18 minor watersheds. The El Dorado Irrigation District encompasses portions of the two largest: the South Fork of the American River and the Cosumnes River watersheds (see accompanying map).

The project area is within the South Fork of the American River drainage basin, near the southerly margin, on a ridge which forms the divide between two minor watersheds.

The water carried in the ditch originates in the South Fork of the American River. Pacific Gas & Electric diverts the water at Kyburz and conveys it 23 miles by gravity as surface flow in a ditch built in the same time period as the EID ditch. The water is delivered to PG&E's Forebay Reservoir, the point of origin of the EID ditch.

Chemical water quality in the ditch is very good. A report of chemical analysis is given in Table 3.

Physical quality of the water is generally good, although turbidity is a significant problem. Recent tests of physical quality (Table 4) show that turbidity increases significantly as water flows along the ditch. The worst effect occurs in the area downstream from Reservoir No. 1, primarily due to the steep gradient and resulting erosive force of the flows.
LEGEND

- Major Watershed Divide
- Secondary Watershed Divide
- Project Area

Major Watersheds
<table>
<thead>
<tr>
<th>Location</th>
<th>Res. #1</th>
<th>Forebay</th>
<th>Forebay #5</th>
<th>Camino Ditch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date Sampled</td>
<td>10-4-71</td>
<td>5-25-76</td>
<td>12-15-76</td>
<td>7-1-76</td>
</tr>
<tr>
<td>Hardness</td>
<td>12</td>
<td>10</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>18</td>
<td>15</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>Carbonate</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hydroxide</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>15</td>
<td>12</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Calcium</td>
<td>3.6</td>
<td>3.3</td>
<td>2.4</td>
<td>4.0</td>
</tr>
<tr>
<td>Magnesium</td>
<td>.73</td>
<td>.58</td>
<td>.71</td>
<td>0.5</td>
</tr>
<tr>
<td>Iron (total)</td>
<td>.50</td>
<td>.09</td>
<td>.00</td>
<td>0.02</td>
</tr>
<tr>
<td>Manganese</td>
<td>.06</td>
<td>.00</td>
<td>.00</td>
<td>0.01</td>
</tr>
<tr>
<td>Sodium</td>
<td>1.2</td>
<td>2.3</td>
<td>2.8</td>
<td>2.9</td>
</tr>
<tr>
<td>Potassium</td>
<td>.8</td>
<td>.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlorides</td>
<td>3.5</td>
<td>3.0</td>
<td>4.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Sulfates</td>
<td>1.5</td>
<td>0.1</td>
<td>0.1</td>
<td>1</td>
</tr>
<tr>
<td>Fluorides</td>
<td>.05</td>
<td>.0</td>
<td>.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Nitrates</td>
<td>.05</td>
<td>.00</td>
<td>.03</td>
<td>0.02</td>
</tr>
<tr>
<td>pH</td>
<td>7.5</td>
<td>7.2</td>
<td>7.1</td>
<td>7.4</td>
</tr>
<tr>
<td>Conductivity</td>
<td>31.5 Mhos/cm</td>
<td>105</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color</td>
<td>8</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turbidity</td>
<td>.44</td>
<td>2.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: El Dorado Irrigation District, 1977c.
Table 4

PHYSICAL CHARACTERISTICS OF EID DITCH, MEASURED AT 40 CFS FLOW

<table>
<thead>
<tr>
<th>Location</th>
<th>Conductivity</th>
<th>Turbidity</th>
<th>Dissolved Oxygen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forebay Reservoir</td>
<td>300</td>
<td>3 JTUs</td>
<td>8.1</td>
</tr>
<tr>
<td>Gilmore Road</td>
<td>290</td>
<td>5</td>
<td>8.1</td>
</tr>
<tr>
<td>Upstream from Moose Hall Reservoir</td>
<td>310</td>
<td>15</td>
<td>8.1</td>
</tr>
</tbody>
</table>

Source: El Dorado Irrigation District, August 9, 1977.
Bacteriological quality of the raw ditch water has only recently been tested. Initial tests run by the county indicated fecal-coliform present. The county tests do not indicate the full magnitude of the contamination, so El Dorado ran tests in their own lab. Results from both agencies are summarized in Table 5.

The tests indicate levels typical of untreated raw water supplies. They do not indicate any public health problems to be present at the time of testing. Chlorination would probably disinfect the water sufficiently well to provide for public safety.

Surface runoff from rainfall is intercepted by the canal throughout much of its length. Between Halsey Forebay Reservoir and Reservoir No. 1, all natural drainage courses, overland flow and roadway drainage enters the EID canal. About 345 acres of land are tributary, including residential and commercial acres of Pollock Pines (see Figure 2).

From Reservoir No. 1 to Moose Hall Reservoir, the tributary area is considerably narrower, since the canal more nearly follows the ridge line. In this reach about 100 acres of residential, commercial and vacant land, including considerable frontage on Pony Express Trail, is tributary to the canal. Pipe culverts draining roads in the area frequently empty directly into the canal.

According to EID staff (pers. comm.) the storm drainage of the area has been tributary to the canal since it was constructed over 100 years ago. In effect, this has protected downstream lands from storm drainage water, particularly in the Pollock Pines area. It has also intercepted and diverted whatever natural stream flow occurred in the various drainage courses during the wet season. The frequency and duration of the natural flows in these small streams are unknown.

It is probable that high intensity rainfall or rapid snowmelt in the Camino-Pollock Pines area could cause the flows in the canal to exceed capacity, flooding lands downstream. These occurrences would be short-lived, and none has been formally reported to EID (pers. comm.)
Table 5
1977 BACTERIAL TESTS: RAW CANAL WATER

<table>
<thead>
<tr>
<th>Date/Agency</th>
<th>Forebay Pump</th>
<th>Reservoir #1</th>
<th>Moose Hall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Coliform</td>
<td>Fecal Coliform</td>
<td>Total Coliform</td>
</tr>
<tr>
<td>June 27 El Dorado County Health Department</td>
<td>&gt;16</td>
<td>16</td>
<td>&gt;16</td>
</tr>
<tr>
<td>June 29 El Dorado County Health Department</td>
<td>&gt;16</td>
<td>&gt;16</td>
<td>5.1*</td>
</tr>
<tr>
<td>July 5 El Dorado County Health Department</td>
<td>&gt;16</td>
<td>&gt;16</td>
<td>&gt;16</td>
</tr>
<tr>
<td>July 6 El Dorado County Health Department</td>
<td>16</td>
<td>&gt;16</td>
<td>&gt;16</td>
</tr>
<tr>
<td>July 11 El Dorado County Health Department</td>
<td>5.1</td>
<td>&gt;16</td>
<td>&gt;16</td>
</tr>
<tr>
<td>July 13 El Dorado County Health Department</td>
<td>&gt;16</td>
<td>&gt;16</td>
<td>&gt;16</td>
</tr>
<tr>
<td>July 21 El Dorado Irrigation District</td>
<td>140</td>
<td>17</td>
<td>49</td>
</tr>
<tr>
<td>July 27 El Dorado Irrigation District</td>
<td>17</td>
<td>17</td>
<td>79</td>
</tr>
<tr>
<td>August 2 El Dorado Irrigation District</td>
<td>240</td>
<td>240</td>
<td>350</td>
</tr>
</tbody>
</table>

*Sample inadvertently taken below polymer feed.
Quality of runoff water from undisturbed forest lands in the American River watershed is generally excellent. Urban runoff contains numerous pollutants, including nutrients, significant amounts of heavy metals, pesticides, and fecal-coliform (Sartore, et al., 1974). Since the areas tributary to the canal are a mixture of urban uses and relatively undisturbed forest, the quality of runoff water is anticipated to be of better quality than urban runoff, while containing constituents typical of urban runoff in reduced concentrations.

The timing of runoff is dependent on precipitation. The first heavy rain of the season will carry a sudden surge of accumulated pollutants into the canal at one time. The more closely spaced the periods of runoff are, the lesser the impact of each occurrence relative to pollutant concentration.

**Groundwater**

Groundwater is a limited source of water to the EID. There are no groundwater basins of any size in the area. Local residents have been able to supply limited amounts for household use by drilling shallow wells, but yields are typically meager (EID, 1977).

Most geologic formations in the area are relatively poor sources of groundwater. Wheeldon (1977), in a recent study of the Camino-Fruitridge-Pollock Pines area, has found the Mehrten formation (in which the ditch is located) to contain pervious zones which could supply groundwater during seasons of adequate rainfall. The Mehrten formation caps the Camino-Pollock Pines Ridge and is underlain by the Calaveras formation (see map). Groundwater seeps down to the impervious Calaveras formation underneath, and then migrates laterally to emerge as springs. Little water is retained as storage and "several dry seasons in a row might deplete this water source if these areas undergo extensive development" (Wheeldon, 1977).

Net available groundwater in the area studied by Wheeldon was estimated at 44,100 acre-feet, (Wheeldon, 1977). This figure was reached by calculating average precipitation times acreage then subtracting estimated evapotranspiration and stream runoff, and was based partly on data from the Pleasant Valley area. The study does not address the feasibility of wells for public water supply.
Seepage losses through the earth-lined canal contribute an estimated 1,260 acre-feet per year to the local groundwater. This seepage from the canal has a strong influence on the local groundwater regime. Springs downslope from the canal demonstrate this influence by mirroring the flow pattern in the canal. The normal hydrologic pattern for stream flow is for the period of peak discharge to occur during the winter and spring period of heavy rainfall. The springs in the Blair Road area exhibit the reverse of this normal pattern, having periods of high flow in the summer when the canal carries an increased flow and low flow in the winter, when the canal carries a reduced flow. Whether flow in these springs is completely dependent on seepage from the canal, or whether canal seepage merely enhances a natural flow is not known.

Groundwater along the ditch probably flows generally towards the northward, being consumptively used by vegetation, surfacing in the springs and streams, or recharging downslope areas. Some of the seepage water probably returns to the South Fork of the American River, but the quantity is not known.

Most of the homes in the Blair Road area and along Old Blair Mill Road rely on individual private wells for their water supply. Seepage from Forebay Reservoir and the EID main canal may provide the primary recharge for these wells. Without actually eliminating seepage from the ditch, it is impossible to estimate the importance of recharge due to ditch losses relative to well yields.

Climate

The western slope of the Sierra Nevada range is characterized by warm sunny summers and moderate to heavy winter precipitation. Temperatures range from the sub-zero to well above 100 degrees.

Marine air masses travel east from the Pacific and begin their ascent of the Sierra slope heavily laden with water vapor. Precipitation increases with elevation up to about 6,000 feet then decreases. Average seasonal rainfall ranges from 37.6 inches at Placerville (elevation 1,900) to 50 inches at Pacific House (elevation 3,400). Snowfall increases with elevation up to 9,000 feet then decreases. Average seasonal snowfall ranges from 10 inches at Placerville to 50 inches at Pacific House. Precipitation in the past two seasons has been far below normal with water shortages resulting.
Main Ditch Instream Flow Measurements at Forebay and Patrick lane

<table>
<thead>
<tr>
<th>Date</th>
<th>1/27/2012</th>
</tr>
</thead>
</table>

**GAGE ID#**
- Patrick Ln DS of grizzly

**TRANSECT**
- 7

**USER ID#**
- 4675

**METER BEGIN**
- 0.58

**METER END**
- 0.58

**GH BEGIN**
- 0.58

**GH END**
- 0.58

**EST. DISCHARGE**
- 0

**EST. Q(ADJ)**
- 6.04

<table>
<thead>
<tr>
<th>METER ID#</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>AQUACALC ID#</td>
<td>0</td>
</tr>
<tr>
<td>SOUNDING WT.</td>
<td>0</td>
</tr>
</tbody>
</table>

**START MEAS. AT**
- LEW

**METER TYPE**
- Pygmy ST2

**METER CONST. C1**
- 0.9604

<table>
<thead>
<tr>
<th>METER CONST. C2</th>
<th>CONST. C3</th>
<th>0.96</th>
</tr>
</thead>
<tbody>
<tr>
<td>METER CONST. C4</td>
<td>0.0312</td>
<td></td>
</tr>
<tr>
<td>METER CONST. C5</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**MEAS. SYSTEM**
- SAE

**PERCENT SLOPE**
- 0

| TOTAL VERTICALS | 18 |
| TOTAL STATIONS  | 18 |
| TOTAL WIDTH     | 7.5|
| TOTAL AREA      | 10.1|
| TOTAL DISCHARGE | 6.04|
| PCT DIFFERENCE  | -29%|

**MEAN VELOCITY**
- 0.6

**WETTED PERIMETER**
- 9.74

**HYDRAULIC RADIUS**
- 1.04

**MANNING FACTOR**
- 0

<table>
<thead>
<tr>
<th>OB</th>
<th>DIST</th>
<th>DEPTH</th>
<th>ICE</th>
<th>REV</th>
<th>TIME</th>
<th>COS:VF</th>
<th>LOC</th>
<th>COEF</th>
<th>CLOCK</th>
<th>VEL</th>
<th>AREA</th>
<th>FLOW(Q)</th>
<th>FLAGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
<td>1</td>
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Gene Gutenberger was requested by Reservoir 1 Plant personnel to perform flow monitoring along the Main Ditch because of the low flow reaching the plant compared to releases from Forebay. The flow monitoring was completed on January 27, 2012. The flow rate just downstream of Gage A18 was 8.51 cfs and matched the A18 flow meter. The flow rate at Patrick Land downstream of Grizzly was 6.04 cfs, indicating a 29% loss. Gene indicated that he observed multiple crawdad burrows. Later a crew found larger holes that were repaired by filling them with bentonite.

Note: According to plant records, the plant started up on January 25, 2012.
2016 Instream Flow Study

Result Summary

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Photographs and discharge measurement summaries attached.
Instream flow measurement site downstream of Gage A-18
Instream flow measurement site upstream of Reservoir.
Instream flow measurement site upstream of Reservoir 1 (looking upstream)
Discharge Measurement Summary

File Information
- File Name: A1860116.WAD
- Start Date and Time: 2016/06/01 09:30:35

Site Details
- Site Name: A18 HEAD OF DITCH
- Operator(s): JDB

System Information
- Sensor Type: FlowTracker
- Serial #: P5644
- CPU Firmware Version: 3.9
- Software Ver: 2.30
- Mounting Correction: 0.0%

Units (English Units)
- Distance: ft
- Velocity: ft/s
- Area: ft^2
- Discharge: cfs

Discharge Uncertainty
- Accuracy: 1.0%
- Depth: 0.2%
- Velocity: 0.8%
- Width: 0.1%

Supplemental Data
- (Gage Height Change = 0.000ft)
- # Timings: 40
- # Stations: 19

Measurement Results

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Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.
### Discharge Measurement Summary

**Date Generated:** Thu Jun 2 2016

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**Total Discharge: 10.8299**

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**Discharge Measurement Summary**

**File Information**
- **File Name**: A1860816.WAD
- **Start Date and Time**: 2016/06/08 11:40:44

**Site Details**
- **Site Name**: A18 HEAD OF DITCH
- **Operator(s)**: JDB

**System Information**
- **Sensor Type**: FlowTracker
- **Serial #**: P5644
- **CPU Firmware Version**: 3.9
- **Software Ver**: 2.30
- **Mounting Correction**: 0.0%

**Units (English Units)**
- **Distance**: ft
- **Velocity**: ft/s
- **Area**: ft^2
- **Discharge**: cfs

**Discharge Uncertainty**
- **Category**
  - **Accuracy**: 1.0%
  - **Depth**: 0.2%
  - **Velocity**: 0.6%
  - **Width**: 0.1%
  - **Method**: 1.9%
- **ISO**: 1.0%
- **Stats**: 0.4%

**Summary**
- **Averaging Int.**: 40
- **Rew**: Total Width: 11.900
- **Mean SNR**: 47.0 dB
- **Mean Temp**: 58.42 °F
- **Disch. Equation**: Mid-Section
- **Mean Velocity**: 1.6644
- **Total Discharge**: 20.7567

**Supplemental Data**

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Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.
Discharge Measurement Summary

File Information
File Name: MD060816.WAD
Start Date and Time: 2016/06/08 12:50:04

Site Details
Site Name: MAIN DITCH AT RES 1
Operator(s): JDB

System Information
Sensor Type: FlowTracker
Serial #: P5644
CPU Firmware Version: 3.9
Software Ver: 2.30
Mounting Correction: 0.0%

Units (English Units)
Distance: ft
Velocity: ft/s
Area: ft^2
Discharge: cfs

Discharge Uncertainty
Category | ISO | Stats
--- | --- | ---
Accuracy | 1.0% | 1.0%
Depth | 0.1% | 0.6%
Velocity | 0.4% | 1.5%
Width | 0.1% | 0.1%
Method | 0.9% | -
# Stations | 22.2% | -
Overall | 2.6% | 1.9%

Summary
Averaging Int.: 40
Start Edge: REW
Mean SNR: 38.4 dB
Mean Temp: 60.79 °F
Disch. Equation: Mid-Section

Total Width: 13.500
Total Area: 31.254
Mean Depth: 2.315
Mean Velocity: 0.5227
Total Discharge: 16.3363

Supplemental Data
# | Time | Location | Gauge Height | Rated Flow | Comments
--- | --- | --- | --- | --- | ---
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## Discharge Measurement Summary

**Date Generated:** Thu Jun 9 2016

### File Information
- **File Name:** MD060816.WAD
- **Start Date and Time:** 2016/06/08 12:50:04

### Site Details
- **Site Name:** MAIN DITCH AT RES 1
- **Operator(s):** JDB

### Measurement Results

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<td>1.2600</td>
<td>0.6090</td>
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<td>2.080</td>
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<td>1.3100</td>
<td>0.7792</td>
</tr>
<tr>
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<td>12.30</td>
<td>None</td>
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<td>0.0</td>
<td>2.080</td>
<td>2.080</td>
<td>0.5950</td>
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<td>0.4718</td>
<td>1.3100</td>
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</tr>
<tr>
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<td>0.0</td>
<td>2.080</td>
<td>2.080</td>
<td>0.5950</td>
<td>1.00</td>
<td>0.4718</td>
<td>1.3100</td>
<td>0.7792</td>
</tr>
<tr>
<td>11</td>
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<td>12.30</td>
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<td>0.0</td>
<td>2.080</td>
<td>2.080</td>
<td>0.5950</td>
<td>1.00</td>
<td>0.4718</td>
<td>1.3100</td>
<td>0.7792</td>
</tr>
<tr>
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<td>12:58</td>
<td>12.30</td>
<td>None</td>
<td>0.000</td>
<td>0.0</td>
<td>2.080</td>
<td>2.080</td>
<td>0.5950</td>
<td>1.00</td>
<td>0.4718</td>
<td>1.3100</td>
<td>0.7792</td>
</tr>
<tr>
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<td>12:58</td>
<td>12.30</td>
<td>None</td>
<td>0.000</td>
<td>0.0</td>
<td>2.080</td>
<td>2.080</td>
<td>0.5950</td>
<td>1.00</td>
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<td>1.3100</td>
<td>0.7792</td>
</tr>
<tr>
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<td>None</td>
<td>0.000</td>
<td>0.0</td>
<td>2.080</td>
<td>2.080</td>
<td>0.5950</td>
<td>1.00</td>
<td>0.4718</td>
<td>1.3100</td>
<td>0.7792</td>
</tr>
<tr>
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<td>12.30</td>
<td>None</td>
<td>0.000</td>
<td>0.0</td>
<td>2.080</td>
<td>2.080</td>
<td>0.5950</td>
<td>1.00</td>
<td>0.4718</td>
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<td>2.080</td>
<td>2.080</td>
<td>0.5950</td>
<td>1.00</td>
<td>0.4718</td>
<td>1.3100</td>
<td>0.7792</td>
</tr>
</tbody>
</table>

Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.
### System Information
- Sensor Type: FlowTracker
- Serial #: P5644
- CPU Firmware Version: 3.9
- Software Ver: 2.30
- Mounting Correction: 0.0%

### Units (English Units)

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<tr>
<th>Distance</th>
<th>ft</th>
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</thead>
<tbody>
<tr>
<td>Velocity</td>
<td>ft/s</td>
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<tr>
<td>Area</td>
<td>ft^2</td>
</tr>
<tr>
<td>Discharge</td>
<td>cfs</td>
</tr>
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</table>

### Discharge Uncertainty

<table>
<thead>
<tr>
<th>Category</th>
<th>ISO</th>
<th>Stats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>1.0%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Depth</td>
<td>0.1%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Velocity</td>
<td>0.5%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Width</td>
<td>0.1%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Method</td>
<td>0.9%</td>
<td>-</td>
</tr>
<tr>
<td># Stations</td>
<td>2.0%</td>
<td>-</td>
</tr>
<tr>
<td>Overall</td>
<td>2.5%</td>
<td>2.1%</td>
</tr>
</tbody>
</table>

### Summary

<table>
<thead>
<tr>
<th>Averaging Int.</th>
<th>40</th>
</tr>
</thead>
<tbody>
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<td>Start Edge</td>
<td>REW</td>
</tr>
<tr>
<td>Mean SNR</td>
<td>46.1 dB</td>
</tr>
<tr>
<td>Mean Temp</td>
<td>66.88 °F</td>
</tr>
<tr>
<td>Disch. Equation</td>
<td>Mid-Section</td>
</tr>
</tbody>
</table>

| Total Width    | 13.650 |
| Total Area     | 17.050 |
| Mean Velocity  | 1.8138 |
| Total Discharge| 30.9246 |

### Supplemental Data (Gauge Height Change = 0.000 ft)

<table>
<thead>
<tr>
<th>#</th>
<th>Time</th>
<th>Location</th>
<th>Gauge Height</th>
<th>Rated Flow</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Fri Jul 1 09:51:41 PDT 2016</td>
<td>0.000</td>
<td>1.230</td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>Fri Jul 1 10:53:58 PDT 2016</td>
<td>3.000</td>
<td>1.230</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(file://C:/Program%20Files%20(x86)/SonTek/FlowTracker/Resources/Reports/Summary.htm 7/5/2016)
System Repo1t

Page 2 of5

Discharge Measurement Summary
File Information
File Name
Start Date and Time

Date Generated: Tue Jul 5 2016

Site Details
A1870116.WAD
2016/07/01 09:55:14

Site Name
Operator(s)

AlB MAIN DITCH
JDB

Measurement Results
St

Clock
Loc
Method
Depth % 0ep MeasO
Vel
Corrfact
MeanY
Area
0 09:55 16.65
None
o.ooc
o.c
0.0
0.0000
1.00
0.0000 0.000
1 09:55 15.9(
O.E
0.50C
O.E
0.200
1.7369
1.00
1.7369 0.387
15.1C
0.8/0.
1.50C
0.
1.200
2.7201
1.00
2.4173 0.975
2 09:59
2.114S
15.1C
0.8/0.
1.50C
0 .~
0.300
2 09:58
14.6(
3
10 :00
0.2/0.~
1.60C
0.
1.280
2.9091
1.00
2.5989 0.800
14.6(
10 :0
0.2/0.~
1.60C
0 .~
0.320
2.288
3
4
10 :05 14.1C
0.8/0.
1.70C
0.
1.360
2.6089
1.00
2.3675 0.850
4
10 :04
14.1C
0.8/0.
1.70C
0 .~
0.340
2.1260
13.6(
5
10 :06
0.2/0.~
1.70C
0.
1.360
2.4846
1.00
2.1048 0.850
13.6(
10 :08
0.2/0.~
1.70C
0 .~
0.340
1.7251
5
10 :1
13.1C
0.2/0.6/0.~
1.70C
0.
0.680
1.8914
1.00
1.9650 0.850
6
10 :1
13.1C
0.2/0.6/0.~
1.70C
O.E
0.680
1.7766
6
10 :10 13.1C
0.2/0.6/0.~
1.70C
0 .~
1.360
2.4154
6
2.279S
7
10 :15 12.6(
0.8/0.
1.80C
0.
1.440
1.00
1.7766 0.900
12.6(
10 :14
0.8/0.
1.80C
0 .~
0.360
1.2736
7
0.2/0.6/0.8
1.800
0.2
1.440 2.2762
1.00
1.7148 0.900
8 10:16 12.10
8 10:18 12.10
0.2/0.6/0.8
1.800
0.6
0.720
1.7740
0.2/0.6/0.8
1.800
0.8
0.360
1.0351
8 10:16 12.10
11.6(
10 :20
0.8/0.
1.80C
0.
1.440
2.2618
1.00
1.9831 0.900
9
11.6(
10 :19
0.8/0.
1.80C
0 .~
0.360
1.7044
9
0.2/0.~
1.80C
0.
1.440
2.2694
1.00
1.8304
0.900
10
10 :21 11.1(
11.1(
10
10 :2
0.2/0.~
1.80C
0 .~
0.360
1.3914
10.6(
0.8/0.
1.80C
0.
1.440
2.2828
1.00
1.4711 0.900
11 10 :24
0.8/0.
1.80C
0 .~
0.360
0.6594
11 10 :23 10.6(
12
10 :25 10.1C
0.2/0.~
1.70C
0.
1.360
2.3576
1.00
1.5796 0.850
10 :26
10.1C
0.2/0.~
1.70C
0 .~
0.340
0.801
12
9.6(
13 10 :30
0.8/0.
1.70C
0.
1.360
2.3274
1.00
1.9746 0.850
9.6(
0.8/0.
1.70C
0 .~
0.340
1.621
13 10 :29
14 10:31
9.10
0.2/0.8
1.600
0.2
1.280 2.3009
1.00
1.8337 0.800
14 10:32
9.10
0.2/0.8
1.600
0.8
0.320
1.3665
15 10:34
8.60
0.2/0.6/0.8
1.500
0.2
1.200 2.2933
1.00
1.5033 0.750
15 10:35
8.60
0.2/0.6/0.8
1.500
0.6
0.600
1.5341
15 10:33
8.60
0.2/0.6/0.8
1.500
0.8
0.300
0.6516
16
10 :38
8.1C
0.8/0.
1.50C
0.
1.200
2.270
1.00
1.6685 0.750
16
10 :3
8.1C
0.8/0.
1.50C
0 .~
0.300
1.066
7.6(
17
10 :40
O.E
1.40C
O.E
0.560
1.4144
1.00
1.4144
0.700
10 :43
7.1C
O.E
1.30C
O.E
0.520
1.560
1.00
1.5607 0.650
18
6.6(
10 :45
O.E
1.20C
O.E
0.480
1.7769
1.00
1.7769 0.600
19
20 10 :46
6.1C
O.E
1.00C
O.E
0.400
1.8481
1.00
1.8481 0.500
1.675S
5.6(
21 10 :4
O.E
0.85C
O.E
0.340
1.00
1.6755 0.468
5.0(
O.E
0.70C
O.E
0.280
1.3304
1.00
1.3304
0.420
22 10 :48
4.4(
O.E
0.50C
O.E
0.200
0.4836
1.00
0.4836 0.500
23 10 :49
3.0(
24
10 :49
None
o.ooc
o.c
0.0
0.0000
1.00
0.0000 0.000
Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

Flow

%Q

0.0000
0.6730
2.3567

0.0
2.2
7.6

2.0792

6.7

2.0125

6.5

1.7892

5.8

1.6704

5.4

1.5988

5.2

1.5432

5.0

1.7847

5.8

1.6472

5.3

1.3239

4.3

1.3427

4.3

1.6785

5.4

1.4670

4.7

1.1275

3.6

1.2514

4. 0

0.9900
1.0143
1.0663
0.9240
0.7834
0.5589
0.2418
0.0000

3.2
3.3
3.4
3.0
2.5
1.8
0.8
0.0

file:///C:/Program%20Files%20(x86)/SonTek!FlowTracker/Resources/RepOits/Summruy.htm

7/5/2016


Discharge Measurement Summary

File Information
- File Name: R1070116.WAD
- Start Date and Time: 2016/07/01 12:03:34

Site Details
- Site Name: RES 1070116
- Operator(s): JDB

System Information
- Sensor Type: FlowTracker
- Serial #: P5644
- CPU Firmware Version: 3.9
- Software Ver: 2.30
- Mounting Correction: 0.0%

Units (English Units)
- Distance: ft
- Velocity: ft/s
- Area: ft^2
- Discharge: cfs

Summary
- Averaging Int.: 40
- Start Edge: REW
- Mean SNR: 43.7 dB
- Mean Temp: 68.19 °F
- Disch. Equation: Mid-Section
- # Stations: 21
- Total Width: 12.799
- Total Area: 25.742
- Mean Depth: 2.011
- Mean Velocity: 1.0264
- Total Discharge: 26.4219

Discharge Uncertainty
<table>
<thead>
<tr>
<th>Category</th>
<th>ISO</th>
<th>Stats</th>
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</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>1.0%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Depth</td>
<td>0.1%</td>
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</tr>
<tr>
<td>Velocity</td>
<td>0.3%</td>
<td>1.3%</td>
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<tr>
<td>Width</td>
<td>0.1%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Method</td>
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Supplemental Data
<table>
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<tr>
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<th>Time</th>
<th>Location</th>
<th>Gauge Height</th>
<th>Rated Flow</th>
<th>Comments</th>
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<td>2.550</td>
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<td></td>
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System Repo1t

Page 2 of 5

Discharge Measurement Summary
File Information
File Name
Start Date and Time

Date Generated: Tue Jul 5 2016

Site Details
R1070116.WAD
2016/07/01 12:03:34

Site Name
Operator(s)

RES 1 070116
JDB

Measurement Results
St

0
1

~
~

5
5
6
6

a
a
9
9
10
10
11
11
1
1
1
1
1~
1~

15
1S
16
16
1
1
1a
1a
19
19
20
Rows

Depth
% 0ep
Method
Mea sO
Vel
Corrfact
MeanY
Area
0.(
0.000(
15.20
None
0.000
0.0
1.00
0.0000 0.000
0.577~
0.34(
14.40
0.6
0.850
0.6
1.00
0.577~
0.595
12 :0~
0.48(
13.80
0.6
1.200
0.6
0.8805
1.00
0.8809 0.720
1.52(
12 :0~
13.20
0.8/0.2
1.900
0.2
0.988
1.00
0.9137 1.140
0.38(
12:0
13.20
0.8/0.2
1.900
0.8
0.839
1.76(
12:05 12.60
0.2/0.8
2.200
0.2
1.0171
1.00
0.8565 1.320
12:1( 12.60
0.44(
0.2/0.8
2.200
0.8
0.6955
1.84(
1.140~
12:1
12.00
0.8/0.2
2.300
0.2
1.00
1.0581 1.380
0.46(
12:11 12.00
0.8/0.2
2.300
0.8
0.975
1.84(
12:13 11.40
0.2/0.8
2.300
0.2
1.209f
1.00
1.0966 1.380
12 : 1~
0.46(
11.40
0.2/0.8
2.300
0.8
0.983f
1.84(
1.298
2.300
0.2
1.00
1.2~
1.380
12:H
10.80
0.8/0.2
0.46(
0.8/0.2
2.300
0.8
1.110f
12:15 10.80
1.84(
1.345~
12:1
10.20
0.2/0.8
2.300
0.2
1.00
1.223~
1.380
1.101~
0.46(
12:1f 10.20
0.2/0.8
2.300
0.8
12:2(
1.80(
9.60
0.8/0.2
2.250
0.2
1.412
1.00
1.2892 1.350
0.45(
12 : 1~
9.60
0.8/0.2
2.250
0.8
1.165
1.80(
12:21
9.00
0.2/0.8
2.250
0.2
1.253
1.00
1.2006 1.350
0.45(
1.148(
12:2
9.00
0.2/0.8
2.250
0.8
12 :2~
1.84(
1.385~
8.40
0.8/0.2
2.300
0.2
1.00
1.2802 1.380
0.46(
8.40
0.8/0.2
2.300
0.8
1.1745
12:23
1.92(
12:25
7.80
0.2/0.8
2.400
0.2
1.00
1.1859 1.440
1.2841
0.48(
12:2E
7.80
0.2/0.8
2.400
0.8
1.087f
1.92(
1.231
12 :2~
7.20
0.8/0.2
2.400
0.2
1.00
1.0942 1.440
0.48(
0.957(
12:2
7.20
0.8/0.2
2.400
0.8
2.00(
12:25
6.60
0.2/0.8
2.500
0.2
1.137
1.00
0.9701 1.500
12:3(
0.50(
6.60
0.2/0.8
2.500
0.8
0.802~
2.16(
12:3
6.00
0.8/0.2
2.700
0.2
1.18~
1.00
1.0180 1.620
0.54(
12:3
6.00
0.8/0.2
2.700
0.8
0.849
2.16(
12:33
5.40
0.2/0.8
2.700
0.2
0.932
1.00
0.9037 1.620
12 :3~
0.54(
0.875(
5.40
0.2/0.8
2.700
0.8
2.16(
12:3E
4 .80
0.8/0.2
2.700
0.2
1.030
1.00
0.9186 1.620
0.54(
4 .80
0.8/0.2
2.700
0.8
0.8071
12:35
1.80(
12:3
4 .20
0.2/0.8
2.250
0.2
0.890
1.00
0.8755 1.686
0.45(
12 :3~
4 .20
0.2/0.8
2.250
0.8
0.860
1.28(
12:4
3.30
0.8/0.2
1.600
0.2
0.718'
1.00
0.6962 1.438
0.32(
12:4(
3.30
0.8/0.2
1.600
0.8
0.6735
0.(
0.000(
12:4(
2.40
None
0.000
0.0
1.00
0.0000 0.000
in italics indicate a QC warning . See the Quality Control page of this report for more information.

Clock

12:03
12:03

loc

Flow

%0

0.0000
0.3437
0.6344
1.0417

0.0
1.3
2.4
3.9

1.1307

4.3

1.4602

5.5

1.5134

5.7

1.6622

6.3

1.6884

6.4

1.7406

6.6

1.6210

6. 1

1.7667

6.7

1.7078

6.5

1.5757

6.0

1.4554

5.5

1.6495

6.2

1.4642

5.5

1.4884

5.6

1.4764

5.6

1.0014

3.8

0.0000

0.0

file:///C:/Program%20Files%20(x86)/SonTek!FlowTracker/Resources/RepOits/Summruy.htm 7/5/2016


Upper Main Ditch 2016 Water Loss
Forebay to Reservoir 1 Water Treatment Plant

2016 Operations Summary

The Reservoir 1 Water Treatment Plant came on line May 26, 2016. Water loss calculations begin June 1, 2016 to allow for watering up the ditch and stabilizing seepage. Losses are based on the difference between Forebay Gage A-18 and the flow meter at the Reservoir 1 Water Treatment Plant, less backwash water returned ahead of the meter. As shown in Figure 1 and 2, flows were ramped up to 30 cfs in June to allow for incremental instream flow measurement. In early July, the flow rate was reduced to 20 cfs and continued at that rate until the end of September when the water treatment plant was taken off line for Project 184 maintenance. Flow continued in the ditch at 0.5 to 1 cfs to deliver water to ditch customers until late October when flow was shut down to dry up the ditch for construction of the Blair Road Bridge Replacement Project. Total water loss is underestimated to the extent carriage losses associated with delivering water to raw water customers after the treatment plant was taken off line are not included in the calculations. Flow in late June is corrected for meter spikes that resulted in replacement of the parshall flume transducer.

Table 1 – 2016 Upper Main Ditch Water Loss

<table>
<thead>
<tr>
<th></th>
<th>July 7, 2016 - September 30, 2016</th>
<th>June 1, 2016 - September 30, 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forebay A-18 Gage</td>
<td>3,464</td>
<td>5,296</td>
</tr>
<tr>
<td>Plant Inlet</td>
<td>2,847</td>
<td>4196</td>
</tr>
<tr>
<td>Water loss</td>
<td>617</td>
<td>1,100</td>
</tr>
<tr>
<td>Percent loss</td>
<td>17.8%</td>
<td>20.8%</td>
</tr>
</tbody>
</table>
Figure 1 – Forebay versus Reservoir 1 Headworks (Cubic-feet/second)

Figure 2 – Forebay versus Reservoir 1 Headworks (Acre-feet/day)
TECHNICAL MEMORANDUM

To: Tracey Eden-Bishop  
El Dorado Irrigation District

From: Ryan M. Abernathy, P.E. # 79136  
Zack Washburn, C.E.G. #2624

Date: December 16, 2015

Re: SEEPAGE ESTIMATE  
EID Upper Main Ditch  
El Dorado County, California  
Project No. 15-144.00

SAGE Engineers, Inc. (SAGE) is pleased to submit this memorandum presenting estimates of seepage loss from the approximately 3-mile-long Upper Main Ditch, in El Dorado County, California. This work was performed to assist El Dorado Irrigation District (EID) in securing water conservation grants for the Upper Main Ditch Piping project. The project consists of the construction of a new pipeline within portions of the unlined Upper Main Ditch (canal) alignment, which connects Forebay Reservoir to the Reservoir 1 Water Treatment Plant (WTP). The remaining pipe is proposed to be installed beneath Blair Road, which roughly parallels the existing canal alignment. The pipeline will eliminate approximately 3 miles of open ditch and is intended to reduce water loss between the facilities. Our findings indicate a minimum water loss of 2 to 11 percent due to seepage through the canal at flows of 40 cubic feet per second (cfs), and a 4 to 21 percent loss at flows of 20 cfs. These are likely minimum estimates because they do not include losses associated with animal burrows, areas of shallow and/or fractured rock, evapotranspiration, etc.

This memorandum describes our scope of work, and summarizes observations from a limited geologic reconnaissance, procedures used for percolation and permeability testing, seepage modelling, and estimated losses in the following sections.

SCOPE OF WORK

We performed a limited field exploration program in general accordance with the scope of services presented in our proposal dated November 6, 2015 and our Master Services Agreement with EID dated January 1, 2014. Specifically, our scope consisted of:

- Reviewing readily available geologic maps and reports, and an environmental assessment provided by EID. Based on our literature review and access along the canal, we identified locations suitable for limited field exploration (percolation and permeability testing).
- Performing five (5) percolation (perc) tests in shallow excavations in the canal bottom.
- Driving 3-inch diameter Shelby tubes with a 20 pound slide hammer to collect samples from the canal adjacent to each perc test.
Laboratory testing of five (5) samples for permeability testing using ASTM method D5084.

Reviewing the results of perc and permeability testing and modelling seepage from the canal using SEEP/W software for 2 soil/rock conditions at flow rates of 20 and 40 cfs.

Reviewing literature for and estimating the amount of evapotranspiration along the canal.

Preparing this memorandum, which summarizes geologic conditions, field procedures, test results, modeling, and seepage estimates.

PREVIOUS LOSS ESTIMATES

We reviewed the Environmental Assessment for the Proposed El Dorado Canal Pipeline Project (Jones and Stokes, 1977), which includes estimates of seepage and evapotranspiration losses based on flow measurements performed by Mr. E. M. Padjin (C.E.) and trained EID staff in July of 1977. They found that loss generally scaled with flow rate. Between Forebay Reservoir and the Blair Road crossing (STA 120+50 feet), they estimated losses of 0.8 cfs and 4 cfs (4 to 10 percent) at flow rates of 18 and 40 cfs, respectively (Attachment 1). When these loss estimates are extrapolated to the entire length of the canal that will be replaced (15,400 feet), the losses are estimated to be 1 cfs to 5.1 cfs (6 to 13 percent).

In 2012, EID performed additional flow measurements (EID, 2015a). They measured 8.51 cfs at the upstream end of the canal and 6.04 cfs just downstream of Patrick Lane, which equates to approximately 2.5 cfs (29 percent) water loss. Patrick Lane is approximately 1,800 feet upstream of the water treatment plant. They noted the presence of multiple animal burrows and voids in the canal, the larger of which were later filled with bentonite.

EID continuously measures flow at the Forebay Reservoir water rights reporting gauge A18 and at the Reservoir 1 WTP headworks. Review of flow monitoring data from 2009 through 2014 indicates annual water losses in the range of 10% and 23% (EID, 2015b).

GEOLOGIC RECONNAISSANCE

To provide geotechnical recommendations for a previous phase of the Upper Main Ditch piping project, we met with Domenichelli & Associates (D&A) on October 22, 2015 to perform a geologic reconnaissance of the upper approximate ½-mile-long reach of the canal from Forebay Reservoir (forebay) to the Pinewood Lane crossing. From STA 1+00 to STA 4+50, we observed fractured meta-sedimentary rock exposed in the bank excavation and locally in the canal bottom. The rock exposed in the bank is generally closely to moderately fractured (2” to 12” spacing), moderately hard, and moderately strong. Although we were not able to fully classify the rock in the canal bottom due to flowing water (<½ cfs), the rock is generally consistent with regional geologic mapping that show this portion of the canal underlain by Paleozoic-aged marine rocks (Wagner et al., 1981).

Farther downstream, from STA 4+50 to Pinewood Lane (STA 25+25), we observed reddish brown fine-grained soil exposed in the banks and berm. We observed similar fine-grained soil with occasional andesitic cobbles during a walkdown from Pinewood Lane to the water treatment plant (STA 158+84) with EID on the same date. The regional geologic map indicates that the portion of the canal downstream of

1 Approximate stationing (STA) based on AutoCAD drawing received from Domenichelli & Associates on November 24, 2015
STA 4+50 is underlain by volcanic rocks of the Mehrten Formation, which commonly weather to material consistent with the observed soil.

PERCOLATION TESTING

Procedures
SAGE geologists Matt Buche and Zack Washburn met representatives of EID at Forebay Reservoir on November 18th and 19th, 2015 to perform perc testing at select locations on the Upper Main Ditch. Upon arrival, we observed flow in the bottom of the canal, at about the same rate as observed during our October reconnaissance, estimated to be approximately 0.10 cfs coming from intermittent flow from the Forebay Dam seepage pump station. After discussing possible effects of the water on the perc tests with EID, we elected to run the tests on topographic high spots in the canal bottom that were not inundated.

We used a post hole digger (clamshell) to create cylindrical excavations (test holes) in the canal bottom as shown on Attachment 1. The test holes were 6 inches in diameter and ranged from 12 to 18 inches in depth. We placed a folding stick ruler at the base of each test hole to measure water levels during testing. We also placed two inches of gravel in the bottom of the holes to protect from scouring when adding water for the tests. Typically test holes are presoaked to saturate the soil; however, the ground was still saturated by the minor flow in the canal. Accordingly, we did not presoak the test holes.

Each test hole was initially filled with water to a level of 6 inches of above the top of the gravel. We performed falling head tests by measuring the drop in the water level at 30 minute intervals. After each measurement, we added water to raise the water level to the starting elevation (6 inches above the gravel). Testing continued until three consecutive measurements differed by less than 1/8 inch.

Percolation Test Results
Table 1 shows the approximate stationing and measured percolation rates for each of the five tests performed. Flowing water was present at the upper two perc test locations and standing water was observed within 80 lineal feet of the third perc test, located at STA 86+50. The measured percolation rates at these locations may be minimums due to possible increased pore pressure around the test holes.

<table>
<thead>
<tr>
<th>Test Location</th>
<th>Material Type</th>
<th>Measured Percolation Rate (min/inch)</th>
<th>Estimated Hydraulic Conductivity² (cm/day)</th>
<th>Estimated Hydraulic Conductivity² (cm/day)</th>
<th>Estimated Hydraulic Conductivity² (cm/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4+50</td>
<td>fine-grained soil</td>
<td>96</td>
<td>4</td>
<td>&lt;8.3</td>
<td>4.7</td>
</tr>
<tr>
<td>26+00</td>
<td>fine-grained soil</td>
<td>120</td>
<td>4</td>
<td>&lt;8.3</td>
<td>6.3</td>
</tr>
<tr>
<td>86+50</td>
<td>fine-grained soil</td>
<td>480</td>
<td>NA²</td>
<td>&lt;8.3</td>
<td>1.5</td>
</tr>
<tr>
<td>130+00</td>
<td>coarse-grained soil</td>
<td>20</td>
<td>20</td>
<td>16½</td>
<td>47</td>
</tr>
<tr>
<td>134+50</td>
<td>coarse-grained soil/weathered rock</td>
<td>8</td>
<td>50</td>
<td>&gt;50</td>
<td>NA</td>
</tr>
</tbody>
</table>

² Based on Amoozegar, A., Comparison of saturated hydraulic conductivity and percolation rate: Implications for designing septic tank systems, 1997.
³ Based on Natural Resources Conservation Service, Table 4 on page 12 of Soil Potential Ratings, Subsurface Sewage Disposal Systems for Single Family Residences, February 2009.
⁵ Not available because percolation rate is beyond the limits of the correlation.
The percolation rates range from 8 to 480 minutes per inch (MPI). Based on Soil Conservation Service (SCS) reports, the Environmental Assessment (Jones and Stokes, 1977) citesperc rates ranging from 0.2 to 6.3 inches per hour for the soil along the canal. Converting the SCS rates from inches per hour, yields rates of 9.5 to 300 MPI, similar to our measurements.

To compare the measured perc rates with the following permeability test results, we used 3 different methods to estimate hydraulic conductivity from the percolation rates, as indicated in Table 1. Note that the terms “hydraulic conductivity” and “permeability” are used interchangeably in practice and in this memorandum.

PERMEABILITY TESTING

We collected relatively undisturbed rock and soil samples from the bottom of the canal and berm using a 20 pound slide hammer to drive 3-inch diameter Shelby tubes adjacent to each perc test. We submitted four (4) samples collected from the canal bottom and one (1) from the berm for laboratory permeability testing using ASTM method D5084. Permeability is the measure of the ability of a material to allow fluid to pass through it. Test D5084 measures the rate at which water passes through a fully saturated sample and is usually reported in units of centimeters per second (cm/sec). The permeability test results are included with this memorandum as Appendix A and summarized in the Table 2. Note, the table also provides test results in more usable units of cm/day to allow for better comprehension of the data.

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Sample Location</th>
<th>Position in Canal</th>
<th>Lab Test Permeability (cm/sec)</th>
<th>Lab Test Permeability (cm/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perm 1</td>
<td>4+50</td>
<td>berm</td>
<td>1.78 e-4</td>
<td>15.38</td>
</tr>
<tr>
<td>Perm 2</td>
<td>26+00</td>
<td>bottom</td>
<td>3.83 e-6</td>
<td>0.33</td>
</tr>
<tr>
<td>Perm 3</td>
<td>86+50</td>
<td>bottom</td>
<td>2.87 e-7</td>
<td>0.02</td>
</tr>
<tr>
<td>Perm 4</td>
<td>130+00</td>
<td>bottom</td>
<td>1.19 e-6</td>
<td>0.10</td>
</tr>
<tr>
<td>Perm 5</td>
<td>134+50</td>
<td>bottom</td>
<td>1.45 e-4</td>
<td>12.53</td>
</tr>
</tbody>
</table>

SEEPAGE MODELING

Procedures

Based on the limited number of samples collected and the potential variability in permeability along the canal, we elected to average the permeabilities measured from the canal bottom samples in our model. We divided the canal into four equal length segments, each representing 3,971 feet of native canal bank and bottom. We used the permeability from sample Perm 1 to model the fill comprising the berm along the full length of the canal. Canal cross sections were established for modeling purposes from the 100-foot-cross sections cut in the Civil 3D file prepared by D&A (D&A, November 2015).

We analyzed the four canal cross sections using SEEP/W version 8.15.3.11339 by GEO-SLOPE, 2012. In our models, we assumed that the canal reaches steady state conditions, meaning that the canal runs at constant head sufficiently long so that the seepage velocities do not vary with time. Furthermore, we assumed that the canal runs constantly so that the soil becomes fully saturated. To help determine that these assumptions and others were appropriate, we ran sensitivity cases that varied the saturated/nonsaturated condition, groundwater table, preferential flow ratios, canal head, and impermeable boundary depth. We found that most of these assumptions did not have a large effect on
the seepage volume. See the Seepage Estimates section, below, for further discussion on the sensitivity cases.

The permeabilities used in our models were directly based on the lab-determined values presented in Tables 2 and 3. However, because the permeability values estimated from our percolation testing were generally an order of magnitude higher than the lab values (see Table 3 for comparison), we ran the models with the permeabilities increased by one order of magnitude to establish a potential range of seepage loss.

The models were analyzed assuming both 40 cfs and 20 cfs canal flows. Based on discussions with D&A, this results in approximate canal heads of 2.5 and 1.33 feet, respectively, above the bottom of the canal. The results of the seepage modeling are discussed below.

**TABLE 3 – COMPARISON OF LAB PERMEABILITIES WITH ESTIMATED RATES FROM PERC TESTING**

<table>
<thead>
<tr>
<th>Test Location</th>
<th>Lab Test Permeability (cm/sec)</th>
<th>Lab Test Permeability (cm/day)</th>
<th>Estimated Hydraulic Conductivity from Perc Test (cm/day)</th>
<th>Estimated Hydraulic Conductivity from Perc Test (cm/day)</th>
<th>Estimated Hydraulic Conductivity from Perc Test (cm/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4+50</td>
<td>1.78 e-4</td>
<td>15.38 (sample from berm)</td>
<td>&lt;8.3 (perc test from bottom)</td>
<td>&lt;8.3 (perc test from bottom)</td>
<td>4.7 (perc test from bottom)</td>
</tr>
<tr>
<td>26+00</td>
<td>3.83 e-6</td>
<td>0.33</td>
<td>4</td>
<td>&lt;8.3 (perc test from bottom)</td>
<td>6.3</td>
</tr>
<tr>
<td>86+50</td>
<td>2.87 e-7</td>
<td>0.02</td>
<td>NA</td>
<td>&lt;8.3 (perc test from bottom)</td>
<td>1.5</td>
</tr>
<tr>
<td>130+00</td>
<td>1.19 e-6</td>
<td>0.10</td>
<td>20</td>
<td>16 ½</td>
<td>47</td>
</tr>
<tr>
<td>134+50</td>
<td>1.45 e-4</td>
<td>12.53</td>
<td>&gt;50</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

**Seepage Estimates**

Based on the seepage modeling for 40 cfs canal flow, we estimate the seepage losses to range from about 0.8 to 4.5 cfs (2 to 11 percent). For the 20 cfs canal flow, we estimate seepage losses of about 0.8 to 4.2 cfs (4 to 21 percent). As previously mentioned, the range in the loss estimates is primarily due to the difference in conductivities measured from permeability testing (lower values) versus those estimated from percolation testing (higher values).

We found that the seepage models were sensitive to changes in preferential flow direction (horizontal vs. vertical) and depth to an impermeable layer. Bedded clay layers can have a preferential horizontal flow direction typically up to 4 times the vertical direction (ASDSO, 2014). Additionally, most seepage models assume an impermeable layer/boundary at depth. By varying the preferential flow ratio and impermeable boundary depth, we estimate the ranges of water loss presented above. Based on our experience with unlined canals, the uncertainty in the parameters established for the seepage models, the variability of the canal materials in areas not observed for this study, and the sensitivity of the calculated flow estimates to some of the key model parameters, we believe the upper end of our loss estimate range to be more likely than the lower end.

**OTHER SOURCES OF POSSIBLE WATER LOSS**

We reviewed readily available publications to estimate potential water loss from the canal due to evapotranspiration (sum of evaporation and transpiration from plants and trees). Although it is difficult to quantify evapotranspiration (ET), there are numerous models that attempt to do so. The models range from simple temperature and radiation-driven equations to more complex algorithms.
We reviewed a study that measured actual evapotranspiration using instruments on towers above the forest canopy at the Blodgett Research Station (Fisher et al., 2004). The research station is located about 10 miles north of the canal, underlain by the same soil type and geologic formation (Cohasset Series soil and Mehrten Formation), and covered with similar tree species (Ponderosa Pine, Douglas Fir, White Fir and Incense Cedar). The instruments measure flux and record up to 200 watts per square meter of evapotranspiration during the summer months. This amount equates to approximately 0.1 cfs or ¼ percent of water loss from the canal due to ET.

We observed rodent burrows in the banks and berm during our reconnaissance and walkdown. It is likely that additional water loss, that is not included in our model, is occurring through burrows and other pathways, such as zones of shallow and/or fractured rock. The observation of seasonal springs that form during the dry summer months on the downhill side of the canal (Jones and Stokes, 1977) suggests that water flows through larger voids or at least areas of higher permeability are present that were not represented in our model.

**COMPARISON OF SEEPAGE ESTIMATES AND CONCLUSIONS**

The following chart presents water loss estimates from our modeling with those from flow meter measurements for comparison and discussion. At flows of 40 cfs, the high end of the modeled range is similar to the 1977 flow meter estimates. Conversely, at 20 cfs the low end of the modeled range generally coincides with the 1977 measurements. In general, the upper limit of the modeled seepage losses are within the range of Forebay/Reservoir 1 WTP flow metering data (EID, 2015b).

The water loss estimated by EID in 2012 is greater than both the estimates from 1977 data and our seepage. The reason for this is unknown, but may be due to other sources of potential water loss as discussed above, possibly degradation of the berm and resulting increased water loss, or imprecise measurements of the cross sectional area used in the flow meter estimates.
There are numerous factors that contribute to uncertainty in the water loss estimates, including: limited conductivity data with only 5 data points (permeability samples) for 3 miles of canal; and the possible increased pore pressure due to flowing water and resulting lower percolation rates. Also it is important to consider that conductivity values typically range a few orders of magnitude, even within the same soil or rock type. Based on the available data, it appears that at flows of 40 cfs on the order of 10 percent of the water that leaves the forebay is lost during travel to the treatment plant.

LIMITATIONS

This technical memorandum has been prepared for the sole use of El Dorado Irrigation District and its agents, specifically for design of the improvements described herein for the subject project. The seepage estimates presented in this technical memorandum are solely professional opinions based on limited percolation testing, limited permeability testing, SEEP/W modelling, and professional experience with similar projects. SAGE is not responsible for the data and methods presented by others.

The information provided in this technical memorandum is valid for a period of three (3) years from the date of issuance. Conditions may arise that were not apparent at the time of this design (e.g., changes in design geometries, soil design parameters, loadings, etc.). In addition, changes in applicable standard of practice can occur, whether from legislation or the broadening of knowledge. Accordingly, the information provided in this technical memorandum may be invalidated, wholly or partially, by changes outside of our control. Should changes occur that might affect the design presented herein, SAGE should be notified to evaluate the validity of this technical memorandum to those changes. This document may not be reproduced for any other reason than pertains to the project for which it was prepared.

Attachments:

Attachment 1 – Percolation and Flow Test Locations (prepared by D&A)
Appendix A - Sierra Testing Laboratories – Lab Test Results

References:


Eldorado Irrigation District a, Conversation Record, Flow metering completed January 27, 2012 to identify losses along Main Ditch, December 2, 2015

Eldorado Irrigation District b, personal communication with EID staff, December 16, 2015.


HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA
Sample Identification: Perm 1A Berm
Location: Roots & Weeds
Remarks:

Sample Depth, ft.: 0-18"
Lab No.: S44504
Sample Type: Driven Liner

TEST RESULTS
Permeability, cm/sec.: 1.78E-04
Effective Confining Pressure, psi: 5
Average Hydraulic Gradient: 2.9

TEST SAMPLE DATA

Before Test
Specimen Height, cm: 6.73
Specimen Diameter, cm: 7.14
Dry Unit Weight, pcf: 72.0
Moisture Content, %: 26.1

After Test
Specimen Height, cm: 6.73
Specimen Diameter, cm: 7.14
Dry Unit Weight, pcf: 74.3
Moisture Content, %: 34.0

Test Method: ASTM D5684 Method C

PROJECT NUMBER: 15-120 November 19, 2015

SIERRA TESTING LABORATORIES, INC. BIOCHEMICAL AND POTENTIAL TESTING SERVICES
485 Pierroz Rd, Unit D, Placerville, CA 95667
Ph 530-622-1101 Fax 530-622-1191
HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA
Sample Identification: Penn 2 Bottom
Location: 0
Remarks:

Sample Depth, ft.: 0-8"
Lab No.: S44505
Sample Type: Driven Liner

TEST RESULTS
Permeability, cm/sec.: 3.83E-06
Average Hydraulic Gradient: 5.3
Effective Confining Pressure, psi: 5

TEST SAMPLE DATA
Before Test
Specimen Height, cm: 7.11
Specimen Diameter, cm: 7.19
Dry Unit Weight, pcf: 80.6
Moisture Content, %: 37.6

After Test
Specimen Height, cm: 7.11
Specimen Diameter, cm: 7.19
Dry Unit Weight, pcf: 78.7
Moisture Content, %: 41.6

Test Method: ASTM D5084 Method C

SCHRA TESTING LABORATORIES, INC.
485 Pennzo Rd, Unit D, Placerville, CA 95667
Ph 530-622-1101 Fax 530-622-1191

EID UMD

November 19, 2015
PROJECT NUMBER: 15-120
HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Perm 3 Bottom
Location: 0
Remarks:

Sample Depth, ft.: 0-9"
Lab No.: S44506
Sample Type: Driven Liner

TEST RESULTS

Permeability, cm/sec.: 2.61E-07
Effective Confining Pressure, psi: 5
Average Hydraulic Gradient: 7.7

TEST SAMPLE DATA

Before Test
Specimen Height, cm: 7.62
Specimen Diameter, cm: 7.19
Dry Unit Weight, pcf: 83.1
Moisture Content, %: 37.2

After Test
Specimen Height, cm: 7.62
Specimen Diameter, cm: 7.19
Dry Unit Weight, pcf: 83.0
Moisture Content, %: 39.8

Test Method: ASTM D5084 Method C

PROJECT NUMBER: 15-120

November 24, 2015

EID UMD

485 Placoz Rd, Unit D, Placerville, CA 95667
Ph 530-622-1101 Fax 530-622-1191
HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Penn 4 Bottom
Location: 0
Remarks:

Sample Depth, ft.: 0-9"
Lab No.: S44507
Sample Type: Driven Liner

TEST RESULTS

Permeability, cm/sec.: 1.19E-06
Effective Confining Pressure, psi: 5
Average Hydraulic Gradient: 6.1

TEST SAMPLE DATA

Before Test
Specimen Height, cm: 7.87
Specimen Diameter, cm: 7.14
Dry Unit Weight, pcf: 72.7
Moisture Content, %: 50.8

After Test
Specimen Height, cm: 7.77
Specimen Diameter, cm: 7.14
Dry Unit Weight, pcf: 74.6
Moisture Content, %: 49.7

Test Method: ASTM D5081 Method C

PROJECT NUMBER: 15-120
November 24, 2015

SIERRA TESTING LABORATORIES, INC.
485 Pierroz Rd., Unit D, Placerville, CA 95667
Ph 530-622-1101 Fax 530-622-1191

EID UMD
HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Perm 5 Bottom
Location: Broken, very weathered rock
Remarks: Sample Type: Driven Liner

Sample Depth, ft.: 0-9"  Lab No.: S44508

TEST RESULTS

Permeability, cm/sec.: 1.45E-04  Average Hydraulic Gradient: 4.8
Effective Confining Pressure, psi: 5

TEST SAMPLE DATA

Before Test
Specimen Height, cm: 7.62
Specimen Diameter, cm: 7.14
Dry Unit Weight, pcf: 60.6
Moisture Content, %: 69.9

After Test
Specimen Height, cm: 7.62
Specimen Diameter, cm: 7.14
Dry Unit Weight, pcf: 64.7
Moisture Content, %: 60.3

PROJECT NUMBER:  15-120  November 19, 2015

SIERRA TESTING LABORATORIES, INC.
PHYSICAL AND MATERIAL TESTING SERVICES

485 Pierroz Rd, Unit D, Placerville, CA 95667
Ph 530-622-1101  Fax 530-622-1181

EID UMD
Appendix B Engineering Studies

B.6 YOUNGDAHL CONSULTING GROUP, INC. GROUNDWATER RESOURCES IMPACT ANALYSIS FOR EL DORADO IRRIGATION DISTRICT UPPER MAIN DITCH PIPING PROJECT (APRIL 7, 2017)
GROUNDWATER RESOURCES IMPACTS ANALYSIS
FOR
EL DORADO IRRIGATION DISTRICT
UPPER MAIN DITCH PIPING PROJECT
POLLOCK PINES, CALIFORNIA

Project No. E13237.008
April 2017

YOUNGDAHL
CONSULTING GROUP, INC.
Building Innovative Solutions
El Dorado Irrigation District
2890 Mosquito Road
Placerville, CA 95667

Attention: Ms. Tracy Eden-Bishop, Senior Civil Engineer

Subject: UPPER MAIN DITCH PIPING PROJECT, POLLOCK PINES
Groundwater Resource Impacts Analysis
Report

Dear Ms. Eden-Bishop:

In accordance with your authorization, Youngdahl Consulting Group, Inc. has completed a Groundwater Resource Impacts Analysis for the planned piping of the Upper Main Ditch, leading from Forebay Reservoir to the Reservoir 1 Water Treatment Plant in Pollock Pines, California. The primary purpose of this assessment was to evaluate potential impacts on water supply wells located in the proximity of the Upper Main Ditch. We estimated that there is currently from 2,199 acre-feet to 2,593 acre-feet per year of groundwater recharge from both rainfall infiltration and Upper Main Ditch losses. The Upper Main Ditch Pipeline project has the potential to remove approximately 81 percent of the groundwater recharge; however, the current groundwater consumption in this area is very small, approximately 2.8 acre-feet per year. It is our opinion that there would not be a significant impact on the existing domestic water wells. There is a small potential for wells in close proximity to the Upper Main Ditch to see some minor impacts.

Very truly yours,
Youngdahl Consulting Group, Inc.

David C. Sederquist, C.E.G, C.HG.
Senior Engineering Geologist/Hydrogeologist

Distribution: One (1) electronic copy to El Dorado Irrigation District, Attention Ms. Tracy Eden-Bishop
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Figure 1 – Topographic Map
Figure 2 - Geology Map

Appendix A – Natural Resources Conservation Service Reports
Appendix B – Water Well Driller’s Reports
1.0 EXECUTIVE SUMMARY

The El Dorado Irrigation District (District) is proposing to implement the Upper Main Ditch Piping Project (Project) to replace a 3-mile section of water supply ditch with a buried pipeline. The proposed pipeline would convey raw water while reducing water leakage and losses and improve the quality of water entering the Reservoir 1 Water Treatment Plant (WTP). The Upper Main Ditch (Main Ditch) conveys a maximum of 15,080 acre-feet annually of raw water from the El Dorado Forebay Reservoir to the WTP. The water is then treated and distributed throughout the District’s public drinking water system. Because the majority of the ditch is uncovered and unlined, a portion of the water is lost to seepage and evapotranspiration. The most recent studies of flow loss measurements by consultants for the District have shown that the ditch losses average up to 1,800 acre-feet per year, depending on flow rates and weather conditions.

There are numerous residential parcels in proximity to the Upper Main Ditch. Whereas most of these parcels are served by District piped water, eight water supply wells have been identified (The Westmark Group, 2013). There may be a potential for the elimination of seepage from the Main Ditch to adversely impact available groundwater resources.

Previous studies have included an Environmental Assessment by Jones and Stoke (1977), The Westmark Group (2013), SAGE Engineers, Inc. (2015), and Tully & Young, Inc. (2017). These studies provided estimates of seepage losses and identified wells in proximity to the Main Ditch. Youngdahl was able to obtain Driller’s Reports for five of eight wells, finding reported depths ranging from 200 to 380 feet and well yields ranging from 8 gallons per minute (gpm) to 34 gpm.

Thirty years of rainfall records from Sly Park, south of Pollock Pines, were reviewed along with evapotranspiration estimates from Camino, California providing monthly averages of rainfall and evapotranspiration along with annual rainfalls ranging from 14.4 inches in 2013 to 72.9 inches in 1998.

An estimated groundwater recharge area for the Main Ditch and domestic water well supplied parcels is bounded by the ridge top in Pollock Pines, the North Fork of Long Canyon to the east, a ridge above Iowa Canyon to the west, and roughly paralleling the north side of the Upper Main Ditch representing approximately 675 acres (Figure 1). The estimated average groundwater recharge from rainfall for the 675-acre area ranges from 423 acre-feet to 816 acre-feet per year. When the estimated average infiltration from the Main Ditch losses are added to the estimated recharge from rainfall, the range of groundwater recharge for an average rainfall year is 2,199 to 2,593 acre-feet. The estimated ratio of groundwater recharge to total rainfall ranges from 0.16 to 0.31 for the study area.

The removal of the average Main Ditch infiltration of 1,777 acre-feet from the total of 2,199 acre-feet per year (average ditch loss plus average rainfall recharge at 30%
runoff) would reduce groundwater recharge by approximately 81 percent. The removal of the average Main Ditch infiltration of 1,777 acre-feet from the total of 2,593 acre-feet per year (average ditch loss plus average rainfall recharge at 10% runoff) would reduce groundwater recharge by approximately 69 percent.

The District’s 2016 Water Resources and Service Reliability Report indicates that annual consumption in the eastern part of the services area, including Pollock Pines, is about 0.35 acre-feet per year per single-family residential unit. For eight wells, this would indicate an average consumption of 2.8 acre-feet per year. The current groundwater consumption in this area is very small. Natural recharge is capable of sustaining adequate groundwater resources for the current rates of consumption of these wells. There still remains a small potential for localized conditions to result in an adverse impact to a well, especially those wells that are very near to the Upper Main Ditch.

Baseline conditions should be established for the eight wells prior to the installation of the pipeline. The yield of each well should be tested for a period of four hours or more to establish a short term yield value. At the completion of yield testing, water samples should be collected and analyzed to establish a baseline for water quality. When the Main Ditch is replaced with a pipeline, the baseline testing of yield and water quality can be used to provide reference points for preexisting conditions.

2.0 PROJECT DESCRIPTION

The El Dorado Irrigation District (District) is proposing to implement the Upper Main Ditch Piping Project (Project). The purpose of the Project is to replace a 3-mile section of water supply ditch with a buried pipeline which would convey raw water while reducing water leakage and losses, and improving the quality of water entering the Reservoir 1 Water Treatment Plant (WTP). The Upper Main Ditch (Main Ditch) conveys a maximum of 15,080 acre-feet annually of raw water from the El Dorado Forebay Reservoir to the WTP which is then treated and distributed throughout the District’s public drinking water system. Because most of the ditch is uncovered and unlined, a portion of the water is lost to seepage and evapotranspiration. Studies of flow loss measurements by consultants to the District have shown that an average of nearly 1,800 acre-feet per year is lost to seepage and evapotranspiration from the Upper Main Ditch (Tully & Young, Inc., 2017).

There are numerous residential parcels in proximity to the Upper Main Ditch. Whereas most of these parcels are served by District piped water, eight water supply wells have been identified (The Westmark Group, 2013). There may be a potential for the elimination of seepage from the Main Ditch to adversely impact available groundwater resources.

Youngdahl Consulting Group, Inc. (Youngdahl) reviewed the following existing documentation:

1) Geology;
2) Natural Resources Conservation Service soil data;
3) Nearby rainfall records;
4) Nearby evapotranspiration estimates;
5) Drillers reports;
6) United States Geologic Survey topographic maps;
7) Consultants reports; and
8) Accepted methods for estimating groundwater recharge from precipitation.

This information was used to create a conceptual model of the existing groundwater resource conditions and to estimate the likely impacts of replacing the Main Ditch with a pipeline. The research was conducted using readily available information and was completed under the existing On-Call Professional Services contract between the District and Youngdahl.

3.0 GEOLOGY

3.1 Regional Geology
The site is situated in the Sierra Nevada geomorphic province in El Dorado County, California. This province is dominated by plutonic rocks that comprise the Sierra Nevada Mountain Range. Tectonic uplift of the range began in the late Triassic period with the onset of active plate subduction along the continental margin. At that time, the continental margin was located where the present day Sierra Nevada Mountain Range is today. Subduction continued throughout the Jurassic period and resulted in accretion of island arcs, atolls, and other remnants of land on the subducting plate to the existing continental margin in addition to the continued uplift of the Sierra Nevada Mountain Range. Collectively, these accreted “terranes” are known as the Sierra Nevada metamorphic belt.

The Sierra Nevada metamorphic belt is divided into three sections: the Eastern, Central and Western blocks, based on a series of northwest trending fault systems. These sections or “terranes” are primarily composed of accumulations of Paleozoic and/or Mesozoic marine sediment and volcanic rocks. The Project is underlain by Paleozoic-age metasedimentary rock, and Tertiary-age sedimentary and volcanic rocks of the Eastern block of the Sierra Nevada metamorphic belt (Busch, 2001).

3.2 Project Area Geology
The Project is mapped by Busch (2001) as being underlain by the Shoo Fly Complex and Mehrten Formation. The Shoo Fly Complex is described as being highly deformed miogeosynclinal deposits composed predominately of quartzofeldspathic schist and gneiss; quart-mica schist, and phyllite. The Mehrten Formation is described as being stream channel, alluvial and mudflow deposits derived mainly from andesitic volcanic rocks.

Youngdahl is of the opinion that the Valley Springs Formation is also potentially present in the subsurface at the Project. The Valley Springs Formation is of Oligocene to early Miocene in age (Schweikert, 1981), and was deposited unconformably onto the eroded surface of the Shoo-Fly Complex. Locally, it is composed primarily of rhyolitic ashflow tuffs and alluvial deposits derived primarily from rhyolitic volcanic rocks.

According to Schweikert (1981), the Mehrten Formation is part of a group of andesitic volcanic events that occurred after a 5 to 10 million year hiatus from the rhyolitic volcanics. The Mehrten Formation in the project area is represented mostly by volcanic mudflow rocks (agglomerates) derived from andesitic ash and vulcanism to the east in the Sierra Nevada. Following pre-volcanic event erosion, the deposits traveled down
stream channels and valleys carved within the underlying rock and form the resistant ridge top capping units (lava cap) found in the Pollock Pines to Placerville area.

Lindgren (1911) studied the geology of the Tertiary-age gravels of the Sierra Nevada of California in depth. The Valley Springs Formation filled the valleys of the principal streams present at the time of the volcanic eruptions. The subsequent volcanic flows of the Mehrtten Formation further filled the valleys and spread over large areas. These volcanic flows formed the ridge that underlies Pollock Pines. Lindgren described the gravels that underlie and are within the Mehrtten and Valley Springs Formations near Placerville and Pollock Pines based on observations of surface exposures and from gold mining records. For the Valley Springs Formation, Lindgren indicated that there are incorporated beds of quartzose and metamorphic gravel, with the Valley Springs formation being about 400 feet thick in the vicinity of Newtown (southwest of Pollock Pines). The thickness of the Mehrtten Formation ranges from 400 feet in the vicinity of Placerville to 700 feet east of Placerville.

Lindgren (1911) indicated that the Tertiary American River channel entered the Pollock Pines area at Pacific House (east of Pollock Pines along US Highway 50) with the deepest part of the channel at an elevation of 3,500 feet. The elevation of the channel at Badger Hill near Iowa Canyon is 3,000 feet. The gravels in the channel at Pacific House consist of quartz and metamorphic rocks and are not over 10 feet thick. There are some minor gravels within the overlying Valley Springs Formation. The old river valley was about 3 miles wide in this location. The main ridge underneath Pollock Pines doesn't cover the main Tertiary River Channel. Lindgren indicated that the bedrock on the north side is generally high and that the Mehrtten Formation andesitic tuff simply covers the northern slope of the Tertiary-age American River valley.

In summary, the Project is underlain by metamorphic rocks, andesitic lava and mudflow rocks, possible rhyolitic volcanics, and possible ancient stream channels. Where gravels may be present, there is a potential for gravel aquifers. Otherwise, groundwater will most likely be found only in fractured rock.

### 3.3 Soils

Youngdahl estimated an approximate area of groundwater recharge bounded by the ridge top in Pollock Pines, the North Fork of Long Canyon to the east, a ridge above Iowa Canyon to the west, and roughly paralleling the north side of the Upper Main Ditch (Figure 1). According to a search of the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) online soil survey (Soil Web), the soils in this area are predominately composed of the Cohasset loam, 9 to 15 percent slopes, the Cohasset loam, 15 to 30 percent slopes, the McCarthy cobbly loam, 9 to 50 percent slopes, and the Josephine very rocky loam, 15 to 50 percent slopes (Appendix A).
Table 1 - Soils

<table>
<thead>
<tr>
<th>Soil Name</th>
<th>Drainage Class</th>
<th>Limiting Layer Ksat* (micrometers per second)</th>
<th>Hydrologic Soil Group</th>
<th>Available Water Storage in profile (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohasset loam, 9 to 15 percent slopes</td>
<td>Well Drained</td>
<td>8.3 (28 inches per day)</td>
<td>B</td>
<td>6.9</td>
</tr>
<tr>
<td>Cohasset loam, 15 to 30 percent slopes</td>
<td>Well Drained</td>
<td>8.3 (28 inches per day)</td>
<td>B</td>
<td>6.9</td>
</tr>
<tr>
<td>McCarthy cobbly loam, 9 to 50 percent slopes</td>
<td>Well Drained</td>
<td>25.4 (86 inches per day)</td>
<td>B</td>
<td>3.4</td>
</tr>
<tr>
<td>Josephine very rocky loam, 15 to 50 percent slopes</td>
<td>Well Drained</td>
<td>9.0 (30 inches per day)</td>
<td>B</td>
<td>7.8</td>
</tr>
</tbody>
</table>

* Capacity of the most limiting layer to transmit water. Obtained from the Web Soil Survey, 10 March 2016.

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) describes Drainage Class as referring to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized; excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. The Soil Survey Manual defines the Well Drained class as:

**Well drained.** Water is removed from the soil readily but not rapidly. Internal free water occurrence commonly is deep or very deep; annual duration is not specified. Water is available to plants throughout most of the growing season in humid regions. Wetness does not inhibit growth of roots for significant periods during most growing seasons. The soils are mainly free of the deep redoximorphic features that are related to wetness.

The NRCS describes saturated hydraulic conductivity (Ksat) as follows:

*Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.*

The NRCS defines Hydrologic Soil Group B as soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

The NRCS discusses available water storage as follows:
Available water capacity (AWC) refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in centimeters of water per centimeter of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure, with corrections for salinity and rock fragments. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. It is not an estimate of the quantity of water actually available to plants at any given time.

Available water supply (AWS) is computed as AWC times the thickness of the soil. For example, if AWC is 0.15 cm/cm, the available water supply for 25 centimeters of soil would be 0.15 x 25, or 3.75 centimeters of water.

4.0 PREVIOUS STUDIES

The District provided Youngdahl with studies addressing well locations and seepage estimates. In addition, Youngdahl also reviewed a land capability study for a tentative subdivision map on Blair Road and directly adjacent to the Upper Main Ditch where Youngdahl completed 28 percolation tests for an onsite wastewater disposal feasibility study.

4.1 Jones and Stokes, Environmental Assessment, Proposed El Dorado Main Canal Pipeline Project

The District provided Youngdahl excerpts of this report to provide information on Main Ditch water losses. The report discusses water loss measurements along a segment of the ditch that resulted in an estimate of three percent loss for that segment. Later measurements by District staff, of the segment from Forebay Reservoir to the Blair Road crossing, resulted in an estimate of a nine percent loss at a 40 cfs flow for that section. The District used these values to estimate that at full deliveries to the Main Ditch, about 1,260 acre-feet per year would be lost in the section from Forebay Reservoir to Blair Road. Because the measurements didn't include the entire Main Ditch, the District indicated that the estimate understated the losses to an unknown degree.

4.2 The Westmark Group Septic System and Domestic Well Locations Report

The Westmark Group (Westmark) researched septic systems and wells for properties adjoining the Upper Main ditch in 2013 (Westmark, 2013). They reported that they researched file information at the El Dorado County Department of Environmental Management and California Department of Water Resources well records. Westmark indicated that they obtained seven well completion reports with five of these for parcels adjoining the Upper Main Ditch. The information on the reports was insufficient for locating the wells on the parcels. Westmark walked along the ditch alignment to identify surface structures that would indicate the likely presence of wells. They provided maps showing parcels and well locations in proximity to the Upper Main Ditch.

4.3 SAGE Engineers, Inc. Seepage Estimate

SAGE Engineers, Inc. (SAGE) prepared a memorandum presenting estimates of seepage loss for the Upper Main Ditch (SAGE, 2015). SAGE reviewed geologic maps and reports and the Jones and Stokes environmental assessment. They identified
locations along the Upper Main Ditch suitable for limited field exploration (percolation and permeability testing).

SAGE performed a geologic reconnaissance reporting fractured meta-sedimentary rocks from STA 1+00 to 4+50 (Pinewood Lane crossing). They reported the remainder of the Upper Main Ditch to be underlain by the Mehrten Formation.

SAGE excavated cylindrical holes 6 inches in diameter and from 12 to 18 inches deep in the bottom of the Upper Main Ditch. All holes were in locations previously described as being underlain by the Mehrten Formation. They placed a folding stick ruler and two inches of gravel in each hole before filling with water to a depth of 6 inches above the gravel. Falling head tests were performed by measuring the water level drop every 30 minutes and then refilling. Testing continued until three consecutive measurements did not vary by more than 1/8-inch.

The percolation rates ranged from 8 minutes per inch to 480 minutes per inch. SAGE used three methods to estimate hydraulic conductivity from percolation test data. The estimated hydraulic conductivities ranged from 1.5 centimeters per day (cm/day) to more than 50 cm/day.

SAGE collected five soil samples for permeability testing using ASTM Method D5084. The permeability measurements ranged from 0.02 cm/day to 15.38 cm/day.

An evapotranspiration (ET) study for forested terrain at the Blodgett Research Station near Georgetown was reviewed. SAGE estimated that in the summer months, the Main Ditch loses approximately 0.1 cubic feet per second (cfs) or ½ percent water loss due to ET.

In their review of the Jones and Stokes Study, SAGE indicated that losses of 0.8 cfs at an 18 cfs flow and 4 cfs at a 40 cfs flow were reported in 1977. The losses for the entire Main Ditch were estimated to be 1 cfs to 5.1 cfs (6 to 13 percent). SAGE discussed a flow measurement event that reported a 29 percent water loss. For that flow measurement event, the district reported the presence of multiple animal borrows, the largest of which were later filled with bentonite. Based on flow monitoring data from 2009 through 2014, annual water losses were estimated by SAGE to be in the range of from 10 percent to 20 percent.

Seepage modeling was performed using SEEP/W software by GEO-SLOPE. SAGE estimated that for 40 cubic feet per second (cfs) of flow the seepage loss ranged from 0.8 to 4.5 cfs (2 to 11 percent). For a 20 cfs flow, they estimated a seepage loss from 0.8 to 4.2 cfs (4 to 21 percent). SAGE concluded that, based on the available data, it appears that at flows of 40 cfs, on the order of 10 percent of the water that leaves the Forebay is lost.

4.4 Tully & Young, Inc. Main Ditch Loss Analysis
Tully & Young, Inc. prepared an analysis of Upper Main Ditch losses for EID. They evaluated the losses due to seepage and evapotranspiration. Their analysis included a review of past flow studies for the Upper Main Ditch and flow measurement data obtained by EID in 2016.
Tully & Young, Inc. applied flow data for water exiting the Forebay Reservoir and entering the Water Treatment Plant (WTP). Mathematical models were developed using the 2016 data. Ditch cross section geometry was assessed to develop estimated loss rates outside of the flow ranges for the 2016 data.

A curve was developed correlating percentage flow loss with flow rates. They then were able to create an analytical curve model that fits almost all of the previous flow-loss measurement data; this was then used to create a look-up table to estimate losses for historical monthly flow records for 2009 through 2015 for releases from Forebay Reservoir. The table prepared by Tully & Young, Inc. is presented below.

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<th>Year</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
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<td>174</td>
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<tr>
<td>December</td>
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<td>0</td>
<td>0</td>
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<td>Annual Loss</td>
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<td>1,611</td>
<td>2,143</td>
<td>2,165</td>
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<td>1,777</td>
</tr>
<tr>
<td>Total Supplied</td>
<td>11,585</td>
<td>8,289</td>
<td>6,998</td>
<td>7,318</td>
<td>12,048</td>
<td>8,663</td>
<td>5,437</td>
<td>8,620</td>
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<tr>
<td>Percent Loss</td>
<td>17%</td>
<td>21%</td>
<td>24%</td>
<td>22%</td>
<td>18%</td>
<td>22%</td>
<td>25%</td>
<td>21%</td>
</tr>
</tbody>
</table>

4.5 Youngdahl Consulting Group, Inc. Land Capability Study for Blair Road

In 2006 Youngdahl completed percolation testing to determine the feasibility of onsite wastewater disposal for a tentative map for a 28-lot subdivision. Thirty-one test pits were excavated to depths of from 6 feet to 12½ feet. The soils included loamy sand, silt loam, sandy clay loam, and silty clay loam. Many of the pits terminated in weathered rock described as volcanic ash with andesitic cobbles. The soils were described as being Cohasset Loam.

Percolation tests were performed by constructing four holes 6 to 7 inches in diameter approximately 12 inches deep in the sloping bottoms of each trench; at depths ranging from 24 inches to 63 inches. Perforated pipe – float gauge percolation test apparatus were installed in each hole with a pea gravel pack. The holes were filled with water to depths ranging from 8 to 13 inches and the rate of drop was measured in minutes per inch, with each hole being refilled as necessary.

The percolation rates were averaged for each of 28 test pits and ranged from 4 minutes per inch to 39 minutes per inch. The average percolation rate for the project was 9.9
minutes per inch. The median percolation rate was 6 minutes per inch. The geometric mean was 7.3 minutes per inch.

SAGE used a method developed by Amoozegar (1997) to estimate the hydraulic conductivities from the falling head percolation test data, with values estimated to range from 4 to 50 centimeters per day (cm/day). Using Figure 2 from the Amoozegar report, the Blair Road percolation test data indicates hydraulic conductivities ranging from 9 to 85 cm/day with a mean of 39 cm/day, somewhat exceeding the values estimated by SAGE. However the Blair Road percolation tests were performed next to a relatively localized segment of the Main Ditch and do not necessarily represent conditions along the entire Main Ditch. Additionally, the Blair Road percolation tests penetrated large soil profiles that likely differed from the conditions of testing performed for the Main Ditch. In general, both sets of testing supports that the soils beneath the Main Ditch are capable of relatively high infiltration rates.

5.0 DEPARTMENT OF WATER RESOURCES DRILLER’S REPORTS

In California, drillers are required to file Driller’s Reports with the California Department of Water Resources (DWR). These reports used to be confidential. In June of 2015, Section 13752 of the California Water Code was revised making these reports publicly available. However, there is still confidential information on these so the DWR has to redact some information prior to releasing the reports. On 19 February 2016, Youngdahl filed requests for all eight of the wells identified in the Westmark study. On 8 March 2016, Youngdahl received Driller’s Reports for five of the eight requested wells (Appendix B). DWR reported that no reports were available for three of the requested wells.

All Driller’s Reports for the study area show that the wells were drilled by air rotary methods. Air rotary drilling is performed by using compressed air to activate a downhole hammer equipped with a drill bit that is rotated as it is advanced into the ground. The compressed air clears the cuttings from the hole as it is advanced. The driller observes the cuttings and keeps a log of rock types, fractures, and water flows. Very few drillers are trained as geologists, so the reported lithology is very subjective.

In El Dorado County, in order to obtain a residential building permit, a water supply must be proven that can supply at least 5 gallons per minute (gpm) for four hours. When drilling wells to support a residence, well drilling customers usually have a goal of at least this much water flow. Drillers then usually conclude drilling a well with a four-hour airlift test to demonstrate that the well is capable of supplying the required amount of water. When a well is found to be incapable of supplying 5 gpm, the choice is either to drill deeper (at additional cost) or to make up the shortfall with storage. For example, a system with a 4 gpm well can achieve the 5 gpm requirement by using a storage tank that takes more than 4 hours to fill but will then provide the requisite 5 gpm for four hours.
Table 3 – Summary of Driller’s Reports

<table>
<thead>
<tr>
<th>*Well No.</th>
<th>El Dorado County Assessor’s Parcel Number</th>
<th>Domestic Water Well (CA DWR Records)</th>
<th>Total Depth (feet)</th>
<th>Final Airlift Yield (gpm)</th>
<th>Driller’s Reported Lithology</th>
<th>Static Water Level (feet)</th>
<th>First Water Level (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>101-240-33-100</td>
<td>Yes</td>
<td>200</td>
<td>17</td>
<td>34-162 feet: hard cemented gravel 162-200 feet: hard diorite Fractures: 87, 125, 162 feet</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>101-220-08-100</td>
<td>Yes</td>
<td>360</td>
<td>34</td>
<td>22-169 feet: Gray lava with fractures 169-360 feet: gray granite with fractures</td>
<td>47</td>
<td>49</td>
</tr>
<tr>
<td>3</td>
<td>101-220-17-100</td>
<td>No</td>
<td>380</td>
<td>8</td>
<td>46-224 feet: Gray lava 225-380: Granite Fractures: 224, 317, 336, 352 feet</td>
<td>143</td>
<td>224</td>
</tr>
<tr>
<td>5</td>
<td>101-030-12-100</td>
<td>No</td>
<td>360</td>
<td>15+</td>
<td>28-93 feet: Soft gray lava 93-300 feet: Hard gray lava Fractures: 122, 155, 238, 253, 268 feet</td>
<td>103</td>
<td>Not reported</td>
</tr>
</tbody>
</table>

* Refers to well numbers on Figure 2

6.0 RAINFALL AND EVAPOTRANSPIRATION

Youngdahl reviewed California Department of Water Resources California Data Exchange Center records for the weather station at Sly Park (south of Pollock Pines) for the years 1986 through 2015 (30 years). The California Irrigation Management Information System (CIMIS) was accessed for information from the Camino station to obtain evapotranspiration data. The data is provided in Table 4.

Table 4 – Estimated Average Rainfall and Evapotranspiration

<table>
<thead>
<tr>
<th>Month</th>
<th>Average Rainfall (inches)</th>
<th>Average Evapotranspiration (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>7.62</td>
<td>1.55</td>
</tr>
<tr>
<td>February</td>
<td>7.72</td>
<td>1.94</td>
</tr>
<tr>
<td>March</td>
<td>7.38</td>
<td>3.26</td>
</tr>
<tr>
<td>April</td>
<td>4.11</td>
<td>4.54</td>
</tr>
<tr>
<td>May</td>
<td>3.01</td>
<td>6.12</td>
</tr>
<tr>
<td>June</td>
<td>0.75</td>
<td>7.78</td>
</tr>
<tr>
<td>July</td>
<td>0.03</td>
<td>8.89</td>
</tr>
<tr>
<td>August</td>
<td>0.04</td>
<td>8.19</td>
</tr>
<tr>
<td>September</td>
<td>0.66</td>
<td>6.08</td>
</tr>
<tr>
<td>October</td>
<td>2.49</td>
<td>3.96</td>
</tr>
<tr>
<td>November</td>
<td>4.58</td>
<td>1.94</td>
</tr>
<tr>
<td>December</td>
<td>7.59</td>
<td>1.32</td>
</tr>
<tr>
<td>Totals</td>
<td>46.0</td>
<td>55.57</td>
</tr>
</tbody>
</table>
Annual rainfall amounts ranged from 14.4 inches in 2013 to 72.9 inches in 1998.

7.0 GROUNDWATER RECHARGE ESTIMATES

Rainfall that impacts the ground typically follows multiple paths and undergoes various fates. Some infiltrates into the ground, some runs off as sheet flow into drainage channels and streams, and some evaporates back into the air. For groundwater recharge, Freeze and Cherry (1979) provide the following relationship:

\[ P = Q_s + R + E_r \]

- \( P \) is the average annual precipitation;
- \( Q_s \) is the surface-water component of the average annual runoff;
- \( R \) is the average annual groundwater recharge; and
- \( E_r \) is the average annual evapotranspiration from the recharge area.

Youngdahl estimated the average monthly and average annual rainfall and evapotranspiration. However, rainfall is lost to evapotranspiration only when the water is available. When the near surface soil moisture content is low, such as in the summer months, there is little near surface water to lose to evapotranspiration.

Runoff is difficult to estimate without stream gauges or other measurement devices. For hillslope hydrology and streamflow generation, Freeze and Cherry (1979) refer to field studies that indicate that:

*Overland flow is a relatively rare occurrence in time and space, especially in humid, vegetated basins. Most overland-flow hydrographs originate from small portions of the watershed that constitute no more than 10 percent, and often as little as 1 to 3 percent of the basin area, and even on these restricted areas, only 10 to 30 percent of the rainfalls cause overland flow.*

Some of the rainfall infiltration resurfaces due to subsurface stormflow. Freeze and Cherry (1979) discuss that subsurface stormflow can become a quantitatively significant runoff component only on convex hillslopes that feed deeply incised channels, and then only when the permeabilities of the soils in the hillslope are in the very highest bracket of the feasible range.

The amount of rainfall that recharges groundwater can be expressed as a ratio. Donovan, Katzer, and Brothers (2009), use the term Recharge Coefficient for this ratio.

The estimated area of groundwater recharge for the Main Ditch and domestic water well supplied parcels is bounded by the ridge top in Pollock Pines, the North Fork of Long Canyon to the east, a ridge above Iowa Canyon to the west, and roughly paralleling the north side of the Upper Main Ditch (Figure 1). This represents approximately 675 acres.

Youngdahl converted the estimated Main Ditch infiltration into estimated equivalent rainfall in inches based on the extent of the recharge area. Water balances were estimated as follows:
1) Tulley & Young, Inc. estimated that an annual average of 1,777 acre-feet of water can be lost (see Table 2 above).
2) The average rainfall was estimated minus 10 percent and 30 percent runoff per Freeze and Cherry (1979).
3) The evapotranspiration (Eto) was adjusted to potential evapotranspiration (PET) for both 10 percent and 30 percent runoff based on the availability of rainfall and near surface water.
4) The remaining rainfall was assumed to contribute to groundwater recharge at the 10 percent and 30 percent rainfall runoff values.
5) The average annual contribution of the Main Ditch losses due to infiltration was added to the estimated rainfall recharge to provide estimates of groundwater recharge in an average rainfall year.

Table 6 – Estimated Groundwater Recharge

<table>
<thead>
<tr>
<th>Month</th>
<th>Average Ditch Infiltration Inches Rainfall Equivalent</th>
<th>Average Inches Rainfall</th>
<th>Potential Eto (PET) Inches</th>
<th>Inches Rainfall at 10% Runoff</th>
<th>Inches Rainfall at 30% Runoff</th>
<th>Inches PET at 10% Runoff</th>
<th>Inches PET at 30% Runoff</th>
<th>Inches Infiltration at 10% Runoff</th>
<th>Inches Infiltration at 30% Runoff</th>
<th>Plus ditch (inches)</th>
<th>30% Runoff Plus Ditch</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>1.96</td>
<td>6.86</td>
<td>7.62</td>
<td>6.86</td>
<td>1.55</td>
<td>1.55</td>
<td>5.31</td>
<td>3.79</td>
<td>7.27</td>
<td>5.74</td>
<td></td>
</tr>
<tr>
<td>February</td>
<td>2.37</td>
<td>6.95</td>
<td>7.72</td>
<td>6.95</td>
<td>1.94</td>
<td>1.94</td>
<td>5.01</td>
<td>3.47</td>
<td>7.38</td>
<td>5.84</td>
<td></td>
</tr>
<tr>
<td>March</td>
<td>2.93</td>
<td>6.65</td>
<td>7.38</td>
<td>6.65</td>
<td>3.26</td>
<td>3.26</td>
<td>3.99</td>
<td>1.91</td>
<td>6.31</td>
<td>4.83</td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>3.31</td>
<td>3.70</td>
<td>4.11</td>
<td>3.70</td>
<td>2.88</td>
<td>2.88</td>
<td>0.00</td>
<td>0.00</td>
<td>3.31</td>
<td>3.31</td>
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</tr>
<tr>
<td>May</td>
<td>3.95</td>
<td>2.70</td>
<td>3.01</td>
<td>2.70</td>
<td>2.10</td>
<td>2.10</td>
<td>0.00</td>
<td>0.00</td>
<td>3.95</td>
<td>3.95</td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>4.31</td>
<td>0.68</td>
<td>0.75</td>
<td>0.68</td>
<td>0.53</td>
<td>0.53</td>
<td>0.00</td>
<td>0.00</td>
<td>4.31</td>
<td>4.31</td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>4.34</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.02</td>
<td>0.02</td>
<td>0.00</td>
<td>0.00</td>
<td>4.34</td>
<td>4.34</td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>4.31</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.03</td>
<td>0.03</td>
<td>0.00</td>
<td>0.00</td>
<td>4.31</td>
<td>4.31</td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>4.13</td>
<td>0.59</td>
<td>0.66</td>
<td>0.59</td>
<td>0.46</td>
<td>0.46</td>
<td>0.00</td>
<td>0.00</td>
<td>4.13</td>
<td>4.13</td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>0.00</td>
<td>2.24</td>
<td>2.49</td>
<td>2.24</td>
<td>1.74</td>
<td>1.74</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>0.00</td>
<td>4.12</td>
<td>4.58</td>
<td>4.12</td>
<td>1.94</td>
<td>1.94</td>
<td>2.18</td>
<td>1.27</td>
<td>2.18</td>
<td>1.27</td>
<td></td>
</tr>
<tr>
<td>December</td>
<td>0.00</td>
<td>6.83</td>
<td>7.59</td>
<td>6.83</td>
<td>1.32</td>
<td>1.32</td>
<td>5.51</td>
<td>4.00</td>
<td>5.51</td>
<td>4.00</td>
<td></td>
</tr>
<tr>
<td>Annual</td>
<td>31.6</td>
<td>46.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21.40</td>
<td>14.4</td>
<td>53.0</td>
<td>46.0</td>
</tr>
</tbody>
</table>

At some point during recharge the soil absorbs infiltrating water. This becomes available stored water that does not contribute to recharge. The Cohasset loam is reported to have approximately 6.9 inches of water storage holding capacity. This was subtracted from the rainfall recharge estimates to represent evapotranspiration by plant uptake during the dry season.
Table 7 - Estimated Groundwater Recharge Totals
Adjusted for Soil Water Holding Capacity

<table>
<thead>
<tr>
<th>Inches of Recharge</th>
<th>Average Rainfall Infiltration at 30% Runoff (inches)</th>
<th>Average Rainfall Infiltration at 10% Runoff (inches)</th>
<th>Main Ditch Infiltration at 1.777 acre-feet per year (inches)</th>
<th>Average Total Infiltration at 30% runoff per year (inches)</th>
<th>Average Total Infiltration at 10% runoff per year (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5</td>
<td>14.5</td>
<td>31.6</td>
<td>39.1</td>
<td>46.1</td>
<td>2,593</td>
</tr>
<tr>
<td>816</td>
<td>816</td>
<td>1,777</td>
<td>2,199</td>
<td>2,593</td>
<td></td>
</tr>
</tbody>
</table>

The estimated average groundwater recharge from rainfall for the 675-acre area ranges from 423 acre-feet to 816 acre-feet per year. When the estimated infiltration from the Main Ditch losses are added in, the range of groundwater recharge for an average rainfall year at the average estimated Main Ditch loss of 1,777 acre-feet is from 2,199 to 2,593 acre-feet per year. The estimated ratio of natural groundwater recharge (excluding ditch loss contributions) to total rainfall ranges from 0.16 to 0.32 for the study area.

The removal of the Main Ditch infiltration of an average of 1,777 acre-feet from the total of 2,199 acre-feet per year (average ditch loss plus average rainfall recharge at 30% runoff) would reduce groundwater recharge by approximately 81 percent.

Comparison with Other Groundwater Recharge Estimates

Donavan, Katzer, and Brothers (2009) completed a review of ground-water recharge estimates in Nevada. They reviewed older methods where recharge to rainfall ratios are indexed to amounts of precipitation. They reported recharge to rainfall ratios as low as zero for less than eight inches of annual precipitation ranging to more than 0.25 for more than 20 inches of annual precipitation using the Maxey-Eakin Method. For the more recent Southern Nevada Water Authority method, they reported a value of 0.45 for more than 20 inches of precipitation.

Bartolino (2007) performed an assessment of areal recharge to the Spokane Valley-Rathdrum Prairie Aquifer in Washington and Idaho. As part of this work, he estimated recharge ratios for four different methods and for several locations. Two of the methods are based on crop consumptive use and would not applicable to the Pollock Pines area. One method (The Langbein method) estimates recharge on the basis of empirical data from basins. Bartolino reported the Langbein method to estimate recharge at 4 percent of mean annual precipitation. The other method, the Eastern Snake River Plain Aquifer methods (ESPAM) uses recharge calculations on a basis of precipitation-recharge relations from other basins. The ESPAM method has parameters for lava-rock, thin soil, and thick soil. The thin soil relation is probably closest to the conditions in Pollock Pines. The ESPAM method estimated recharge ranging from 10 to 29 percent on a mean monthly basis and from 16 to 23 percent of mean annual precipitation. This later estimate is closer to our estimate for Pollock Pines.

The estimated groundwater recharge from precipitation for the Pollock Pines area by this study falls within the ranges of estimates of Bartolino (2007) for the Spokane Valley-Rathdrum Prairie Aquifer in Washington and Idaho using the ESPAM method and below the ranges of estimates of Donavan, Katzer, and Brothers (2009) for more than 20 inches of annual precipitation.
8.0 CONSUMPTION VIA WELLS

There are eight wells in the study area. The District's 2016 Water Resources and Service Reliability Report indicates that annual consumption in the eastern part of the services area, including Pollock Pines, is about 0.35 acre-feet per year per single-family residential unit. For eight wells, this would indicate an average consumption of 2.8 acre-feet per year.

Where there is data on the lithology for the wells, all wells were reported to be in fractures at the completion of drilling. Only one of the five Driller's Report reviewed reported gravels, but was reported to be hard cemented gravel. Where drillers reported diorite or granite, this is most likely the gneiss of the Shoo-Fly formation, which often appears to have a granular texture similar to granitoid rocks. Where gray lava is reported, this is most likely either andesitic lava flows or cemented andesitic mud flows of the Mehrten Formation. The hard cemented gravel reported in one well is probably cemented volcanic mud flow breccia of the Mehrten Formation.

The five well depths ranged from 200 to 380 feet. The depths of first water reported by the drillers ranged from 30 to 335 feet. The static water levels reported at the completion of drilling ranged from 30 to 180 feet.

It is likely that all of the wells are drawing their water from fractured rock reservoirs. Freeze and Cherry (1979) report hydraulic conductivity values of from approximately 0.05 gallons per day per square foot to 1,000 gallons per day per square foot for fractured igneous and metamorphic rock. The well yields based on 4-hour airlift tests ranged from 8 to 34 gpm. The hydraulic conductivities of the fractured aquifers are likely to be in the middle of the typical range for fractured rock.

Well yields based on airlift testing aren't always representative of long term well performance. Fractured rock aquifers commonly have a geometry defined by the rock lithology, fracture orientations, and fracture density. It is common for a well to penetrate a fractured rock aquifer with a limited lateral extent. Once the localized supply of groundwater is depleted, the yield of the well can drop off dramatically. This can take years to reach that point, but is most common when a significant leak in a water supply line is undetected or when a large amount of water is used, such as for irrigation or the filling of a swimming pool. At that point, well owners may see a dramatic drop off in the production capacity of their well.

The reverse situation can occur when a driller has penetrated fractures yielding an inadequate amount of water and shuts down for the night. If the water rises substantially in the boring overnight, it can fill previously dry fractures. Upon resuming drilling the following day, the driller will measure a larger yield of water than when he stopped the previous day. If he quickly penetrates additional fractures, they may mistake the additional yield as coming from those fractures. Such a well may pass a 4-hour airlift test but prove inadequate for long term use.

Other conditions can impact a wells long term performance. These conditions can include a well with an inadequate upper seal, which can allow sediment to collect at the bottom. Also, some wells experience bio-fouling where bacterial mats grow and plug well screens.
9.0 FINDINGS AND CONCLUSIONS
The average annual recharge from rainfall and Upper Main Ditch losses for the 675 acre study area is from 2,199 to 2,593 acre-feet per year. The estimated average groundwater recharge from only rainfall for the 675-acre area ranges from 423 acre-feet to 816 acre-feet per year. The Upper Main Ditch Pipeline project has the potential to remove approximately 81 percent of the average groundwater recharge in the study area. The current groundwater consumption in this area is approximately 2.8 acre-feet per year; 0.11 to 0.13 percent of the average total annual recharge or approximately 0.34 to 0.66 percent of the recharge from only rainfall. In our opinion, natural recharge is capable of sustaining adequate groundwater resources for the current rates of consumption using wells.

The rainfall and evapotranspiration estimates are conservative in that both Camino and Sly Park are at lower elevations that Pollock Pines. The rainfall at Sly Park is likely to be less than that for Pollock Pines and the evapotranspiration is likely to be greater at Camino.

There remains a small potential for localized conditions to result in an adverse impact to a well, especially those wells that are very near to the Main Ditch.

10.0 LIMITATIONS
This groundwater resource study has been prepared for the sole use of the El Dorado Irrigation District and its agents, specifically for estimating groundwater recharge for the Upper Main Ditch Pipeline Project. The estimates of groundwater recharge are based upon information provided by the El Dorado Irrigation District, review of the listed literature, data obtained from State of California websites, and professional opinion. Youngdahl is not responsible for the data and methods presented by others.

The information provided in this study is valid for a period of three years from the date of the study. Conditions may arise that were not apparent at the time of this study. In addition, changes in the applicable standard of practice can occur, whether from legislation or the broadening of knowledge. Accordingly, the information provided in this study may be invalidated, wholly or partially, by changes outside of our control. Should changes occur that might affect the findings and recommendations presented herein, Youngdahl Consulting Group, Inc. should be notified to evaluate the validity of this technical information to those changes. This document may not be reproduced for any other reason than pertains to the project for which it was prepared.

11.0 REFERENCES

Figures
Appendix A
Natural Resources Conservation Service Reports
The soil surveys that comprise your AOI were mapped at 1:20,000. Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Dorado Area, California
Survey Area Data: Version 7, Sep 15, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 14, 2011—Oct 30, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.
### Map Unit Legend

<table>
<thead>
<tr>
<th>Map Unit Symbol</th>
<th>Map Unit Name</th>
<th>Acres in AOI</th>
<th>Percent of AOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>CmC</td>
<td>Cohasset loam, 9 to 15 percent slopes</td>
<td>288.9</td>
<td>39.1%</td>
</tr>
<tr>
<td>CmD</td>
<td>Cohasset loam, 15 to 30 percent slopes</td>
<td>228.8</td>
<td>31.0%</td>
</tr>
<tr>
<td>ImE</td>
<td>Iron Mountain very rocky sandy loam, 3 to 50 percent slopes</td>
<td>0.7</td>
<td>0.1%</td>
</tr>
<tr>
<td>JrC</td>
<td>Josephine gravelly loam, 9 to 15 percent slopes</td>
<td>13.9</td>
<td>1.9%</td>
</tr>
<tr>
<td>JsE</td>
<td>Josephine very rocky loam, 15 to 50 percent slopes</td>
<td>50.4</td>
<td>6.8%</td>
</tr>
<tr>
<td>JIC</td>
<td>Josephine silt loam, 5 to 15 percent slopes</td>
<td>0.2</td>
<td>0.0%</td>
</tr>
<tr>
<td>McE</td>
<td>Mariposa-Josephine very rocky loams, 15 to 50 percent slopes</td>
<td>31.0</td>
<td>4.2%</td>
</tr>
<tr>
<td>MhE</td>
<td>McCarthy cobbly loam, 9 to 50 percent slopes</td>
<td>100.5</td>
<td>13.6%</td>
</tr>
<tr>
<td>W</td>
<td>Water</td>
<td>23.9</td>
<td>3.2%</td>
</tr>
<tr>
<td><strong>Totals for Area of Interest</strong></td>
<td></td>
<td><strong>738.3</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>
Saturated Hydraulic Conductivity (Ksat)—El Dorado Area, California
(EID Upper Main Ditch)

MAP LEGEND

Area of Interest (AOI)

Soils

Soil Rating Polygons

Transportation

Background

Soil Rating Lines

Soil Rating Points

Water Features

Background

Streams and Canals

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service


Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Dorado Area, California

Survey Area Data: Version 7, Sep 15, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 14, 2011—Oct 30, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.
# Saturated Hydraulic Conductivity (Ksat)

<table>
<thead>
<tr>
<th>Map unit symbol</th>
<th>Map unit name</th>
<th>Rating (micrometers per second)</th>
<th>Acres in AOI</th>
<th>Percent of AOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>AfC</td>
<td>Aiken loam, 9 to 15 percent slopes</td>
<td>7.1150</td>
<td>43.5</td>
<td>1.4%</td>
</tr>
<tr>
<td>AfC2</td>
<td>Aiken loam, 9 to 15 percent slopes, eroded</td>
<td>6.4701</td>
<td>0.5</td>
<td>0.0%</td>
</tr>
<tr>
<td>AfD</td>
<td>Aiken loam, 15 to 30 percent slopes</td>
<td>7.1150</td>
<td>65.5</td>
<td>2.1%</td>
</tr>
<tr>
<td>AgD</td>
<td>Aiken cobble loam, 3 to 30 percent slopes</td>
<td>7.1150</td>
<td>16.2</td>
<td>0.5%</td>
</tr>
<tr>
<td>CmB</td>
<td>Cohasset loam, 3 to 9 percent slopes</td>
<td>8.3079</td>
<td>4.3</td>
<td>0.1%</td>
</tr>
<tr>
<td>CmC</td>
<td>Cohasset loam, 9 to 15 percent slopes</td>
<td>8.3079</td>
<td>521.7</td>
<td>16.7%</td>
</tr>
<tr>
<td>CmD</td>
<td>Cohasset loam, 15 to 30 percent slopes</td>
<td>8.3079</td>
<td>360.2</td>
<td>11.5%</td>
</tr>
<tr>
<td>CoC</td>
<td>Cohasset cobble loam, 3 to 15 percent slopes</td>
<td>8.3079</td>
<td>0.4</td>
<td>0.0%</td>
</tr>
<tr>
<td>CoE</td>
<td>Cohasset cobble loam, 15 to 50 percent slopes</td>
<td>8.3079</td>
<td>28.1</td>
<td>0.9%</td>
</tr>
<tr>
<td>ImE</td>
<td>Iron Mountain very rocky sandy loam, 3 to 50 percent slopes</td>
<td>39.5366</td>
<td>143.6</td>
<td>4.6%</td>
</tr>
<tr>
<td>JrC</td>
<td>Josephine gravelly loam, 9 to 15 percent slopes</td>
<td>9.0000</td>
<td>77.2</td>
<td>2.5%</td>
</tr>
<tr>
<td>JsE</td>
<td>Josephine very rocky loam, 15 to 50 percent slopes</td>
<td>9.0000</td>
<td>85.9</td>
<td>2.8%</td>
</tr>
<tr>
<td>JIC</td>
<td>Josephine silt loam, 5 to 15 percent slopes</td>
<td>4.4858</td>
<td>133.1</td>
<td>4.3%</td>
</tr>
<tr>
<td>JuE</td>
<td>Josephine very rocky silt loam, 9 to 50 percent slopes</td>
<td>9.0000</td>
<td>278.1</td>
<td>8.9%</td>
</tr>
<tr>
<td>MaD</td>
<td>Mariposa gravelly silt loam, 3 to 30 percent slopes</td>
<td>7.8434</td>
<td>99.3</td>
<td>3.2%</td>
</tr>
<tr>
<td>MbE</td>
<td>Mariposa very rocky silt loam, 3 to 50 percent slopes</td>
<td>7.8434</td>
<td>80.1</td>
<td>2.6%</td>
</tr>
<tr>
<td>MbF</td>
<td>Mariposa very rocky silt loam, 50 to 70 percent slopes</td>
<td>7.8434</td>
<td>25.7</td>
<td>0.8%</td>
</tr>
</tbody>
</table>
## Description

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ksat values have been grouped according to standard Ksat class limits.

## Rating Options

- **Units of Measure:** micrometers per second
- **Aggregation Method:** Dominant Component
- **Component Percent Cutoff:** None Specified
- **Tie-break Rule:** Slowest
- **Interpret Nulls as Zero:** No
- **Layer Options (Horizon Aggregation Method):** Depth Range (Weighted Average)
  - **Top Depth:** 0
  - **Bottom Depth:** 50
- **Units of Measure:** Inches

---

<table>
<thead>
<tr>
<th>Map unit symbol</th>
<th>Map unit name</th>
<th>Rating (micrometers per second)</th>
<th>Acres in AOI</th>
<th>Percent of AOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>McE</td>
<td>Mariposa-Josephine very rocky loams, 15 to 50 percent slopes</td>
<td>7.8434</td>
<td>330.5</td>
<td>10.6%</td>
</tr>
<tr>
<td>MhE</td>
<td>McCarthy cobbled loam, 9 to 50 percent slopes</td>
<td>25.4028</td>
<td>726.2</td>
<td>23.3%</td>
</tr>
<tr>
<td>MrD</td>
<td>Musick sandy loam, 15 to 30 percent slopes</td>
<td>10.4622</td>
<td>6.8</td>
<td>0.2%</td>
</tr>
<tr>
<td>SkD</td>
<td>Sites loam, 15 to 30 percent slopes</td>
<td>5.3291</td>
<td>15.9</td>
<td>0.5%</td>
</tr>
<tr>
<td>SrE</td>
<td>Sites very rocky loam, 15 to 50 percent slopes</td>
<td>5.3291</td>
<td>52.1</td>
<td>1.7%</td>
</tr>
<tr>
<td>W</td>
<td>Water</td>
<td></td>
<td>24.1</td>
<td>0.8%</td>
</tr>
<tr>
<td><strong>Totals for Area of Interest</strong></td>
<td></td>
<td><strong>3,119.1</strong></td>
<td><strong>100.0%</strong></td>
<td></td>
</tr>
</tbody>
</table>
Appendix B
Water Well Driller's Reports
February 24, 2016

Mr. Dave Sederquist
Youngdahl Consulting Group, Inc.
1234 Glenhaven Court
El Dorado Hills, CA 95762

Dear Mr. Sederquist:

In response to your request, enclosed is a copy of the Well Completion Report for the well for the following location:

3000 Stellar Lane, Pollock Pines, CA; El Dorado County
WCR: #746450
The well was located using the following: APN, address.

If you need additional information or have any questions, please contact Steven Reichmuth at (916) 376-9612 or fax (916) 376-9676.

Sincerely,

Jeremiah Shaffer, P.E., Chief
Groundwater Supply Assessment and Special Studies Section

Enclosures
WELL COMPLETION REPORT

Date Work Began: 10-16-99  
Date Work Ended: 10-16-99

Owner's Well No. 746450  
Permit No. 1912  
Permit Date: 9-27-99

File with DWR WELL COMPLETION REPORT

WELL LOCATION

Address: 3000 Stellar Lane
City: Pollock Pines, CA. 956
County: El Dorado
APN Book: 101 Page 240 Parcel 331
Township: Range Section
Latitude: North Longitude

WATER LEVEL & YIELD OF COMPLETED WELL

Depth to first water: 30 (ft) below surface
Depth of static water level: 30 (ft) & date measured 10-16-99
Estimated yield: 17 (gpm) & test type: Air lift
Test length: 4 (hrs) total drawdown: (ft)

Depth of completed well: 200 (feet)

Geologic Log

 fractures: 87, 125, 162

GEOLOGIC LOG

<table>
<thead>
<tr>
<th>ORIENTATION (°)</th>
<th>ROTARY AIR FLUID</th>
</tr>
</thead>
<tbody>
<tr>
<td>VERTICAL</td>
<td>WATER</td>
</tr>
<tr>
<td>HORIZONTAL</td>
<td>WATER</td>
</tr>
<tr>
<td>DEGREE OF ANGLE</td>
<td>WATER</td>
</tr>
</tbody>
</table>

* May not be representative of a well's long-term yield.

CARTOGRAPHER'S SIGNATURE

CARTOGRAPHER'S CERTIFICATION

Robert Dawson Drilling & Pumps

P.O. Box 1021 Shingle Springs, CA. 95682

REV. 11-97

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

ORIGINAL

File with DWR

Page 1 of 1

Owner's Well No. D9468

Date Work Began

Local Permit Agency: El Dorado Environmental Management

Name

Mailing

WELL OWNER

Address

City

County

APN Book

Township

Range

Section

Latitude

Longitude

Creation of this report is complete and accurate to the best of my knowledge and belief.

Robert Dawson Drilling & Pumps

P.O. Box 1021 Shingle Springs, CA. 95682

If additional space is needed, use next consecutively numbered form.

DWR USE ONLY - DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE

LONGITUDE

APN/OTHER

ATTRACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME

PERSON, FIRM, OR CORPORATION (TYPE OR PRINTED)

ADDRESS

CITY

STATE

ZIP

Signature

WELL DRILLER AUTHORIZED REPRESENTATIVE

DATE ISSUED

C-3 LICENSE NUMBER
February 24, 2016

Mr. Dave Sederquist  
Youngdahl Consulting Group, Inc.  
1234 Glenhaven Court  
El Dorado Hills, CA 95762

Dear Mr. Sederquist:

In response to your request, enclosed is a copy of the Well Completion Report for the well for the following location:

3000 Balsam Drive, Pollock Pines, CA; El Dorado County  
WCR: #473903  
The well was located using the following: APN, WCR location information.

If you need additional information or have any questions, please contact Steven Reichmuth at (916) 376-9612 or fax (916) 376-9676.

Sincerely,

Jeremiah Shaffer, P.E., Chief  
Groundwater Supply Assessment and Special Studies Section

Enclosures
WELL COMPLETION REPORT

Owner's Well No. 4-21
Date Work Began 4-21, Ended 4-22

LOCAL PERMIT AGENCY: El Dorado Environmental
Permit No. 3527, Permit Date 04-20-94

GEOLOGIC LOG

DEPTH FROM SURFACE

0 - 22 ft. Red Clay
22 - 43 ft. Gray Lava
43 - 111 ft. Ex/2 Gray Lava w/ Granite
111 - 163 ft. Ex/3 Granite
163 - 244 ft. Ex/4 Granite
244 - 280 ft. Ex/5 Granite
280 - 285 ft. Ex/6 Granite
285 - 304 ft. Ex/7 Granite
304 - 325 ft. Ex/8 Granite
325 - 360 ft. Gr/Granite

TOTAL DEPTH OF BORING: 360 ft.
TOTAL DEPTH OF COMPLETED WELL: 360 ft.

WELL LOCATION

Address: Placerville, CA
County: El Dorado
APN Book: 104, Page: 220-08
Township: 11T, Range: 12E, Section: 36

DEG. MIN. SEC. DEG. MIN. SEC.
WEST NORTH

ACTIVITY (L)

NEW WELL MODIFICATION/REPAIR

DESTROY (Describe Procedures and Materials under "GEOLOGIC LOG")

PLANNED USE(S)

WATER SUPPLY

Domestic
Public
Irrigation
Industrial
"TEST WELL"
CATHODIC PROTECTION
OTHER (Specify)

SOUTH

MONITORING

Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc.

PLEASE BE ACCURATE & COMPLETE.

DRILLING METHOD

Air Rotary

FLUID WATER

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL: 47 ft. & DATE MEASURED: 4-22
ESTIMATED YIELD: 3.4 GPM & TEST TYPE: Air Lift
TEST LENGTH: 4 ft., TOTAL DRAWDOWN: 360 ft.

May not be representative of a well's long-term yield.

CASING(S)

DEPTH FROM SURFACE

BRE-HOLE DIA. (Inches)

110

40

0

0.280

0.360

0.360

40

110

60

0

0.280

0.360

4

4

CASING TYPE

PVC

PVC

PVC

PVC

INTERNAL DIAMETER (Inches)

6

6

4

4

GUAGE OR WALL THICKNESS (Inches)

F480

F480

116

116

SLOT SIZE (Inches)

ANNULAR MATERIAL

DEPTH FROM SURFACE

BRE-HOLE DIA. (Inches)

40

0

0.280

0.360

40

110

60

0

0.280

0.360

4

4

CASING TYPE

PVC

PVC

PVC

PVC

INTERNAL DIAMETER (Inches)

6

6

4

4

GUAGE OR WALL THICKNESS (Inches)

F480

F480

116

116

SLOT SIZE (Inches)

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME

ADDRESS

PLACERVILLE, CA 95667

STATE ZIP

4-22-94

457342

DEGREE MIN. SEC.

DWR 188 REV. 7-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM
February 24, 2016

Mr. Dave Sederquist
Youngdahl Consulting Group, Inc.
1234 Glenhaven Court
El Dorado Hills, CA 95762

Dear Mr. Sederquist:

Based on the information provided, we are unable to locate a Well Completion Report for:

2900 Red Hood Trail, Pollock Pines, CA; El Dorado County
APN: 101-220-17

If you need additional information or have any questions, please contact Steven Reichmuth at (916) 376-9612 or fax (916) 376-9676.

Sincerely,

Jeremiah Shaffer, P.E., Chief
Groundwater Supply Assessment and Special Studies Section

Enclosures
February 24, 2016

Mr. Dave Sederquist
Youngdahl Consulting Group, Inc.
1234 Glenhaven Court
El Dorado Hills, CA 95762

Dear Mr. Sederquist:

In response to your request, enclosed is a copy of the Well Completion Report for the well for the following location:

2890 Red Hook Trail, Pollock Pines, CA; El Dorado County
WCR: #704072
The well was located using the following: APN, WCR location information.

If you need additional information or have any questions, please contact Steven Reichmuth at (916) 376-9612 or fax (916) 376-9676.

Sincerely,

Jeremiah Shaffer, P.E., Chief
Groundwater Supply Assessment and Special Studies Section

Enclosures
**WELL COMPLETION REPORT**

**STATE OF CALIFORNIA**

**OWNER**

**Page** 1 of 2

**Owner's Well No.:**

**Date Work Began:** 7-5-98, **Ended:** 7-5-98

**Local Permit Agency:** El Dorado

**Permit No.:** 904072

**File with DWR**

**Page:** 1 of 2

---

**ORIENTATION (V)-vertical, HORIZONTAL -angle (specify)**

**DEPTH TO FIRST WATER** 224 ft. below surface

<table>
<thead>
<tr>
<th>DEPTH FROM SURFACE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 4</td>
<td>Topsoil</td>
</tr>
<tr>
<td>4 - 46</td>
<td>Red Clay</td>
</tr>
<tr>
<td>46 - 224</td>
<td>Gray Lava</td>
</tr>
<tr>
<td>224 - 317</td>
<td>Gran Granite</td>
</tr>
<tr>
<td>317 - 335</td>
<td>GR Gran</td>
</tr>
<tr>
<td>335 - 336</td>
<td>GR Gran</td>
</tr>
<tr>
<td>336 - 362</td>
<td>GR Gran</td>
</tr>
<tr>
<td>362 - 380</td>
<td>Hard GR Gran</td>
</tr>
</tbody>
</table>

**TOTAL 8 GPM.**

**TOTAL DEPTH OF BORING** 380 ft.

**TOTAL DEPTH OF COMPLETED WELL** 380 ft.

**DEEP LOG**

<table>
<thead>
<tr>
<th>DEPTH FROM SURFACE</th>
<th>BORE HOLE DIA. (inches)</th>
<th>CASING(S)</th>
<th>ANNUAL MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>60</td>
<td>PVC 6</td>
<td>11</td>
</tr>
<tr>
<td>200</td>
<td>300</td>
<td>PVC 4</td>
<td>125</td>
</tr>
</tbody>
</table>

**CERTIFICATION**

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

**ARROW WELL DRILLING**

P.O. Box 523

Placerville, CA 95667

**Signed**

**WELL DRILLER AUTHORIZED REPRESENTATIVE**

**DATE SIGNED**

**CERTIFICATION STATEMENT**

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

**ARROW WELL DRILLING**

P.O. Box 523

Placerville, CA 95667

**Signed**

**WELL DRILLER AUTHORIZED REPRESENTATIVE**

**DATE SIGNED**

**CERTIFICATION STATEMENT**

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

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P.O. Box 523

Placerville, CA 95667

**Signed**

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P.O. Box 523

Placerville, CA 95667

**Signed**

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**DATE SIGNED**

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I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

**ARROW WELL DRILLING**

P.O. Box 523

Placerville, CA 95667

**Signed**

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**DATE SIGNED**

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I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

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P.O. Box 523

Placerville, CA 95667

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Placerville, CA 95667

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P.O. Box 523

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Placerville, CA 95667

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Placerville, CA 95667

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**CERTIFICATION STATEMENT**

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February 24, 2016

Mr. Dave Sederquist  
Youngdahl Consulting Group, Inc.  
1234 Glenhaven Court  
El Dorado Hills, CA 95762

Dear Mr. Sederquist:

Based on the information provided, we are unable to locate a Well Completion Report for:

2501 Blair Road, Pollock Pines, CA; El Dorado County  
APN: 101-030-12

If you need additional information or have any questions, please contact Steven Reichmuth at (916) 376-9612 or fax (916) 376-9676.

Sincerely,

Jeremiah Shaffer, P.E., Chief  
Groundwater Supply Assessment and Special Studies Section

Enclosures
February 24, 2016

Mr. Dave Sederquist
Youngdahl Consulting Group, Inc.
1234 Glenhaven Court
El Dorado Hills, CA 95762

Dear Mr. Sederquist:

In response to your request, enclosed is a copy of the Well Completion Report for the well for the following location:

2621 Sanders Drive, Pollock Pines, CA; El Dorado County
WCR: #e0104753
The well was located using the following: APN, address.

If you need additional information or have any questions, please contact Steven Reichmuth at (916) 376-9612 or fax (916) 376-9676.

Sincerely,

Jeremiah Shaffer, P.E., Chief
Groundwater Supply Assessment and Special Studies Section

Enclosures
**Well Completion Report**

**State of California**

**Owner's Well Number:** 1

**Date Work Began:** 4-14-10  **Date Work Ended:** 4-18-10

**Permit Agency:** E/DOtado County

**Permission Number:** 5-843  **Permit Date:** 4-12-10

---

### Orientation
- **Vertical**
- **Horizontal**
- **Angle**

### Drilling Method
- **Rotary**
- **Air**
- **Fluid**
- **Water**

### Depth from Surface
- **Feet**
- **Ft**

### Description
- **Material, grain size, color, etc.**

<table>
<thead>
<tr>
<th>Depth from Surface</th>
<th>0</th>
<th>5</th>
<th>6.5</th>
<th>360</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S</td>
<td>R</td>
<td>G</td>
<td>S</td>
</tr>
</tbody>
</table>

**Red Soil**

**Soft Cemented Gravel**

**Firm Cemented Gravel**

---

### Orientation Sketch

- **Fractures - 335-345**

---

### Well Location
- **Address:** 2621 Sanders Ln.
- **City:** Pollock Pines
- **County:** Eldorado

### Well Location Details
- **Latitude:**
  - **N:**
  - **W:**
- **Datum:**
  - **Dec. Lat.:**
  - **Dec. Long.:**
- **APN Book:**
  - **Page:**
  - **Partition:**
- **Township:**
  - **Range:**
  - **Section:**

### Activity
- **New Well**
- **Modification/Repair**
- **Deepen**
- **Other**
- **Destroy**

### Planned Uses
- **Water Supply**
  - **Domestic**
  - **Public**
- **Irrigation**
- **Industrial**
- **Cathodic Protection**
- **Dewatering**
- **Heat Exchange**
- **Injection**
- **Monitoring**
- **Remediation**
- **Sparging**
- **Test Well**
- **Vapor Extraction**
- **Other**

### Water Level and Yield of Completed Well
- **Depth to first water:** 335 Feet below surface
- **Water Level:** 180 Feet
- **Date Measured:** 4-18-10

### Estimated Yield
- **15± GPM**

### Test Length
- **9 Hours**

### Total Drawdown
- **360 Feet**

---

### Casings
- **Borehole Diameter:**
- **Type:**
- **Material:**
- **Wall Thickness:**
- **Outside Diameter:**
- **Screen:**
- **Slot Size:**
- **Depth from Surface:**
- **Fill:**
- **Description:**

<table>
<thead>
<tr>
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<th>0</th>
<th>8.2</th>
<th>340</th>
<th>360</th>
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<tbody>
<tr>
<td>Borehole Diameter</td>
<td>11</td>
<td>6</td>
<td>6+</td>
<td>6+</td>
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<tr>
<td>Type</td>
<td></td>
<td>Solid PVC</td>
<td></td>
<td>Screen PVC</td>
</tr>
<tr>
<td>Material</td>
<td></td>
<td>125</td>
<td>125</td>
<td>510+</td>
</tr>
<tr>
<td>Wall Thickness</td>
<td></td>
<td>6</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Outside Diameter</td>
<td></td>
<td>4</td>
<td>4</td>
<td>2x1/8</td>
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<tr>
<td>Screen</td>
<td></td>
<td>125</td>
<td>510+</td>
<td></td>
</tr>
<tr>
<td>Slot Size</td>
<td></td>
<td>4</td>
<td>2x1/8</td>
<td></td>
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### Annular Material
- **Depth from Surface:**
- **Fill:**
- **Description:**

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<th>22</th>
<th>22</th>
<th>25</th>
<th>75</th>
<th>82</th>
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<tbody>
<tr>
<td>Fill</td>
<td>Cement</td>
<td>Clean Fill</td>
<td>Cement</td>
<td>Bentonite</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

### Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

**Name:** Ronsey-Lang Well Drilling & Pumps Inc.

**Address:** PO Box 1017

**City:** Shingle Springs
**State:** CA
**Zip:** 95682

**Date Signed:** 4-30-10
**Signature:** C-57 License Number: 936606

---

**Attachments**
- [ ] Geologic Log
- [ ] Well Construction Diagram
- [ ] Geophysical Log(s)
- [ ] Soil/Water Chemical Analyses
- [ ] Other

**Additional Information:** Attach additional information, if it exists.
February 24, 2016

Mr. Dave Sederquist
Youngdahl Consulting Group, Inc.
1234 Glenhaven Court
El Dorado Hills, CA 95762

Dear Mr. Sederquist:

Based on the information provided, we are unable to locate a Well Completion Report for:

4061 Natural Way, Pollock, CA; El Dorado County
APN: 101-210-36

If you need additional information or have any questions, please contact Steven Reichmuth at (916) 376-9612 or fax (916) 376-9676.

Sincerely,

Jeremiah Shaffer, P.E., Chief
Groundwater Supply Assessment and
Special Studies Section

Enclosures
February 24, 2016

Mr. Dave Sederquist
Youngdahl Consulting Group, Inc.
1234 Glenhaven Court
El Dorado Hills, CA 95762

Dear Mr. Sederquist:

In response to your request, enclosed is a copy of the Well Completion Report for the well for the following location:

5607 Gilmore Road, Pollock Pines, CA; El Dorado County
WCR: #0937435
The well was located using the following: APN, WCR location information.

If you need additional information or have any questions, please contact Steven Reichmuth at (916) 376-9612 or fax (916) 376-9676.

Sincerely,

Jeremiah Shaffer, P.E., Chief
Groundwater Supply Assessment and Special Studies Section

Enclosures
STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

STATE WELL NO./STATION NO. J12-635

LATITUDE 38°12'16"

LONGITUDE 121°13'20"

WELL OWNER

Name
Mailing Address

CITY

WELL LOCATION

Address 3515 Gilmore Rd
City Placerville
County EL DORADO
APN #01-100-90
Township II N Range 12 E Section 35

LATITUDE 38°12'16"

LONGITUDE 121°13'20"

LOCATION SKETCH

NEW WELL
MODIFICATION/REPAIR
- Deepen
- Other (Specify)

DESTROY (Describe Procedures and Material under "GEOLOGIC LOG")

PLANNED USE(S)
- Domestic
- Public
- Industrial
- Irrigation
- TEST WELL
- OTHER (Specify)

DRILLING METHOD
- WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL
123 (Feet)

ESTIMATED YIELD
30 (GPM) & TEST TYPE AIR LIFT

TEST LENGTH
4 (Hrs.) TOTAL DRAWDOWN

*May not be representative of a well’s long-term yield.

ROTARY METHOD
FLUID WATER

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 123 (Feet)

ESTIMATED YIELD 30 (GPM) & TEST TYPE AIR LIFT

TEST LENGTH 4 (Hrs.) TOTAL DRAWDOWN

Casing(S)

MATERIAL
GRADE
INTERNAL DIAMETER (Inches)
SLOT SIZE IF ANY (Inches)
SLOT SIZE (Inches)

0
102
10-5/8
PVC / blank
6
F160
0
25

0
100
6
PVC / blank
4
F480
0

0
300
6
PVC / screen
4
F480
0

0
122
6
PVC / screen
4
F480
0

ATTACHMENTS

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief...

SIGNED

4340 Leisure Lane
Placerville CA 95667

DATE SIGNED 6-30-07

WELL DRILLER/AUTHORIZED REPRESENTATIVE

453362

APN/STATION

DWR USE ONLY - DO NOT FILL IN

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM
Appendix B Engineering Studies

B.7  EL DORADO IRRIGATION DISTRICT CONSUMPTION REPORT (2016)
CONSUMPTION REPORT

- Potable / Raw Water
- Recycled Water
- Ditch Systems

REPORTING YEAR: 2016
<table>
<thead>
<tr>
<th>FIGURE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Zones</td>
<td>5</td>
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</tbody>
</table>

### POTABLE / RAW WATER SUMMARIES

<table>
<thead>
<tr>
<th>Authorized / Metered / Billed Potable Water</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authorized / Metered / Billed Potable Water</td>
<td>7</td>
</tr>
<tr>
<td>Other Authorized / Billed &amp; Unbilled Water</td>
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</tr>
<tr>
<td>Potable Supplement to Recycled System</td>
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### POTABLE WATER SERVICE ZONES

<table>
<thead>
<tr>
<th>Zones</th>
<th>PAGE</th>
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<tbody>
<tr>
<td>Zones 1, 2, 3</td>
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<tr>
<td>Zones 4, 5, 6</td>
<td>11</td>
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<tr>
<td>Zones 7, 9, 10</td>
<td>12</td>
</tr>
<tr>
<td>Zones 11, 12, 13</td>
<td>13</td>
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<tr>
<td>Zones 18, 28</td>
<td>14</td>
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<tr>
<td>Zones 14, 15</td>
<td>15</td>
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</tbody>
</table>
# TABLE OF CONTENTS

**RECYCLED WATER SUMMARY**

- Recycled Water System Summary .......................................................... 17
- Recycled Water Service Zone Detail ...................................................... 18

**DITCH SYSTEMS**

- Ditch System Summary ........................................................................ 20
- Ditch System Service Zone Detail ......................................................... 21
SERVICE ZONE

FIGURE
POTABLE / RAW WATER

SUMMARIES

and

SERVICE ZONE DETAIL
<table>
<thead>
<tr>
<th>User Category</th>
<th># Services</th>
<th># Services with Usage</th>
<th>Annual Acre-Feet</th>
<th>Acre-Feet per Service</th>
<th>Multi-Family Units with Consumption</th>
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</thead>
<tbody>
<tr>
<td>Agricultural Metered Irrigation</td>
<td>228</td>
<td>209</td>
<td>2,931</td>
<td>14.02</td>
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<td>Commercial / Industrial</td>
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<td>1,258</td>
<td>1,486</td>
<td>1.18</td>
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<td>Commercial Landscape</td>
<td>389</td>
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<td>697</td>
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<td>Ditch Systems</td>
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<td>14</td>
<td>440</td>
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<td>924</td>
<td>1,240</td>
<td>1.34</td>
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<tr>
<td>Municipal (City of Placerville)</td>
<td>14</td>
<td>13</td>
<td>1,307</td>
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<td>Recreational Turf Services</td>
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<td>105</td>
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<td>30,583</td>
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<tr>
<td>Single Family Residential - Dual</td>
<td>5,030</td>
<td>4,466</td>
<td>675</td>
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<td>Small Farm Irrigation</td>
<td>502</td>
<td>497</td>
<td>1,181</td>
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<tr>
<td><strong>TOTALS</strong></td>
<td><strong>40,619</strong></td>
<td><strong>38,427</strong></td>
<td><strong>22,627</strong></td>
<td></td>
<td><strong>7,602</strong></td>
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</table>
## Description of Use

<table>
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<tr>
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<th>Water Source</th>
<th>Billing Status</th>
<th>Meter Status</th>
<th># Meters</th>
<th>Acre-Feet</th>
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<tbody>
<tr>
<td>Temporary Water Use Permit</td>
<td>Potable</td>
<td>Billed</td>
<td>Metered</td>
<td>48</td>
<td>122</td>
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<tr>
<td>Bulk Water Stations - Permanent</td>
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<td>Billed</td>
<td>Metered</td>
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<td>23</td>
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<td>Billed</td>
<td>Metered</td>
<td>2</td>
<td>3</td>
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**Billed Metered Subtotal** 58 148

<table>
<thead>
<tr>
<th>Description of Use</th>
<th>Water Source</th>
<th>Billing Status</th>
<th>Meter Status</th>
<th># Meters</th>
<th>Acre-Feet</th>
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<td>Private Fire Services</td>
<td>Potable</td>
<td>Unbilled</td>
<td>Metered</td>
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<td>6</td>
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<td>Lift Stations</td>
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<td>Metered</td>
<td>60</td>
<td>79</td>
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<tr>
<td>Collection System Flushing</td>
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<td>Unbilled</td>
<td>Metered</td>
<td>1</td>
<td>2</td>
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<tr>
<td>Clear Creek Aesthetics Flow Maintenance District</td>
<td>Raw</td>
<td>Unbilled</td>
<td>Metered</td>
<td>1</td>
<td>1,639</td>
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**Unbilled Metered Subtotal** 447 1,726

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<th>Meter Status</th>
<th># Meters</th>
<th>Acre-Feet</th>
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<tbody>
<tr>
<td>Collection System Trucks</td>
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<td>Unmetered</td>
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<td>0.03</td>
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<td>System Flushing</td>
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<td>Unbilled</td>
<td>Unmetered</td>
<td>--</td>
<td>26</td>
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**Unbilled Unmetered Subtotal** 0 26

**GRAND TOTAL** 505 1,900
<table>
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<tr>
<th>Description of Location</th>
<th>Service Zone</th>
<th>Annual Acre-Feet</th>
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<tbody>
<tr>
<td>Serrano Golf Course</td>
<td>01</td>
<td>0</td>
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<tr>
<td>Village C Recycled Water Tank</td>
<td>01</td>
<td>18</td>
</tr>
<tr>
<td>800 Tank</td>
<td>02</td>
<td>72</td>
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<tr>
<td>940 Tank</td>
<td>02</td>
<td>168</td>
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<tr>
<td>Bridlewood Recycled Water Tank</td>
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<td>312</td>
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<tr>
<td><strong>TOTAL POTABLE WATER SUPPLEMENT</strong></td>
<td></td>
<td><strong>571</strong></td>
</tr>
</tbody>
</table>
## EL DORADO IRRIGATION DISTRICT
### Potable Water Service Zones

**REPORTING YEAR: 2016**

<table>
<thead>
<tr>
<th>Service Zone</th>
<th>Service Class</th>
<th># Services</th>
<th># Services with Usage</th>
<th>Annual Acre-Feet</th>
<th>Acre-Feet per Service</th>
<th>Multi-Family Units with Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Commercial / Industrial</td>
<td>18</td>
<td>17</td>
<td>22</td>
<td>1.32</td>
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<td></td>
<td>Commercial Landscape</td>
<td>6</td>
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<td>0.00</td>
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<td>324</td>
<td>329</td>
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<tr>
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<td><strong>Totals for Zone 01</strong></td>
<td><strong>2,948</strong></td>
<td><strong>2,571</strong></td>
<td><strong>740</strong></td>
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<td>02</td>
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<td>296</td>
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<td>1.36</td>
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<td>Commercial Landscape</td>
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<td>Multi-Family Residential</td>
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<td>125</td>
<td>231</td>
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<td>Recreational Turf Services</td>
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<td>36</td>
<td>269</td>
<td>7.48</td>
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<td></td>
<td>Single Family Residential</td>
<td>8,278</td>
<td>7,803</td>
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<td></td>
<td>Single Family Residential - Dual</td>
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<td>2,237</td>
<td>296</td>
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<td>0</td>
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<tr>
<td></td>
<td>Small Farm Irrigation</td>
<td>18</td>
<td>18</td>
<td>30</td>
<td>1.68</td>
<td>0</td>
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<tr>
<td></td>
<td><strong>Totals for Zone 02</strong></td>
<td><strong>11,399</strong></td>
<td><strong>10,675</strong></td>
<td><strong>5,852</strong></td>
<td></td>
<td><strong>1,430</strong></td>
</tr>
<tr>
<td>03</td>
<td>Agricultural Metered Irrigation</td>
<td>39</td>
<td>38</td>
<td>832</td>
<td>21.90</td>
<td>0</td>
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<td>Commercial / Industrial</td>
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<td>21</td>
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<td>Multi-Family Residential</td>
<td>35</td>
<td>35</td>
<td>24</td>
<td>0.68</td>
<td>75</td>
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<tr>
<td></td>
<td>Recreational Turf Services</td>
<td>8</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td>Small Farm Irrigation</td>
<td>77</td>
<td>76</td>
<td>144</td>
<td>1.89</td>
<td>0</td>
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<td></td>
<td><strong>Totals for Zone 03</strong></td>
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<td><strong>942</strong></td>
<td><strong>1,469</strong></td>
<td><strong>75</strong></td>
<td><strong>0</strong></td>
</tr>
</tbody>
</table>

**Zone 1 - Bass Lake**

**Zone 2 - El Dorado Hills**

**Zone 3 - Lotus/Coloma**
## Service Class \# Services \# Services with Usage Annual Acre-Feet Acre-Feet per Service Multi-Family Units with Consumption

### Zone 04

<table>
<thead>
<tr>
<th>Service Class</th>
<th># Services</th>
<th># Services with Usage</th>
<th>Annual Acre-Feet</th>
<th>Acre-Feet per Service</th>
<th>Multi-Family Units with Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Metered Irrigation</td>
<td>3</td>
<td>3</td>
<td>29</td>
<td>9.58</td>
<td></td>
</tr>
<tr>
<td>Commercial / Industrial</td>
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<td>191</td>
<td>226</td>
<td>1.18</td>
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</tr>
<tr>
<td>Commercial Landscape</td>
<td>85</td>
<td>79</td>
<td>71</td>
<td>0.90</td>
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</tr>
<tr>
<td>Multi-Family Residential</td>
<td>146</td>
<td>146</td>
<td>329</td>
<td>2.26</td>
<td>2,185</td>
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### Totals for Zone 04

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Zone 7 - El Dorado / Diamond Springs  
Zone 9 - Swansboro  
Zone 10 - Camino / Fruitridge
**Service Clas s # Services  # Services with Usage  Annual Acre-Feet  Acre-Feet per Service  Multi-Family Units with Consumption**

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<th>Service Class</th>
<th>Total</th>
<th>Total with Consumption</th>
<th>Annual Acre-Feet</th>
<th>Acre-Feet per Service</th>
<th>Total Multi-Family Units</th>
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### EL DORADO IRRIGATION DISTRICT

**Potable Water Service Zones**

**REPORTING YEAR: 2016**

<table>
<thead>
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<th>Service Zone</th>
<th>Service Class</th>
<th># Services</th>
<th># Services with Usage</th>
<th>Annual Acre-Feet</th>
<th>Acre-Feet per Service</th>
<th>Multi-Family Units with Consumption</th>
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**Zone 18 - North Placerville**

**Zone 28 - South Placerville**
EL DORADO IRRIGATION DISTRICT

Satellite Potable Water Service Zones

REPORTING YEAR: 2016

<table>
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<th>Service Class</th>
<th>Active Services</th>
<th>Active Services With Usage</th>
<th>Annual Acre Feet</th>
<th>Acre-Feet per Active Service</th>
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Zone 14 - Outingdale  Zone 15 - Strawberry
RECYCLED WATER
Summary
And
Service Zone Detail
## Recycled Water System Summary

**REPORTING YEAR: 2016**

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<th># Services</th>
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<th>Annual Acre-Feet</th>
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<td># Services with Usage</td>
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<tr>
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<td>Commercial / Industrial</td>
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Zone 1 - Bass Lake           Zone 2 - El Dorado Hills           Zone 4 - Cameron Park

EL DORADO IRRIGATION DISTRICT
Recycled Water Service Zones
REPORTING YEAR: 2016
DITCH SYSTEMS

Summary

And

Service Zone Detail
## Ditch System Summary

**REPORTING YEAR:** 2016

<table>
<thead>
<tr>
<th>Source</th>
<th>Service Class</th>
<th># Services with Usage</th>
<th>Annual Acre-Feet</th>
<th>Acre-Feet per Service</th>
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<tbody>
<tr>
<td>Raw</td>
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<tr>
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<td>143</td>
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<td>1.33</td>
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<tr>
<td><strong>Totals</strong></td>
<td></td>
<td><strong>72</strong></td>
<td><strong>1,100</strong></td>
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### EL DORADO IRRIGATION DISTRICT

**Ditch System Service Zone Detail**

**REPORTING YEAR: 2016**

<table>
<thead>
<tr>
<th>Service Zone</th>
<th>Source</th>
<th>Ditch</th>
<th>Service Class</th>
<th># Services</th>
<th># Services with Usage</th>
<th>Annual Acre-Feet</th>
<th>Acre-Feet per Service</th>
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<td><strong>72</strong></td>
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