Alternatives Study

Yakima-Tieton Irrigation District Main Canal Rehabilitation and Cowiche Creek Water Exchange

Prepared for

Yakima-Tieton Irrigation District

September 2013

CH2MHILL®

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Acronyms and Abbreviations

cfs	cubic feet per second
gpm	gallons per minute
NOAA	National Oceanic and Atmospheric Administration
NYCD	North Yakima Conservation District
O&M	operations and maintenance
PCBC	precast concrete box culvert
psi	pounds per square inch
ROW	right-of-way
TWUA	Tieton Water Users' Association
YRBWEP	Yakima River Basin Water Enhancement Program
YTAHP	Yakima Tributary Access and Habitat Program
YTID	Yakima-Tieton Irrigation District

SECTION 1

Introduction

1.1 Background

The Yakima-Tieton Irrigation District (YTID) delivers untreated Tieton River water to approximately 27,900 acres of agricultural, industrial, and residential land northwest of Yakima, Washington. YTID was first organized as the Tieton Water Users' Association (TWUA) in 1906. All landowners were required to join the association and assign their water rights to the TWUA.

Soon after the TWUA was formed, it entered into a contract with the U.S. Government to design and construct irrigation conveyance and distribution facilities. The original distribution system consisted of a 12-mile-long Main Canal in the Tieton River canyon and 320 miles of open canal distribution laterals. The first irrigation water was delivered in 1910.

YTID was established by the Yakima County Commissioners under the authority of the Revised Code of Washington (RCW) 87.03. In 1947, the Bureau of Reclamation transferred all operation and maintenance responsibilities to YTID. The title of the land on which the facilities are located remains in the name of the U.S. Government.

In the late 1970s, YTID initiated a $70 million Rehabilitation and Betterment Project, funded by the Bureau of Reclamation, the Department of Ecology, and YTID. The entire distribution system was replaced by 1986. CH2M HILL provided engineering design and construction management services for the distribution system replacement. The project included more than 230 miles of pipeline ranging from 4 to 90 inches in diameter, six booster pump stations, and two hydroelectric generating plants. The project also included the French Canyon Dam and Regulating Reservoir. However, the 12-mile-long Main Canal was not replaced because of high costs and the repayment capability of the water users.

1.2 Project Purpose and Need

The Main Canal is now more than 100 years old and is the only source of irrigation water for more than 4,000 users. The existing canal has failed numerous times because of age, unstable geology, and storm events. Canal failures disrupt the delivery of water and are costly to repair.

Many of the crops grown within YTID are high-value trees and vines and are subject to permanent damage caused by lack of water. The crops, primarily apples, cherries, and wine grapes, represent a large part of the local economy. YTID spends a significant amount of time and effort maintaining the Main Canal to improve its reliability. The open canal creates a barrier and a hazard to wildlife and people. Deer, elk, and other animals are lost in the canal each year.

The purpose of this study is to identify reliable, cost-effective, constructable, and environmentally acceptable long-term water supply facilities for YTID users. The project is also designed to support fisheries restoration in Cowiche Creek and provide opportunities to serve other water users.

1.3 Approach

This study identifies and evaluates alternatives for rehabilitating the Main Canal. It identifies the apparent best alternative based on evaluation criteria important to YTID. This study also identifies the next steps toward design and construction. The study approach is as follows:

- Document YTID's preferences and design criteria
- Develop and screen preliminary project alternatives
- Identify potentially feasible rehabilitation alternatives

- Evaluate and compare the alternatives based on criteria important to YTID
- Select an apparent best alternative and estimate total project costs
- Identify facilities needed to serve Cowiche Creek water users
- Recommend near-term action items required to validate the apparent best alternative

1.4 Study Limitations

This study is the first step in a long list of activities required to rehabilitate the Main Canal and provide service to Cowiche Creek water users. The study is based on visual inspections of the facilities and knowledge of the existing system. As-built information and field data are limited. Many of the recommendations and conclusions are judgments by experienced engineers familiar with the YTID system.

To proceed with the predesign phase of the project, the following information is needed:

- Detailed topographic survey and mapping
- Detailed biological surveys
- Geotechnical drilling
- Land ownership information
- Contact with permitting and regulatory agencies
- Construction contractor input

This information will provide additional clarity to the project scope, schedule, and budget. The cost estimates presented in this report are suitable for comparing alternatives, but are not recommended for project budgeting or financing.

SECTION 2

Existing Main Canal

The Main Canal was constructed between 1906 and 1909. The 12-mile-long canal is parallel to U.S. Highway 12 and the Tieton River. The canal begins at a gravity diversion dam upstream from the unincorporated community of Rimrock Retreat. The canal begins at river grade, 2,310 feet above sea level, and terminates at French Canyon Reservoir, 2,160 feet above sea level. Because the grade of the Tieton River is much steeper than the canal, the canal is perched nearly 400 feet above the river near its end. Figures 2-1a through 2-1e, included at the end of this section, show the existing canal.

Photo 1, Main Canal, circa 1910. The canal was constructed from precast concrete segments.

The canal consists of approximately 9 miles of horseshoe-shaped, precast concrete segments and six tunnels totaling about 3 miles in length. The original precast concrete segments were 8-1/2 feet in diameter, 2 feet long, and 4 inches thick. In most places, the canal is partially buried, extending 4 to 6 feet above the surrounding grade. Photo 1 shows the original canal as it appeared circa 1910.

The precast canal segments were installed on a constant downhill slope of 8.71 feet per mile (0.17 percent). At this slope, water flows rapidly through the flume. In 1918, 14 inches of concrete were added to the top of the canal because the demand for new irrigation water exceeded the available capacity of the canal.

The tunnels were drilled, blasted, and excavated by hand and lined with concrete. Slightly smaller than the precast flume, the finished inside diameter of the tunnels is 6 feet, 1 inch, with a circular shape. Photo 2 shows one of the original tunnels before it was lined with concrete. The tunnels were not enlarged when additional freeboard was added to the canal. Because the tunnels are smaller than the flume, they were constructed on a steeper slope of 23.9 feet per mile (0.45 percent).

P33-A22YB-414 Steeple tunnel no. 1, Tieton canal, Tieton canyon. Reclamation photo by Unknown. 09/25/1907.

Photo 2, Tunnel construction, 1907. Tunnels were drilled, blasted, and excavated by hand.

2.1 Regional Setting

2.1.1 Climate

The Main Canal is on the eastern flanks of the Cascade Mountains. Precipitation and weather conditions are severe and change rapidly. The nearest weather station is at Tieton Dam, 6 miles west of the Main Canal diversion. From a recent 30-year period of record, the average high temperature was 79°F in July, and the average low temperature was 18°F in January. Extreme temperatures have ranged between -22°F to 102°F. The average annual precipitation was 26 inches, with more than half falling as snow. The maximum 24-hour rainfall was 2.75 inches, and the maximum 1-month snowfall was 67 inches.

2.1.2 Topography and Geology

The Main Canal was constructed along the steep south side of the Tieton River canyon. The canyon is cut through intact, fractured, and weathered basalt rock. Geologic mapping of the area shows a variety of rock formations, mostly basalt. The basalt originated from volcanic activity in the Goat Rocks Wilderness, as far as

50 miles to the southwest. Portions of the steeply sloping canyon wall are mapped showing ancient landslides. Upper reaches of the canal are located in a heavy pine and fir forest, and lower reaches are located in dry climate grasses and brush. Vehicle access along the canal is limited, and few bridges cross the river.

2.1.3 Biology

The Tieton River canyon provides habitat for high-value fish and wildlife including elk, bear, big horn sheep, eagle, and deer. In 2002, a biological assessment was prepared for hydropower improvements at the Tieton Dam. The dam is a few miles upstream of the Main Canal. The biological assessment identified gray wolf (*Canis lupus*) as a federally endangered species under the Endangered Species Act. Federally threatened species included steelhead (*Oncorhynchus mykiss*), bull trout (*Salvelinus confluentus*), bald eagle (*Haliaeetus leucocephalus),* northern spotted owl *(Strix occidentalis caurina)*, Canada lynx (*Lynx Canadensis),* grizzly bear (*Ursus arctos horribilis),* marbled murrelet (*Brachyramphus marmoratus marmoratus), and* Ute ladies'-tresses (*Spiranthes diluvialis)*. In addition, at least 15 species were listed on State of Washington threatened or endangered species lists. (S.P. Cramer and Associates, 2002).

2.1.4 Land Use

The Tieton River canyon includes a variety of land uses and ownership. Like many parts of the Central Cascades, the land is divided into a checkerboard pattern, a legacy from the 19th century when Congress gave alternating square miles to railroad companies. The U.S. Forest Service, the State Department of Fish and Wildlife, and the Washington State Department of Natural Resources are also among the largest landowners in the project area. A few parcels within the project boundaries are privately held, particularly near the upstream end of the Main Canal at Rimrock Retreat.

In 2007, the Nature Conservancy with several state and federal agencies completed a 4-year project to bring 20,000 acres into public ownership and protect it from development. The nonprofit group transferred parcels to the State Department of Fish and Wildlife. The area includes nearly 8 miles of the Tieton River and the adjacent uplands near the Main Canal.

The Washington State Department of Transportation owns right-of-way along Highway 12. The highway runs the full length of the proposed Main Canal rehabilitation project, along the north side of the river. Several large fiber optic cables buried in the highway right-of-way make new canal alignments along the highway less attractive. Forest service roads within the project boundaries are mostly used by outdoor enthusiasts and by YTID to access the Main Canal.

The Tieton River canyon is popular for hiking, bird watching, fishing, hunting, mushroom gathering, camping, and rafting. In recent years, the Bureau of Reclamation has increased water discharge into the Tieton River during September. The Tieton River provides some of the best white-water rafting in the state during these high flow periods, and several commercial rafting companies regularly serve the river. The canyon, with its near-vertical basalt formations, is also a popular rock climbing area.

Prehistoric archaeological sites have been identified in the project area. Native Americans used these sites for fishing and hunting. In 2002, YTID conducted a cultural resources survey of the powerline corridor for the Tieton Dam hydroelectric facility. The survey identified one archeological site potentially eligible for the National Register, which included a scatter of stone tools.

2.2 Upper Main Canal

For this study, the canal has been divided into upper and lower sections. The Upper Main Canal extends from the Tieton River diversion through the Windy Point Tunnel, near Milepost 5.5 (see Figures 2-1b and 2-1c). The Upper Main Canal is on a moderately steep side slope of the canyon, not high above the Tieton River. There is not a continuous access road along the Upper Main Canal, but several Forest Service roads and public bridges provide access to both the headworks facilities near Milepost 0.0 and the west portal of

the Windy Point Tunnel near Milepost 5.0. Photo 3 shows the typical Upper Main Canal configuration, topography, and vegetation.

Photo 3, Typical Upper Main Canal Configuration and Topography, 2013.

Because of the accessibility and moderate topography of the Upper Main Canal, constructing new facilities along the existing canal alignment may be feasible. In many areas, the ground is flat enough to construct temporary haul roads adjacent to the canal. However, no construction work can be performed along the existing alignment during the irrigation season (March through mid-October) because the canal must remain in service. Winter construction work in any part of the Tieton River canyon is difficult because of snow, ice, limited daylight, and north-facing slopes.

After the eruption of Mt. St. Helens in 1980, several steel pipe bridges were installed to eliminate cross drainage obstructions. The locations of the pipe bridges are shown in Figures 2-1b and 2-1c, and Photo 4 shows an existing pipe bridge.

Photo 4, Typical 102-inch-diameter pipe bridge at drainage crossings, 2013.

The Upper Main Canal includes an existing diversion dam, head gates, debris screens, fish screens, a gaging station, and a short section of unlined earth canal. These facilities are expected to remain in service. If the design flow is increased to 370 cubic feet per second (cfs), the head gates and the fish screens may need to be modified.

2.3 Lower Main Canal

The Main Canal downstream of the Windy Point Tunnel is much higher above the Tieton River and is less accessible. A steep, primitive Forest Service Road, shown in Figure 2-1d, provides access to the east portal of the Windy Point Tunnel near Milepost 5.5. The same road provides access to the Main Canal near Milepost 7.1. However, most of the Lower Main Canal is perched on a steep, rocky hillside with no access by vehicle and no room for haul roads or other construction work. From Mileposts 6.0 to 6.6 and beyond Milepost 7.7, the topography is particularly steep and accessible only by foot. Photo 5 shows the typical Lower Main Canal configuration and topography near Milepost 6.5.

Photo 5, Typical Lower Main Canal Configuration and Topography, 2013.

For the Lower Main Canal, relocating the new facility away from the existing canal may be desirable. By relocating the facility away from the existing canal alignment, construction can be completed while the canal is in service. New rights-of-way will be needed, and the existing pipe bridges cannot be reused.

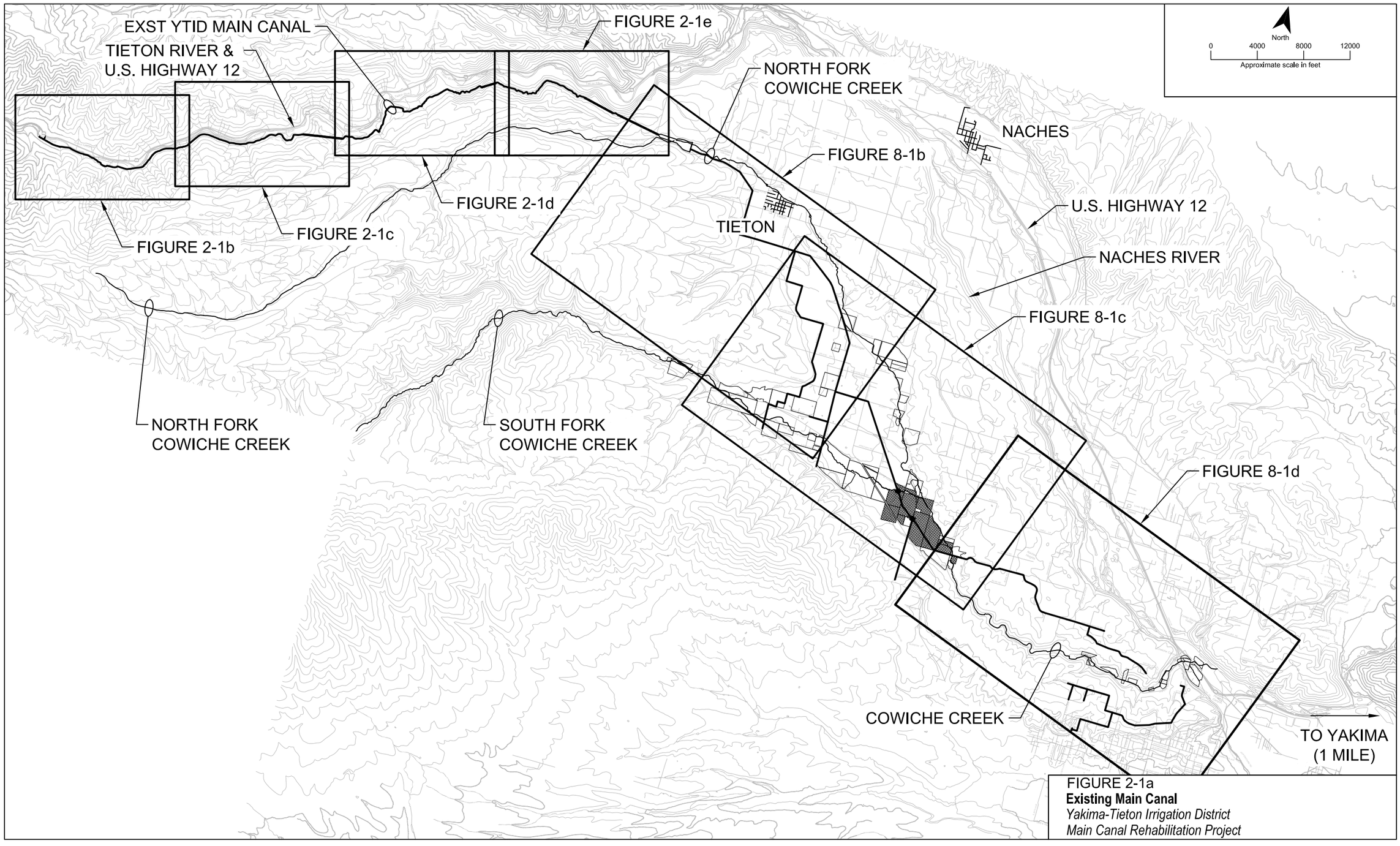


FIGURE 2-1a
Existing Main Canal
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

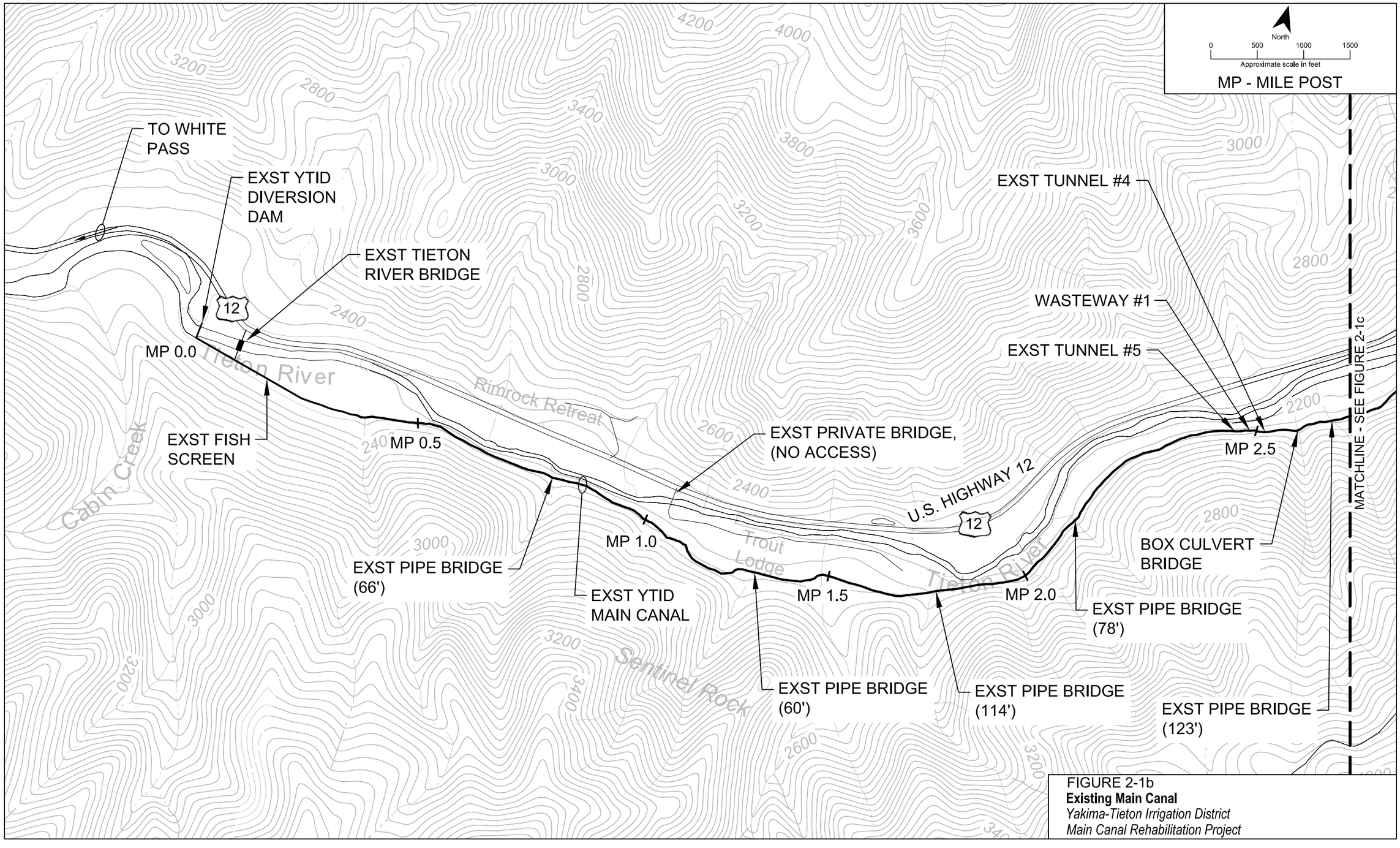


FIGURE 2-1b
Existing Main Canal
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

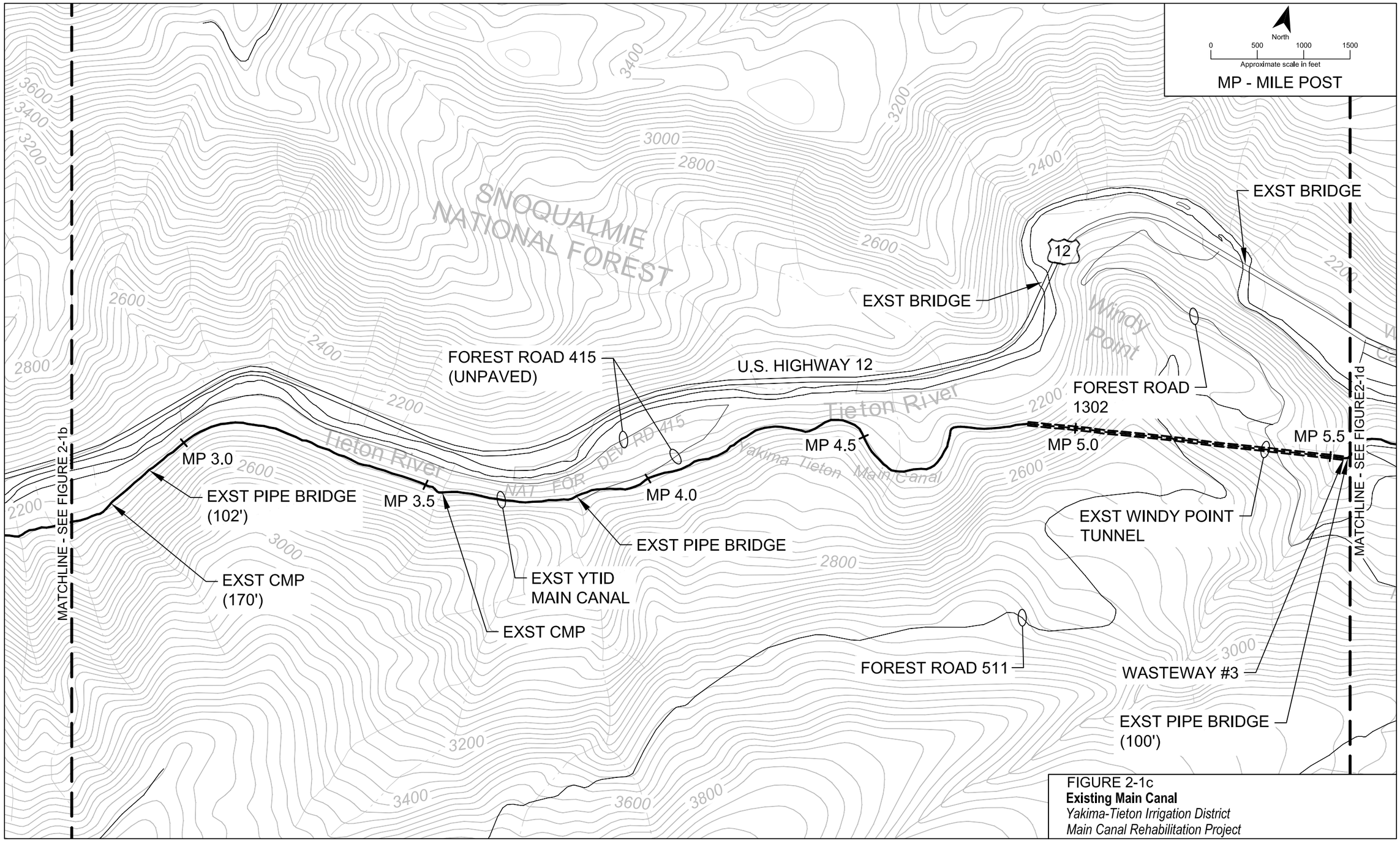


FIGURE 2-1c
Existing Main Canal
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

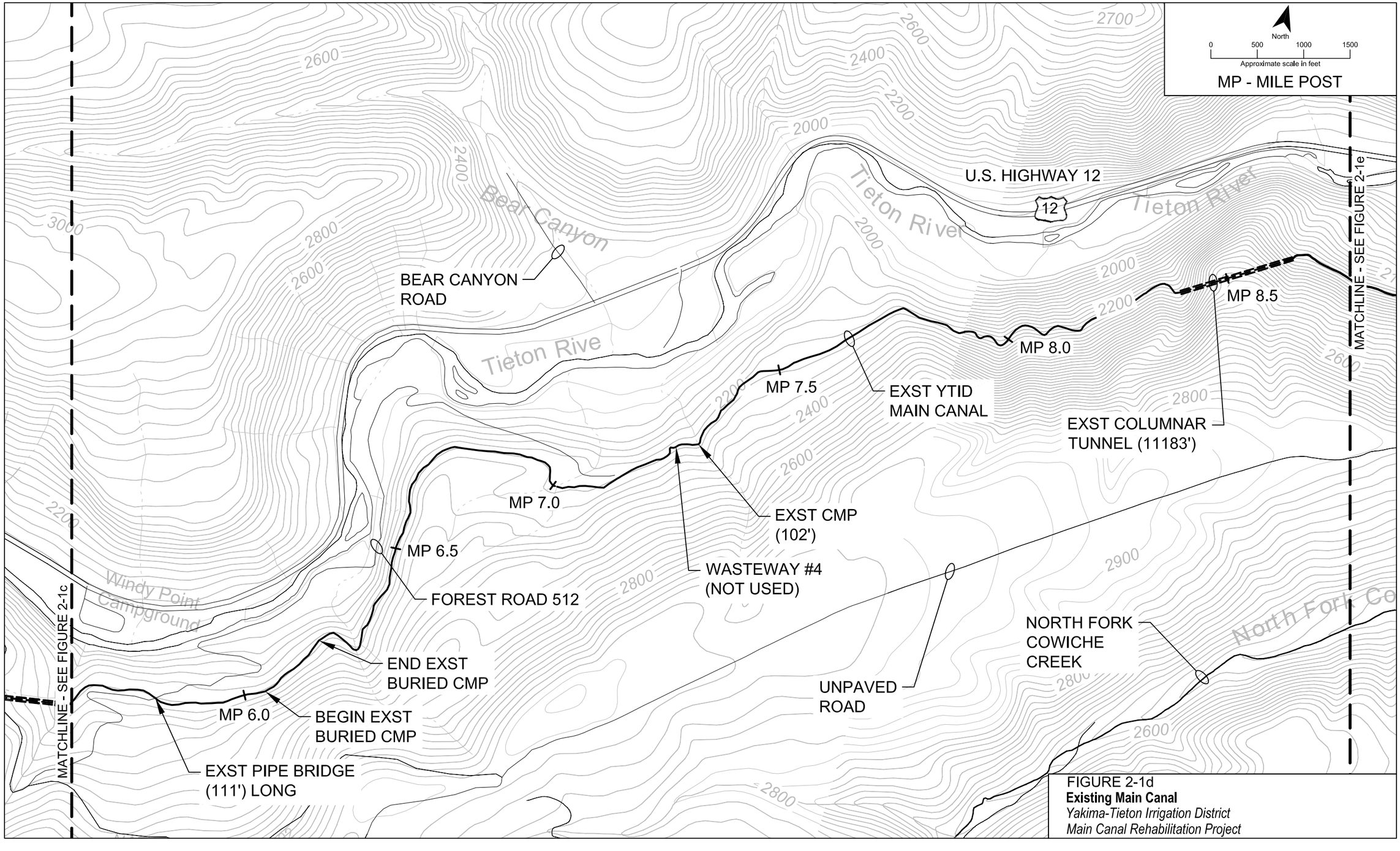


FIGURE 2-1d
Existing Main Canal
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

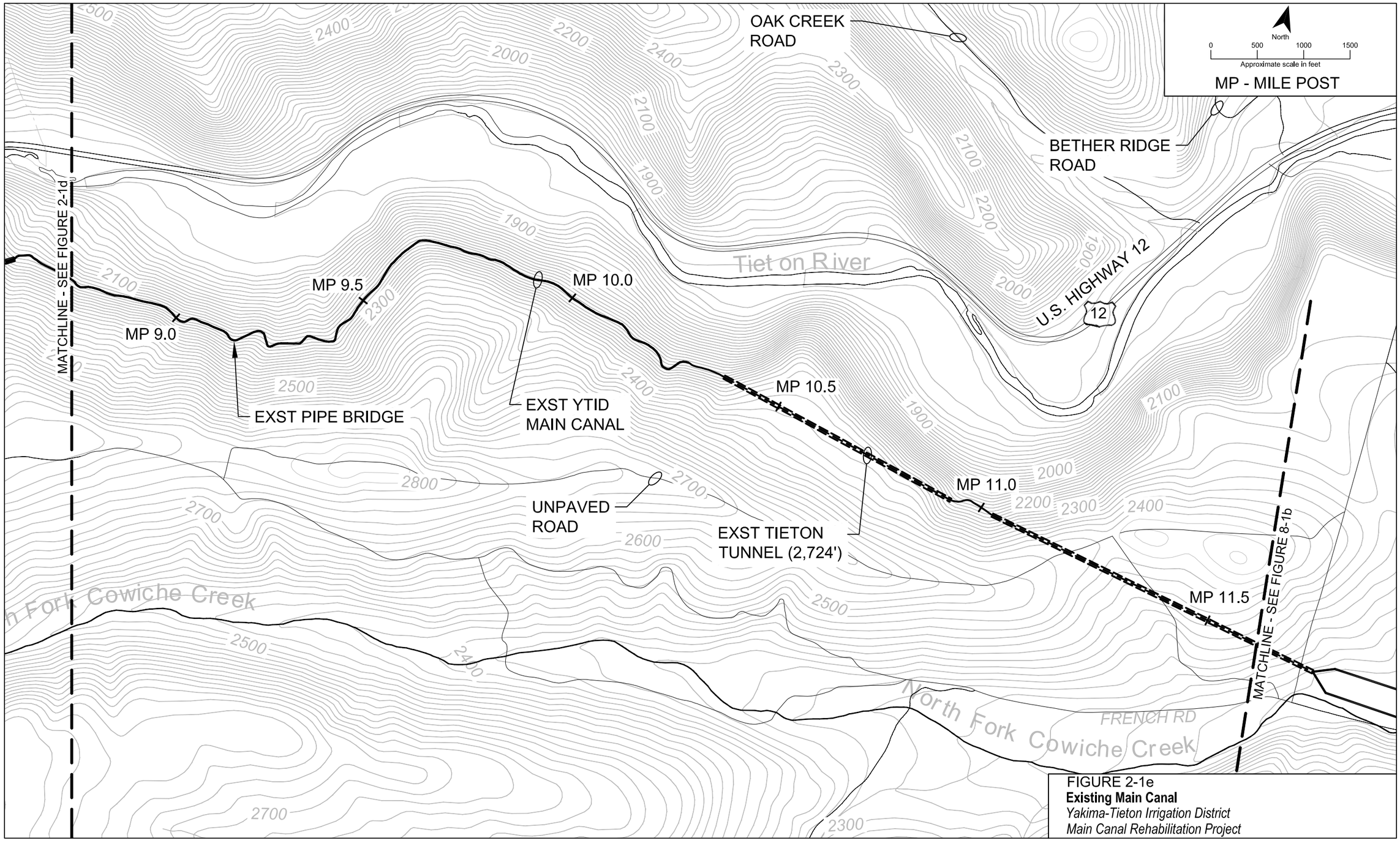


FIGURE 2-1e
Existing Main Canal
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

SECTION 3

Main Canal Improvement Alternatives

3.1 Design Criteria

For most landowners within the YTID service area, the Main Canal is the only source of irrigation and frost protection water. Therefore, the canal must provide continuous, reliable service during the irrigation season, even during construction. A typical irrigation season extends from March 1 through October 15, but varies slightly depending on weather conditions and available water supply.

In 1918, the canal was improved by raising its sidewalls, which increased its capacity to approximately 345 cfs. Over time, with age deterioration, repairs, and continuous use, the peak capacity of the canal has declined to about 300 cfs today. YTID's goal is to restore the original canal capacity and provide an additional 25 cfs to support other regional water goals. A design capacity of 370 cfs will meet YTID's needs and provide flexibility to meet other potential needs, including the following:

- Water deliveries to Cowiche Creek water users
- Service to Ahtanum Irrigation District
- Regional groundwater augmentation
- Municipal water deliveries
- Fish habitat enhancement in Cowiche Creek, Ahtanum Creek, and Wide Hollow Creek
- Off-peak, green power production

Rehabilitation of the Main Canal should also include the following:

- Improved reliability (lower risk of catastrophic canal failures from debris slides and erosion)
- Improved access roads for operations and maintenance
- A design life of up to 100 years
- Reduced operations and maintenance costs
- An affordable, constructable, and environmentally acceptable project
- Improved safety for wildlife and the public
- Flexibility for year-round operations

3.2 Overview of Project Alternatives

CH2M HILL conveyance and geotechnical engineers conducted several site visits to review and discuss potential project alternatives. Refurbishing the existing canal and tunnels was considered, but dismissed for the following reasons:

- The existing open canal and tunnels are more than 100 years old. Increasing the capacity of the existing canal by raising sidewalls, reducing friction losses, or providing alternative sources of water is not feasible.
- The existing Main Canal crosses areas of unstable geology.
- Potential rock and debris fall threaten the canal.
- Vehicle access to the existing canal is not possible in most locations.

The following three basic concepts to rehabilitate the existing Main Canal were discussed with YTID staff at the beginning of this analysis:

1. Construct new facilities along the existing canal alignment.
2. Construct a new pipeline near the existing canal or along the Tieton River.

3. Construct a tunnel to convey water from the existing Tieton River diversion to French Canyon Reservoir, eliminating the need for the canal.

Each of these concepts presents special challenges ranging from environmental impacts, access, and space limitations, to construction sequencing constraints and cost. In addition to the three concepts listed above, the following concepts were reviewed, but were rejected:

- Installing a new polyethylene pipeline inside the existing concrete canal and constructing a pump station near the headworks to force the design flow through the pipe at times of peak demand. This concept was rejected because of the irregular canal alignment, pumping cost and reliability concerns, and susceptibility to geologic failures.
- Installing a new pump station near the end of the Main Canal to pump water from the Tieton River to French Canyon Reservoir. The river is more than 400 vertical feet below the reservoir at this location. Therefore, this concept requires a 30,000-horsepower pump station, new diversion dam, fish ladder, and fish screen in the Tieton River and a 5,300-foot tunnel through the hillside. This concept was rejected because of construction and operating costs, environmental impacts in the river, and pumping equipment reliability concerns.
- Installing a pump station near the Wapatox Diversion Dam on the Naches River. This concept is similar to the Tieton River pump station and was rejected for similar reasons.
- Installing a new pipeline under Highway 12 the full length of the canal. This concept was rejected because several vital fiber-optics cables are already buried under the road, and in most locations, the topography and right-of-way cannot accommodate a large-diameter pipeline. Where sufficient right-of-way is available, pipeline alignments are considered.

3.3 Initial Screening of Alternatives

All of the alternative concepts were considered, and many were rejected because of cost, constructability, land use, or environmental impact concerns. A continuous tunnel from the Tieton River diversion to French Canyon Reservoir was also eliminated because of high costs, lack of right-of-way, and uncertain geology. Although the continuous tunnel concept was eliminated, shorter tunnels in critical areas may be viable and are being considered.

3.4 Potentially Feasible Project Alternatives

YTID expressed a preference for a gravity flow system, similar to the existing canal. CH2M HILL examined several gravity conveyance alternatives for rehabilitating the canal. The following three basic concepts were evaluated: (1) the existing canal will be demolished and replaced with a new precast concrete box culvert (PCBC); (2) the existing canal will be replaced with a new buried pipeline; and (3) new tunnels will be constructed to replace portions of the existing canal, or the existing tunnels will be rehabilitated. These three basic concepts can be combined into dozens of hybrid configurations that contain elements of each concept. The three basic concepts are summarized below.

3.4.1 Precast Concrete Box Culvert

Under this concept, the PCBC will be installed along the same alignment and elevation as the existing canal (see Figure 3-1 included at the end of this section). The horseshoe-shaped flume will be demolished, removed, and replaced with rectangular PCBC segments. Based on preliminary hydraulic calculations, the inside dimensions of the PCBC will be 6 feet high, 10 feet wide, and 5 feet long. Each segment will weigh approximately 30,000 pounds, light enough to be loaded, unloaded, and installed by a large forklift or excavator.

The PCBC concept has several advantages. The horizontal and vertical alignment of the PCBC will match the existing canal's alignment. As a result, no new right-of-way is required, and disturbance of the existing right-of-way is minimized. In addition, environmental permitting is simplified, and the cost of earthwork excavation and backfill is minimized. The PCBC will be fully enclosed with a concrete deck on top that can be used as an access road. The top deck will prevent rock and debris from entering the canal and prevent wildlife from becoming entrapped in the canal. Manhole covers in the top deck will provide easy access to the inside of the PCBC for inspection and maintenance.

Like the existing canal, the PCBC will be installed along a constant downhill slope. As a result, the PCBC will flow partially full and drain by gravity. The PCBC segments will be joined together with a high-quality rubber gasket and stainless-steel bolts. The gaskets and bolts will provide a leak-tight seal. The PCBC will be partially exposed, similar to the existing canal. The PCBC concept is well-suited for the existing canal alignment, where steep side slopes limit work areas and construction access. However, because the PCBC cannot withstand internal pressure more than a few pounds per square inch (psi), it is not feasible for alignments other than the existing canal.

Because the PCBC will be constructed on the same line and grade as the existing canal, and YTID delivers water continuously from March 1 through October 15, the PCBC must be constructed during winter when water is not delivered. Winter construction presents constructability challenges including limited daylight hours, ice and snow on the access roads and canal alignment, and wet or frozen backfill. Cold-weather construction work will be slower, more expensive, and more risky than similar work during summer. The project must be phased to ensure that YTID operations are not interrupted during the normal spring frost-protection period. In addition, cast-in-place transition sections are required to transition flow from the rectangular PCBC to the circular, 102-inch pipe bridges.

3.4.2 Pressure Pipelines

Under this concept, large-diameter pressure pipelines will replace the existing canal (see Figure 3-2 included at the end of this section). Based on preliminary hydraulic calculations, the inside diameter of the pipe will be 96 inches. For this study, the pipeline material is assumed to be welded steel core with a cement-mortar lining and coating; other pipe materials will be considered at later stages of design. The pipe joints will likely be welded together. The pipeline will be backfilled with 5 feet minimum cover, and an all-weather access road will be constructed above the pipe.

The pipeline concept is well-suited for almost any alignment lower in elevation than the existing canal. If constructed lower than the existing canal, the pipeline can be installed on an uphill or downhill grade. The pipeline will flow full and operate as an inverted siphon. The water pressure in the pipeline will range from near zero at the elevation of the existing canal to more than 200 psi near French Canyon Reservoir.

In most places, the pipeline can be constructed completely independently of the existing canal. Therefore, work will not interfere with YTID water deliveries and can be completed during summer when daylight is abundant, temperatures are warm, and the soil is dry. The use of pressure pipelines offers unlimited alignment opportunities.

However, the pressure pipeline concept requires a large quantity of excavation and backfill to bury the pipeline and a large work space for construction. The pipeline trench will be a minimum 17 feet deep and 40 feet wide. In addition to the space required for the trench, additional right-of-way is required for stockpiling the excavated soil and constructing haul roads to place the pipe and backfill. The ideal width of temporary construction easement will be up to 100 feet wide, which will create land acquisition, constructability, and permitting challenges. In most areas, the ground is expected to contain large boulders that will be slow and difficult to remove. In addition, alignments near the river may contain saturated soil below the water table, and pumping, treating, and disposing of the water may be slow and costly.

3.4.3 Gravity Tunnels

In some cases, tunneling may be the most cost-effective canal improvement. Tunneling may be required to cross the Tieton River or to cross topographic features too high for gravity flow. Under this concept, new tunnels will be constructed, or, in some locations, the existing tunnels will be rehabilitated.

Figures 2-1a through 2-1e show the five existing tunnels along the Main Canal. These tunnels were constructed by drilling and blasting the rock, then forming and pouring a 6-foot-diameter concrete lining inside the tunnel. Wood cribbing was used to support the tunnel and form the concrete lining. Little else is known about these tunnels. The tunnels are reportedly in good condition. No tunnel collapses or other significant maintenance issues have been reported.

The tunnels are undersized to accommodate the design flow rate of 370 cfs. Therefore, rehabilitating and enlarging the tunnels may be required to achieve the desired flow capacity. Figure 3-3, included at the end of this section, shows one option for rehabilitating a tunnel. The concrete lining inside the tunnel will be removed, and, if necessary, the rock tunnel will be enlarged. A new 8-foot-diameter steel-pipe lining will be inserted into the tunnel, and the annular space between the rock and steel-pipe lining will be filled with grout. Upon completion, the finished inside diameter will increase from 6 to 8 feet.

Rehabilitating the tunnels may be desirable because the basic tunnel is already in place and the amount of rock material to be excavated is not significant. In addition, the tunnel is accessible during winter. Core drilling through the existing liner can be performed in advance of the work to determine the thickness of the lining, void space behind the lining, and native rock material. Core drilling can be used to determine the best method of removing the concrete lining and installing the new steel liner. However, the existing tunnels must be available for service from March 1 through October 15. The work may need to be sequenced over several years to ensure that YTID operations are not interrupted.

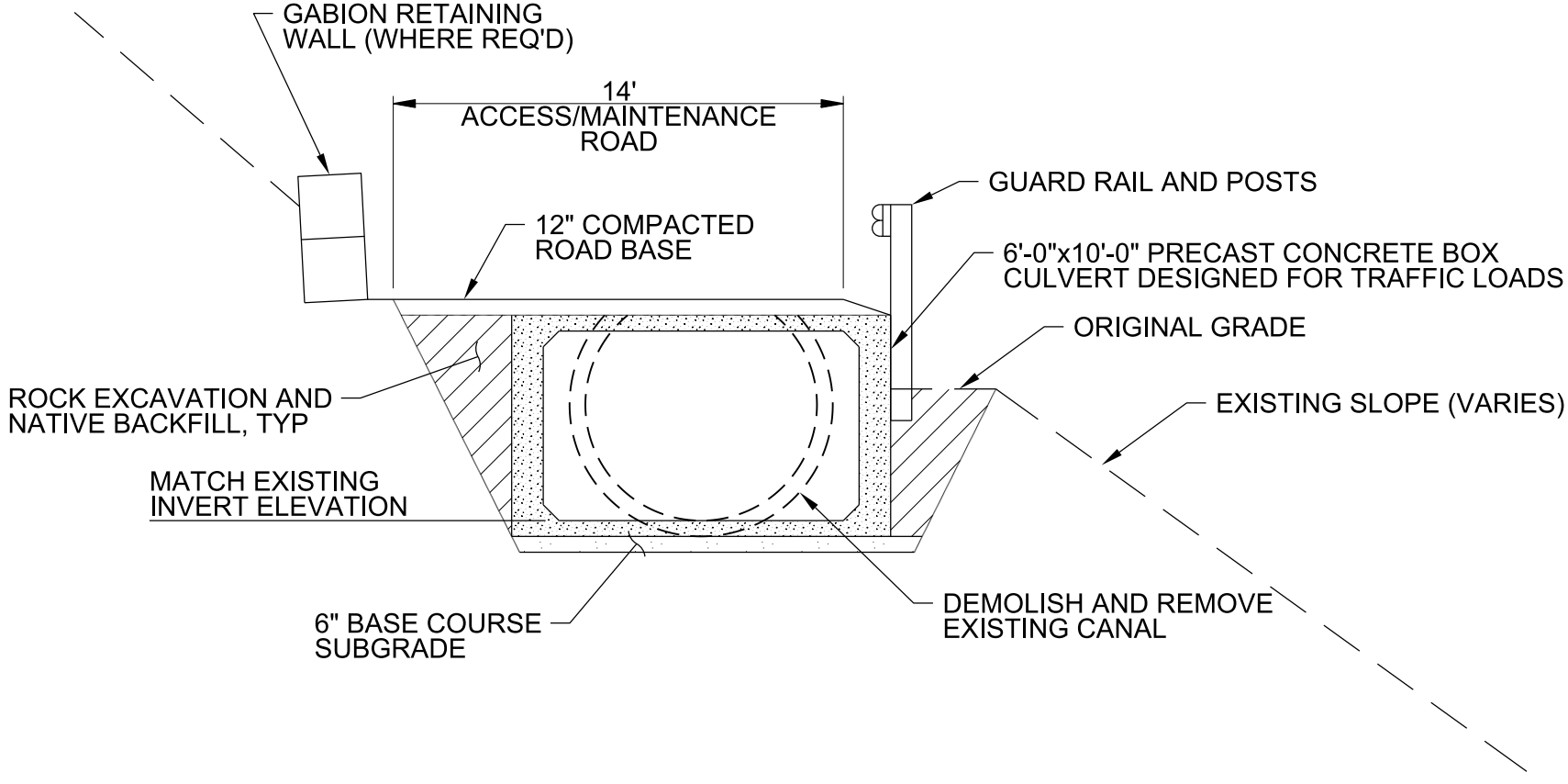
A similar configuration can be employed to construct a new tunnel. New tunnel construction will allow the work to be completed independently of YTID's existing canal during summer to avoid delaying or interfering with water deliveries.

Tunneling under the river requires specialized tunneling methods because the work is below the water table and deep below the surrounding ground surface. Typically, river crossings require a vertical tunneling shaft on each side of the river. After the vertical shafts are constructed, a horizontal tunnel is drilled from one shaft to the other, under the riverbed. For this project, the vertical tunneling shafts will be approximately 30 feet wide by 40 feet long and up to 40 feet deep. Dewatering pumps, a concrete floor, and sheetpile sidewalls typically need to be installed to protect workers in the bottom of the shaft.

3.4.4 Hybrid Alternatives

The three basic concepts presented above (box culvert, pressure pipelines, and tunnels) can be combined into dozens of potentially feasible alignment configurations. The feasible alternatives are shown in Figures 3-4a through 3-5d and are discussed in Section 6. The PCBC concept follows the existing main canal alignment. Pipelines and tunnels are shown at other locations that might be environmentally acceptable, constructable, and easy to access, operate, and maintain. Development of these alignments was based on site visits, existing, available information, discussions with YTID, and our knowledge of YTID's existing system.

Node numbers are assigned to each junction point to identify 61 independent project segments. Any combination of segments extending from the headworks to French Canyon Reservoir is a potentially feasible alignment. Section 4 discusses the evaluation criteria used to determine which alignments are favorable.



NOTES:

1. ALL WORK TO BE PERFORMED FROM OCTOBER 15 THROUGH MARCH 1.

FIGURE 3-1
Precast Concrete Box Culvert
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

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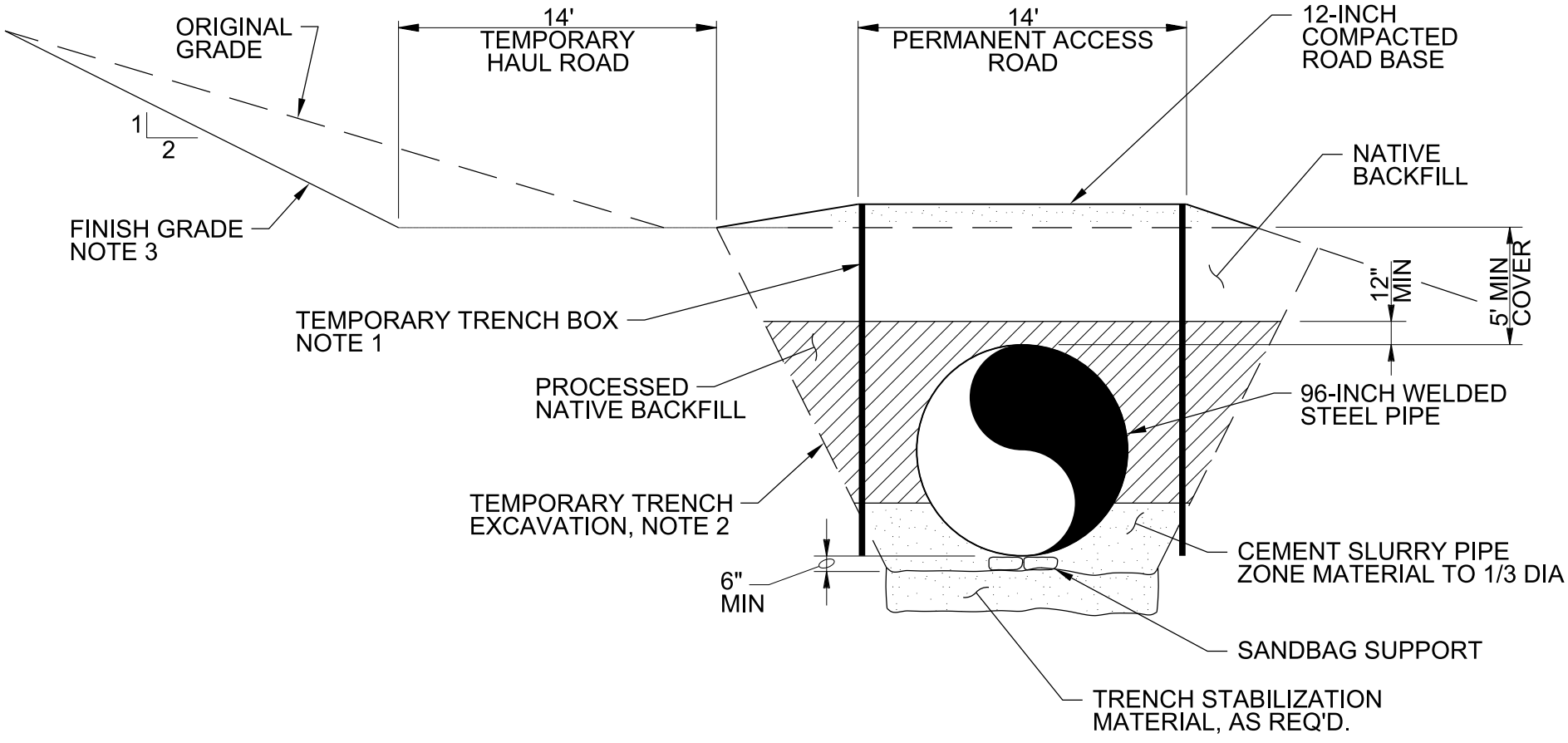

NOTES:

1. SHORE EXCAVATION FOR CONSTRUCTION SAFETY IN ACCORDANCE WITH CURRENT OSHA REQUIREMENTS.
2. TRENCH EXCAVATION INCLUDES BOULDERS AND GROUNDWATER.
3. REVEGETATE FINISH GRADE AFTER PIPE INSTALLATION.

FIGURE 3-2
Typical Large-Diameter Pipe
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

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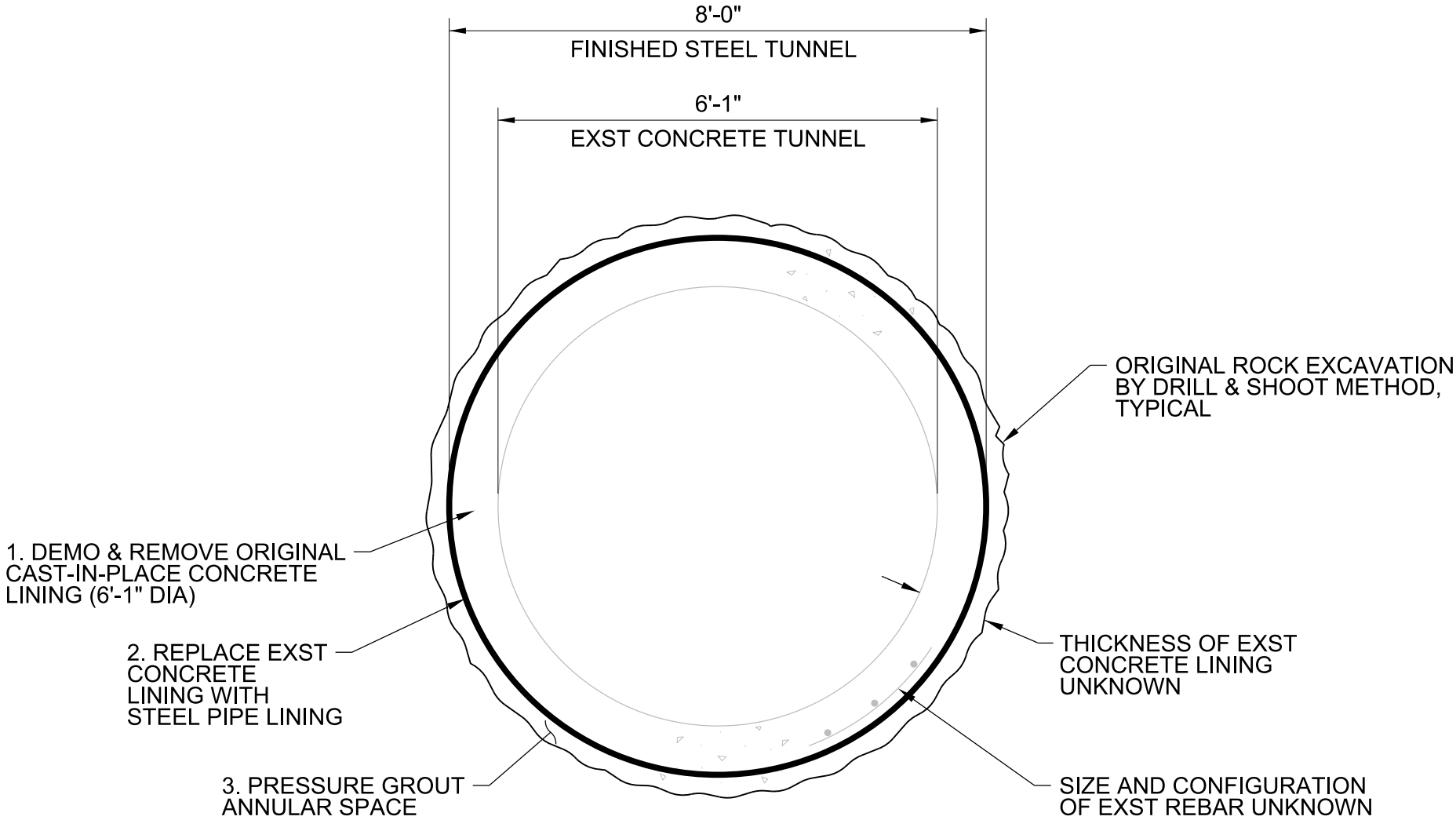

NOTES:

1. ALL WORK TO BE PERFORMED FROM OCTOBER 15 THROUGH MARCH 1.

FIGURE 3-3
Typical Tunnel Rehabilitation
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

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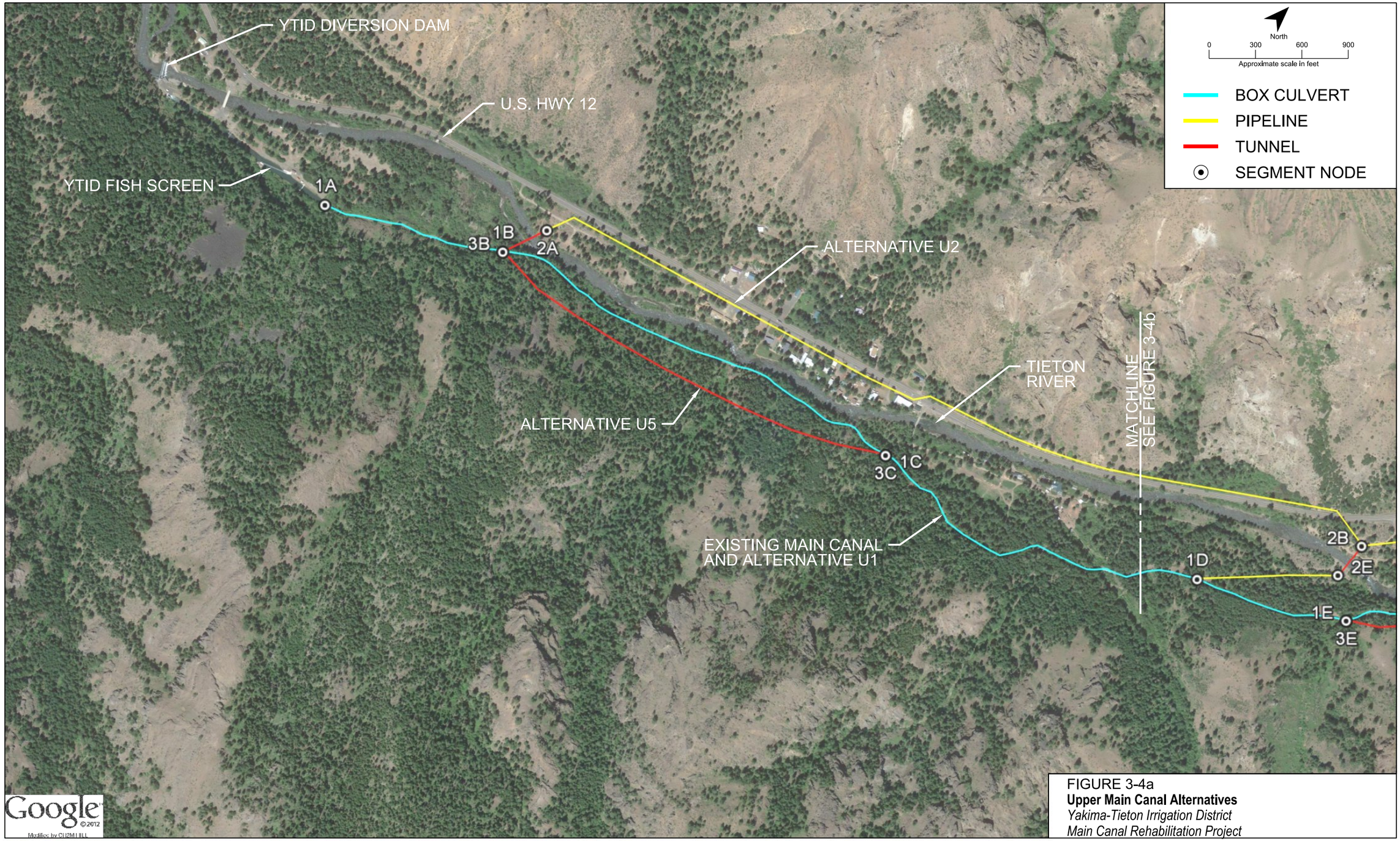

FIGURE 3-4a
Upper Main Canal Alternatives
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

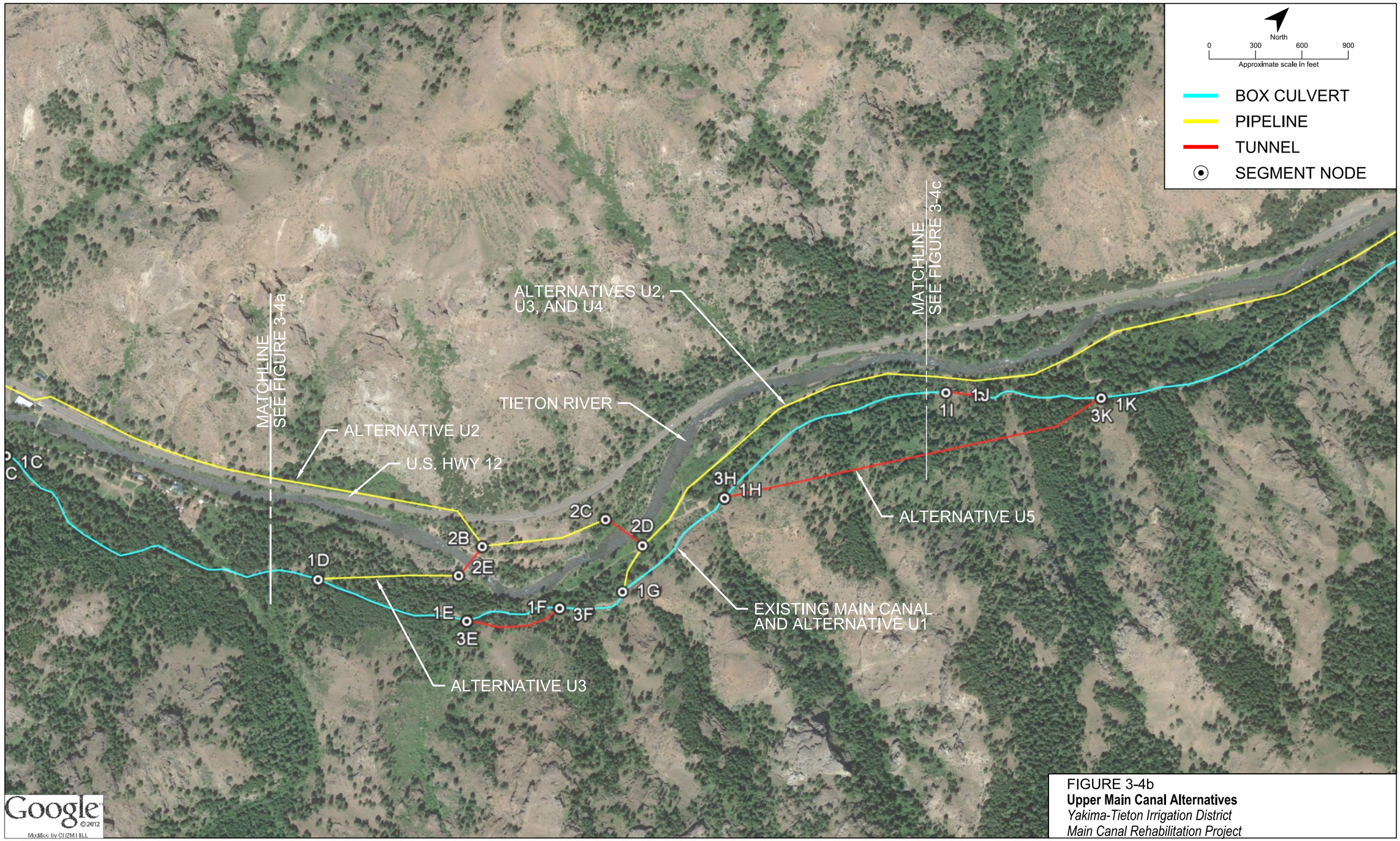

FIGURE 3-4b
Upper Main Canal Alternatives
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

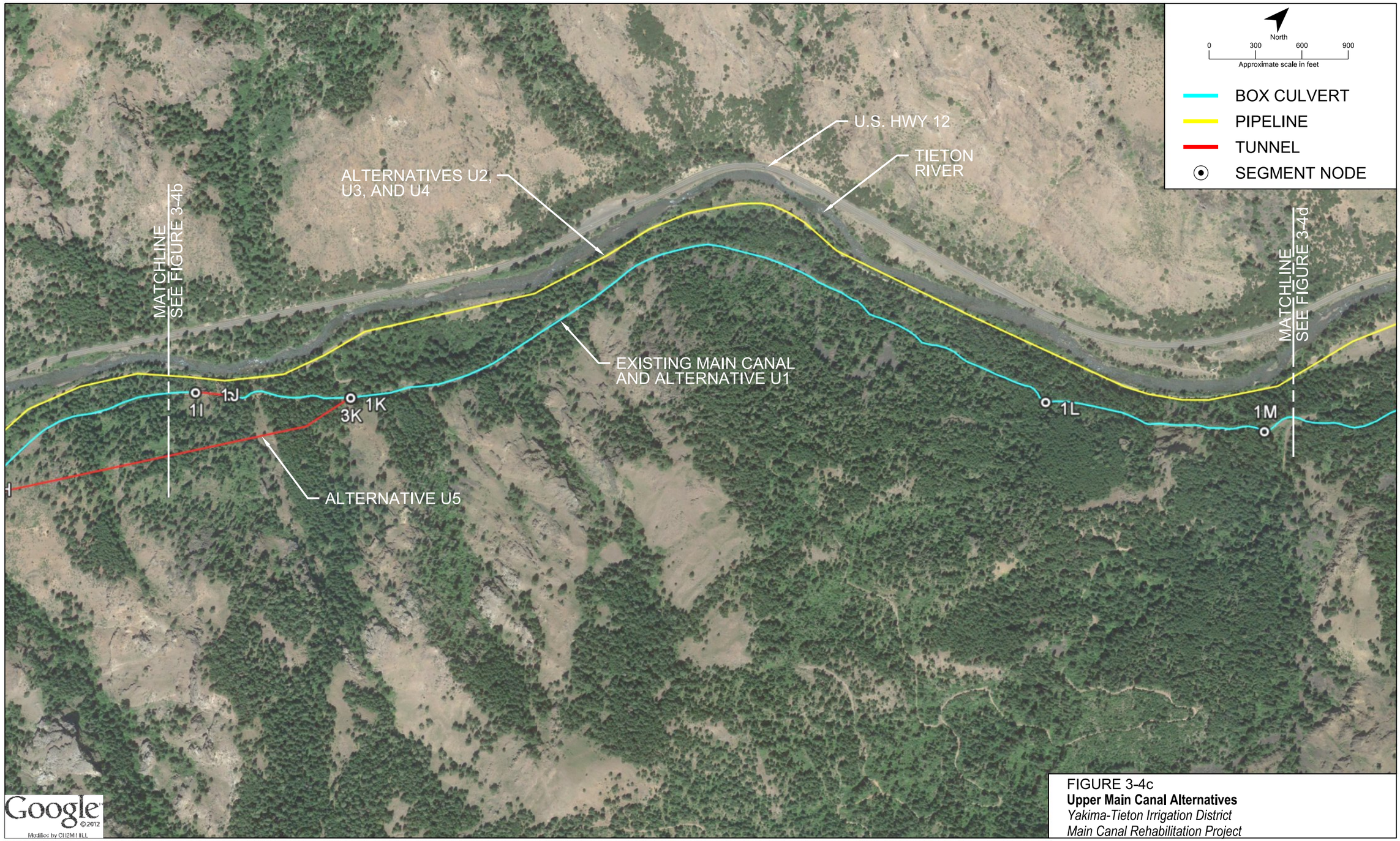

FIGURE 3-4c
Upper Main Canal Alternatives
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

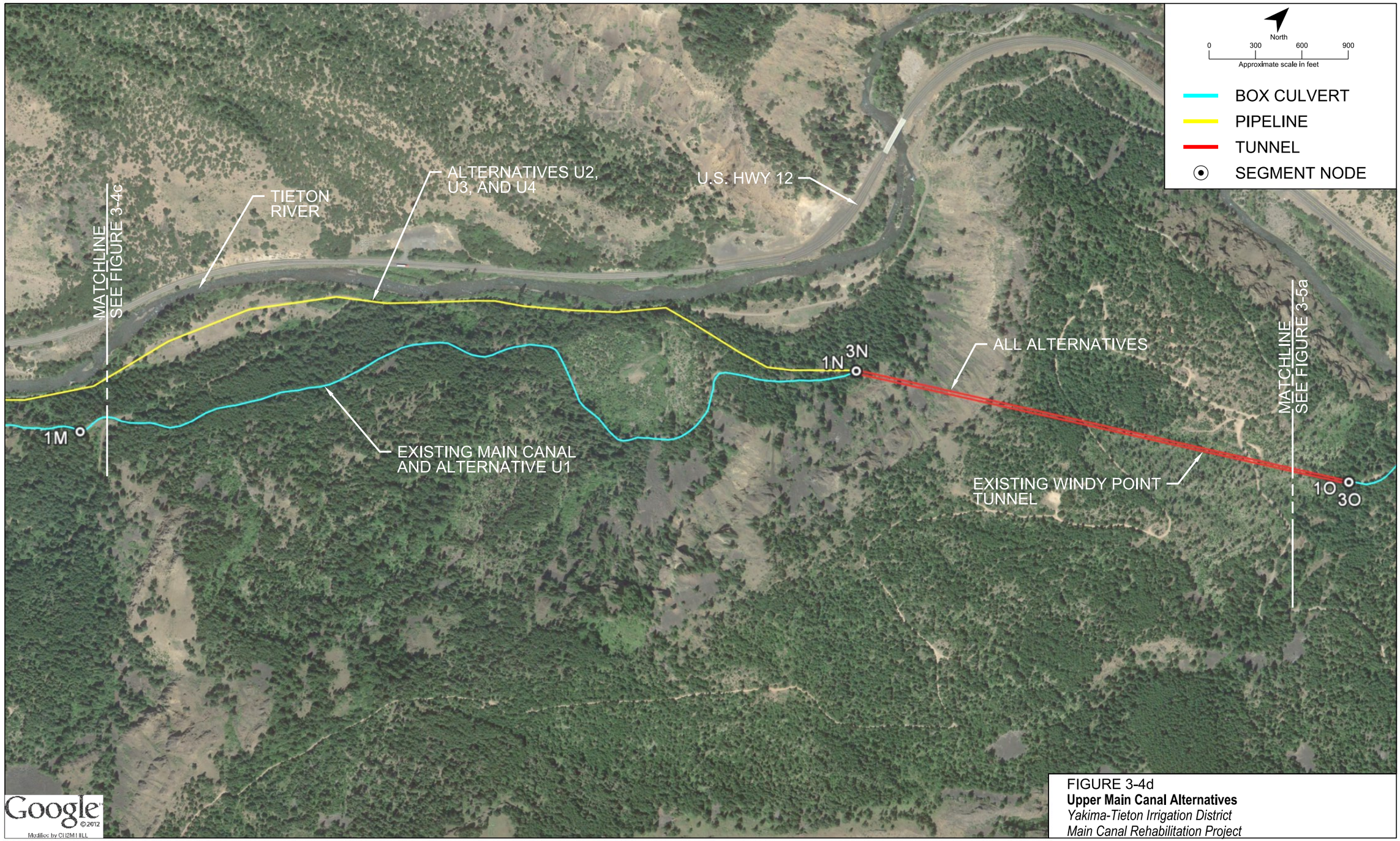

FIGURE 3-4d
Upper Main Canal Alternatives
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

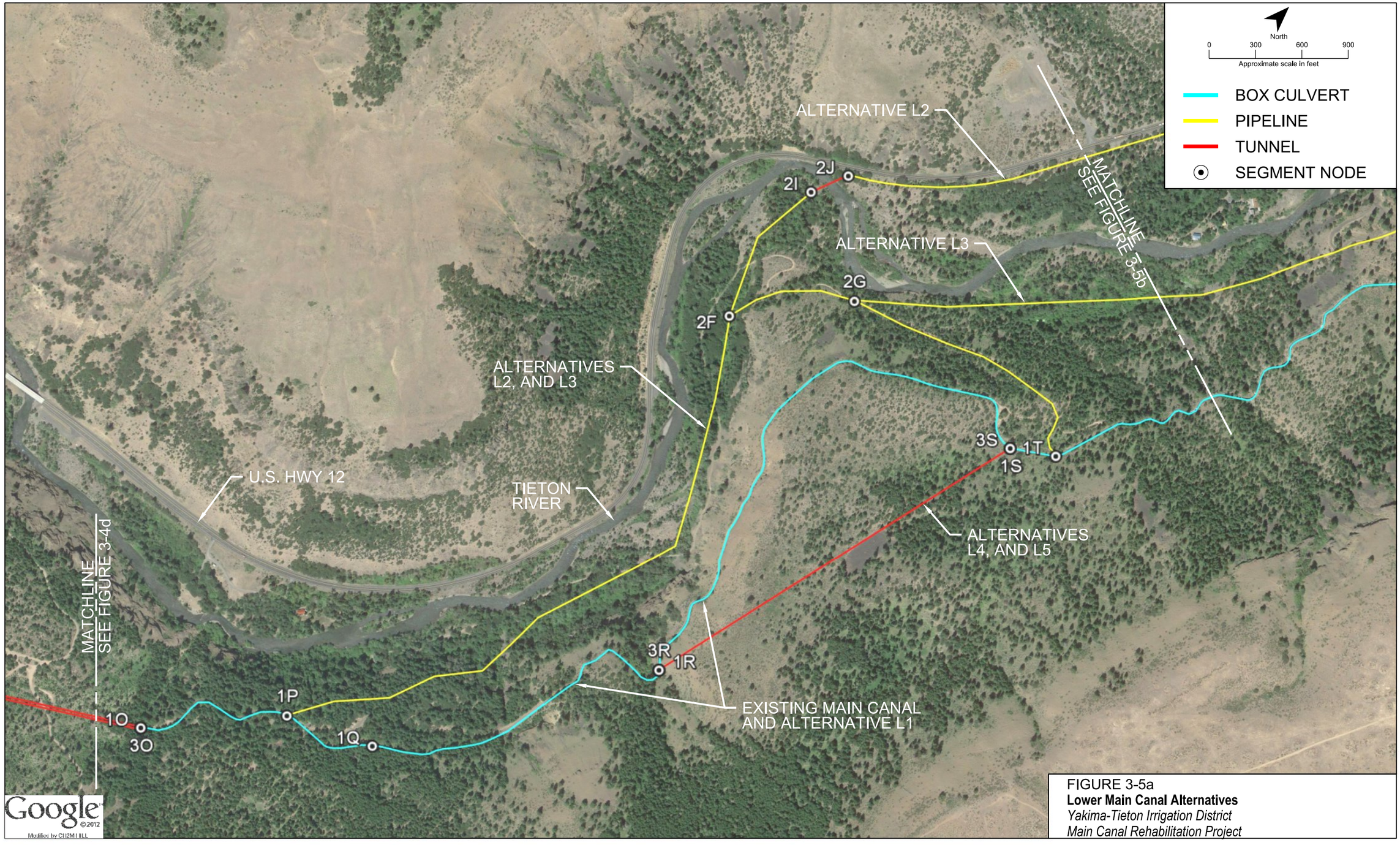

FIGURE 3-5a
Lower Main Canal Alternatives
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

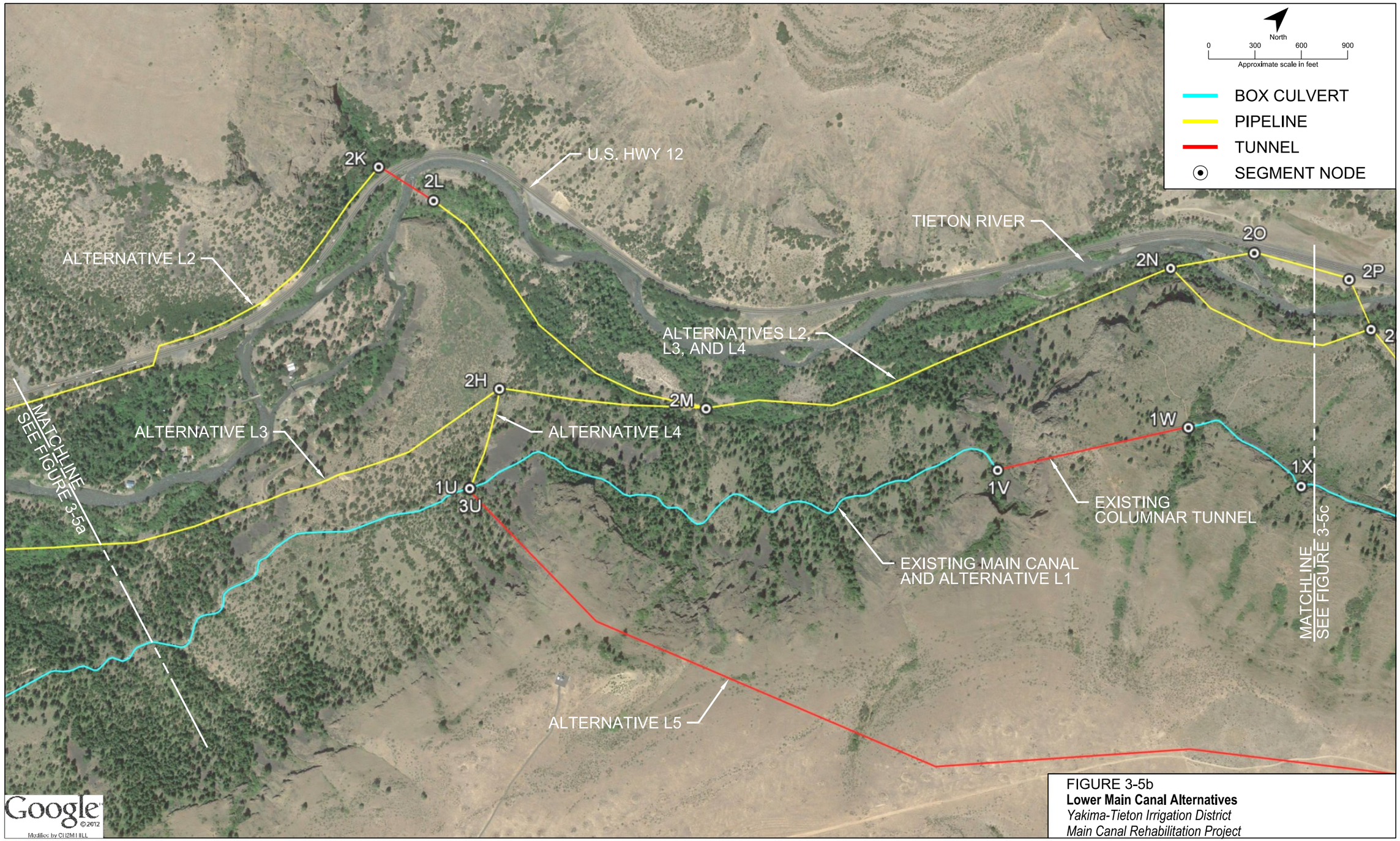

FIGURE 3-5b
Lower Main Canal Alternatives
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

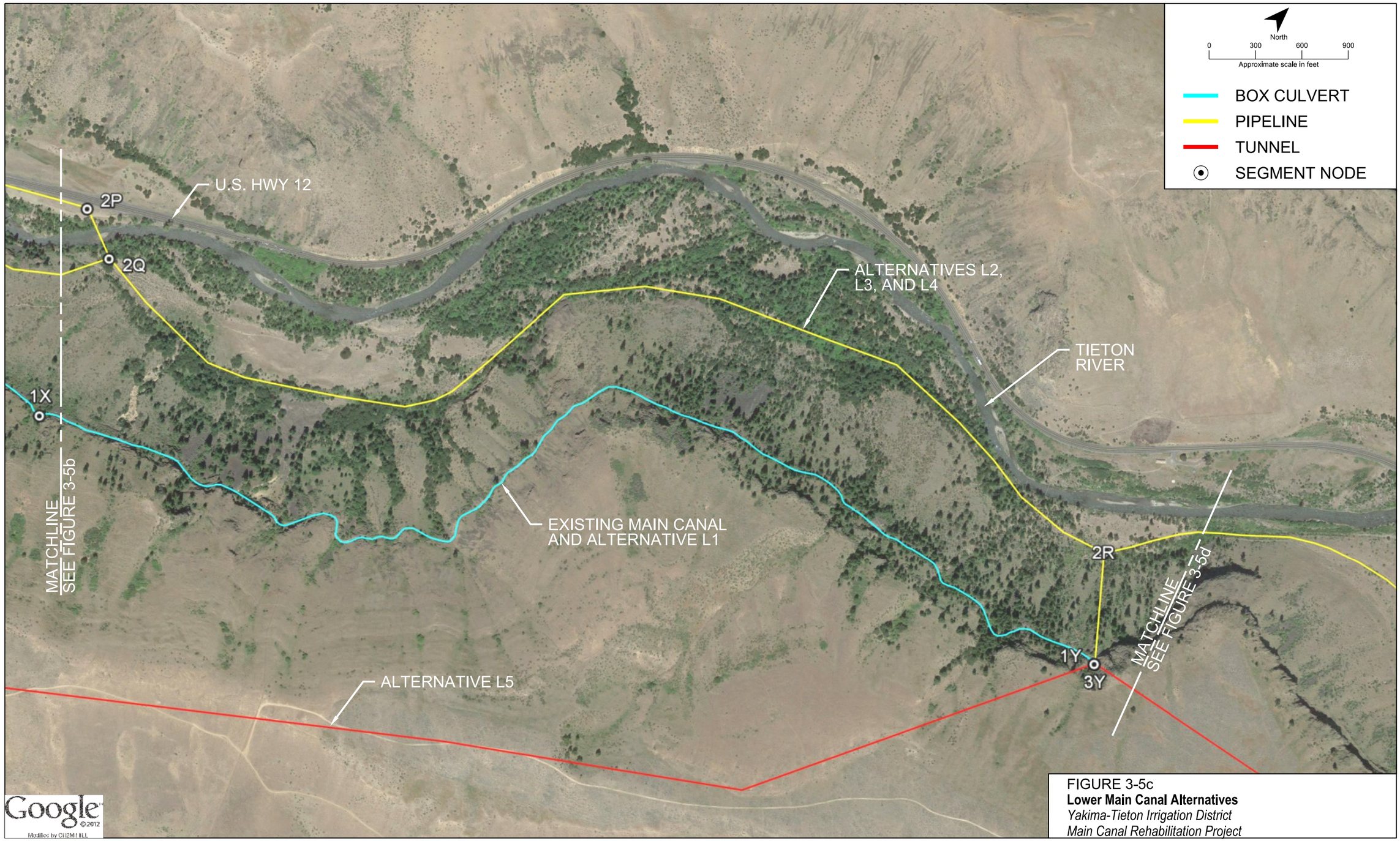

FIGURE 3-5c
Lower Main Canal Alternatives
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

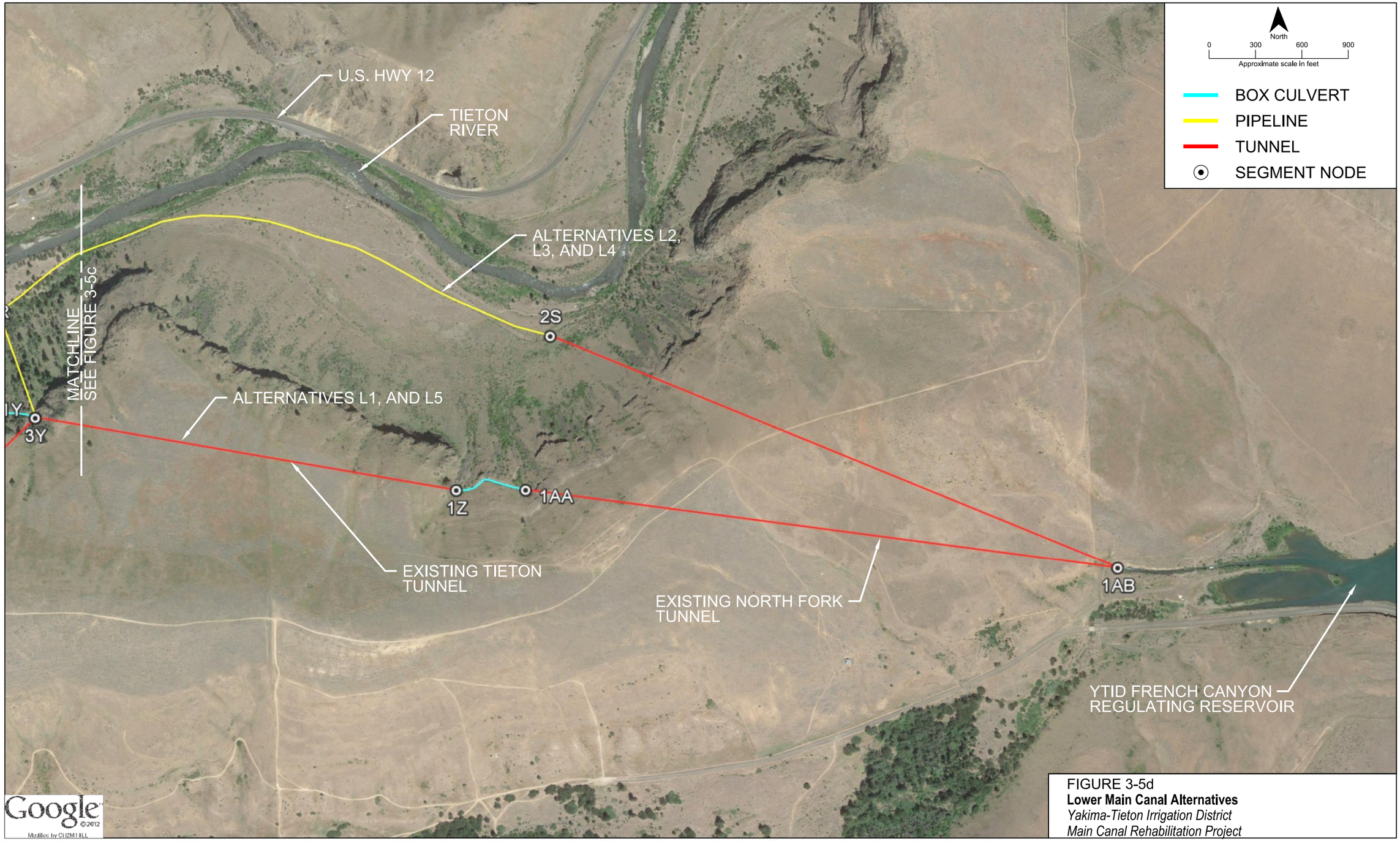

FIGURE 3-5d
Lower Main Canal Alternatives
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

CH2MHILL

SECTION 4

Alternatives Evaluation

4.1 Evaluation Criteria

CH2M HILL developed a systematic and impartial method of evaluating and ranking the alignment alternatives. First, 47 evaluation criteria were developed to independently rank and score each project segment. The evaluation criteria are consistent with YTID's goals for this project. Second, a point scoring system was developed to prioritize the evaluation criteria and quantify the benefits and constraints of each project segment relative to the criteria.

The evaluation criteria were divided into the following three categories:

- **Permitting and Environmental Criteria.** Before a project can be constructed, its environmental, biological, and socioeconomic impacts must be studied, documented, and permitted. A project with a low impact on the environment and public will generally receive public and agency support and avoid costly mitigation. Of particular concern are impacts on endangered species and their habitat and impacts on wetlands and water quality. CH2M HILL identified 21 environmental and permitting evaluation criteria for assessing the project segments (see Table 4-1, included at the end of this section).
- **Constructability Criteria.** Project construction must avoid costly change orders and claims, schedule delays, service interruptions, and hazardous or unique construction conditions. CH2M HILL developed 15 constructability criteria for assessing the project segments (see Table 4-2, included at the end of this section).
- **Operations and Maintenance Criteria.** Most importantly, the completed project must provide many years of reliable service, be easy to operate and maintain, and require reasonable and predictable operations and maintenance costs. A project that is inexpensive to build may not be desirable if the long-term operations and maintenance costs are high. CH2M HILL developed 11 operations and maintenance criteria for assessing the project segments (see Table 4-3, included at the end of this section).

Construction cost is also an important consideration. Developing a low-cost, affordable project that achieves the previously listed objectives is a key goal of YTID. The cost of each project segment is a function of the type of construction (box culvert, pipeline, etc.), the length of the segment, and the evaluation criteria listed above. Section 5 of this report includes the methodology, approach, and results of cost estimating.

4.2 Evaluation Scorecards

The evaluation criteria were used to develop a "scorecard" for each project segment. The scorecards are located in Appendix A. On the scorecards, the 47 evaluation criteria are listed, and a risk level (high, medium, low, or negligible) is assigned to each criterion for each project segment. Brief comments are provided on the scorecards to justify the risk level selections for each criterion. The assigned risk levels are based on the information presented in Tables 4-1 through 4-3 as well as visual observations in the field, knowledge of YTID's system, discussions with YTID staff, and project experience.

4.3 Criteria Scoring

Some evaluation criteria are more important to YTID than others. For example, long-term operations and maintenance issues are more important than temporary impacts during construction. To accommodate the variability of criteria importance, CH2M HILL developed a scoring system for the criteria. In the point scoring system, the total value of all 47 criteria is set at 100 points. Each criterion is assigned a fraction of the total, depending on its importance.

The point value for each criterion and the scores for each project segment were developed using the following three-step process:

1. Assign importance factors to each category of evaluation criteria.
2. Force-rank the criteria within each category and assign a weighting factor to each criterion.
3. Assign point values to the risk levels and determine total point values for each project segment.

In Step 1, an importance factor is assigned to each of the three evaluation categories (environmental, constructability, and operations and maintenance). The importance factors are expressed as percentages, from 0 to 100 percent, as shown in Table 4-4. Although the number of evaluation criteria for each category varies, these importance factors adjust and fix the total point value for each category of criteria.

TABLE 4-4
Evaluation Category Importance Factors

Evaluation Category	Importance Factor	Total Points	Justification
Environmental/ Permitting	25%	25	A project with high environmental impacts may require extensive mitigation costs, project delays, or litigation.
Constructability	25%	25	A project that is difficult to build may result in excessive claims, change orders, delays, or environmental impacts.
Operations and Maintenance (O&M)	50%	50	O&M requirements of the project will persist for decades. O&M considerations are of particular importance to the District.
	100%	100	

The importance factors listed in Table 4-4 may be adjusted based on input from YTID or other stakeholders. As discussed in Section 7 of this report, changes to the importance factors may change the overall results and recommendations.

In Step 2, the criteria within each category are force-ranked or prioritized when compared to all other criteria within the same category. For example, in the environmental and permitting category, permanent impacts on wetlands may be more important than temporary noise impacts on local residents.

Table 4-5, included at the end of this section, summarizes the force-ranking methods and results. The rows and columns of the table are labeled with the criteria. The intersection of each row and column contains an entry that shows which criterion is considered more significant. For example, the intersection of Column “E” and Row “O” contains an “E,” which indicates that wetland impacts are more significant than noise impacts. Each criterion is compared with all other criteria within the same category.

Table 4-5 includes a total count, count percentage, and weighting factor for each criterion. For example, the force-rank count on wetland impacts (Column E) is 19, versus a total count of 231. The count percentage ratio is 8.2 percent (19/231). The count percentage ratio is multiplied by the total point value for all environmental/permitting criteria (25 points) to arrive at a final criterion weighting factor of 2.1. This process continues for all criteria. The point value (weighting factor) assigned to each criterion reflects YTID’s priorities and goals. High point values represent high priorities for YTID.

In Step 3, a separate point value is assigned to each risk level (negligible, low, medium, and high). These risk levels describe the impacts of a given criterion for a specific segment. For example, wetlands impacts may be low for one segment and high for another segment.

Point values of 0, 2, 4, and 6 have been arbitrarily assigned to the negligible, low, medium, and high risk levels, respectively. The final score for each criterion and segment is the product of the weighting factor for

the criterion and the risk level. For example, the total score for a high- and low-risk wetland impact at two different project segments follows:

Criterion	Weighting Factor	Risk Level	Risk Score	Total Score
Wetlands	2.1	High	6	12.6
Wetlands	2.1	Low	2	4.2

The scorecards in Appendix A contain the final scores for each criterion and each project segment. The sum of the point values for all criteria on a given segment becomes the overall risk score for that segment. Total scores for the project segments range from 128 to 321. Higher scores indicate higher risk and complexity.

4.4 Summary of Project Segment Scoring

Table 4-6 summarizes weighted average risk scores for each type of construction and each category of evaluation criteria.

TABLE 4-6
Weighted Average Risk Scores

		Evaluation Category			
Type of Construction	No. of Segments	Environmental/ Permitting	Constructability	Operations and Maintenance	Total Score
Box Culvert	22	35	75	97	208
Pipeline	21	73	51	87	211
Tunnels	18	20	102	97	219

Observations and explanations for the scoring results are provided below.

4.4.1 Environmental/Permitting Scores

In the environmental/permitting category, tunneling has the lowest risk. Because tunneling is below ground, it typically does not affect sensitive biology or habitat, and it does not disturb the public. River tunneling scores raise the average score for this type of construction because of potential water quality and fisheries impacts.

Box culvert construction has a relatively low risk on the environment. The box culvert is located in the disturbed right-of-way of the existing flume; therefore, construction will create minimal new impacts on the public or the environment.

Pipeline construction has a higher potential risk on the environment. Pipeline construction requires new land clearing, which is often adjacent to or in the river, and may be visible or disruptive to the public. Pipeline construction directly adjacent to or within the river channel has the highest overall permitting and environmental risk.

4.4.2 Constructability Scores

In the constructability category, pipeline construction has the lowest risk. Large-diameter pipeline construction is common throughout the United States, and many large contractors are well qualified to provide the work. Pipelines for this project are located in areas that do not interfere with existing YTID water deliveries, except at locations where pipelines connect to the existing canal. This allows the work to be completed during summer when temperatures are mild and daylight hours are long.

Box culvert construction reflects the higher risk of winter construction, the potential for delays and impacts on YTID operations caused by working within the existing canal right-of-way, and the risks associated with working on the steep hillside segments, particularly below the Windy Point Tunnel.

Tunneling is typically high risk work, particularly when the tunneled material is non-homogeneous and below the water table.

4.4.3 Operations and Maintenance Scores

In the operations and maintenance category, pipelines have the lowest risk because they are located on flatter ground, buried, and easier to access than the box culverts or tunnels, especially for the Lower Main Canal downstream of the Windy Point Tunnel.

If the importance factors shown in Table 4-4 are changed to emphasize a different set of priorities, the risk scores for all project segments will change.

4.4.4 Total Risk Scores

In Sections 5 and 6 of this report, the risk score for each project segment is compared to the average, and this ratio is used to adjust the cost of the project segment. In Section 7, the series of segments with the best overall cost and risk ranking is identified as the apparent best alignment.

TABLE 4-1
Permitting and Environmental Evaluation Criteria

			Examples of Criterion Risk Levels			
Permitting/Environmental Criterion		**Why is this Criterion Important to the District?**	**High Impact/Risk**	**Medium Impact/Risk**	**Low Impact/Risk**	**Negligible Impact/Risk**
A	State/Federal Endangered Species	Federally listed endangered species in Yakima County include the bull trout, grizzly bear, and gray wolf. State protected species include the Golden Eagle and bull trout. Environmental studies (biological assessment, habitat management plan), mitigation measures, and required scheduling constraints can delay the project and increase costs.	Construction occurs in-river (open-cut trenching) where bull trout can be directly affected. Also, construction during spring, summer, or fall has high risk of encountering bears as compared to winter construction, when bears hibernate.	Construction occurs under the river (tunneling) or within the riparian area (100 feet from the river), where sediments from construction can enter the river, potentially harming fish and habitat. Construction can occur in spring, summer, and fall as an option to winter construction.	Construction occurs near the river (beyond the 100-foot riparian area, but within the 200-foot shorelines area) where sediments from construction can enter the river, potentially harming fish and habitat. Construction can occur in spring, summer, and fall as an option to winter construction.	Construction occurs far from the river (beyond the 200-foot shorelines area) and may be elevated above the river to distance construction from river. Construction occurs only during the winter.
B	Migratory Fish and Wildlife	In-river work, potential release of sediments, or construction noise in-river requires environmental studies, mitigation measures, and approved fish window for construction period, which can delay the project and increase costs. Also, provisions for wildlife passage can increase costs.	Construction occurs in-river during the approved fish window or requires an extension to work beyond approved fish window. Wildlife passage should be provided for the project.	Construction in-river can be completed within the approved fish window without schedule extension, or construction occurs within the 100-foot riparian area. Wildlife passage may be required for the project.	Construction occurs outside the river where an approved fish window is not necessary, and work is beyond the 100-foot riparian area.	Construction occurs outside the river where an approved fish window is not necessary, and work is beyond the 200-foot shorelines area.
C	Migratory Birds/Raptors	Migratory bird nests must not be disturbed during nesting/fledging season, which may delay construction and increase costs. Potential impacts require environmental studies and mitigation measures. Also, habitat-protected areas may prohibit construction activities.	Construction occurs within 1/4 mile of protected habitat (Oak Creek cliffs where Golden Eagles nest) or occurs within thickly forested lands during the nesting/fledging season.	Construction occurs within 1/2 mile of protected habitat (Oak Creek cliffs where Golden Eagles nest) or occurs on a mix of forested and non-forested lands during the nesting/fledging season.	Construction occurs more than ½ mile from protected habitat (Oak Creek cliffs where Golden Eagles nest) and occurs on predominately non-forested lands. Work may or may not occur during the nesting/fledging season.	Construction occurs more than 1 mile from protected habitat (Oak Creek cliffs where Golden Eagles nest) and occurs on non-forested lands outside the nesting/fledging season.
D	Riparian Habitat	Construction activities within the riparian area (100 feet from the river) require environmental studies (habitat management plan) and mitigation measures, which can increase costs.	Construction occurs within the riparian area.	Construction occurs outside the riparian area but within the shorelines area (200 feet from the river).	Construction occurs outside the shorelines area.	Construction occurs outside the shorelines area.
E	Wetlands	Construction activities within wetland areas require environmental studies (wetland inventory, delineation, and mitigation plan) and mitigation measures, which can increase costs.	Construction occurs within wetlands.	Construction may occur within wetlands because construction occurs within the riparian area or floodplain where likelihood of wetlands is high.	Construction is not likely to occur within wetlands because construction area is outside the riparian area and floodplain. It may be within the shorelines area but elevated above the river.	Construction will avoid wetlands because construction area is outside the shorelines area and floodplain and may be elevated above the river.
F	Streambed/Shoreline Encroachment	Tieton River shoreline areas are protected within 200 feet of the river, and work within the floodplain can require restrictions, environmental studies (hydraulic analysis), and mitigation measures, which can increase costs.	Construction occurs within the shorelines area or within the floodplain.	Construction occurs within the shorelines area but may be outside the floodplain.	Construction occurs outside the shorelines area but within the floodplain.	Construction occurs outside the shorelines area and above the floodplain.
G	Land Use	New right-of-way (ROW) requires new agreements from private landowners and government agencies. The proximity of private landowners to the project may impose requirements to avoid property damage, noise, dust, access delays, or safety concerns. These requirements and ROW acquisition can delay the project and increase costs.	Construction occurs outside existing ROW. Construction activity is noticeable or requires use of residential property or businesses for access, stockpiling, or other uses.	Construction occurs outside existing ROW. Construction is not noticeable from property owners, but requires large swaths of vegetation removal.	Construction occurs within existing ROW and is noticeable or is adjacent to private landowners or government agencies.	Construction occurs within existing ROW and is not noticeable or is at a distance from private landowners or government agencies.
H	Erosion/Vegetation Removal	Erosion controls and the amount of vegetation removal required for construction can delay the project and increase costs.	Steep hillsides and narrow working spaces require large earthwork that is subject to erosion. Also, site is thickly vegetated with shrubs and trees that need to be removed.	Steep hillsides and narrow working spaces require large earthwork, but shrub and tree removal is minimal, or construction workspace is adequate, but site is thickly vegetated with shrubs and trees.	Adequate construction workspace is available, and few shrubs and trees require removal.	Ground surface disturbance is minimal because work is on flat ground with adequate working space. Few to no shrubs and trees require removal.
I	Water Quality	Construction activities must protect water quality (prevent frac-out and spills), which can require environmental studies and mitigation or restoration measures that delay the project and increase costs.	Works requires open trench construction in the Tieton River or construction within the riparian area.	Work requires tunneling under the river or work outside the riparian area but within the shorelines area.	Construction occurs outside the shorelines area and may be elevated above the river.	Construction occurs far from the river or elevated above the river where frac-out is unlikely and spills will not reach the river. Also, ground surface excavation is minimal.

TABLE 4-1
Permitting and Environmental Evaluation Criteria

			Examples of Criterion Risk Levels			
Permitting/Environmental Criterion		**Why is this Criterion Important to the District?**	**High Impact/Risk**	**Medium Impact/Risk**	**Low Impact/Risk**	**Negligible Impact/Risk**
J	Air Quality	Dust control complaints from the public can delay the project, and dust control measures can increase costs.	Construction occurs on Highway 12 ROW or construction is on or near private property.	Construction activity is visible and near or adjacent to Highway 12 or private property.	Construction activity is visible but not near Highway 12 or private property.	Construction activity is not visible and is not near Highway 12 or private property.
K	Hazardous Materials	Encountering hazardous materials during construction can result in cleanup that delays the project and increases costs.	Construction occurs on private property where there may be historical spills or underground storage tanks.	Construction occurs on Highway 12 where there may be historical spills, but not near residences and businesses.	Construction occurs near Highway 12 ROW or near private property where there may be historical spills or underground storage tanks.	Construction occurs far from Highway 12 and far from private properties.
L	Cultural Resources	Encountering cultural resources during construction can result in preserving archeological findings that delays the project and increases costs.	Construction occurs next to the river where cultural resource sites are more likely.	Construction occurs near the river where cultural resource sites have a likelihood of occurrence.	Construction occurs near the river but on elevated ground. Cultural resources sites are possible but less likely.	Construction occurs far from the river and elevated above the river. Cultural resources sites are not expected.
M	Historic Resources	Documentation of historic properties and structures older than 50 years can increase costs.	Construction occurs on the existing canal route. The canal is older than 50 years and likely eligible for listing because of its historic significance.	Construction occurs near Rimrock Retreat or other residences or businesses where buildings may be historic.	Construction occurs near properties that may be historic because land is near human activity, but rugged nature of the land makes this unlikely.	Construction occurs far from known historic resources. Construction occurs on land far from the river and on elevated ground where human activities have been minimal.
N	Aesthetics	Alteration of the view shed can lead to public complaints and protection of views that can delay the project and increase costs.	Construction activity, construction pathway, or final transport mechanism (aboveground canal) is in full view of the public.	Final transport mechanism (pipeline) is not viewable by the public, but construction and construction pathway are visible from Highway 12 or from private property.	Final transport mechanism may be viewable by the public. Construction activity and construction pathway may be visible at a distance.	Construction activity or final transport mechanism (tunnel) is not viewable by the public.
O	Noise	Construction noise can generate complaints from the public, resulting in mitigation measures that can delay the project and increase costs.	Construction occurs through Rimrock Retreat or past residences and businesses.	Construction occurs near Rimrock Retreat or near residences and businesses.	Construction occurs near Highway 12, but not near Rimrock Retreat or residences and businesses.	Construction occurs far from Highway 12, Rimrock Retreat, or residences and businesses.
P	Transportation/Traffic	Traffic delays or detours caused by construction activities can generate complaints from the public, resulting in mitigation measures that can delay the project and increase costs.	Construction occurs through Rimrock Retreat or past residences and businesses and will restrict access or delay traffic.	Construction occurs along Highway 12, including access to river construction sites where traffic may be delayed during construction.	Construction traffic is on private property ROW where access agreements have been acquired.	Construction occurs far from Highway 12 and far from local residences and businesses.
Q	Recreation Impacts	Section 4(f) regulations require that construction and operational activities must avoid impacts on public parks and wildlife recreational areas. If unavoidable, mitigation measures can delay the project and increase costs.	Construction occurs in public parks or at wildlife recreational areas.	Construction avoids public parks and wildlife recreational areas, but may restrict or delay access or affect use of informal recreational sites or wildlife recreational areas.	Construction occurs near public parks or wildlife recreational areas.	Construction avoids public parks and wildlife recreational areas. There are no anticipated public use impacts, either directly or indirectly, on these properties.
R	Emergency Response	Construction activities that interfere, delay, or prevent emergency response may need mitigation or construction plans that can delay the project and increase costs.	Construction activity causes traffic delays, slowing emergency response on Highway 12 and to residences and businesses. Supplemental services are required.	Construction activity creates traffic delays on Highway 12 and to residences and business that will slow emergency response. Supplemental services are not necessary.	Construction activity creates traffic delays only to local residences and businesses, but not on Highway 12. Supplemental services are not necessary.	Construction activity does not create traffic delays on Highway 12 or to residences and businesses. Therefore, there is no delay in emergency response.
S	Service Impacts	Construction activities that interfere, delay, or prevent public services may need mitigation or construction plans that can delay the project and increase costs.	Construction activity disrupts public services (e.g., water disconnected). Supplemental services are required.	Construction activity may disrupt public services (e.g., known public services are mapped for avoidance but may be accidently encountered).	Construction activity is near public services, but no known public services are located in construction area.	Construction activity does not disrupt public services. Construction is far removed from public services.
T	Socioeconomic/Economic Impacts	Construction activities that interfere or damage the socioeconomic and economic well-being of the local community may need mitigation or construction plans that can delay the project and increase costs.	Construction activity interferes or damages the socioeconomic and economic well-being of the local community (e.g., temporary closure of a business). Loss to business must be remedied.	Construction activity may interfere or damage the socioeconomic and economic well-being of the local community (e.g., alternative access to business is provided to keep business open).	Construction activity is near residences and businesses but does not interfere or damage the socioeconomic and economic well-being of the local community.	Construction activity does not interfere or damage socioeconomic and economic well-being of the local community. Construction is far removed from human activity centers.
U	Energy Consumption	Energy consumption required to construct a project or energy supply needs for operations can increase costs if existing systems are not adequate.	Project requires major change in energy consumption as compared to existing operations. Existing energy supply is not sufficient for construction/operational needs.	Project requires minor change in energy consumption as compared to existing operations, but existing energy supply is not sufficient for construction/operational needs.	Project requires minor change in energy consumption as compared to existing operations. Existing energy supply is sufficient for construction/operational needs.	Project does not require change to energy consumption as compared to existing operations. No additional energy supply needs are required during construction.

TABLE 4-2
Constructability Evaluation Criteria

	Constructability Criterion	Why is this Criterion Important to the District?	Examples of Criterion Risk Levels			
			High Impact/Risk	**Medium Impact/Risk**	**Low Impact/Risk**	**Negligible Impact/Risk**
V	Easement Acquisition	Easements are required for work on property owned by others. Obtaining easements on property owned by others can be expensive and time-consuming.	Temporary or permanent easements are required from private property owners with existing improvements on the land.	Temporary or permanent easements are required on environmentally sensitive public property.	Temporary easements are required on low-value public property.	No easements are required. YTID has existing easements or already owns the property where proposed facilities are located.
W	Access Constraints	Remote areas difficult to access may require new access roads or bridges to reach the construction site. New roads and bridges are expensive, time-consuming, and a potential environmental impact.	Long roads or bridges must be constructed to reach the construction site.	Short roads must be constructed to reach the work site.	Existing roads are available to reach the construction site, but they are long or steep.	Existing roads provide easy access to the construction site.
X	Landowner Conflicts	Landowner complaints about property damage, noise, dust, access delays, or safety concerns can delay the project and increase costs.	Construction work is directly adjacent to or crosses private residential property or businesses.	Construction work is near private property or the contractor shares access roads with local landowners.	Construction is visible to local landowners but distant. Contractor may cause temporary access delays.	The construction site has no impact on private property.
Y	Utility Conflicts	Utility relocations increase project costs and construction duration.	Construction activities encroach upon and parallel high-value utilities (e.g. fiber optics or high-voltage powerlines).	Construction activities cross lower value utilities that can be temporarily relocated.	Utility conflicts are minor.	No known utility conflicts exist.
Z	Weather Conditions	Winter construction may be required to avoid conflicts with YTID water deliveries. Winter construction can significantly reduce the speed and increase the cost of construction.	Winter construction occurs on steep north-facing slopes or remote areas.	Winter construction occurs on mild slopes and easily accessible areas.	Year-round construction occurs, but connections to existing YTID facilities occur during winter.	Year-round construction occurs on flatter ground. No connections to existing YTID facilities occur.
AA	Soil/Slope Stability	Steep slopes prone to rock and debris slides can be a safety concern and can increase construction costs and construction duration.	Construction area includes known slide areas with recent rockfall or movement. Construction area includes steep side slopes with limited work areas.	Construction area includes steep side slopes. Construction area includes historical slide areas with no recent movement.	Construction area includes moderate side slopes. No recent rock or debris slides have occurred in construction area.	Construction area includes flatter ground with low potential for rock or debris slides.
BB	Subsurface Conditions	Subsurface conditions, especially rock and boulder excavation, can increase project costs and construction duration. In extreme cases, blasting may be required to remove rock.	Tunneling is required in locations where the type of rock may be variable, and subsurface exploration to determine the location and type of rock is not feasible.	Trench excavation is required near the river and may encounter large boulders or require rock excavation.	Trench excavation is required in existing disturbed corridors (e.g., Highway 12) where underground conditions are known.	Subgrade preparation along the existing canal alignment requires minimal excavation and backfill. Potential for significant rock excavation is low.
CC	Groundwater	New construction work must be installed in dry conditions to obtain adequate foundations and compaction. Groundwater removal can increase project costs and delay construction.	Deep trench excavation is required near the river, below the water table. Tunneling is required.	Deep trench excavation is required near the river, partially below the water table.	Subgrade preparation is required along the existing canal alignment where snow, ice, or seeping water can affect foundation conditions and compaction.	Trench excavation is required above the river water table, during summer.
DD	Connections to Existing Facilities	Connections to existing YTID facilities, such as pipe bridges and tunnel portals, may require off-season cast-in-place transition sections, which can be expensive and slow to construct.	Existing tunnels must be rehabilitated in the off-season and must transition to pipelines or box culverts at the tunnel portal.	Work requires multiple connections to existing YTID facilities.	Work is independent of existing YTID facilities except for one or two connections to existing facilities.	Work does not include connections or transitions to existing facilities.
EE	Work Space Constraints	The contractor needs haul roads and laydown areas for materials and equipment. Lack of space increases cost and reduces efficiency.	Tunneling requires a confined space with limited work areas. Portions of the existing canal on steep side slopes are also restrictive. Space is not available for haul roads and laydown areas.	Side slopes are steep with severely constrained space for the work.	Work space is relatively flat with room for at least one haul road adjacent to the work.	The work area is flat with available laydown areas and haul roads.
FF	Equipment and Materials	The use of special equipment and materials can increase construction costs, reduce availability, and increase construction duration.	Work requires extensive special techniques such as open-cut river crossings, temporary river diversions, or sheet pile for tunneling.	Work requires special techniques such as deep trenches, large earth-moving equipment, or rockfall protection.	Work requires limited special techniques such as traffic control or water removal.	Work requires no special construction materials or equipment.
GG	Sequencing/Schedule Constraints					
HH	Unique Construction Methods					
II	YTID Service Interruptions					
JJ	Public Safety/Worker Safety					

TABLE 4-3
Operations and Maintenance Evaluation Criteria

			Examples of Criterion Risk Levels			
	O&M Criterion	**Why is this Criterion Important to the District?**	**High Impact/Risk**	**Medium Impact/Risk**	**Low Impact/Risk**	**Negligible Impact/Risk**
KK	Routine Visual Observation					
LL	Slope Stability Maintenance					
MM	Erosion/Scour Maintenance					
NN	Corrosion Maintenance					
OO	Access Road Maintenance					
PP	Startup/Shutdown Operations					
QQ	Mechanical Maintenance					
RR	Periodic Pipe/Canal Maintenance					
SS	Power Failure					
TT	Redundancy					
UU	Power Production					

TABLE 4-5
Individual Weighting Factors

	Permitting/Environmental Criteria	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	
A	State/Federal Endangered Species	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B	Migratory Fish and Wildlife	A	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
C	Migratory Birds/Raptors	A	C	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
D	Riparian Habitat	A	D	C	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
E	Wetlands	A	E	E	E	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
F	Streambed/Shoreline Encroachment	A	B	C	D	E	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
G	Land Use	A	B	C	D	E	F	G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
H	Erosion/Vegetation Removal	A	B	C	D	E	F	H	H	-	-	-	-	-	-	-	-	-	-	-	-		
I	Water Quality	A	B	C	D	E	F	I	I	I	-	-	-	-	-	-	-	-	-	-	-	-	
J	Air Quality	A	B	C	D	E	F	G	H	I	J	-	-	-	-	-	-	-	-	-	-	-	
K	Hazardous Materials	A	B	C	D	E	K	K	K	K	K	K	-	-	-	-	-	-	-	-	-	-	
L	Cultural Resources	L	L	L	L	L	L	L	L	L	L	L	L	-	-	-	-	-	-	-	-	-	
M	Historic Resources	A	B	C	D	E	F	M	H	I	M	K	L	M	-	-	-	-	-	-	-	-	
N	Aesthetics	A	B	C	D	E	F	N	H	N	N	K	L	N	N	-	-	-	-	-	-	-	
O	Noise	A	B	C	D	**E**	F	G	H	I	O	K	L	O	N	O	-	-	-	-	-	-	
P	Transportation/Traffic	A	B	C	D	E	F	P	H	I	P	K	L	M	N	P	P	-	-	-	-	-	
Q	Recreation Impacts	A	B	C	D	E	Q	Q	Q	Q	Q	K	L	Q	Q	Q	Q	Q	-	-	-	-	
R	Emergency Response	A	B	C	D	E	F	G	H	I	R	K	L	M	N	R	R	Q	R	-	-	-	
S	Service Impacts	A	B	C	D	E	F	G	H	I	S	K	L	M	N	S	S	Q	R	S	-	-	
T	Socioeconomic/Economic Impacts	A	B	C	D	E	T	T	T	T	T	K	L	M	T	T	T	T	T	T	T	-	
U	Energy Consumption	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	T	T	U	
Criterion		**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**Sum**
	Count	20	16	18	17	19	12	6	10	10	2	15	21	8	10	4	5	13	6	4	14	1	**231**
	Importance factor (%)	8.7	6.9	7.8	7.4	8.2	5.2	2.6	4.3	4.3	0.9	6.5	9.1	3.5	4.3	1.7	2.2	5.6	2.6	1.7	6.1	0.4	**100**
	Weighting Factor	2.2	1.7	1.9	1.8	2.1	1.3	0.7	1.1	1.1	0.2	1.6	2.3	0.9	1.1	0.4	0.6	1.4	0.7	0.4	1.5	0.1	**25**

TABLE 4-5
Individual Weighting Factors

	Constructability Criteria	**V**	**W**	**X**	**Y**	**Z**	**AA**	**BB**	**CC**	**DD**	**EE**	**FF**	**GG**	**HH**	**II**	**JJ**	**-**	**-**	**-**	**-**	**-**	**-**	
V	Easement Acquisition	V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
W	Access Constraints	W	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
X	Landowner Conflicts	V	W	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Y	Utility Conflicts	V	W	X	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Z	Weather Conditions	Z	W	Z	Z	Z	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
AA	Soil/Slope Stability	AA	W	AA	AA	Z	AA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
BB	Subsurface Conditions	BB	W	BB	BB	BB	BB	BB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CC	Groundwater	V	W	CC	CC	Z	AA	BB	CC	-	-	-	-	-	-	-	-	-	-	-	-	-	
DD	Connections to Existing Facilities	DD	W	DD	DD	DD	DD	BB	DD	DD	-	-	-	-	-	-	-	-	-	-	-	-	
EE	Work Space Constraints	EE	W	EE	EE	EE	AA	BB	EE	DD	EE	-	-	-	-	-	-	-	-	-	-	-	
FF	Equipment and Materials	V	W	X	FF	Z	AA	BB	CC	DD	EE	FF	-	-	-	-	-	-	-	-	-	-	
GG	Sequencing/Schedule Constraints	GG	GG	GG	GG	GG	GG	BB	GG	GG	GG	GG	GG	-	-	-	-	-	-	-	-	-	
HH	Unique Construction Methods	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH	-	-	-	-	-	-	-	-	
II	YTID Service Interruptions	II	II	II	II	II	II	II	II	II	II	II	II	II	II	-	-	-	-	-	-	-	
JJ	Public Safety/Worker Safety	JJ	JJ	JJ	JJ	JJ	JJ	BB	JJ	JJ	JJ	JJ	JJ	HH	II	JJ	-	-	-	-	-	-	
Criterion		**V**	**W**	**X**	**Y**	**Z**	**AA**	**BB**	**CC**	**DD**	**EE**	**FF**	**GG**	**HH**	**II**	**JJ**	**-**	**-**	**-**	**-**	**-**	**-**	**Sum**
	Count	6	12	4	2	8	8	13	5	10	8	3	12	15	16	13	-	-	-	-	-	-	**135**
	Importance Factor	4.4	8.9	3.0	1.5	5.9	5.9	9.6	3.7	7.4	5.9	2.2	8.9	11.1	11.9	9.6							**100**
	Weighting Factor	1.1	2.2	0.7	0.4	1.5	1.5	2.4	0.9	1.9	1.5	0.6	2,2	2.8	3.0	2.4	-	-	-	-	-	-	**25**

TABLE 4-5
Individual Weighting Factors

	O&M Criteria	KK	LL	MM	NN	OO	PP	QQ	RR	SS	TT	UU	-	-	-	-	-	-	-	-	-	-	
KK	Routine Visual Observation	KK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
LL	Slope Stability Maintenance	KK	LL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MM	Erosion/Scour Maintenance	KK	LL	MM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
NN	Corrosion Maintenance	KK	LL	MM	NN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
OO	Access Road Maintenance	KK	OO	OO	OO	OO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
PP	Startup/ Shutdown Operations	PP	PP	MM	PP	PP	PP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
QQ	Mechanical Maintenance	KK	LL	MM	QQ	OO	PP	QQ	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
RR	Periodic Pipe/Canal Maintenance	RR	RR	RR	RR	RR	RR	RR	RR	-	-	-	-	-	-	-	-	-	-	-	-	-	
SS	Power Failure	KK	LL	MM	NN	OO	PP	QQ	RR	SS	-	-	-	-	-	-	-	-	-	-	-	-	
TT	Redundancy	KK	LL	MM	TT	OO	PP	QQ	RR	TT	TT	-	-	-	-	-	-	-	-	-	-	-	
UU	Power Production	KK	LL	MM	UU	OO	PP	UU	RR	UU	UU	UU	-	-	-	-	-	-	-	-	-	-	
Criterion		**KK**	**LL**	**MM**	**NN**	**OO**	**PP**	**QQ**	**RR**	**SS**	**TT**	**UU**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**Sum**
	Count	10	8	8	3	9	10	5	12	2	4	6	-	-	-	-	-	-	-	-	-	-	**77**
	Importance Factor (%)	13.0	10.4	10.4	3.9	11.7	13.0	6,5	15.6	2.6	5.2	7.8											**100**
	Weighting Factor	6.5	5.2	5.2	1.9	5.8	6.5	3.2	7.8	1.3	2.6	3.9	-	-	-	-	-	-	-	-	-	-	**50**

SECTION 5

Cost Estimating

Cost estimating is a critical step in project planning and alternatives evaluations. YTID's top priority is to select a low-cost project alternative that is environmentally feasible, constructable, and easy to operate and maintain.

Cost estimates for large, complex projects are typically refined and updated as the project evolves. At this early stage of the project, little is known about site-specific conditions. For example, no subsurface drilling has been conducted, so the extent and nature of rock excavation and groundwater removal are unknown. No environmental investigations have been conducted such as wetlands delineation, identification of protected species and their habitat, and environmental mitigation costs. Likewise, technical details have not been developed such as the type of pipe, pressure class, depth of bury, and right-of-way requirements. Because these unknown issues have cost implications, the accuracy of cost estimates at this stage of the project is not precise.

Cost estimates in this report were prepared in accordance with guidelines provided by the Association for the Advancement of Cost Engineering (AACE). Cost estimates for this project are considered Class 4 estimates, which are defined as follows: an estimate based on limited information, where preliminary engineering is 1 percent to 5 percent complete. Additional detailed planning, site investigations, project screening, alternatives analysis, confirmation of economic and technical feasibility, and budget development are required. Estimating methods used for Class 4 estimates include equipment or system process factors, scale-up factors, and parametric modeling techniques. A Class 4 estimate requires further refinement during subsequent stages of the project. The expected accuracy of a Class 4 estimate ranges from –15 percent to –30 percent on the low side and +20 percent to +50 percent on the high side.

Class 4 estimates provide useful information for comparing and selecting alternatives, but should not be used for project budgeting or financing decisions. The cost estimates have been prepared for guidance in project planning from the information available at the time the estimate was prepared. The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. Therefore, final project costs will vary from the estimate presented herein. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be reviewed prior to making financial decisions or establishing project budgets.

5.1 Approach and Methodology

Cost estimates for this project were prepared using the following three basic steps:

1. **Baseline Unit Costs**. Rehabilitation of the Main Canal is expected to include some or all of the following three elements: reinforced concrete box culvert construction, pressure pipeline construction, and tunnel construction. CH2M HILL prepared a baseline unit cost for each of the three construction methods. The baseline unit cost is an "all-in" cost estimate for 100 feet of construction. The all-in cost includes scale factors for every aspect of the work, such as mobilization, demobilization, bonds, insurance, overhead, and profit. Site-specific conditions are included where specific conditions apply to all segments of the project. For example, the baseline cost of box culvert construction includes demolition of the existing canal and assumes work is performed during winter, because these costs are integral to the box culvert method of construction. The baseline unit cost represents the total project cost when multiplied by the length of the project segment. Baseline unit costs include a consistent set of contractor markups and contingencies. Table 5-1 shows the markups for the YTID project.

TABLE 5-1
Baseline Cost Markups

Item	Markup	Markup Amount (%)	Markup Applies To
1	Total Direct Cost (labor, equipment, materials)	0	
2	Project Staff and Home Office Overhead	3	Item 1
3	General Conditions	10	Subtotal of Items 1-2
4	Material Sales and Use Tax	7	Material Direct Cost
5	Contractor's Profit	6	Subtotal of Items 1-4
6	Mobilization/Demobilization	3	Subtotal of Items 1-9
7	Builders Risk and General Liability Insurance	2	Subtotal of Items 1-9
8	Payment and Performance Bonds	2	Subtotal of items 1-9
9	Contingency	30	Subtotal of Items 1-8

2. **Adjusted Baseline Unit Costs.** The baseline unit cost is an average cost for work on this project. However, site-specific conditions vary for each of the project segments. Some segments are easier to permit, build, and operate than others, so the baseline cost of each segment is adjusted to account for these site-specific risk factors. The baseline unit costs are factored up or down depending on the risk scores presented in Section 4. For example, if the risk score for a specific project segment is 140 and the average score for all segments is 100, the baseline unit cost is factored up by 40 percent (140/100) for that segment.
3. **Total Construction Cost.** The total construction cost for any project segment can be estimated by multiplying the adjusted baseline cost for the segment by the length of construction for that segment. By selecting any sequence of segments that deliver water from the headworks to French Canyon Reservoir, a total project cost can be developed for any alignment alternative. These cost estimates are construction costs only. Non-construction costs such as right-of-way acquisition, environmental mitigation, permitting, engineering, legal fees, and construction administration are presented in Section 7.

5.2 Baseline Unit Costs

5.2.1 Box Culverts

Appendix B contains the baseline unit cost estimate for box culvert construction. The fully installed baseline cost for box culvert construction is $253,000 per 100 feet of construction, or $2,530 per foot. Box culvert construction is shown in Figure 3-1. Box culverts can be constructed at any location where the concrete flume is replaced along the original canal alignment.

To develop this estimate, CH2M HILL contacted two large precast concrete fabricators in Washington. The fabricators prepared cost estimates for fabricating the box culvert segments and delivering them to the jobsite. CH2M HILL cost estimators prepared estimates for the labor and equipment to install the box culvert. The following key assumptions are included in the box culvert cost estimates:

- Box culvert segments will be fabricated in Yakima. The aggregate, cement, and labor are readily available in the Yakima area.
- Box culvert segments may be fabricated year-round, but will be transported to the jobsite and installed between October 15 and March 1 to avoid disrupting YTID water deliveries. Construction will be phased

over three or four winter seasons. The cost estimate includes an 18 percent allowance for the higher cost of winter construction work.

- Because the box culvert will be installed on the same line and grade as the existing canal, the cost estimate includes demolition and removal of the canal.
- Up to 150 feet of box culvert will be installed per day, after the existing canal is demolished and the subgrade is prepared.
- Each box culvert segment will be transported to the point of installation with a three-axle truck and installed with a large forklift.
- The box culvert includes a high-quality rubber gasket joint and stainless steel bolts that provide a drip-tight joint after assembly.
- Because the canal alignment has many tight horizontal curves, special forms are required to fabricate tapered ends for deflecting the joints at curves.
- The finished box culvert will be partially exposed, similar to the existing flume. This minimizes earthwork and work space requirements.

5.2.2 Pressure Pipelines

Appendix B contains the baseline unit cost for pipeline construction. The fully installed baseline cost for pipeline construction is $225,000 per 100 feet of construction, or $2,250 per foot. Pipeline construction is shown in Figure 3-2. Pipelines can be constructed along any alignment that is lower in elevation than the existing canal.

For this study, CH2M HILL assumed that welded steel pipe will be installed. Other pipe materials should be considered during later phases of the project. Large-diameter welded steel pipe is not produced in Washington. Pipe of this size will likely be manufactured in Portland, Oregon; or Tracy, California.

Large-diameter steel pipe fabricators provided cost estimates for fabricating pipe and delivering it to the jobsite. CH2M HILL's cost estimators prepared labor and equipment estimates to install the pipe. The following key assumptions are included in the box culvert cost estimates:

- Large-diameter steel pipe will be fabricated out of state and transported to the jobsite by truck.
- Pipeline construction will not interfere with the existing YTID flume or water deliveries. The pipe will be installed during summer and fall. An allowance for winter construction is not required.
- Upon completion of the pipeline, the existing canal will be abandoned in place. Demolition and removal are not required.
- The cost estimate includes clearing and grubbing of new pipeline right-of-way. However, land acquisition costs, if any, are not known at this time and not included in the estimate.
- Steel pipe will be cement-mortar lined and polyethylene tape wrapped to inhibit corrosion.
- Pipe joints will be welded.
- The rate of installation for the pipe is 100 feet per day. The installation rate is lower for pressure pipelines than box culverts because pipelines require a larger amount of earthwork and welding.
- The cost estimate includes an allowance for rock and groundwater removal from the trench; however, the location and extent of rock excavation are not known at this time.

5.2.3 Tunnels

Several tunneling methods will be considered for this project, including drill and shoot (blasting), bore and jack, microtunneling, and the use of a tunnel boring machine. Tunneling methods and associated costs are

site-specific and require exploratory drilling, groundwater monitoring, surveying, and geologic mapping. The optimal tunnel construction method is not known at this time. For this project, CH2M HILL relied on average costs from similar projects.

Appendix B contains a cost estimate for tunnel rehabilitation work shown in Figure 3-3. Tunneling costs are estimated at $352,000 per 100 feet of pipe, or $3,520 per foot. Based on the limited data available from the site, this cost estimate is appropriate for both tunnel rehabilitation and new tunneling construction. Additional site investigations are required to refine the tunneling estimates.

The cost of tunneling under the river is estimated at $1 million per hundred feet of tunnel. This estimate includes the cost of vertical tunnel shafts on either side of the river and the cost of tunneling below the water table. The cost of the vertical shafts is estimated at $750,000 per shaft, or $1.5 million per tunnel.

5.3 Risk Adjustment Factors

The baseline unit costs represent average construction costs per hundred feet of construction. However, each segment of the project has special permitting, constructability, and operations and maintenance requirements, so the baseline costs have been adjusted commensurate with the risk. The risk scores in Appendix A provide the basis for this cost adjustment.

To develop a risk adjustment factor, the risk score of each project segment is divided by the weighted average score for the type of facility being considered. For example, if the total risk score for a pipeline segment is 220, and the weighted average risk score for all pipelines is 200, the baseline unit cost is adjusted upward by 10 percent (220 divided by 200) for that segment. In this example, the risk adjustment factor is 1.10.

Table 5-2 summarizes the baseline cost adjustments for all project segments. The total cost of each segment is the adjusted baseline cost multiplied by the length of the segment.

TABLE 5-2
Segment Data

Segment No.	Canal/Pipe I.D.	Segment Type	Length (ft)	Baseline Unit Cost ($/100-ft)	Permitting Risk	Construction Risk	O&M Risk	Total Risk	Weighted Average Risk	Risk Adjust Factor	Adjusted Baseline Unit Cost	Total Cost
1	1A-1B	RC Box	1,213	$252,000	75	50	47	171	208	0.82	$207,751	$2,520,000
2	1B-1C	RC Box	2,859	$252,000	89	68	47	204	208	0.98	$247,355	$7,070,000
3	1C-1D	RC Box	2,356	$252,000	53	57	57	167	208	0.80	$202,821	$4,780,000
4	1D-1E	RC Box	1,013	$252,000	32	53	57	142	208	0.68	$172,226	$1,740,000
5	1E-1F	RC Box	628	$252,000	66	63	58	188	208	0.90	$227,600	$1,430,000
6	1F-1G	RC Box	464	$252,000	58	53	69	180	208	0.87	$218,171	$1,010,000
7	1G-1H	RC Box	912	$252,000	34	63	69	166	208	0.80	$201,608	$1,840,000
8	1H-1I	RC Box	1,644	$252,000	56	67	48	172	208	0.83	$208,311	$3,420,000
10	1J-1K	RC Box	797	$252,000	56	67	58	182	208	0.88	$220,914	$1,760,000
11	1K-1L	RC Box	5,012	$252,000	30	67	79	176	208	0.84	$212,926	$10,670,000
12	1L-1M	RC Box	1,451	$252,000	30	64	58	152	208	0.73	$184,577	$2,680,000
13	1M-1N	RC Box	5,791	$252,000	27	49	69	145	208	0.70	$176,135	$10,200,000
15	1O-1P	RC Box	1,054	$252,000	25	66	91	182	208	0.88	$220,692	$2,330,000
16	1P-1Q	RC Box	632	$252,000	24	53	88	165	208	0.79	$200,318	$1,270,000
17	1Q-1R	RC Box	2,202	$252,000	21	112	109	243	208	1.17	$294,176	$6,480,000
18	1R-1S	RC Box	3,808	$252,000	17	82	99	198	208	0.95	$239,671	$9,130,000
19	1S-1T	RC Box	303	$252,000	17	56	78	150	208	0.72	$182,121	$550,000
20	1T-1U	RC Box	3,694	$252,000	23	63	88	174	208	0.84	$210,797	$7,790,000
21	1U-1V	RC Box	3,947	$252,000	21	86	127	234	208	1.13	$283,546	$11,190,000
23	1W-1X	RC Box	884	$252,000	21	99	144	263	208	1.27	$319,299	$2,820,000
24	1X-1Y	RC Box	8,356	$252,000	37	109	175	321	208	1.55	$389,376	$32,540,000
26	1Z-1AA	RC Box	473	$252,000	28	95	139	263	208	1.26	$318,406	$1,510,000

TABLE 5-2
Segment Data

Segment No.	Canal/Pipe I.D.	Segment Type	Length (ft)	Baseline Unit Cost ($/100-ft)	Permitting Risk	Construction Risk	O&M Risk	Total Risk	Weighted Average Risk	Risk Adjust Factor	Adjusted Baseline Unit Cost	Total Cost
29	2A-2B	Pipeline	5,813	$225,000	105	50	52	207	211	0.98	$220,902	$12,840,000
30	2B-2C	Pipeline	827	$225,000	72	26	52	150	211	0.71	$159,867	$1,320,000
32	2D-1N	Pipeline	15,088	$225,000	83	62	105	250	211	1.19	$267,143	$40,310,000
33	1P-2F	Pipeline	4,331	$225,000	77	69	106	253	211	1.20	$269,571	$11,680,000
34	2F-2G	Pipeline	852	$225,000	30	36	86	152	211	0.72	$161,761	$1,380,000
35	2G-2H	Pipeline	4,828	$225,000	55	62	86	203	211	0.96	$217,016	$10,480,000
36	2H-2M	Pipeline	1,352	$225,000	18	36	75	128	211	0.61	$137,044	$1,850,000
37	2M-2N	Pipeline	3,181	$225,000	39	37	106	182	211	0.87	$194,692	$6,190,000
38	2N-2O	Pipeline	544	$225,000	136	74	82	292	211	1.38	$311,275	$1,690,000
39	2O-2P	Pipeline	635	$225,000	72	26	52	150	211	0.71	$159,867	$1,020,000
40	2P-2Q	Pipeline	353	$225,000	136	74	82	292	211	1.38	$311,275	$1,100,000
41	2Q-2R	Pipeline	7,578	$225,000	78	39	99	216	211	1.02	$230,394	$17,460,000
42	2R-2S	Pipeline	3,894	$225,000	68	36	75	180	211	0.85	$191,658	$7,460,000
44	1D-2E	Pipeline	915	$225,000	53	50	52	155	211	0.74	$165,462	$1,510,000
46	1G-2D	Pipeline	331	$225,000	74	45	64	182	211	0.87	$194,676	$640,000
47	2F-2I	Pipeline	992	$225,000	74	36	75	184	211	0.87	$196,873	$1,950,000
49	2J-2K	Pipeline	4,487	$225,000	88	43	62	193	211	0.92	$206,329	$9,260,000
51	2L-2M	Pipeline	2,290	$225,000	50	39	75	164	211	0.78	$175,416	$4,020,000
52	2G-1T	Pipeline	1,825	$225,000	28	56	83	167	211	0.79	$178,255	$3,250,000
53	1U-2H	Pipeline	671	$225,000	31	53	75	159	211	0.75	$169,549	$1,140,000
54	2R-1Y	Pipeline	715	$225,000	28	102	109	239	211	1.14	$255,383	$1,830,000
28	1B-2A	River Tunnel	319	$1,000,000	115	77	97	289	219	1.32	$1,321,170	$4,210,000

TABLE 5-2
Segment Data

Segment No.	Canal/Pipe I.D.	Segment Type	Length (ft)	Baseline Unit Cost ($/100-ft)	Permitting Risk	Construction Risk	O&M Risk	Total Risk	Weighted Average Risk	Risk Adjust Factor	Adjusted Baseline Unit Cost	Total Cost
31	2C-2D	River Tunnel	294	$1,000,000	106	64	109	280	219	1.28	$1,278,437	$3,760,000
43	2S-1AB	New Tunnel	3,958	$352,000	35	77	108	220	219	1.01	$353,920	$14,010,000
45	2E-2B	River Tunnel	251	$1,000,000	100	64	97	262	219	1.20	$1,196,291	$3,000,000
48	2I-2J	River Tunnel	258	$1,000,000	101	64	97	263	219	1.20	$1,202,229	$3,100,000
50	2K-2L	River Tunnel	432	$1,000,000	112	64	97	274	219	1.25	$1,252,704	$5,410,000
55	3B-3C	New Tunnel	2,844	$352,000	20	95	58	174	219	0.79	$279,313	$7,940,000
56	3E-3F	New Tunnel	644	$352,000	16	95	58	170	219	0.78	$273,390	$1,760,000
57	3H-3K	New Tunnel	2,529	$352,000	14	100	90	203	219	0.93	$327,226	$8,280,000
58	3N-3O	New Tunnel	3,277	$352,000	14	92	90	196	219	0.89	$314,708	$10,310,000
59	3R-3S	New Tunnel	2,680	$352,000	14	100	90	203	219	0.93	$326,530	$8,750,000
60	3N-3Q	New Tunnel	1,384	$352,000	14	77	82	172	219	0.79	$277,029	$3,830,000
61	3U-3Y	New Tunnel	12,934	$352,000	14	102	97	213	219	0.98	$343,244	$44,400,000
9	1I-1J	Tunnel Rehab	222	$352,000	16	120	101	237	219	1.08	$381,712	$850,000
14	1N-1O	Tunnel Rehab	3,269	$352,000	11	118	79	208	219	0.95	$334,736	$10,940,000

TABLE 5-2
Segment Data

Segment No.	Canal/Pipe I.D.	Segment Type	Length (ft)	Baseline Unit Cost ($/100-ft)	Permitting Risk	Construction Risk	O&M Risk	Total Risk	Weighted Average Risk	Risk Adjust Factor	Adjusted Baseline Unit Cost	Total Cost
22	1V-1W	Tunnel Rehab	1,268	$352,000	11	126	118	254	219	1.16	$409,366	$5,190,000
25	1Y-1Z	Tunnel Rehab	2,769	$352,000	12	126	127	265	219	1.21	$426,785	$11,820,000
27	1AA-1AB	Tunnel Rehab	3,864	$352,000	22	126	127	275	219	1.26	$442,810	$17,110,000
			Length		**Weighted Average Risk**							
		RC Box	49,493		35	75	97	208			$196,873	<25th Percent
		Pipeline	61,502		73	51	87	211			$230,394	<50th Percent
		Tunnels	43,196		20	102	97	219			$319,299	<75th Percent
		Total	154,191		46	73	93	212				

SECTION 6

Comparison of Main Canal Alternatives

In this section, the alignments shown in Figures 3-4a through 3-5d and the data presented in Table 5-2 are used to assemble and compare potential project alternatives. Any sequence of project segments that connect the headworks to French Canyon Reservoir may be considered a potential alternative.

For this report, the project alternatives are presented in two groups: the Upper Main Canal alternatives and the Lower Main Canal alternatives. The Upper Main Canal extends from the headworks near the Tieton River through the Windy Point Tunnel. The Lower Main Canal extends from the outlet of the Windy Point Tunnel to French Canyon Reservoir.

6.1 Upper Main Canal Alternatives

For the Upper Main Canal, CH2M HILL considered five alignment alternatives. The five alternatives are shown in Figures 3-4a through 3-4d (Section 3). Appendix C provides data tables that list the project segments, risk scores, and cost estimates for each alternative. The five Upper Main Canal alternatives are as follows:

1. Alternative U1: Alternative U1 replaces the existing canal with a new precast box culvert along the same alignment. Little or no new right-of-way is required, and minimal land clearing is necessary because the new canal follows the original alignment. The total length of the alignment is 5.23 miles, including 4.61 miles of box culvert and 0.62 mile for the Windy Point Tunnel. This alternative does not include new river crossings.
2. Alternative U2: Alternative U2 installs a new 96-inch-diameter pipeline across the Tieton River, adjacent to U.S. Highway 12 near Trout Lodge and parallel to the river. This alternative includes two new tunnels under the Tieton River. The total length of the alignment is 5.08 miles, including 4.34 miles of pipeline and 0.74 mile of tunnels. The existing canal will be abandoned in place.
3. Alternative U3: Alternative U3 includes a combination of box culvert and new pipeline. The existing canal will be replaced with a new box culvert for the first 1.2 miles downstream of the headworks. From there, a new 3.3-mile-long pipeline will be constructed adjacent to the Tieton River. This alternative includes two new river crossings to avoid a rock outcrop south of the river.
4. Alternative U4: Similar to Alternative U3, Alternative U4 includes a combination of box culvert and new pipeline. The existing canal will be replaced with a new box culvert for the first 1.6 miles downstream of the headworks. From there, a new 2.9-mile-long pipeline will be constructed adjacent to the Tieton River. This alternative does not cross the river.
5. Alternative U5: Alternative U5 is similar to Alternative U1, except that two new tunnels will be constructed at locations where the existing canal is difficult to access and replace. This alternative consists of 3.57 miles of new box culvert and 1.64 mile of tunnel.

In all five Upper Main Canal alternatives, the Windy Point Tunnel will be rehabilitated and enlarged, or a new tunnel parallel to the existing tunnel will be constructed. No other alternatives are presented for the Windy Point Tunnel because no reasonable alternatives are apparent. A pipeline alignment adjacent to U.S. Highway 12 around Windy Point could be constructed, but would be substantially longer and more expensive than reconstructing the tunnel.

Table 6-1 summarizes the Upper Main Canal alternatives and compares the environmental, constructability, operations and maintenance, and cost benefits and constraints of each. The apparent best alternative is discussed in Section 7.

6.2 Lower Main Canal Alternatives

For the Lower Main Canal, CH2M HILL considered five alignment alternatives. The five alternatives are shown in Figures 3-5a through 3-5d (Section 3). Appendix C provides data tables that list the project segments, risk scores, and cost estimates for each alternative. The five Lower Main Canal alternatives are as follows:

1. Alternative L1: Alternative L1 replaces the existing canal with a new box culvert along the same alignment and rehabilitates three existing tunnels. Little or no new right-of-way is required, and minimal land clearing is necessary because the new canal follows the existing canal alignment. The total length of the alignment is 6.30 miles, including 4.80 miles of box culvert and 1.50 miles of tunnels. The existing concrete canal will be demolished and removed.
2. Alternative L2: Alternative L2 moves the existing canal down from the steep hillside and creates a new alignment parallel to the Tieton River. A new 96-inch-diameter pipeline will be installed across the river and within portions of the Highway 12 corridor. This alignment includes four new river crossings and one new tunnel. The total length of the alignment is 6.44 miles, including 0.20 mile of box culvert, 5.36 miles of pipeline, and 0.88 mile of tunnel. The existing canal will be abandoned in place.
3. Alternative L3: Alternative L3 moves the existing canal down from the steep hillside. A new 96-inch-diameter pipeline will be installed on the south side of the river. No new river crossings are required. The total length of the alignment is 6.14 miles, including 0.20 mile of box culvert, 4.93 miles of pipeline, and 1.01 miles of tunnel. The existing canal will be abandoned in place.
4. Alternative L4: Alternative L4 includes a combination of new box culvert along the existing canal alignment, a new 96-inch-diameter pipeline, and two new tunnels to avoid the steep hillside. The total length of the alignment is 6.17 miles, including 1.49 miles of box culvert, 3.16 miles of pipeline, and 1.52 miles of tunnel. The existing canal will be abandoned in place.
5. Alternative L5: Alternative L5 uses the existing canal alignment to the extent possible and several long tunnels to avoid the steep hillside slopes and potential environmental impacts along the river. The total length of the alignment is 5.80 miles, including 1.49 miles of box culvert and 4.21 miles of tunnel.

Table 6-2 summarizes the Lower Main Canal alternatives and compares the environmental, constructability, operations and maintenance, and cost benefits and constraints of each. The apparent best alternative is discussed in Section 7.

TABLE 6-1
Upper Main Canal Alternatives
(Headworks through the Windy Point Tunnel)

				Key Benefits/Constraints							
				Environmental/Permitting		Constructability		Operations and Maintenance		Cost Estimate	
Alt.	Description	Total Length (mi.)	Total Risk Score	Risk Score	Comments	Risk Score	Comments	Risk Score	Comments	Construction Cost (millions)	Comments
U1	Replace existing canal with new box culvert along same alignment.	5.23	172	41 (Favorable)	This alternative requires little or no new right-of-way and minimal new land disturbance. Permitting and public acceptance are considered favorable compared to other alternatives.	64 (Neutral)	The new box culvert alignment conflicts with the existing canal. Construction will need to be phased over several winter seasons to avoid disrupting YTID service.	66 (Favorable)	The new box culvert will flow partially full and drain by gravity, similar to the existing canal. Day-to-day operations will be similar to the existing canal. The covered top deck on the box culvert will eliminate debris and wildlife entrapment. Access for maintenance will be favorable.	$60.3 (Favorable)	Lowest cost alternative. Moderate potential for unforeseen cost escalation because the benefits of using the existing right-of-way are offset by winter construction requirements and potential interference with YTID water deliveries.
U2	Install new 96-inch pipeline in Highway 12 near Trout Lodge and parallel to the Tieton River. Abandon the existing canal in place.	5.08	228	79 (Unfavorable)	This alternative will have adverse public impacts near Rimrock Retreat and potentially adverse environmental impacts at two river crossings. Significant new right-of-way acquisition and temporary land clearing are required.	62 (Neutral)	This alternative is independent of the existing canal. The work can be completed during summer without risk of disrupting YTID water deliveries. Tunneling under the river is both expensive and risky.	87 (Neutral)	The pipeline will be buried and less susceptible to slides and erosion damage compared to other alternatives. Operations and maintenance of the pipeline will be slightly more complex compared to the existing canal or new box culvert, but similar to existing pipelines throughout YTID. Access for maintenance will be generally favorable.	$75.3 (Unfavorable)	Highest cost alternative. High potential for unforeseen cost escalation because of potential public impacts near Rimrock Retreat and environmental and construction risks at two new river crossing tunnels.
U3	Replace 1.2 miles of existing canal near the headworks with a new box culvert. Install 3.3 miles of 96-inch pipeline including two new river crossings.	5.13	222	71 (Unfavorable)	This alternative includes potentially adverse environmental impacts at two river crossings. Extensive new right-of-way acquisition and temporary land clearing are required. Public impacts will be minimal.	64 (Neutral)	The initial 1.2 miles below the headworks will be constructed during winter to avoid conflicts with YTID water deliveries. The remaining 3.3 miles can be completed during summer without risk of disrupting YTID water deliveries. Tunneling under the river is risky because of groundwater and variable subsurface conditions.	87 (Neutral)	The pipeline will be buried and less susceptible to slides and erosion damage compared to a box culvert or the existing canal. Operations and maintenance of the pipeline will be slightly more complex compared to a box culvert, but similar to existing pipelines throughout YTID. Access for maintenance will be generally favorable.	$74.6 (Unfavorable)	High cost estimate compared to other alternatives. Moderate potential for unforeseen cost escalation because of potential environmental impacts and construction risks at two new river crossing tunnels.
U4	Replace 1.6 miles of existing canal near the headworks with a new box culvert. Install 2.9 miles of 96-inch pipeline along an existing powerline corridor.	5.16	221	70 (Neutral)	This alternative requires extensive new right-of-way acquisition and temporary land clearing. Public impacts will be minimal. This alternative has a lower potential for environmental impact because there are no river crossings.	65 (Neutral)	The initial 1.6 miles below the headworks will be constructed during winter to avoid conflicts with YTID water deliveries. The remaining 2.9 miles can be completed during summer without risk of disrupting YTID water deliveries.	86 (Neutral)	The pipeline will be buried and less susceptible to slides and erosion damage compared to a box culvert or the existing canal. Operations and maintenance of the pipeline will be slightly more complex compared to a box culvert, but similar to existing pipelines throughout YTID. Access for maintenance will be generally favorable.	$69.8 (Neutral)	Moderate cost estimate compared to other alternatives. Lower potential for unforeseen cost escalation because the work can be completed during summer, there are no river crossings, and there is a low risk of interfering with YTID water deliveries.
U5	Replace existing canal with new box culvert. Construct two new tunnels at locations where box culverts are difficult to construct.	5.21	171	30 (Favorable)	The new box culvert requires little or no new right-of-way and minimal new land disturbance. Permitting and public acceptance are considered favorable compared to other alternatives. New right-of-way is required for tunnels.	69 (Unfavorable)	The new box culvert alignment conflicts with the existing canal. Construction will need to be phased over several winter seasons to avoid disrupting YTID service. Tunneling work is risky because of potential variability in subsurface conditions.	71 (Favorable)	The new box culvert and tunnels will flow partially full and drain by gravity, similar to the existing canal. Day-to-day operations will be similar to the existing canal. Access for maintenance will be favorable.	$63.4 (Neutral)	Low cost compared to other alternatives. Moderate to high potential for cost escalation because of winter construction and tunneling work.

TABLE 6-2
Lower Main Canal Alternatives
(Windy Point Tunnel Outlet to French Canyon Reservoir)

				Key Benefits/Constraints							
				Environmental/Permitting		Constructability		Operations and Maintenance		Cost Estimate	
Alt.	Description	Total Length (mi.)	Total Risk Score	Risk Score	Comments	Risk Score	Comments	Risk Score	Comments	Construction Cost (millions)	Comments
L1	Replace existing canal with new box culvert along the same alignment.	6.30	251	24 (Favorable)	This alternative requires little or no new right-of-way and minimal new land disturbance. Permitting and public acceptance are considered favorable compared to other alternatives.	99 (Unfavorable)	The new box culvert will replace the existing canal on steep side-slopes, with poor construction access and limited work space. Construction will be phased over several winter seasons to avoid disrupting YTID water deliveries.	128 (Unfavorable)	The new box culvert will flow partially full and drain by gravity, similar to the existing canal. Day-to-day operations will be similar to the existing canal. Long-term access for operations and maintenance is poor.	$109.7 (Unfavorable)	Highest cost alternative. High potential for unforeseen cost escalation because of poor access, steep hillside construction, and potential interference with YTID water deliveries.
L2	Install new 96-inch pipeline adjacent to Highway 12 and the Tieton River, including four new river crossings. Abandon the existing canal in place.	6.44	207	68 (Neutral)	This alternative uses existing Highway 12 corridor and avoids private property to the extent possible. However, long sections of the pipeline will be installed within and adjacent to the Tieton River in previously undisturbed areas. New right-of-way acquisition and temporary land clearing are required. Four river crossings could have a high environmental impact.	49 (Favorable)	Construction will occur in relatively flat areas. The work could be completed during summer because it does not conflict with the existing YTID canal. Construction access is fair in most locations, and there is ample space for lay-down areas and haul roads. River tunnel crossings are risky because of groundwater and variable rock conditions.	90 (Neutral)	Long-term access for operations and maintenance is fair because the ground is relatively flat. A new bridge across the Tieton River may be required for suitable access.	$86.7 (Neutral)	Moderate cost compared to other alternatives. Moderate potential for unforeseen cost escalation and overruns because of environmental and construction risks at river crossings.
L3	Install new 96-inch pipeline on south side of Tieton River. Abandon the existing canal in place.	6.14	203	56 (Neutral)	Long sections of the pipeline will be installed within and adjacent to the Tieton River in previously undisturbed areas. New right-of-way acquisition and temporary land clearing are required. Potential environmental impacts are less significant because there are no river crossings.	53 (Favorable)	Construction will occur in relatively flat areas. The work could be completed during summer because it does not conflict with the existing YTID canal. Construction access is fair in most locations, and there is ample space for lay-down areas and haul roads.	95 (Neutral)	Long-term access for operations and maintenance is fair because the ground is relatively flat. A new bridge across the Tieton River may be required for suitable access.	$76.7 (Favorable)	Lowest cost alternative. Low to moderate potential for unexpected cost escalation. Environmental mitigation costs associated with work near the river are unpredictable.
L4	Install a combination of new box culvert along the existing canal alignment, new 96-inch pipeline on south side of Tieton River, and a new tunnel to avoid the steep hillside.	6.17	195	43 (Favorable)	A significant portion of this alternative follows the existing canal alignment. No new right-of-way and little land clearing are required in these areas. There are no river crossings. Permitting and public acceptance are considered moderate to favorable.	59 (Neutral)	Construction work that follows the existing canal will be completed during winter, with limited work space and lay-down areas. Pipeline work near the river could be completed during summer on flatter ground with more room to work. Construction access is fair.	94 (Neutral)	Long-term access for operations and maintenance is fair. A new bridge across the Tieton River may be required for suitable access.	$79.1 (Neutral)	Moderate cost compared to other alternatives. Moderate potential for unexpected cost escalation because of winter construction work and tunneling risks.
L5	Replace existing canal with new box culvert. Construct long tunnels to avoid the steep hillside and work near the river.	5.80	220	17 (Favorable)	A significant portion of this alternative follows the existing canal alignment. No new right-of-way and little land clearing are required in these areas. There are no river crossings. This alternative includes a long, new tunnel. Permitting and public acceptance are considered favorable compared to other alternatives.	100 (Unfavorable)	Construction work that follows the existing canal will be completed during winter, with limited work space and lay-down areas. The project includes a long, new tunnel. Tunneling work is risky because of variable subsurface conditions.	103 (Unfavorable)	The new box culvert and tunnel will flow partially full and drain by gravity, similar to the existing canal. Day-to-day operations will be similar to the existing canal. Long-term access for operations and maintenance is poor.	$102.0 (Unfavorable)	High cost alternative. High potential for unforeseen cost overruns because of difficult and unknown construction conditions.

SECTION 7

Apparent Best Alternative

Based on information presented in Section 6, Alternative U1 is the preferred project alternative for the Upper Main Canal. Alternative U1 involves replacing the existing canal with a new precast concrete box culvert and rehabilitating or reconstructing the Windy Point Tunnel.

Alternative U1 is a low-cost and relatively low-risk option. Estimated construction costs are $60.3 million. The new box culvert concept has favorable permitting and public acceptance attributes, compared to other alternatives, primarily because it requires minimal new right-of-way acquisition and land disturbance. However, constructability considerations are less favorable, compared to other alternatives, because the work must be completed during several winter seasons, and there is potential, but avoidable, risk of interfering or delaying normal YTID water deliveries during spring. From an operations and maintenance standpoint, the new box culvert concept will function similar to the existing concrete flume. Startup, shutdown, and routine inspection activities will be similar to the existing canal, except the new box culvert will include an all-weather access road the full length of the canal.

Figures 7-1a through 7-1d, included at this end of this section, show the preferred project alternative for the Upper Main Canal. This alternative includes approximately 4.61 miles of new box culvert and 0.62 mile of tunnel construction (Windy Point Tunnel).

Alternative L3 is the preferred project alternative for the Lower Main Canal. Alternative L3 involves constructing a new 96-inch pipeline parallel to the river and abandoning the existing canal in place. This alternative includes a new inclined tunnel from the elevation of the river to French Canyon Reservoir. The existing Columnar Tunnel, Tieton Tunnel, and North Fork Tunnel will be abandoned in place, along with other portions of the existing canal.

Alternative L3 is the lowest-cost alternative. Estimated construction costs are $76.7 million. Portions of this alignment present environmental permitting and public acceptance challenges. However, this alignment is superior to other alternatives with respect to constructability, safety, long-term operations and maintenance, and cost considerations. The pipeline will be installed below the frost depth and remain full of water during winter.

Figures 7-2a through 7-2d, included at this end of this section, show the preferred project alternative for the Lower Main Canal. This alternative consists of 0.20 mile of box culvert, 4.93 miles of pipeline, and 1.01 miles of new tunnel.

7.1 Key Assumptions and Considerations

7.1.1 Upper Main Canal

Implementation of the apparent best alternative for the Upper Main Canal requires that work along the existing canal be performed during winter. To accomplish this work efficiently, the contractor will need to maximize working time during favorable weather conditions, and the work must be sequenced to minimize potential delays. YTID should consider terminating all irrigation deliveries no later than September 30 and providing prompt, limited canal access to the contractor by October 1.

When winter work begins, the contractor will need durable, all-weather access roads for efficient and productive work. Therefore, construction of access road improvements may be required during summer, so the roads are ready for immediate use on October 1. In addition, all box culvert segments may need to be delivered to the jobsite and checked for defects prior to the start of winter work. Finally, contract documents should be developed to minimize potential impacts on YTID, while allowing the contractor to work more if weather conditions are favorable and work less if weather conditions are unfavorable. Because

of the winter work requirements, this alternative will be best implemented using several sequential design contracts (i.e., one contract for each winter season).

The existing pipe bridges along the Upper Main Canal represent a significant investment to YTID. At this time, these bridges can likely remain in place. No significant modifications are required to the pipe bridges to implement the box culvert concept, except that cast-in-place transition sections are required from the square box culvert configuration to the round pipe-bridge configuration. Detailed hydraulics investigations are required to develop and confirm these concepts.

This alternative does not include modifications to the headworks (diversion dam, head gates, fish ladder, fish screen, and flow gaging station, etc.) to accommodate the higher Cowiche Creek water diversions. CH2M HILL has requested the original design drawings and design criteria from the Bureau of Reclamation. Further investigations and field testing of the headworks should be conducted to validate these assumptions.

7.1.2 Lower Main Canal

The apparent best alternative is an all-new pipeline alignment. While there are no known fatal flaws associated with this alignment, future investigations may reveal extraordinary, unanticipated obstacles or costs. For example, cost estimates presented in this document do not include potentially significant costs or delays associated with mitigating or avoiding a significant archaeological find. A reconnaissance archaeological investigation by a qualified professional is required to investigate and map this alignment and confirm its feasibility. Likewise, this study assumes that avoiding or mitigating environmental impacts, such as the Golden Eagle habitat near Milepost 10.0, can be accomplished without extraordinary, unanticipated costs. Eagle habitat and other environmental and biological impacts and cost estimates will not be known until resource agency coordination begins and detailed biological investigations are conducted.

Tunneling through the stratified, non-homogeneous basalt near Mileposts 11.0 to 11.5 may present significant, unanticipated obstacles. Confirming the validity of this alignment requires geologic mapping and exploratory drilling. Finally, this study assumes that new easements and rights-of-way can be acquired from existing landowners. If existing landowners refuse to cooperate, implementation costs and schedule assumptions may be invalid. The costs to perform these field investigations and validate the apparent best alternative are included in the total project cost estimate below.

7.2 Apparent Total Project Cost

The cost estimates provided earlier in this section are contract costs. Contract costs are equivalent to the anticipated total bid price by the construction contractor. Contract costs include mobilization, demobilization, bonds, insurance, overhead, profit, and all labor, equipment and materials to complete the work. The contract cost includes a 30 percent contingency allowance to account for inevitable changes in scope, schedule, and site conditions. As field information is collected and the design progresses, the estimated cost of labor, equipment, and materials will become more precise, and the contingency allowance will be gradually reduced.

The contract costs presented above are shown in 2013 dollars. For this study, the mid-point of construction is assumed to be 2018. Therefore, contract costs are escalated by 2 percent per year to account for inflation. The total inflation escalation is 10.4 percent over 5 years.

The total project cost estimate includes several other line-items, including right-of-way acquisition and environmental mitigation costs. These two factors, when added to the contract cost, are called total field costs. For this project, right-of-way acquisition is assumed to be 1 percent of the total contract cost. Most of the right-of-way is unimproved and owned or controlled by public agencies. Environmental mitigation costs are assumed to be 2 percent of contract costs. Examples of environmental mitigation costs include the cost

of replacing or mitigating wetland impacts or payments to a mitigation bank to account for riparian habitat losses. Environmental mitigation costs are traditionally not included in the contractor's bid price.

The total project cost also includes line-item costs for non-contract costs. At this stage of a project, non-contract costs are traditionally estimated as a percentage of the contract cost. Non-contract costs include data collection and preliminary design (4 percent), environmental permitting (5 percent), final design (8 percent), construction management and inspection (10 percent), and YTID's legal and administrative costs (2 percent).

The total apparent project cost is shown in Table 7-1. Section 5 discusses the accuracy and limitations of cost estimates at this stage of the project.

TABLE 7-1
Apparent Total Project Cost ($ millions)

Upper Main Canal Improvements (2013 dollars)	$60.3
Lower Main Canal Improvements (2013 dollars)	$76.7
Escalation to Mid-point of Construction (10.4 percent)	$14.2
Total Contract Cost	**$151.2**
Right-of-way Acquisition (1 percent)	$1.5
Environmental Mitigation (2 percent)	$3.0
Total Field Cost	**$155.8**
Preliminary Design (4 percent)	$6.0
Environmental Permitting (5 percent)	$7.6
Final Design (8 percent)	$12.1
Construction Management (10 percent)	$15.1
District Legal and Administrative Costs (2 percent)	$3.0
Total Project Cost	**$199.6**

This cost estimate does not include pipeline distribution system improvements required to serve Cowiche Creek parcels. Planning and cost estimating for serving the Cowiche Creek parcels is being conducted by the North Yakima Conservation District (NYCD).

7.3 Implementation Schedule

This study is the first step in a long sequence of activities required to complete the project. Providing a detailed implementation schedule at this stage may be counterproductive. Instead, Figure 7-3, included at the end of this section, focuses on near-term activities required to validate the project and provides a general implementation schedule for long-term activities. This schedule requires updates as more information is collected and funding opportunities are identified. The near-term validation activities listed on the schedule are discussed below.

7.4 Validating the Apparent Best Alternative

Several low-cost, near-term action items should be undertaken to validate the apparent best alternative.

7.4.1 Environmental Permitting

CH2M HILL recommends the preparation of an environmental permitting workplan. The permitting workplan will identify required permits for the project, agencies involved in reviewing and issuing the permits, fieldwork required to submit the permit applications, and estimated schedules for securing each permit. This plan will serve as a guidance document for early discussions with regulatory agencies.

Eventually, site investigations will be required to examine, document, and map threatened and endangered species and their habitat. As the first step in this process, CH2M HILL recommends developing a low-cost "avoidance map." The map will be created using Google Earth aerial photography and will display data and reconnaissance-level site investigations. For example, a 1-day reconnaissance-level investigation of potential wetland sites will be conducted, and the potential sites will be plotted on the map. Existing floodplain mapping will also be shown on the map as will approximate boundaries of regulatory 200-foot setbacks from the ordinary high water mark. This map will be an excellent tool for early discussions with regulatory agencies.

After the draft permitting workplan and avoidance map have been created, a pre-application meeting with the regulatory agencies should be conducted. Invitees will include the agencies that will review the Joint Aquatic Resources Permit Application (JARPA). Topics that will be discussed at the meeting include the following:

1. Main Canal alignment alternatives (this study)
2. The apparent best alternative and justifications for the selection
3. The permitting workplan
4. The avoidance map and known environmental issues
5. The next steps required, including conducting field surveys, obtaining detailed resource information (cultural, biological, wetlands, geological, etc.), and preparing mapping that identifies the constraints for the selected preferred alternative.

Agencies that will be invited to the pre-application meeting are listed in Table 7-2.

TABLE 7-2
Pre-application Agencies

Agency[a]	Permit
JARPA Agencies:	
United States Army Corps of Engineers	• Section 404 Permit (fills or excavations in the waters of the U.S. including wetlands)
United States Fish and Wildlife	• Section 7 Approval – Endangered Species Act • Migratory Bird Treaty Act • Bald and Golden Eagle Protection Act
National Marine Fisheries Services	• Section 7 Approval – Endangered Species Act
Washington State Fish and Wildlife	• Hydraulic Project Approval (in-river mitigation) • Wildlife Protection Areas
Washington State Department of Ecology	• Section 401 Permit (water quality certification) • National Pollutant Discharge Elimination System (NPDES) (construction general permit)
Department of Natural Resources	• Aquatic authorization for entry and to obtain lease of state owned waters
Yakima County	• Shorelines Substantial Development Permit • Floodplain Development Permit • Critical Areas Ordinance (includes habitat management, wetlands, etc.)

TABLE 7-2
Pre-application Agencies

Agency[a]	Permit
Other Interested Agencies:	
United States Forest Service	• Timber removal, habitat management, water resource protection, recreation
Yakima Tribes	• Cultural resources, habitat management, water resource protection
Other Selected Stakeholders	• Temporary and permanent easements

[a]This list does not include all regulatory agencies involved in permitting this project (e.g., Washington State Department of Archeology and Historic Preservation. The focus will be on agencies that manage natural resources.

A site visit of the preferred canal alternative could be conducted as part of the meeting to provide an opportunity for the regulatory staff to understand the project better and provide feedback. This site visit will not include the entire alternative routes, but instead, will concentrate on those areas of anticipated concern (e.g., Tieton River encroachment, Golden Eagle protected areas, known wetlands near the canal).

7.4.2 Cultural Resource Investigations

CH2M HILL recommends YTID conduct a Phase 1 archaeology survey of the apparent best alignment. A Phase 1 survey includes research into existing documented archaeological sites and a site walk conducted by qualified resource professionals to look for additional, visible artifacts. No excavation or collection of artifacts will occur. The anticipated level of effort would be a 2- or 3-day field trip by two experienced professionals. The site visit will focus on the new alignment downstream of the Windy Point Tunnel. Findings will be documented in a technical memorandum, and recommendations on avoidance or mitigation strategies will be provided.

7.4.3 Land Ownership Maps

Early discussions on right-of-way acquisition, permitting, and field investigations will require more information on current land ownership. CH2M HILL recommends an initial desktop study to collect existing information on land ownership records. Field surveying is not anticipated for this activity, but will be required during subsequent phases of the design. The land ownership information will be plotted on the avoidance map discussed in Section 7.4.1.

7.4.4 Geologic and Tunneling Reconnaissance Investigations

CH2M HILL recommends a 2- or 3-day reconnaissance investigation of geologic and geotechnical conditions along the preferred project alignment. This effort will begin with a review of geologic maps, geotechnical boring data, and landslide maps. The data review will be followed by a site visit by qualified tunneling engineers to examine the preferred alignment. This effort should be conducted this winter so that the existing Windy Point Tunnel, Tieton Tunnel, and North Fork Tunnel can be examined. A subsurface exploration plan will be prepared as the product of these efforts. The plan will show and describe locations for additional subsurface testing and monitoring.

FIGURE 7-1a
Apparent Best Alternative, Upper Main Canal
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

FIGURE 7-1b
Apparent Best Alternative, Upper Main Canal
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

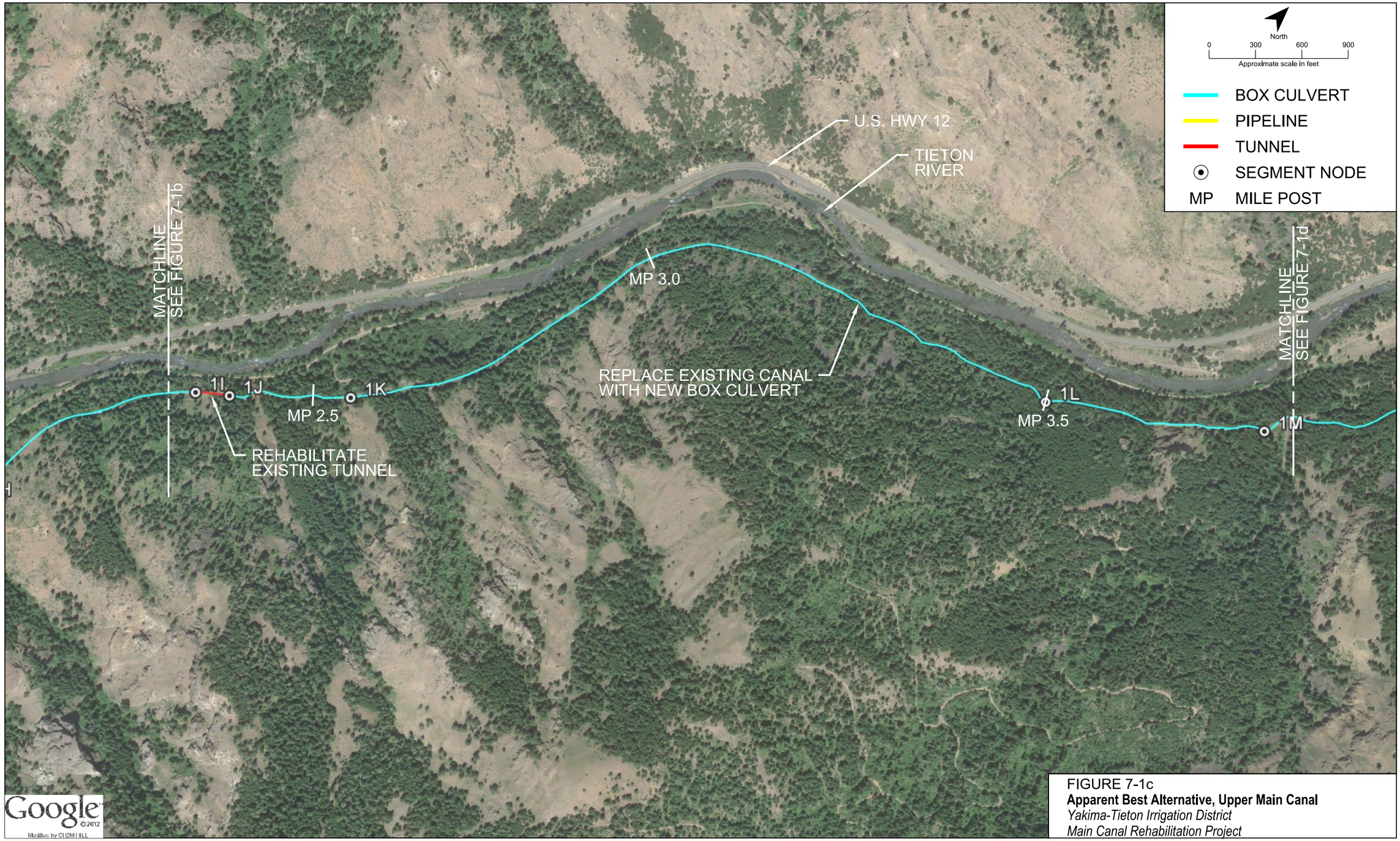

FIGURE 7-1c
Apparent Best Alternative, Upper Main Canal
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

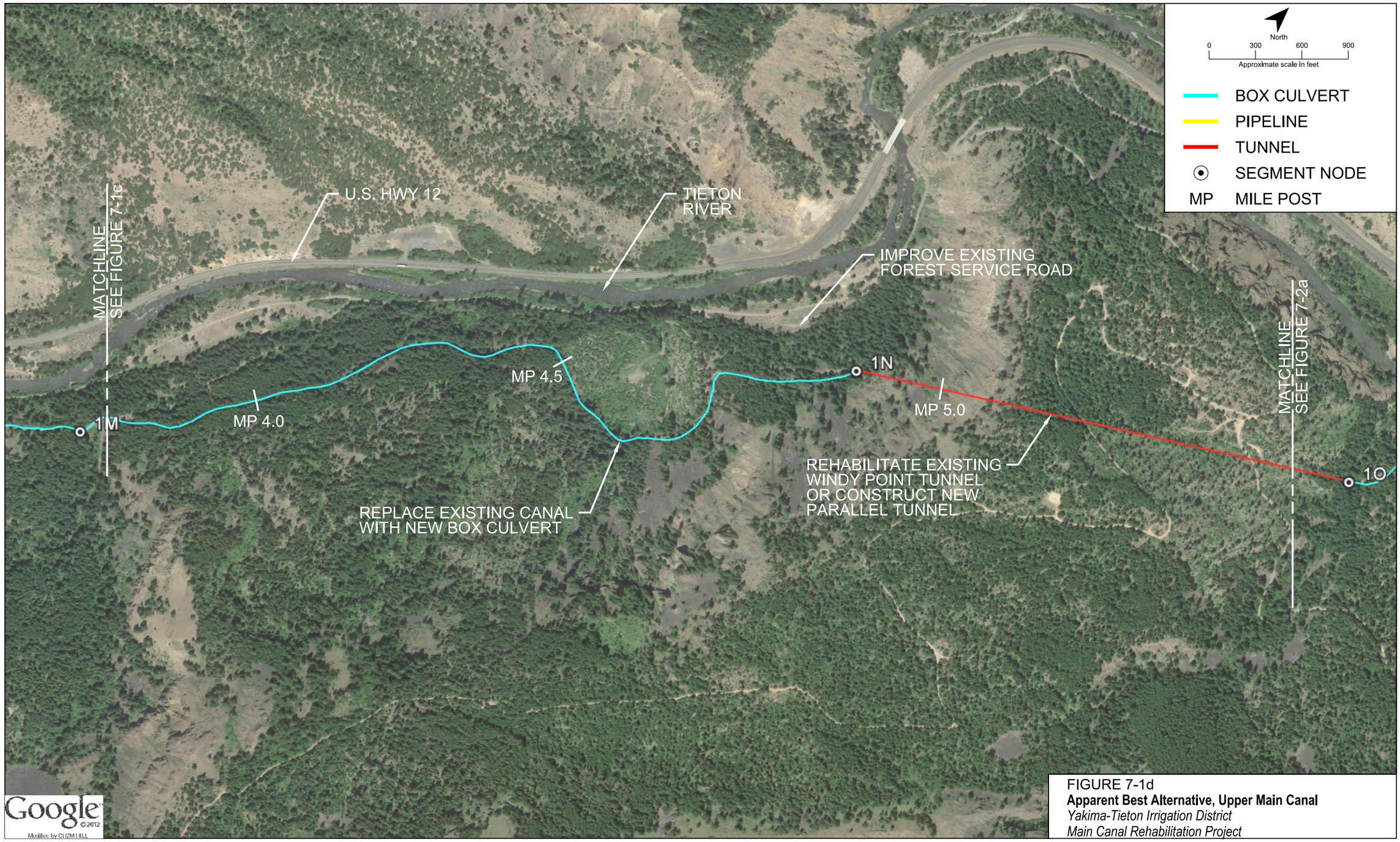

FIGURE 7-1d
Apparent Best Alternative, Upper Main Canal
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

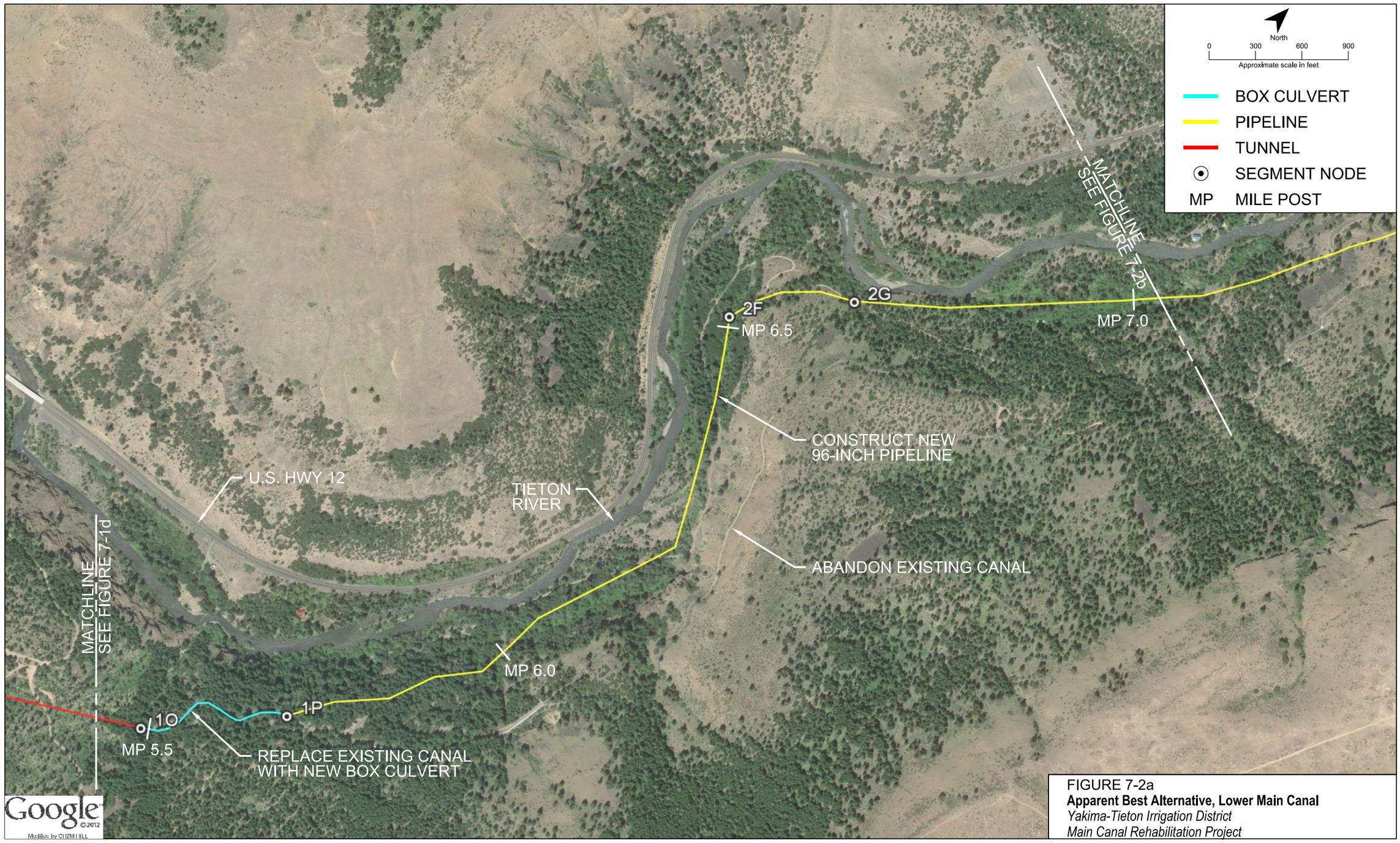

FIGURE 7-2a
Apparent Best Alternative, Lower Main Canal
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

FIGURE 7-2b
Apparent Best Alternative, Lower Main Canal
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

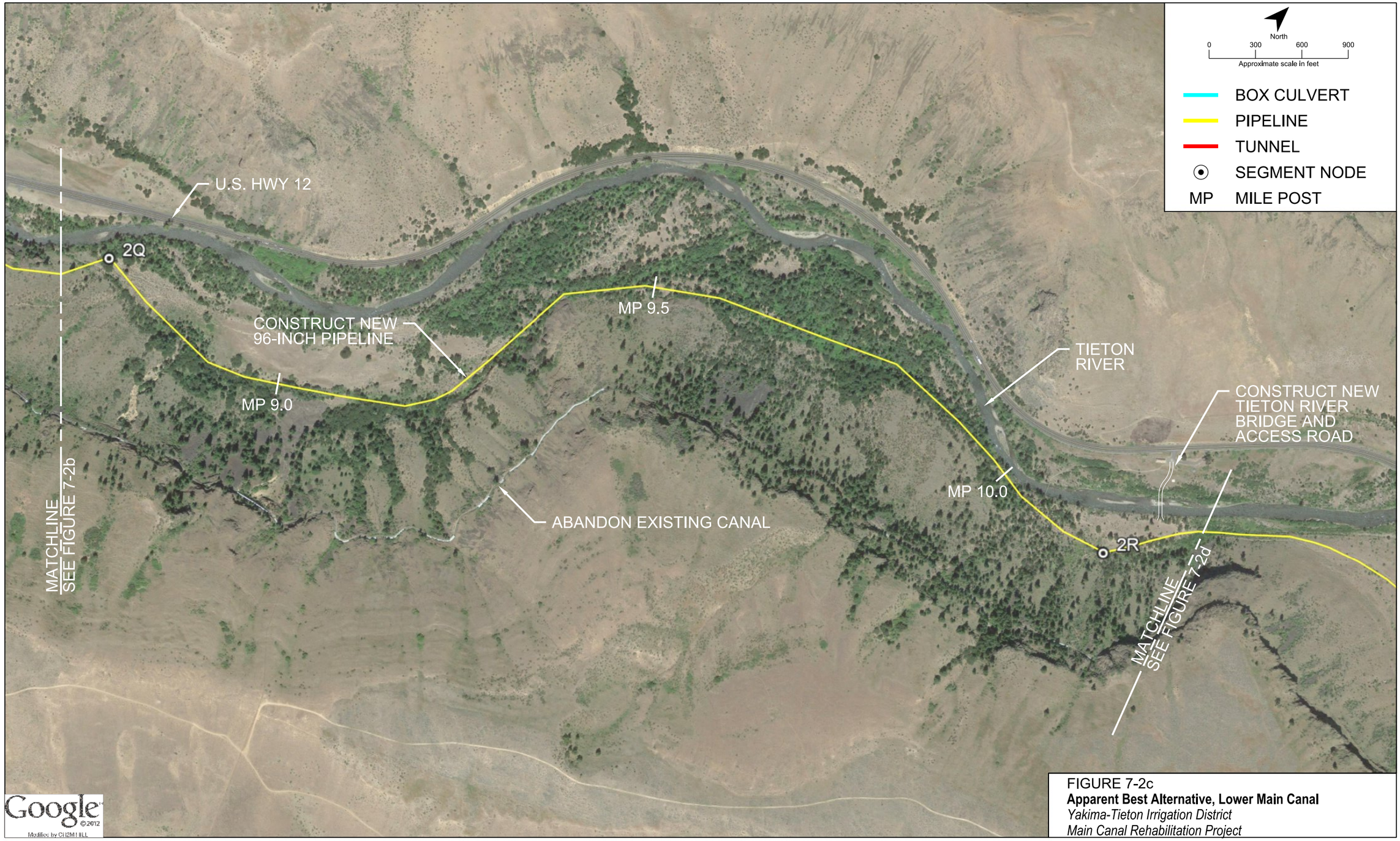

FIGURE 7-2c
Apparent Best Alternative, Lower Main Canal
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

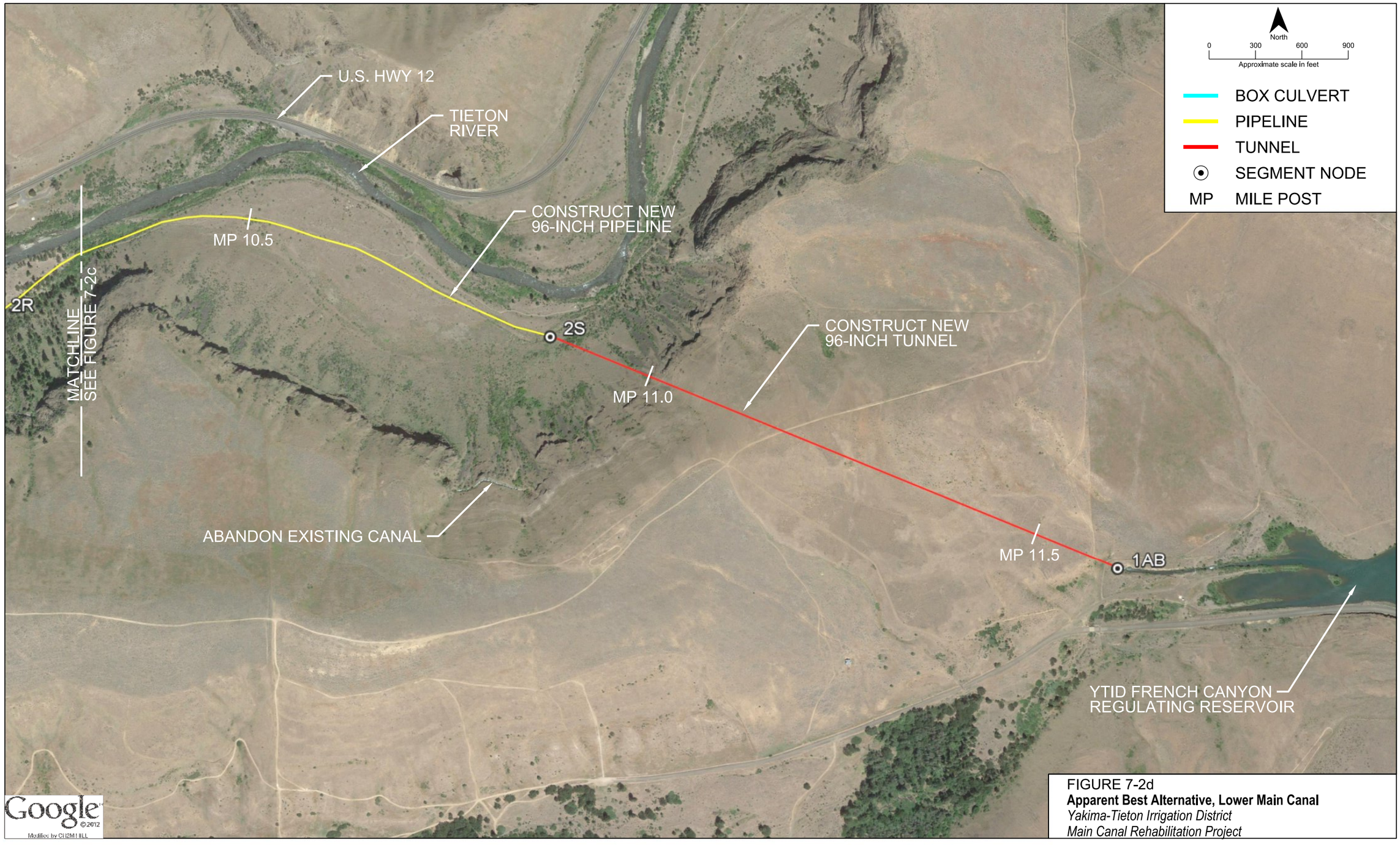

FIGURE 7-2d
Apparent Best Alternative, Lower Main Canal
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

ID	Task Mode	Task Name	Duration	Start	Finish
1		**Refine/Validate Best Apparent**	**140 days**	**Mon 12/2/13**	**Fri 6/13/14**
2		Develop Permitting Workplan	40 days	Mon 12/2/13	Fri 1/24/14
3		Develop Land Ownership Maps	20 days	Mon 12/30/13	Fri 1/24/14
4		Conduct Regulatory Pre-application	40 days	Mon 1/27/14	Fri 3/21/14
5		Conduct Phase I Archaeological Site	40 days	Mon 4/21/14	Fri 6/13/14
6		Conduct Tunneling and Geotechnical	50 days	Mon 12/2/13	Fri 2/7/14
7		Review Headworks Design and Develop	40 days	Mon 12/2/13	Fri 1/24/14
8		**Field Data Collection**	**160 days**	**Mon 1/27/14**	**Fri 9/5/14**
9		Devleop Aerial Photography and	50 days	Mon 1/27/14	Fri 4/4/14
10		Conduct Wetlands Delineation	50 days	Mon 1/27/14	Fri 4/4/14
11		Secure Access Agreements for	60 days	Mon 1/27/14	Fri 4/18/14
12		Perform Geotechnical Investigations	60 days	Mon 4/21/14	Fri 7/11/14
13		Perform Biological Field Investigations	100 days	Mon 4/21/14	Fri 9/5/14
14		**Pemitting**	**500 days**	**Mon 9/8/14**	**Fri 8/5/16**
15		Prepare Biological Assessment	100 days	Mon 9/8/14	Fri 1/23/15
16		Prepare Biological Opinion	150 days	Mon 1/26/15	Fri 8/21/15
17		Prepare Draft EIR	150 days	Mon 8/24/15	Fri 3/18/16
18		Prepare Final EIR	100 days	Mon 3/21/16	Fri 8/5/16
19		Prepare Permit Applications	100 days	Mon 9/8/14	Fri 1/23/15
20		Support Permit Development	150 days	Mon 1/26/15	Fri 8/21/15
21		**Preliminary Design**	**340 days**	**Mon 4/7/14**	**Fri 7/24/15**
22		Prepare Project Delivery Plan	40 days	Mon 4/7/14	Fri 5/30/14
23		Prepare 10% Design Plans	150 days	Mon 6/2/14	Fri 12/26/14
24		Prepare Easement Descriptions	150 days	Mon 12/29/14	Fri 7/24/15
25		Prepare Hydrologic/Scour Report	50 days	Mon 4/7/14	Fri 6/13/14
26		**Final Design**	**650 days**	**Mon 12/29/14**	**Fri 6/23/17**
27		**Upper Main Canal**	**400 days**	**Mon 12/29/14**	**Fri 7/8/16**
28		Box Culvert Phase 1	200 days	Mon 12/29/14	Fri 10/2/15
29		Box Culvert Phase 2	200 days	Mon 10/5/15	Fri 7/8/16
30		Tunnels	200 days	Mon 12/29/14	Fri 10/2/15
31		**Lower Main Canal**	**450 days**	**Mon 10/5/15**	**Fri 6/23/17**
32		Pipelines	250 days	Mon 7/11/16	Fri 6/23/17
33		Tunnel	200 days	Mon 10/5/15	Fri 7/8/16
34		**Construction**	**700 days**	**Mon 10/5/15**	**Fri 6/8/18**
35		**Upper Main Canal**	**350 days**	**Mon 10/5/15**	**Fri 2/3/17**
36		Box Culvert Phase 1	150 days	Mon 10/5/15	Fri 4/29/16
37		Box Culvert Phase 2	150 days	Mon 7/11/16	Fri 2/3/17
38		Tunnels	200 days	Mon 10/5/15	Fri 7/8/16
39		**Lower Canal Tunnels**	**500 days**	**Mon 7/11/16**	**Fri 6/8/18**
40		Pipelines	250 days	Mon 6/26/17	Fri 6/8/18
41		Tunnel	200 days	Mon 7/11/16	Fri 4/14/17

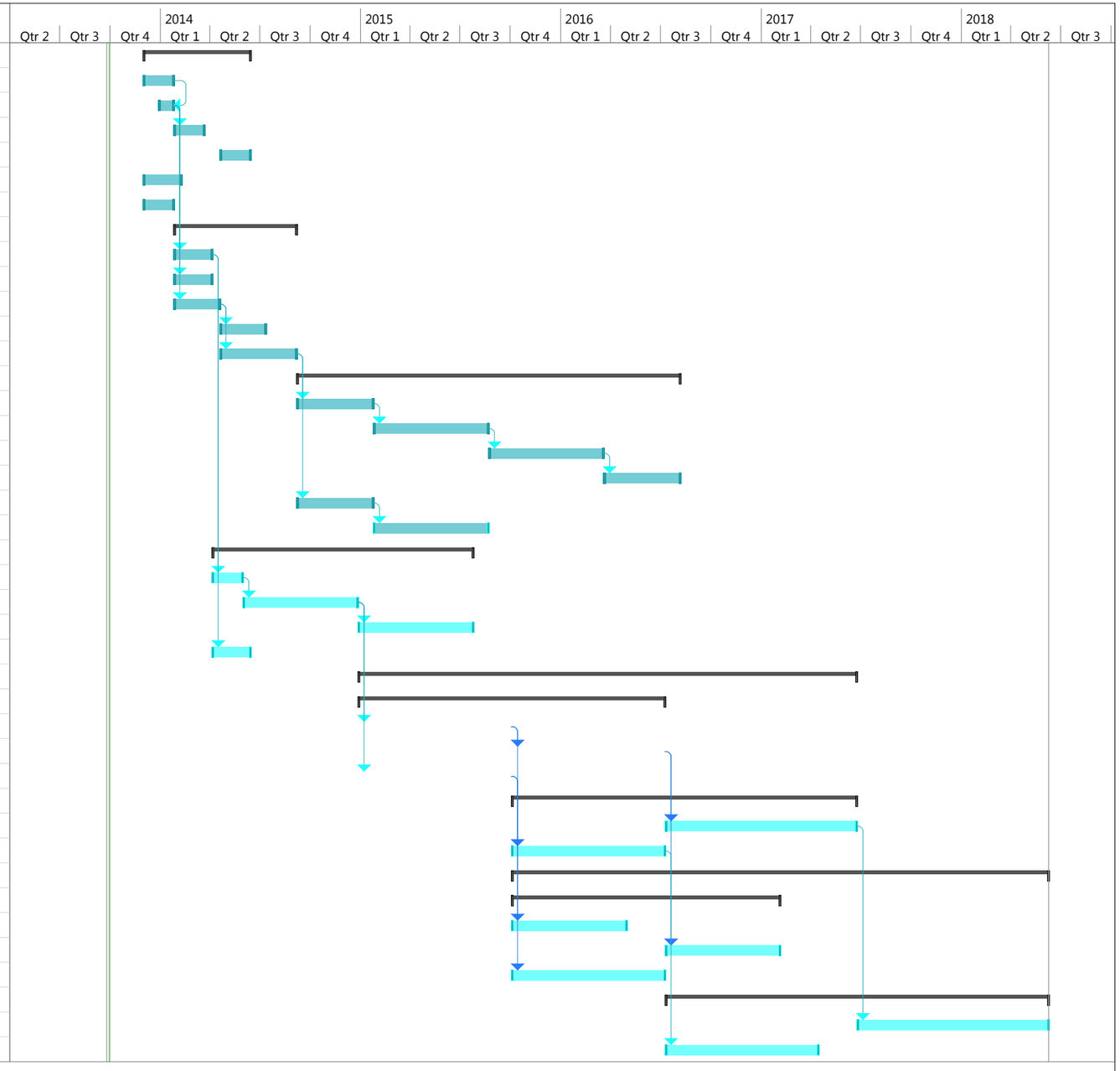

FIGURE 7-3
Project Schedule

SECTION 8

Cowiche Creek Water Exchange

8.1 Background

Salmon and steelhead populations in the Columbia River Basin have declined dramatically over the past 150 years. Pre-development fish populations in the Columbia River have been estimated between 8 and 14 million fish (Yakima Basin Fish & Wildlife Recovery Board, 2009). Recently, the total run of all Columbia River salmon and steelhead ranged from 1 to 2 million fish, with approximately three-quarters of those fish reared in hatcheries.

Similarly, fish populations have declined in the Yakima River Basin in two distinct phases. Between 1850 and 1900, salmon and steelhead populations declined by about 90 percent because of diversions of instream flows into unscreened irrigation canals. From the early to mid-1900s, the construction of dams for hydropower, irrigation, and flood control blocked many miles of spawning and rearing habitat. The quantity and quality of habitat were also reduced by reduced flow rates below the dams and higher water temperatures in the rivers.

In 1999, the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) classified Middle Columbia River Steelhead as a threatened species under the Endangered Species Act. In 2006, NOAA Fisheries revised its listing to apply only to anadromous (ocean-going) steelhead. This listing applies to steelhead that spawn in large geographic sections of central and eastern Washington and Oregon.

By the late 1900s many federal, state, and local resource agencies began working together to restore fish populations. By 2000, most of the large irrigation diversions on the main stem of the Yakima River had been screened, and attention shifted to smaller creeks and tributaries where thousands of on-farm diversions, pumps, and barriers entrapped fish and blocked their migration routes.

In 2001, the Yakima Tributary Access and Habitat Program (YTAHP) was organized to restore salmonid passage to Yakima River tributaries. YTAHP was composed of organizations involved in watershed management including the Bureau of Reclamation, Washington State Fish and Wildlife, Kittitas County Conservation District, NYCD, Kittitas County Water Purveyors, Ahtanum Irrigation District, and the South Central Washington Resource Conservation and Development Council. In addition, the Yakima Nation participated in the early stages of program development and ongoing coordination.

YTAHP works with voluntary landowners by providing planning, engineering, permitting, funding, and construction of fish migration and habitat improvements in local tributaries to the Yakima River. YTAHP is funded through grants from the Bonneville Power Administration and helps private landowners achieve compliance with laws requiring screening on irrigation withdrawals and to improve fish passage.

NYCD is a member agency of YTAHP. Since 2001, NYCD has been involved in identifying, planning, designing, and constructing fish screens, fish barrier removals, and habitat restoration in Cowiche Creek. YTAHP and NYCD have constructed more than a dozen improvements in Cowiche Creek during the past 10 years.

A significant impediment to further habitat restoration of Cowiche Creek is the over-appropriation and over-use of creek water during the irrigation season. During summer, portions of Lower Cowiche Creek dry up because of irrigation withdrawals from the creek. By 2004, NYCD and YTID began to discuss providing YTID water to Cowiche Creek water users. Under a proposed water exchange agreement, YTID would provide water to Cowiche Creek water users through YTID's existing distribution system. In exchange, the Cowiche Creek water users would stop withdrawing water from Cowiche Creek and exchange their Cowiche Creek water right for an equivalent quantity of Tieton River water provided by YTID. In theory, this agreement will benefit both fisheries restoration in Cowiche Creek and the Cowiche Creek landowners. Water will remain in

Cowiche Creek to provide higher instream flow rates for steelhead spawning and rearing, and delivery of water through YTID's system to landowners will be more reliable than the seasonal supplies available from Cowiche Creek.

Although the details of the agreements between YTID and Cowiche Creek water users have yet to be finalized, the concept has received widespread regulatory support. Local, state, and federal agencies have identified the concept as a recommended mitigation strategy in the 2009 Yakima Steelhead Recovery Plan (Yakima Basin Fish & Wildlife Recovery Board, 2009). The Steelhead Recovery Plan is a federally mandated document that describes proposed actions, cost estimates, and schedules for restoring steelhead to a non-threatened status under the Endangered Species Act.

In good faith and prior to a formal water exchange agreement, YTID agreed to construct a turnout from its main distribution pipeline that will serve a small number of Cowiche water users. Design and construction of the turnout were funded in part by a $925,000 grant from the Washington Salmon Recovery Funding Board. The Board, composed of 22 federal, state, and local agencies, annually distributes state and federal money to selected on-the-ground fish habitat improvement projects throughout the state. A second YTID turnout is planned near Cowiche Creek, but funding and schedule details have not been finalized. Concurrently, NYCD is developing plans for two pressure pipeline distribution systems that will connect to the YTID turnouts and deliver YTID-conveyed water to the Cowiche Creek parcels.

Because YTID's Main Canal Rehabilitation Project is an integral component of the Cowiche Creek Water Exchange Project, this study was funded in part by a grant from the Washington Salmon Recovery Funding Board and the Bureau of Reclamation's Yakima River Basin Water Enhancement Program (YRBWEP). The Bureau of Reclamation runs the Yakima River Project, which supplies water to farmers and others throughout the Yakima Basin. YRBWEP implements projects that improve conditions for fish by improving irrigation systems' efficiency, increasing instream flows, and protecting and enhancing important habitat. YRBWEP has been a key player in fish recovery in central Washington since 1994.

8.2 Cowiche Creek Water Users

To further advance the Cowiche Creek Water Exchange Project, CH2M HILL worked with the Washington State Department of Ecology to identify and map the parcels of land that hold senior Cowiche Creek water rights. Figures 8-1a through 8-1d, included at the end of this section, show these parcels, and Appendix D lists the parcels and their water rights. In total, 66 parcels hold a 25.18-cfs water right. For the most part, these parcels are distributed along the North and South Fork Cowiche Creek near the confluence of the creeks. In addition, 17 parcels are near the confluence of Cowiche Creek and the Naches River (Figure 8-1d).

8.3 YTID's Distribution System

Figures 8-1a through 8-1d also show YTID's existing pipeline distribution system and the locations of the two Cowiche turnouts that will serve some of the Cowiche Creek parcels. The turnouts are near the confluence of the North and South Forks of Cowiche Creek on YTID's 72-inch-diameter main pipeline. The 4-cfs West Lateral Turnout, currently under construction, will serve eight parcels. The planned 4-cfs East Lateral Turnout will serve six parcels. Together, these two turnouts will deliver up to 8 cfs to the Cowiche parcels, or about 32 percent of the total Cowiche water right (25.18 cfs).

The box culvert, pipeline, and tunnel concepts developed earlier in this report will provide sufficient capacity to accommodate both YTID's peak demand (345 cfs) and the peak demand for the Cowiche water users (25 cfs). The existing canal does not have sufficient capacity to convey this additional water. Hence, reconstruction of the Main Canal will provide the infrastructure required to wheel Cowiche water as far as French Canyon Reservoir. However, a key unresolved question is, "To what extent does YTID's existing pipeline distribution system have available capacity to deliver water from French Canyon Reservoir to the Cowiche parcels, without degrading service to existing YTID users?"

To answer this question, CH2M HILL reviewed the original design drawings for YTID's main distribution pipeline between French Canyon Reservoir and the Cowiche Creek turnouts. Appendix E contains the original design hydraulic profile for the main pipeline (CH2M HILL, 1982). The locations of the two proposed turnouts are shown on the drawing. The West Lateral Turnout (Turnout #1) is located at Station 507+00 (50,700 feet southeast of YTID's reservoir as measured along the pipeline). The East Lateral Turnout (Turnout #2) is located at Station 535+00.

The original hydraulic profile indicates the design capacity of YTID pipelines. The 90-inch-diameter pipeline near French Canyon Reservoir has a capacity of 154,260 gallons per minute (gpm) (344 cfs). Below Rosenkrantz Road, the pipeline reduces to 72 inches in diameter, and the design capacity reduces to 108,570 gpm (242 cfs). At YTID's Hydro Station #1 (Cowiche Plant), the capacity further reduces to 102,400 gpm (228 cfs). Finally, at the proposed Cowiche Creek turnouts, the capacity of the 72-inch pipeline is 94,650 gpm (211 cfs).

The flow meter at Hydro Station #1 can be used to compare the design capacity of the pipeline with actual water deliveries. CH2M HILL obtained a 3-year sample of the flow rate data from this facility (see Appendix F). The highest measured flow rate was 240 cfs on May 1, 2013. This flow event was frost-protection water delivered to YTID landowners during spring. The peak summer delivery was 207 cfs on August 24, 2012. The peak summer event appears to be an isolated "spike," which was significantly higher than other peak summer events. For the spring event, the peak-day delivery exceeded the design capacity of the pipeline, while the peak-day delivery in summer was less than the design capacity of the pipeline at Hydro Station #1.

When YTID serves water to Cowiche water users, the flow rate at Hydro Station #1 could increase by as much as 25 cfs. Table 8-1 summarizes the recent measured flow rates at Hydro Station #1, the potential flow rate if all 25 cfs is delivered to the Cowiche Creek parcels, the pipeline design flow rate, and the surplus capacity. The table suggests that the YTID mainline has sufficient capacity to accommodate the Cowiche parcels during summer, but may not have sufficient capacity on peak days during spring frost events. YTID may wish to consider this limitation as agreements are developed with the Cowiche water users.

TABLE 8-1
Comparison of Proposed Water Deliveries through YTID's 72-inch Mainline vs Available Pipeline Capacity

	Spring	Summer
Peak YTID Delivery (cfs)[a]	240	207
Potential Cowiche Delivery (cfs)[b]	25	25
Total Delivery (cfs)	265	232
Design Capacity of 72-inch Mainline (cfs)[c]	228	228
Surplus/(Deficit) Capacity (cfs)	(-37)	(-4)

[a] Based on measured flow rates at YTID Hydro Station #1 for the period August 2010 to September 2013 (Appendix F)

[b] Based on Department of Ecology, Cowiche Creek Water Rights Data (Appendix D)

[c] Based on YTID Main Transmission Pipeline Capacity at Hydro Station #1 (Appendix E)

The analysis above assumes that all Cowiche parcels will be served directly from new turnouts on the 72-inch mainline. Outlying Cowiche parcels far from the 72-inch mainline will require significant new pipeline installations to reach the Cowiche parcels.

In lieu of installing dedicated pipelines from the 72-inch YTID mainline to outlying Cowiche parcels, it may be feasible to serve the parcels from smaller, existing YTID pipelines. For example, parcels along the Upper South Fork Cowiche Creek can be served by YTID Laterals 1J and 1R (see Figure 8-1c). Parcels near the confluence of Cowiche Creek and the Naches River can be served from YTID Lateral 3 or Lateral 7 (see Figure 8-1d). These laterals are smaller in diameter, ranging from 8 to 14 inches. Therefore, their flexibility

and capacity to serve new Cowiche parcels is limited. Serving Cowiche parcels from small-diameter YTID laterals should be considered, but will require additional planning, hydraulics analysis, and alternatives analysis beyond the scope of this report.

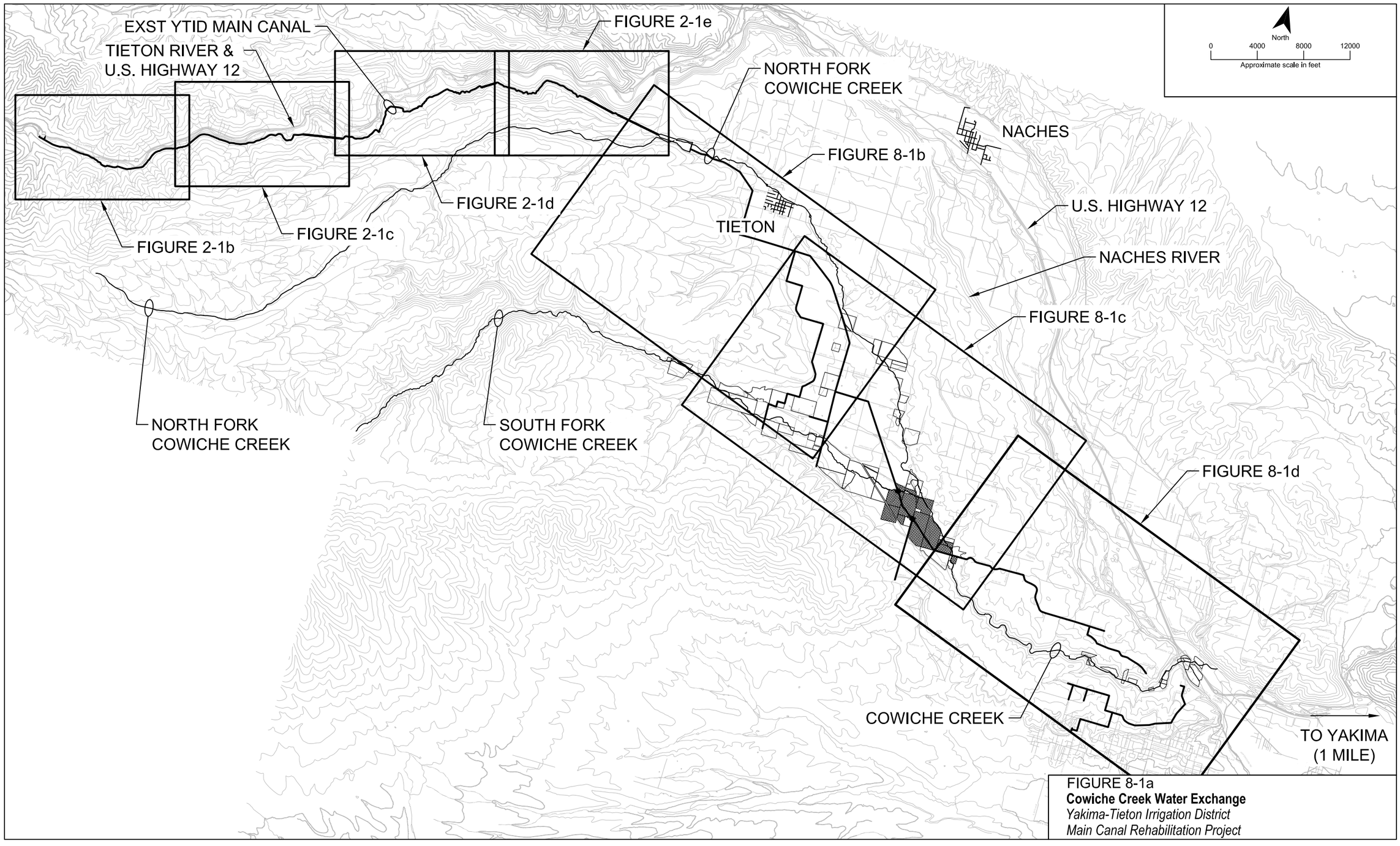

FIGURE 8-1a
Cowiche Creek Water Exchange
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

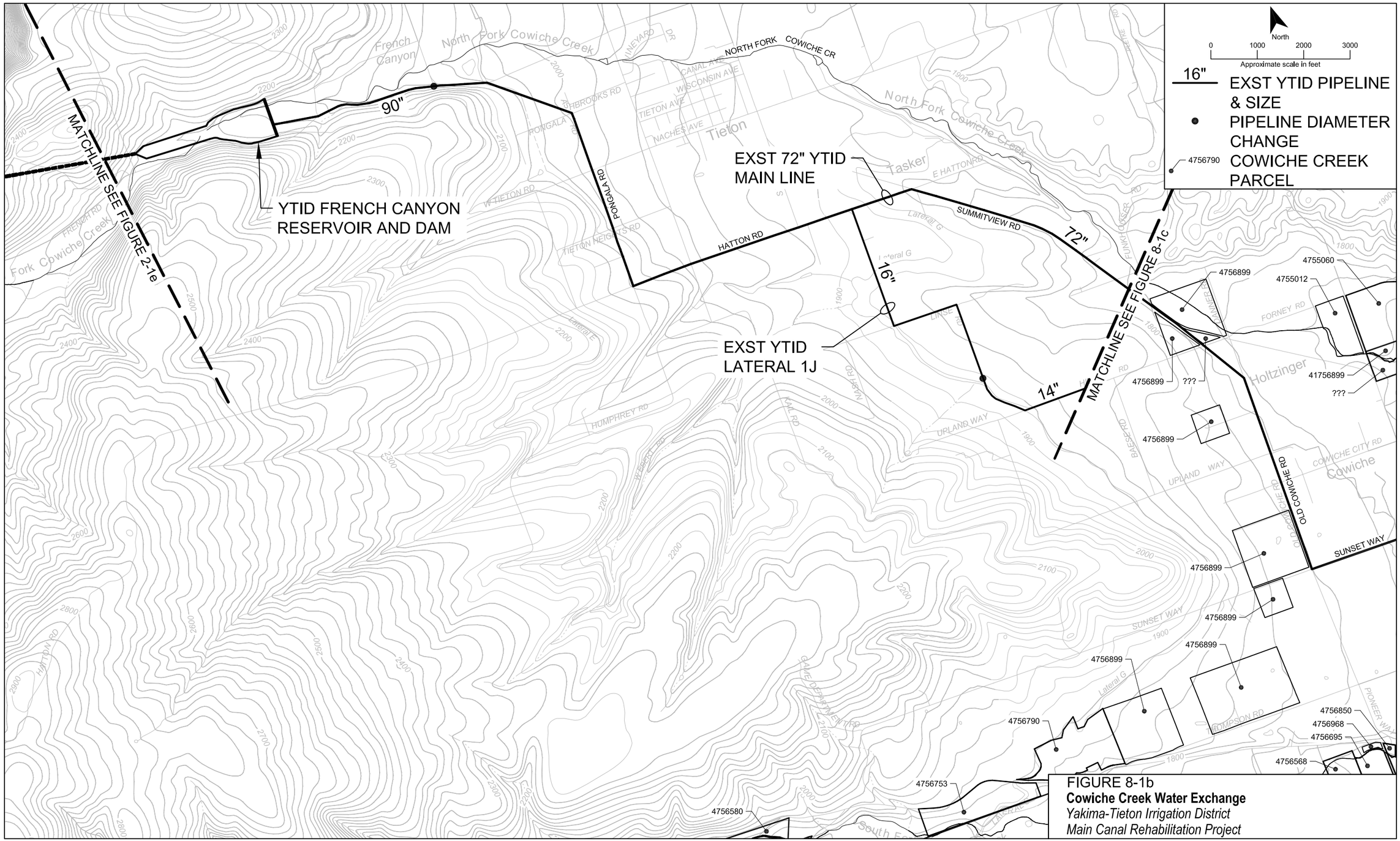

FIGURE 8-1b
Cowiche Creek Water Exchange
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

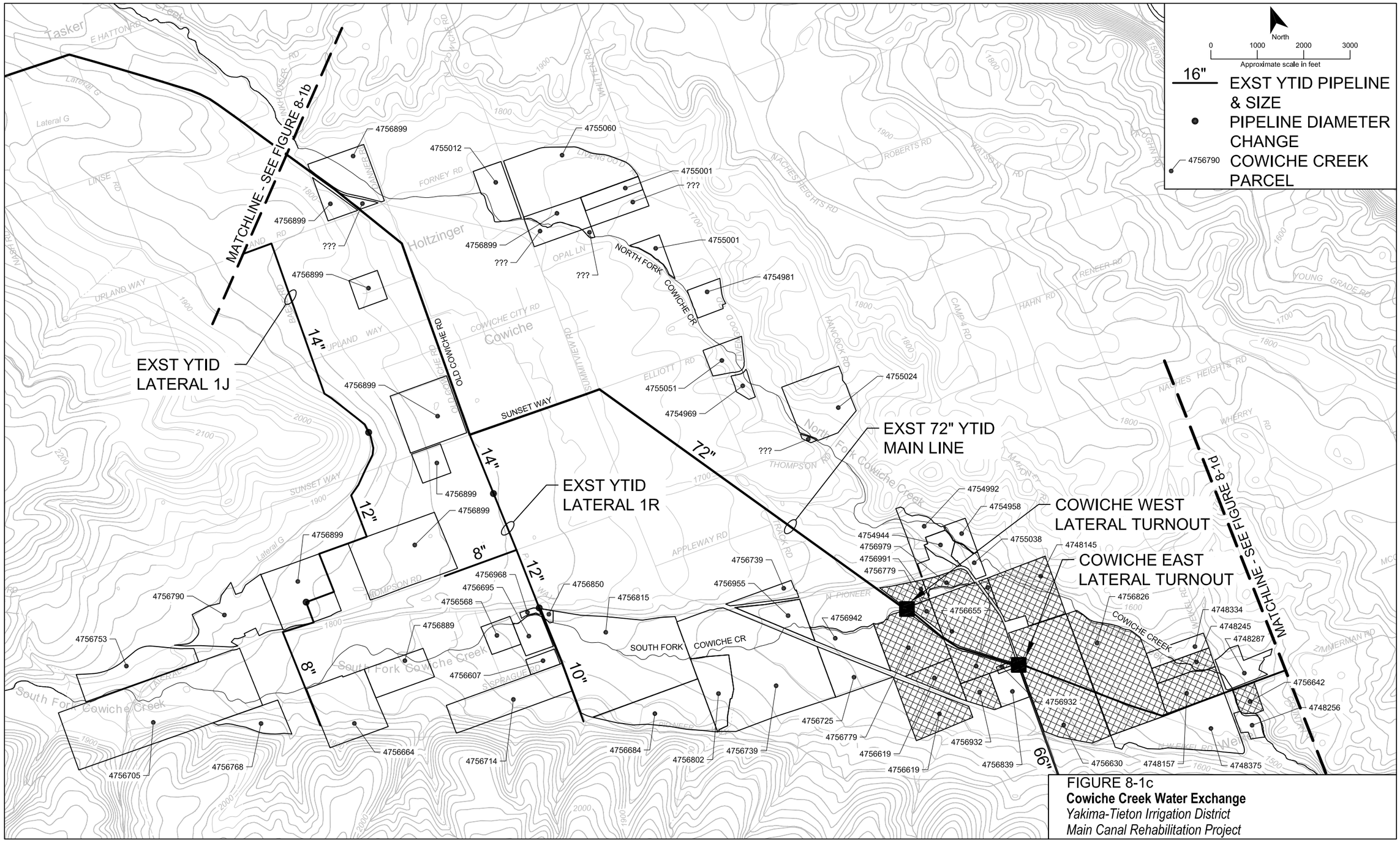

FIGURE 8-1c
Cowiche Creek Water Exchange
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

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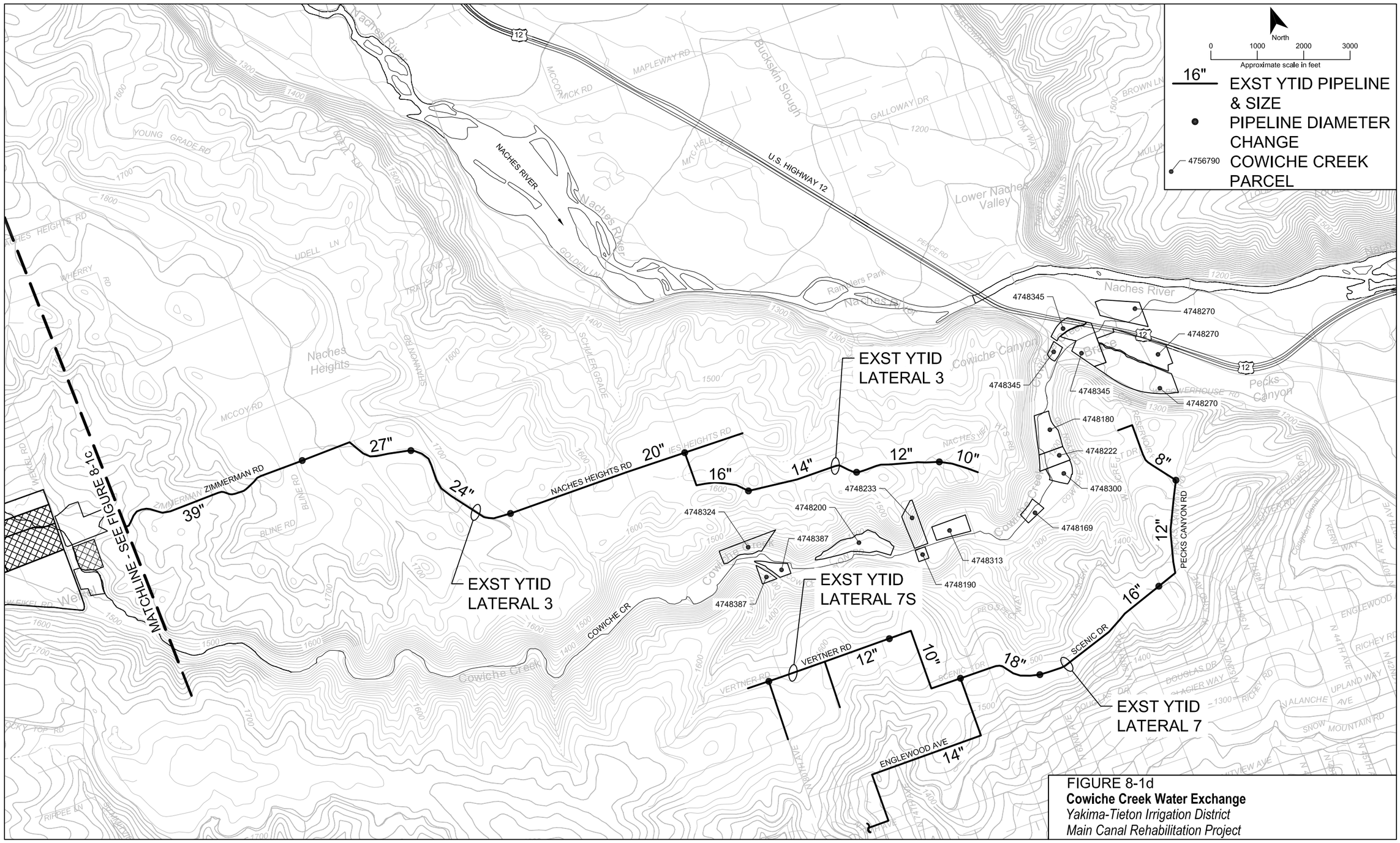


FIGURE 8-1d
Cowiche Creek Water Exchange
Yakima-Tieton Irrigation District
Main Canal Rehabilitation Project

SECTION 9

Conclusions and Recommendations

9.1 Upper and Lower Main Canal

CH2M HILL has identified a project alternative that achieves YTID's goals for a long-term reliable water supply, flexibility to support fisheries restoration in Cowiche Creek, and opportunities to serve other water users. The apparent best alternative consists of the following:

- A 6-foot by 10-foot precast concrete box culvert that replaces the Main Canal from the Tieton River Diversion to the Windy Point Tunnel
- Rehabilitation or reconstruction of the existing Windy Point Tunnel
- A new 96-inch pipeline that parallels the Tieton River until it approaches French Canyon Reservoir
- A new 96-inch tunnel that connects the pipeline to the reservoir

Compared to other alternatives, the selected alternative has the most desirable overall attributes including environmental impacts, constructability, operations and maintenance, and cost.

The total project cost estimate is $200 million. Permitting, design, and construction of the selected alternative is expected to take up to 8 years. The apparent best alternative is shown in Figures 3-1 through 3-3 and Figures 7-1a through 7-1d.

All work along the existing canal must be performed during winter. To accomplish this work efficiently, the contractor will need to maximize working time during favorable weather conditions, and the work must be sequenced to minimize potential delays. YTID should consider terminating all irrigation deliveries no later than September 30 and providing prompt, limited canal access to the contractor by October 1.

While there are no known fatal-flaws associated with this alternative, future investigations could reveal extraordinary, unanticipated costs or obstacles. Project cost and schedule estimates include several key assumptions:

- Regulatory agencies and other project stakeholders will support this project because of its potentially significant net benefit to Cowiche Creek fisheries and economic benefit to the community. Mutually agreeable strategies for avoiding or mitigating environmental impacts, including work in the river and work near Golden Eagle habitat (Milepost 10.0), will be negotiated without incurring extraordinary, unanticipated costs or delays.
- Tunneling through the stratified, non-homogeneous basalt near Mileposts 11.0 to 11.5 is feasible.
- Easements and rights-of-way can be acquired from existing landowners.

Section 9.3 identifies several near-term action items designed to validate these assumptions.

9.2 Cowiche Creek Water Exchange

The total water right for all Cowiche parcels is approximately 25 cfs. YTID's existing 72-inch pipeline has sufficient capacity to deliver 25 cfs to the Cowiche parcels, without sacrificing service to YTID shareholders, assuming the Cowiche turnouts are located directly from the 72-inch pipeline. Because many Cowiche parcels are a considerable distance from the mainline, dedicated new pipelines will be required to serve the remote Cowiche parcels. Alternatively, it may be feasible to serve remote Cowiche parcels from existing, smaller YTID laterals, such as Laterals 1J, 1R, Lateral 3, or Lateral 7. However, specific alternatives require further evaluations. Figures 8-1a through 8-1d show the Cowiche parcels and existing YTID pipelines.

9.3 Recommended Near-Term Action Items

Several low-cost, near-term action items should be undertaken within the next 12 months to validate the apparent best alternative. The action items are summarized below, and details are provided in Section 7.4.

- Environmental Permitting. CH2M HILL recommends the preparation of an environmental permitting workplan. The permitting workplan will identify required permits for the project, agencies involved in reviewing and issuing the permits, fieldwork required to submit the permit applications, and estimated schedules for securing each permit. The workplan will also include an avoidance map of known environmental issues. This plan will serve as a guidance document for early discussions with regulatory agencies. After the draft permitting workplan and avoidance map have been created, a pre-application meeting with the regulatory agencies should be conducted to review the workplan and discuss proposed fieldwork. This activity is a high priority and should begin as soon as possible.
- Cultural Resource Investigations. CH2M HILL recommends YTID conduct a Phase 1 archaeology survey of the apparent best alignment. A Phase 1 survey includes research into existing documented archaeological sites and a site walk conducted by qualified resource professionals to look for visible artifacts. The site visit will focus on the new alignment downstream of the Windy Point Tunnel. Findings will be documented in a technical memorandum, and recommendations on avoidance or mitigation strategies will be provided. This activity should begin in spring 2014.
- Land Ownership Maps. Access agreements for field investigations and early discussions on right-of-way acquisition and permitting will require more information on current land ownership. CH2M HILL recommends an initial desktop study to collect existing information on land ownership records. The land ownership information will be plotted on existing aerial photography. This activity is a high priority and should begin as soon as possible.
- Geologic and Tunneling Reconnaissance Investigations. CH2M HILL recommends a reconnaissance investigation of geologic and geotechnical conditions along the preferred project alignment. This effort will begin with a review of geologic maps, geotechnical boring data, and landslide maps. The data review will be followed by a site visit by qualified tunneling engineers to examine the preferred alignment. This effort should be conducted this winter so that Windy Point Tunnel, Tieton Tunnel, and North Fork Tunnel can be examined. A subsurface exploration plan will be prepared as the product of these efforts. Additional drilling and testing will be required during preliminary design.
- Cowiche Creek Water Exchange. The Cowiche Creek Water Exchange project appears to be a “win/win” opportunity for YTID, the environmental community, and the Cowiche Creek water users. YTID should continue to work with NYCD, YRBWEP, and others to secure long-term water delivery agreements and funding. Planning, design, and construction of the second Cowiche Creek turnout could continue if YTID secures commitments to agreements and funding.

SECTION 10

Works Cited

CH2M HILL. 1982. *Rehabilitation and Betterment Project, Main Transmission Pipeline.* Prepared for Yakima Tieton Irrigation District, Yakima, Washington. December.

S.P. Cramer and Associates. 2002. *Biological Assessment - Potential Impacts from the Tieton Hydroelectric Project on ESA Listed Bull Trout and Steelhead in the Yakima Basin*. Prepared for Tieton Hydropower L.L.C., Yakima, Washington. 103 pp. July.

Yakima Basin Fish & Wildlife Recovery Board. 2009. *2009 Yakima Steelhead Recovery Plan.* Extracted from the *2005 Yakima Subbasin Salmon Recovery Plan* with Updates. August.

Appendix A
Evaluation Scorecards

Segment Evaluation

	1	Segment ID ->	1A-1B	Type->	RC Box	Location:
		Length (ft)->	1,213	Baseline Cost ($/100-ft) ->	$252,000	First canal segment near headworks
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	Route comes close to ESA species in river. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Low	3	No in river work but near river where there are migratory fish.
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	Medium	7	Near riparian habitat.
	E	Wetlands	2.1	High	12	Adjacent high quality wetlands follow canal to river.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Within 200 feet of river shoreline. May be within floodplain.
	G	Land Use	0.6	Low	1	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Vegetation removal to widen construction area may cause permanent impacts to wetlands and cause erosion.
	I	Water Quality	1.1	Medium	4	Near river at coordinate 1B; frac-out and spills to river are more of a hazard.
	J	Air Quality	0.2	Negligible	0	Further from congested area and Hwy 12. Dust from construction less likely to be noticed. Screened by vegetation.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	High potential for cultural resources because of pipeline location near river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land clearing has already occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No known campsites or recreatonal facilities on route segment.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	Energy consumption anticipated to be similar with all alternatives.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	Low	4	Access is good from headworks.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Medium	6	Work must be completed in the winter. Access is good.

Segment Evaluation

	1	Segment ID ->	1A-1B	Type->	RC Box	Location:
		Length (ft)->	1,213	Baseline Cost ($/100-ft) ->	$252,000	First canal segment near headworks
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope/stability issues
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Low	4	Design must incorporate one relatively minor drainage crossing.
	EE	Work Space Constraints	1.5	Low	3	Mild side slopes. Some space available to stage equipment and store materials adjacent to the canal/pipe.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Negligible	0	Mild side slope. Long term maintenance requirements of falling rock, debris, and slides is negligible.
	MM	Erosion/Scour Maintenance	5.2	Low	10	One relatively small drainage crossing. Long term O&M cost is probably minimal
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Negligible	0	Access is good from headworks. Long-term O&M for access would be negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	There is no lost opportunity for hydropower production along this alignment.
		Sum of Scores	100.0		**171**	

Segment Evaluation

	2	Segment ID ->	1B-1C	Type->	RC Box	Location:
		Length (ft)->	2,859	Baseline Cost ($/100-ft) ->	$252,000	Existing canal behind Trout Lodge
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	High	13	Adjacent to river with little working room on steep slopes. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Medium	7	Near river where construction could impact migratory fish.
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	High	11	Within riparian zone (100 feet of river).
	E	Wetlands	2.1	Medium	8	Wetlands known on adjacent segment and this segment is close to river.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Within shoreline's protection zone. May be within floodplain.
	G	Land Use	0.6	Low	1	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep side slopes. Box culvert requires little excavation in canal ROW. Route next to river.
	I	Water Quality	1.1	Medium	4	Near river where frac-out and spills are more of a hazard.
	J	Air Quality	0.2	Medium	1	Across the river and near congested area where people may notice dust generated from construction. Trees shield view.
	K	Hazardous Materials	1.6	Low	3	Human activity across the river. Potential hazardous materials sites unlikely.
	L	Cultural Resources	2.3	High	14	High potential for cultural resources because of pipeline location near river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Medium	4	Visual scape changes less noticed in existing canal alignment where land clearing has occurred except near public areas.
	O	Noise	0.4	Low	1	Construction/operational noises not likely heard by the public because of adjacent river generated noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	Energy consumption anticipated to be similar with all alternatives.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	Medium	9	Access is good from both ends, but slopes are steep and construction access is poor.
	X	Landowner Conflicts	0.7	Medium	3	Moderately high probability of landowner conflicts from residents and businesses directly across the river near Trout Lodge.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. North-facing slope.

Segment Evaluation

	2	Segment ID ->	1B-1C	Type->	RC Box	Location:
		Length (ft)->	2,859	Baseline Cost ($/100-ft) ->	$252,000	Existing canal behind Trout Lodge
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Low	4	Box culvert design must incorporate one existing cross-drainage pipe bridge.
	EE	Work Space Constraints	1.5	Medium	6	Steep side slopes. No space adjacent to the work for materials or equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Medium	10	Work is unconfined but steep side-slopes and space limitations create some safety risks.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Low	10	Steep side slopes with heavy forestation. Long term maintenance of falling rock and debris is probably minimal.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	One existing pipe bridge to remain. Long term O&M costs of cross-drainage facility is probably negligible.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control O&M is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Negligible	0	After the box culvert is installed, access is good to this location from the headworks. Long term O&M would be negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	There is no lost opportunity for hydropower production along this alignment.
		Sum of Scores	100.0		**204**	

Segment Evaluation

	3	Segment ID ->	1C-1D	Type->	RC Box	Location:
		Length (ft)->	2,356	Baseline Cost ($/100-ft) ->	$252,000	Existing canal near downstream of Trout Lodge
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from the river. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Low	3	Beyond 200-foot shoreline. May be within floodplain but on outer boundary.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	Mild side slopes. Box culvert requires little excavation in canal ROW. Closer to river than some segments.
	I	Water Quality	1.1	Low	2	Near river as compared to some segments, but distance makes frac-out and spills not likely to occur.
	J	Air Quality	0.2	Medium	1	People live/work within 0.6 miles from canal; and may notice dust. Existing vegetative screening may be removed during construction.
	K	Hazardous Materials	1.6	Medium	6	Human activity near pipeline construction but far enough way that potential for encountering hazardous materials sites is low.
	L	Cultural Resources	2.3	High	14	High potential for cultural resources because of pipeline location near river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Medium	4	Visual scape changes less noticed in existing canal alignment where land clearing has occurred except near public areas.
	O	Noise	0.4	Medium	2	Construction noises more likely heard because of distance from Hwy 12 and human activity area. River noise masks other noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Medium	3	People live/work within 0.6 miles from canal. Some emergency response conflicts could occur if sharing roadways.
	S	Service Impacts	0.4	Low	1	People live/work within 0.6 miles from canal but service impacts not likely to occur, no need for additional services.
	T	Socio/Economic Impacts	1.5	Medium	6	People live/work 0.6 miles from canal, but should be few socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	Low	4	Construction access is relatively good from both ends and adjacent to the work.
	X	Landowner Conflicts	0.7	Medium	3	Moderately high probability of landowner conflicts from residents near the proposed alignment.
	Y	Utility Conflicts	0.4	Medium	1	Moderately high potential for conflicts with high voltage overhead power lines and utilities serving local residents
	Z	Weather Conditions	1.5	Medium	6	Work must be completed in the winter. Access is good.

Segment Evaluation

	3	Segment ID ->	1C-1D	Type->	RC Box	Location:
		Length (ft)->	2,356	Baseline Cost ($/100-ft) ->	$252,000	Existing canal near downstream of Trout Lodge
		Risk Criterion	**Risk Importance Factor**	**Risk Level**	**Risk Score**	**Risk Level Comments**
Constructability	AA	Soil/Slope Stability	1.5	Low	3	Segment crosses ancient slide area. No evidence of movement since original canal was constructed.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Low	4	Box culvert design must incorporate two moderate sized drainage crossings (one pipe bridge).
	EE	Work Space Constraints	1.5	Low	3	Mild side slopes. Some space available to stage equipment and store materials adjacent to the canal/pipe.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Low	10	Segment crosses ancient slide. No recent movement. Side-slope is mild with heavy forestation. Minimal maintenance expected.
	MM	Erosion/Scour Maintenance	5.2	Low	10	One existing pipe bridge to remain. Long term O&M on drainage crossings is probably minimal.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Negligible	0	After the box culvert is installed, access is good to this location from the headworks. Long term O&M would be negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	There is no lost opportunity for hydropower production along this alignment.
		Sum of Scores	100.0		**167**	

Segment Evaluation

	4	Segment ID ->	1D-1E	Type->	RC Box	Location:
		Length (ft)->	1,013	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from the river. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Low	3	Beyond 200-foot shoreline. May be within floodplain but on outer boundary.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	Mild side slopes. Box culvert requires little excavation in canal ROW. Closer to river than some segments.
	I	Water Quality	1.1	Low	2	Farther from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Further from congested area and Hwy 12. Dust from construction less likely to be noticed. Screened by trees.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	High potential for cultural resources because of pipeline location near river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes will be less noticed in existing canal alignment where land scarring has already occurred.
	O	Noise	0.4	Negligible	0	Construction noises not likely heard because of distance from Hwy 12 and human activity area. River noise masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	Low	4	Access is good from one end and adjacent to the work.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Medium	6	Work must be completed in the winter. Access is good.

Segment Evaluation

	4	Segment ID ->	1D-1E	Type->	RC Box	Location:
		Length (ft)->	1,013	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Low	3	Segment crosses ancient slide area. No evidence of movement since original canal was constructed.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Low	4	No significant connections to existing facilities
	EE	Work Space Constraints	1.5	Low	3	Mild side slopes. Some space available to stage equipment and store materials adjacent to the canal/pipe.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Low	10	Segment crosses ancient slide. No recent movement. Side-slope is mild with heavy forestation. Minimal maintenance expected.
	MM	Erosion/Scour Maintenance	5.2	Low	10	One existing pipe bridge to remain. Long term O&M on drainage crossings is probably minimal.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Negligible	0	After the box culvert is installed, access is good to this location from the headworks. Long term O&M would be negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	There is no lost opportunity for hydropower production along this alignment.
		Sum of Scores	100.0		**142**	

Segment Evaluation

	5	Segment ID ->	1E-1F	Type->	RC Box	Location:
		Length (ft)->	628	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	Route not far from the river (comes within 100 feet). Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Low	3	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	High	11	Areas within riparian protection zone (100 ft of river)
	E	Wetlands	2.1	Medium	8	Wetlands unlikely but comes within 100 feet of river.
	F	Streambed/Shoreline Encroachment	1.3	Medium	5	Mostly within 200-foot shoreline except near coordinate 1E. Likely in floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	Steep side slopes. Box culvert requires little excavation in canal ROW. Route next to river.
	I	Water Quality	1.1	Low	2	Near river where frac-out and spills are more of a hazard.
	J	Air Quality	0.2	Negligible	0	Further from congested area and Hwy 12. Dust from construction less likely to be noticed. Screened by trees.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	High potential for cultural resources because of pipeline location near river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land clearing has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction noises not likely heard because of distance from Hwy 12 and human activity area. River noise masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	Medium	9	Access is available from one end but side-slope is steep and access adjacent to the work is not available
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Steep slope.

Segment Evaluation

	5	Segment ID ->	1E-1F	Type->	RC Box	Location:
		Length (ft)->	628	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Low	3	Rock outcrops with potential for falling rock.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Low	4	No cross-drainage facilities or other known features to integrate.
	EE	Work Space Constraints	1.5	Medium	6	Steep side slopes. No space adjacent to the work for materials or equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Low	10	Side-slope is steep and rocky. Some potential for rolling rock. Long term O&M expected to be minimal.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	No significant drainage crossings. Long term O&M expected to be negligible.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Low	12	After the box culvert is installed, access is good to this location from the headworks. Long term O&M would be minimal.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	There is no lost opportunity for hydropower production along this alignment.
		Sum of Scores	100.0		**188**	

Segment Evaluation

	6	Segment ID ->	1F-1G	Type->	RC Box	Location:
		Length (ft)->	464	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	Route near the river. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Low	3	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	Medium	7	Riparian habitat may be near Coordinate 1F.
	E	Wetlands	2.1	Low	4	Wetlands unlikely but close to river.
	F	Streambed/Shoreline Encroachment	1.3	Medium	5	Beyond 200-foot shoreline except near coordinate 1F. May be within floodplain but on outer boundary.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	Mild side slopes. Box culvert requires little excavation in canal ROW. Closer to river than some segments.
	I	Water Quality	1.1	Low	2	Near river where frac-out and spills are more of a hazard.
	J	Air Quality	0.2	Negligible	0	Further from congested area and Hwy 12. Dust from construction less likely to be noticed. Screened by trees.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	High potential for cultural resources because of pipeline location near river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land clearing has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction noises not likely heard because of distance from Hwy 12 and human activity area. River noise masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	Low	4	Access is good from one end and adjacent to the work.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access.

Segment Evaluation

	6	Segment ID ->	1F-1G	Type->	RC Box	Location:
		Length (ft)->	464	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Low	4	One drainage crossing may require improvements.
	EE	Work Space Constraints	1.5	Low	3	Mild side slopes. Some space available to stage equipment and store materials adjacent to the canal/pipe.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Low	10	Steep side slope with some potential for rolling rock and debris.
	MM	Erosion/Scour Maintenance	5.2	Low	10	One relatively small drainage crossing to maintain. Long-term O&M expected to be minimal.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Low	12	After the box culvert is installed, access is good to this location from the headworks. Long term O&M would be minimal.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	There is no lost opportunity for hydropower production along this alignment.
		Sum of Scores	100.0		**180**	

Segment Evaluation

	7	Segment ID ->	1G-1H	Type->	RC Box	Location:
		Length (ft)->	912	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from river but comes close to shorelines boundary. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Low	3	Beyond 200-foot shoreline. May be above floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep side slopes. Box culvert requires little excavation in canal ROW. Route next but above river.
	I	Water Quality	1.1	Low	2	Above and further from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Further from congested area and Hwy 12. Dust from construction less likely to be noticed. Screened by trees.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	High potential for cultural resources because of pipeline location near river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land clearing has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction noises not likely heard because of distance from Hwy 12 and human activity area. River noise masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	Medium	9	Access is good from one end. Side-slope is steep and access adjacent to the work is poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access.

Segment Evaluation

	7	Segment ID ->	**1G-1H**	Type->	**RC Box**	Location:
		Length (ft)->	**912**	Baseline Cost ($/100-ft) ->	**$252,000**	
		Risk Criterion	**Risk Importance Factor**	**Risk Level**	**Risk Score**	**Risk Level Comments**
Constructability	AA	Soil/Slope Stability	1.5	Low	3	A few areas of rock outcrop and potential for falling rock.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Low	4	Alignment must incorporate one existing cross-drainage pipe bridge.
	EE	Work Space Constraints	1.5	Medium	6	Steep side slopes. No space adjacent to the work for materials or equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Low	10	Side-slopes are steep with rock outcrops. Some potential for falling rock and debris.
	MM	Erosion/Scour Maintenance	5.2	Low	10	One existing cross-drainage pipe bridge to remain. Long-term O&M of drainage facilities is expected to be minimal.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Low	12	After the box culvert is installed, access is good to this location from the headworks. Long term O&M would be minimal.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	There is no lost opportunity for hydropower production along this alignment.
Sum of Scores			100.0		**166**	

Segment Evaluation

	8	Segment ID ->	1H-1I	Type->	RC Box	Location:
		Length (ft)->	1,644	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from river except near Coordinate 1l. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	High	11	May be within 100 foot riparian protection zone.
	E	Wetlands	2.1	Medium	8	Wetlands unlikely but segment near river at coordinate 1l.
	F	Streambed/Shoreline Encroachment	1.3	Medium	5	Beyond 200-foot shoreline except near Coordinate 1l. Areas may be within floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep side slopes. Box culvert requires little excavation in canal ROW. Route next to, but above river.
	I	Water Quality	1.1	Low	2	Above and further from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Further from congested area and Hwy 12. Dust from construction less likely to be noticed. Screened by trees.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	High potential for cultural resources because of pipeline location near river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land clearing has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction noises not likely heard because of distance from Hwy 12 and human activity area. River noise masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	High	13	Access to the site is poor and access adjacent to the work is poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access.

Segment Evaluation

	8	Segment ID ->	1H-1I	Type->	RC Box	Location:
		Length (ft)->	1,644	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Low	3	Steep side slope. Potential for rolling rock.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Low	4	No significant drainage crossings or other known features to incorporate.
	EE	Work Space Constraints	1.5	Medium	6	Steep side slopes. No space adjacent to the work for materials or equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Negligible	0	Steep side slopes with heavy forestation. No known issues with slides, falling rock or debris.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Drainage crossings are negligilble. Low O&M cost expected.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control O&M is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Low	12	After the box culvert is installed, access is good to this location from the headworks. Long term O&M would be minimal.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	There is no lost opportunity for hydropower production along this alignment.
		Sum of Scores	100.0		**172**	

Segment Evaluation

	9	Segment ID ->	1I-1J	Type->	Tunnel Rehab	Location:
		Length (ft)->	222	Baseline Cost ($/100-ft) ->	$352,000	Short existing tunnel near Wasteway #1
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Low	4	Existing tunnel avoids impacts to ESA habitat and species.
	B	Migratory Fish and Wildlife	1.7	Low	3	Tunnel avoids impacts to migratory fish and wildlife. Work can occur outside of the approved fish work window.
	C	Migratory Birds/Raptors	1.9	Negligible	0	Tunnel avoids forrests and trees/nests are not disturbed.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	No wetlands.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline except near coordinate 1l and 1J.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Low	2	No vegetation removal and no erosion potential except for tunnel entrance and exit.
	I	Water Quality	1.1	Negligible	0	Above and further from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Further from congested area and Hwy 12. Dust from construction less likely to be noticed.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Unlikely to discover cultural resources by using existing tunnel.
	M	Historic Resources	0.9	Low	2	The existing conveyance is not likely considered a historic resource to be preserved because it lies in a tunnel.
	N	Aesthetics	1.1	Negligible	0	Visual scape changes less noticed in existing canal alignment where land clearing has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	High	13	Access to the site is poor and access adjacent to the work is poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access.

Segment Evaluation

	9	Segment ID ->	1I-1J	Type->	Tunnel Rehab	Location:
		Length (ft)->	222	Baseline Cost ($/100-ft) ->	$352,000	Short existing tunnel near Wasteway #1
		Risk Criterion	**Risk Importance Factor**	**Risk Level**	**Risk Score**	**Risk Level Comments**
Constructability	AA	Soil/Slope Stability	1.5	Medium	6	Existing tunnel with rock outcrop and potential for rockfall
	BB	Subsurface Conditions	2.4	High	14	Working conditions inside the existing tunnel are unknown and potentially hazardous.
	CC	Groundwater	0.9	Low	2	Groundwater conditions in the existing tunnel are unknown, but not likely to be a significant construction obstacle.
	DD	Connections to Existing Facilities	1.9	Medium	7	Tunnel portals connect to existing YTID canal. No drainage features to incorporate.
	EE	Work Space Constraints	1.5	Medium	6	Steep side slopes. No space adjacent to the work for materials or equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	High	3	Special equipment and materials may be required for tunnel rehabilitation.
	GG	Sequencing/Schedule Constraints	2.2	High	13	Existing tunnel rehab work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	High	17	Tunnel rehab work will require special rock anchoring, demolition, and construction in confined space.
	II	YTID Service Interruptions	3.0	Medium	12	Tunnel rehab creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	High	14	Work inside existing tunnels is higher risk due to confined space and potential for falling debris
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, and general condition of tunnel is not possible without shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Medium	21	Steep rock outcrops. Moderate potential for falling rock and debris.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	No significant drainage features to maintain.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Low	12	After the box culvert is installed, access is good to this location from the headworks. Long term O&M would be minimal.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Easy dewatering for inspection and maintenance. Interior access and mobility is constrained. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	There is no lost opportunity for hydropower production along this alignment.
		Sum of Scores	100.0		**237**	

Segment Evaluation

	10	Segment ID ->	1J-1K	Type->	RC Box	Location:
		Length (ft)->	797	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Low	4	Route away from the river except at Coordinate 1J. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Low	3	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	Medium	7	May have a portion in riparian habitat.
	E	Wetlands	2.1	Low	4	Wetlands unlikely but near river (close to or within 100 feet)
	F	Streambed/Shoreline Encroachment	1.3	Medium	5	Beyond 200-foot shoreline except near coordinate 1J.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep side slopes. Box culvert requires little excavation in canal ROW. Route next to river and forrested.
	I	Water Quality	1.1	Low	2	Above and further from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Further from congested area and Hwy 12. Dust from construction less likely to be noticed. Screened by trees.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	High potential for cultural resources because of pipeline location near river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land clearing has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction noises not likely heard because of distance from Hwy 12 and human activity area. River noise masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	High	13	Access to the site is poor and access adjacent to the work is poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access.

Segment Evaluation

	10	Segment ID ->	1J-1K	Type->	RC Box	Location:
		Length (ft)->	797	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Low	3	Steep side-slope with potential for rolling rock.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Low	4	Design must incorporate one existing cross-drainage pipe bridge.
	EE	Work Space Constraints	1.5	Medium	6	Steep side slopes. No space adjacent to the work for materials or equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability or rockfall issues.
	MM	Erosion/Scour Maintenance	5.2	Low	10	One significant drainage crossing will require periodic inspection and maintenance.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control O&M is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Low	12	After the box culvert is installed, access is good to this location from Windy Pt. Long term O&M would be minimal.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	There is no lost opportunity for hydropower production along this alignment.
		Sum of Scores	100.0		**182**	

Segment Evaluation

	11	Segment ID ->	1K-1L	Type->	RC Box	Location:
		Length (ft)->	5,012	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from and above the river. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline and above floodplain but approaches shorelines boundary in one area.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep side slopes. Box culvert requires little excavation in canal ROW. Route next to river.
	I	Water Quality	1.1	Negligible	0	Above and further from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Far from and above congested area and Hwy 12. Dust from construction not likely to be noticed.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	High potential for cultural resources because of pipeline location near river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land clearing has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction noises not likely heard because of distance from Hwy 12 and human activity area. River noise masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	Medium	9	Access to the segment is fair but access adjacent to the work is not available due to steep side slopes.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access. North facing slope.

Segment Evaluation

	11	Segment ID ->	1K-1L	Type->	RC Box	Location:
		Length (ft)->	5,012	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Low	3	Segment crosses toe of existing talus slope. Potential rock instability.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Medium	7	Design and construction must incorporate four existing cross-drainage facilities
	EE	Work Space Constraints	1.5	Medium	6	Steep side slopes. No space adjacent to the work for materials or equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Low	10	Side-slopes are moderately steep with a few rock outcrops. O&M for rockfall and debris expected to be minimal.
	MM	Erosion/Scour Maintenance	5.2	Medium	21	Four moderate size cross-drainage facilities will require periodic inspection and maintenance.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control O&M is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Low	12	After the box culvert is installed, access is good to this location from Windy Pt. Long term O&M would be minimal.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	There is no lost opportunity for hydropower production along this alignment.
		Sum of Scores	100.0		**176**	

Segment Evaluation

	12	Segment ID ->	1L-1M	Type->	RC Box	Location:
		Length (ft)->	1,451	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from and above the river. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline and above floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep side slopes. Box culvert requires little excavation in canal ROW. Route next to river.
	I	Water Quality	1.1	Negligible	0	Above and further from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Far from and above congested area and Hwy 12. Dust from construction not likely to be noticed. Screened by trees.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	High potential for cultural resources because of pipeline location near river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land clearing has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction noises not likely heard because of distance from Hwy 12 and human activity area. River noise masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	Medium	9	Access to the site is fair but side-slopes are steep and access adjacent to the work is not available.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access. North facing slope.

Segment Evaluation

	12	Segment ID ->	1L-1M	Type->	RC Box	Location:
		Length (ft)->	1,451	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Low	3	Steep side-slope. Potential for rolling rock during construction.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No known cross-drainage facilities or other features to incorporate.
	EE	Work Space Constraints	1.5	Medium	6	Steep side slopes. No space adjacent to the work for materials or equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Medium	10	Work is unconfined but steep side-slopes and space limitations create some safety risks.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Low	10	Steep side-slope with rock outcrop. Some maintenance required for falling rock and debris.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	No significant cross-drainage facilities to inspect or maintain.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control O&M is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Low	12	After the box culvert is installed, access is good to this location from Windy Pt. Long term O&M would be minimal.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	There is no lost opportunity for hydropower production along this alignment.
		Sum of Scores	100.0		**152**	

Segment Evaluation

	13	Segment ID ->	1M-1N	Type->	RC Box	Location:
		Length (ft)->	5,791	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from and above the river. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline and above floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	Mild side slopes. Box culvert requires little excavation in canal ROW. In river valley.
	I	Water Quality	1.1	Negligible	0	Above and far from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Far from and above congested area and Hwy 12. Dust from construction not likely to be noticed. Screened by trees.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	High potential for cultural resources because of pipeline location near river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land clearing has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction noises not likely heard because of distance from Hwy 12 and human activity area. River noise masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	Low	4	Access to the site is relatively good and access adjacent to the work is relatively good.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Medium	6	Work must be completed in the winter. Access is fair. Side-slopes are moderate.

Segment Evaluation

	13	Segment ID ->	1M-1N	Type->	RC Box	Location:
		Length (ft)->	5,791	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Low	3	Alignment crosses ancient landslide and talus slope near Windy Pt. Tunnel. No evidence of recent movement.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No significant connections to existing facilities
	EE	Work Space Constraints	1.5	Low	3	Mild side slopes. Some space available to stage equipment and store materials adjacent to the canal/pipe.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Low	10	Side-slopes are mild. No known rockfall or debris issues. Alignment crosses ancient slide with no known movement.
	MM	Erosion/Scour Maintenance	5.2	Low	10	No significant cross-drainage facilities to inspect or maintain.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Low	12	After the box culvert is installed, access is good to this location from Windy Pt. Long term O&M would be minimal.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	There is no lost opportunity for hydropower production along this alignment.
		Sum of Scores	100.0		**145**	

Segment Evaluation

	14	Segment ID ->	1N-1O	Type->	Tunnel Rehab	Location:
		Length (ft)->	3,269	Baseline Cost ($/100-ft) ->	$352,000	Existing Windy Pt. Tunnel
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Tunnel avoids impacts to ESA habitat and species.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	Tunnel avoids impacts to migratory fish and wildlife. Work can occur outside of the approved fish work window.
	C	Migratory Birds/Raptors	1.9	Negligible	0	Tunnel avoids forrests, and trees/nests are not disturbed.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	No wetlands.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	No vegetation removal and no erosion potential except for tunnel entrance and exit.
	I	Water Quality	1.1	Negligible	0	Above and far from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Far from and above congested area and Hwy 12. Dust from construction not likely to be noticed.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Unlikely to discover cultural resources by using existing tunnel.
	M	Historic Resources	0.9	Low	2	The existing conveyance is not likely considered a historic resource to be preserved because it lies in a tunnel.
	N	Aesthetics	1.1	Negligible	0	Tunnel is not noticeable - has least impact on visual resources.
	O	Noise	0.4	Negligible	0	Construction noises not likely heard because of distance from Hwy 12 and human activity area. River noise masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	Medium	9	Access to the site is relatively good. Access inside the tunnel is poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Medium	6	Work must be completed in the winter. Access is fair to tunnel portals.

Segment Evaluation

	14	Segment ID ->	1N-1O	Type->	Tunnel Rehab	Location:
		Length (ft)->	3,269	Baseline Cost ($/100-ft) ->	$352,000	Existing Windy Pt. Tunnel
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	Rehabilitation of the existing tunnel may require risky work to support the existing structure during enlargement.
	BB	Subsurface Conditions	2.4	High	14	Working conditions inside the existing tunnel are unknown and potentially hazardous.
	CC	Groundwater	0.9	Low	2	Groundwater conditions in the existing tunnel are unknown, but not likely to be a significant construction obstacle.
	DD	Connections to Existing Facilities	1.9	Medium	7	Tunnel portals connect to existing YTID canal
	EE	Work Space Constraints	1.5	High	9	Very tight work area inside existing tunnel.
	FF	Equipment and Materials	0.6	High	3	Special equipment and materials may be required for tunnel rehabilitation.
	GG	Sequencing/Schedule Constraints	2.2	High	13	Existing tunnel rehab work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	High	17	Tunnel rehab work will require special rock anchoring, demolition, and construction in confined space.
	II	YTID Service Interruptions	3.0	Medium	12	Tunnel rehab creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	High	14	Work inside existing tunnels is higher risk due to confined space and potential for falling debris
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, and general condition of tunnel is not possible without shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Low	10	No known tunnel stability issues. Existing and future O&M is expected to be minimal. Some potential for rockfall at portals.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Tunnel requires no cross-drainage inspection or maintenance.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Negligible	0	After the box culvert is installed, access is good to the west portal from Windy Pt. Long term O&M would be minimal.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Gravity tunnel construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Easy dewatering for inspection and maintenance. Interior access and mobility is constrained. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	There is no lost opportunity for hydropower production along this alignment.
		Sum of Scores	100.0		**208**	

Segment Evaluation

	15	Segment ID ->	1O-1P	Type->	RC Box	Location:
		Length (ft)->	1,054	Baseline Cost ($/100-ft) ->	$252,000	Segment is located immediately down stream of Windy Pt. Tunnel
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from and above the river. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline and outside of floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep side slopes. Box culvert requires little excavation in canal ROW. Route above river.
	I	Water Quality	1.1	Negligible	0	Above and far from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Far from and above congested area and Hwy 12. Dust from construction not likely to be noticed. Screened by trees.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Medium	9	Less potential for cultural resources because of pipeline location farther from river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land clearing has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	Medium	9	Access to the site is relatively fair. Side-slopes are steep and access adjacent to the work is not available.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access. North facing slope.

Segment Evaluation

	15	Segment ID ->	1O-1P	Type->	RC Box	Location:
		Length (ft)->	1,054	Baseline Cost ($/100-ft) ->	$252,000	Segment is located immediately down stream of Windy Pt. Tunnel
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Medium	6	Alignment crosses ancient landslide. No known movement since original canal was constructed. Further investigation required.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Low	4	Design and constuction must incorporate one existing cross-drainage pipe bridge.
	EE	Work Space Constraints	1.5	Medium	6	Steep side slopes. No space adjacent to the work for materials or equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Medium	21	Alignment crosses ancient landslide. No known movement since original canal was constructed. Further investigation required.
	MM	Erosion/Scour Maintenance	5.2	Low	10	One existing pipe bridge requires periodic inspection and maintenance.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	There is no lost opportunity for hydropower production along this alignment.
		Sum of Scores	100.0		**182**	

Segment Evaluation

	16	Segment ID ->	1P-1Q	Type->	RC Box	Location:
		Length (ft)->	632	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from and above the river. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested and near river where nests may occur. Approved land clearing possible prior to construction. Available access road.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline and outside of floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. Residential home across the river.
	H	Erosion/Vegetation Removal	1.1	Low	2	Mild side slopes. Box culvert requires little excavation in canal ROW. Above river. Existing access road available.
	I	Water Quality	1.1	Negligible	0	Above and further from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Low	0	Far from and above congested area and Hwy 12. Dust from construction not likely to be noticed by home across the river.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Medium	9	Less potential for cultural resources because of pipeline location farther from river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Medium	4	Visual scape changes less noticed in existing canal alignment where land clearing has occurred. Above residence across river.
	O	Noise	0.4	Low	1	Construction noises not likely heard from residence across river because of pipeline elevation/distance and river masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	Low	4	Access to the site is fair and access adjacent to the work is relatively good.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Medium	6	Work must be completed in the winter. Moderate access. North facing slope.

Segment Evaluation

	16	Segment ID ->	1P-1Q	Type->	RC Box	Location:
		Length (ft)->	632	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Low	3	Alignment crosses ancient landslide. No known movement since original canal was constructed.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Low	4	No significant interference with existing facilities
	EE	Work Space Constraints	1.5	Low	3	Mild side slopes. Some space available to stage equipment and store materials adjacent to the canal/pipe.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Medium	21	Alignment crosses ancient landslide. No known movement since original canal was constructed. Further investigation required.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	No significant cross-drainage facilities to inspect or maintain.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control O&M is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Low	8	Some lost opportunity for power production at this location. River alignments offer potential to generate power.
		Sum of Scores	100.0		**165**	

Segment Evaluation

	17	Segment ID ->	1Q-1R	Type->	RC Box	Location:
		Length (ft)->	2,202	Baseline Cost ($/100-ft) ->	$252,000	Active slide area downstream of Windy Pt. Tunnel
		Risk Criterion	**Risk Importance Factor**	**Risk Level**	**Risk Score**	**Risk Level Comments**
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from and above the river. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	Negligible	0	Few trees and far from river. Approved land clearing could be done prior to construction. No known Golden Eagles.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline and outside of floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep side slopes. Box culvert requires little excavation in canal ROW. Route above river.
	I	Water Quality	1.1	Negligible	0	Above and far from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Far from and above congested area and Hwy 12. Dust from construction not likely to be noticed.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Medium	9	Less potential for cultural resources because of pipeline location farther from river and portions on steep hillside.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land clearing has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	Medium	9	Access to the site is fair. Side-slopes are steep so access adjacent to the work is poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access. North facing slope.

Segment Evaluation

	17	Segment ID ->	1Q-1R	Type->	RC Box	Location:
		Length (ft)->	2,202	Baseline Cost ($/100-ft) ->	$252,000	Active slide area downstream of Windy Pt. Tunnel
		Risk Criterion	**Risk Importance Factor**	**Risk Level**	**Risk Score**	**Risk Level Comments**
Constructability	AA	Soil/Slope Stability	1.5	High	9	Active slide area. Sliding and settlement have occurred in recent history. Steep side slope and potential rolling rock.
	BB	Subsurface Conditions	2.4	High	14	Replacing the existing canal with a box culvert requires little excavation. Slide mitigation may be significant.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Low	4	Design and construction must incorporate one existing pipe-bridge cross-drainage facility.
	EE	Work Space Constraints	1.5	High	9	Steep side slopes. No space adjacent to the work for materials or equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	High	3	Special equipment and materials may be required for slide mitigation
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	High	17	Box culvert requires no unique construction techniques. Slide mitigation may require special equipment and methods.
	II	YTID Service Interruptions	3.0	High	18	Active slide area creates potential for service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Medium	10	Steep slopes increase risk.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	High	31	Active slide area. High risk unless mitigated during design. Steep side slope and potential rolling rock.
	MM	Erosion/Scour Maintenance	5.2	Low	10	One existing cross-drainage facility to maintain and inspect
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Low	8	Some lost opportunity for power production at this location. River alignments offer potential to generate power.
		Sum of Scores	100.0		**243**	

Segment Evaluation

	18	Segment ID ->	1R-1S	Type->	RC Box	Location:
		Length (ft)->	3,808	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from and above the river. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	Negligible	0	Few trees and farther from river. Approved land clearing could be done prior to construction. No known Golden Eagles.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline and outside of floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep side slopes. Box culvert requires little excavation in canal ROW. Route above river.
	I	Water Quality	1.1	Negligible	0	Above and far from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Far from and above congested area and Hwy 12. Dust from construction not likely to be noticed.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Less potential for cultural resources because of pipeline location farther from river and portions on steep hillside.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land clearing has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	High	13	Access to the site is poor. Side-slopes are steep so access adjacent to the work is poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access. North facing slope.

Segment Evaluation

	18	Segment ID ->	1R-1S	Type->	RC Box	Location:
		Length (ft)->	3,808	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	Very steep side slope with rock outcrops and potential rolling rock.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Low	4	No significant interference with existing facilities
	EE	Work Space Constraints	1.5	High	9	Steep side slopes. No space adjacent to the work for materials or equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	Low	1	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Medium	10	Work is unconfined but steep side-slopes and space limitations create some safety risks.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Medium	21	Steep side-slopes with rock outcrops create potential for falling rock and debris.
	MM	Erosion/Scour Maintenance	5.2	Low	10	No significant cross-drainage facilities to inspect or maintain.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Low	8	Some lost opportunity for power production at this location. River alignments offer potential to generate power.
		Sum of Scores	100.0		**198**	

Segment Evaluation

	19	Segment ID ->	1S-1T	Type->	RC Box	Location:
		Length (ft)->	303	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from and above the river. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	Negligible	0	Some areas forrested, other areas have few trees. No cliffs.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline and outside of floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep side slopes. Box culvert requires little excavation in canal ROW. Route above river.
	I	Water Quality	1.1	Negligible	0	Above and far from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Far from and above congested area and Hwy 12. Dust from construction not likely to be noticed.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Less potential for cultural resources because of pipeline location farther from river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land scarring has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	Low	4	Access to the site is fair. Side-slopes are moderate with some access adjacent to the work.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Medium	6	Work must be completed in the winter. Fair access. North facing slope.

Segment Evaluation

	19	Segment ID ->	1S-1T	Type->	RC Box	Location:
		Length (ft)->	303	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Low	3	No known slope stability issues. Moderately steep side slopes.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Low	4	No significant interference with existing facilities
	EE	Work Space Constraints	1.5	Medium	6	Moderate side slopes. Some space adjacent to the work for materials or equipment.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability issues. Long-term O&M considered minimal.
	MM	Erosion/Scour Maintenance	5.2	Low	10	No significant drainage crossings. Long-term O&M considered minimal.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Low	8	Some lost opportunity for power production at this location. River alignments offer potential to generate power.
		Sum of Scores	100.0		**150**	

Segment Evaluation

	20	Segment ID ->	1T-1U	Type->	RC Box	Location:
		Length (ft)->	3,694	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from and above the river. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	Negligible	0	Some areas forrested, other areas have few trees. No cliffs.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely. However, wetlands observed near river channel far below, which makes alternate route there difficult.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline and outside of floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep side slopes. Noticed that a lower alternate route would require a pipeline bridge over a deep drainage.
	I	Water Quality	1.1	Negligible	0	Above and far from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Low	0	Proximity to residences. Dust from construction not likely to be noticed because of distance and elevation above the residences.
	K	Hazardous Materials	1.6	Low	3	Most human activity is on other side of the river. Potential hazardous materials sites are of low risk.
	L	Cultural Resources	2.3	Low	5	Less potential for cultural resources because of pipeline location farther from river and on steep slopes.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Medium	4	Visual scape changes less noticed in existing canal alignment where land scarring has occurred. Proximity to residences.
	O	Noise	0.4	Negligible	0	Construction noises not likely heard because of distance from Hwy 12 and human activity area. River noise masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	Medium	9	Access to the site is fair but side-slopes are steep and access adjacent to the work is poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access. North facing slope.

Segment Evaluation

	20	Segment ID ->	1T-1U	Type->	RC Box	Location:
		Length (ft)->	3,694	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	**Risk Importance Factor**	**Risk Level**	**Risk Score**	**Risk Level Comments**
Constructability	AA	Soil/Slope Stability	1.5	Low	3	No known slope stability issues. Moderately steep side slopes.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Low	4	Alignment must incorporate one existing cross-drainage facility.
	EE	Work Space Constraints	1.5	Medium	6	Steep side slopes. No space adjacent to the work for materials or equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Low	10	No known slope stability issues. Moderately steep side slopes. Some potential for rolling rock and debris.
	MM	Erosion/Scour Maintenance	5.2	Low	10	One large drainage crossing will require periodic inspection and maintenance
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Low	8	Some lost opportunity for power production at this location. River alignments offer potential to generate power.
		Sum of Scores	100.0		**174**	

Segment Evaluation

	21	Segment ID ->	1U-1V	Type->	RC Box	Location:
		Length (ft)->	3,947	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from and above the river.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish). Winter construction reduces potential encounters with bears.
	C	Migratory Birds/Raptors	1.9	Low	4	Some areas forrested, other areas have few trees. No cliffs.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline and outside of floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep side slopes. Box culvert requires little excavation in canal ROW. Route above river.
	I	Water Quality	1.1	Negligible	0	Above and far from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Far from and above congested area and Hwy 12. Dust from construction not likely to be noticed.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Less potential for cultural resources because of pipeline location farther from river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land scarring has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	High	13	Access to the site is poor, side-slopes are steep, and access adjacent to the work is not available.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access. North facing slope.

Segment Evaluation

	21	Segment ID ->	1U-1V	Type->	RC Box	Location:
		Length (ft)->	3,947	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Medium	6	Steep side slopes, falling rock.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	High	11	Alignment must incorporate several cross-drainage facilities
	EE	Work Space Constraints	1.5	Medium	6	Steep side slopes. No space adjacent to the work for materials or equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	High	3	Alignment is located on steep, exposed face. Small, specialized equipment may be required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Negligible	0	Box culvert construction requires no unique construction techniques.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Medium	10	Work is unconfined but steep side-slopes and space limitations create some safety risks.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from road deck on top of box culvert.
	LL	Slope Stability Maintenance	5.2	Medium	21	Steep side-slopes with rock outcrops. Moderately high O&M costs to manage falling rock and debris.
	MM	Erosion/Scour Maintenance	5.2	High	31	Several steep small drainages cross the alignment. Potential for flash flood and debris maintenance is moderately high.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Medium	16	Lost opportunity for power production at this location. River alignments offer potential to generate power.
		Sum of Scores	100.0		**234**	

Segment Evaluation

	22	Segment ID ->	1V-1W	Type->	Tunnel Rehab	Location:
		Length (ft)->	1,268	Baseline Cost ($/100-ft) ->	$352,000	Existing tunnel
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Tunnel avoids impacts to ESA habitat and species.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	Tunnel avoids impacts to migratory fish and wildlife. Work can occur outside of the approved fish work window.
	C	Migratory Birds/Raptors	1.9	Negligible	0	Tunnel avoids forrests, and trees/nests are not disturbed.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	No wetlands.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline and outside of floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	No vegetation removal and no erosion potential except for tunnel entrance and exit, and potentially construction access.
	I	Water Quality	1.1	Negligible	0	Above and far from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Far from and above congested area and Hwy 12. Dust from construction not likely to be noticed.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Unlikely to discover cultural resources by using existing tunnel.
	M	Historic Resources	0.9	Low	2	The existing conveyance is not likely considered a historic resource to be preserved because it lies in a tunnel.
	N	Aesthetics	1.1	Negligible	0	Tunnel is not noticeable - has least impact on visual resources.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	High	13	Access to the site is poor and access inside the tunnel is poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access. North facing slope.

Segment Evaluation

	22	Segment ID ->	1V-1W	Type->	Tunnel Rehab	Location:
		Length (ft)->	1,268	Baseline Cost ($/100-ft) ->	$352,000	Existing tunnel
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	Rehabilitation of the existing tunnel may require risky work to support the existing structure during enlargement.
	BB	Subsurface Conditions	2.4	High	14	Working conditions inside the existing tunnel are unknown and potentially hazardous.
	CC	Groundwater	0.9	Low	2	Groundwater conditions in the existing tunnel are unknown, but not likely to be a significant construction obstacle.
	DD	Connections to Existing Facilities	1.9	Medium	7	Existing tunnel portals transition to YTID canal
	EE	Work Space Constraints	1.5	High	9	Work space inside the existing tunnel is extremely limited.
	FF	Equipment and Materials	0.6	High	3	Special equipment and materials may be required for tunnel rehabilitation.
	GG	Sequencing/Schedule Constraints	2.2	High	13	Existing tunnel rehab work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	High	17	Tunnel rehab work will require special rock anchoring, demolition, and construction in confined space.
	II	YTID Service Interruptions	3.0	Medium	12	Tunnel rehab creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	High	14	Work inside existing tunnels is higher risk due to confined space and potential for falling debris
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Confined space in existing tunnel is not visible. Visual inspection requires shutdown and dewatering.
	LL	Slope Stability Maintenance	5.2	Low	10	No known stability issues with the existing tunnel. Some potential for rock and debris fall at tunnel portals.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	No cross-drainage features to maintain or inspect
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Existing tunnel construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Easy dewatering for inspection and maintenance. Interior access and mobility is constrained. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Medium	16	Lost opportunity for power production at this location. River alignments offer potential to generate power.
		Sum of Scores	100.0		**254**	

Segment Evaluation

	23	Segment ID ->	1W-1X	Type->	RC Box	Location:
		Length (ft)->	884	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from and above the river.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish). Winter construction reduces potential encounters with bears.
	C	Migratory Birds/Raptors	1.9	Low	4	Few trees and no cliffs with Golden Eagles nests.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline and outside floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep side slopes. Box culvert requires little excavation in canal ROW. Route above river.
	I	Water Quality	1.1	Negligible	0	Above and far from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Far from and above congested area and Hwy 12. Dust from construction not likely to be noticed.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Less potential for cultural resources because of pipeline location farther from river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land scarring has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	High	13	Access to the site is poor, side-slopes are steep, and access adjacent to the work is not available.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access. North facing slope.

Segment Evaluation

	23	Segment ID ->	1W-1X	Type->	RC Box	Location:
		Length (ft)->	884	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	High risk of debris slides and falling rock. Steep side slopes.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Medium	7	Alignment must incorporate two existing cross-drainage facilities
	EE	Work Space Constraints	1.5	Medium	6	Steep side slopes. No space adjacent to the work for materials or equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	High	17	Steep exposed face may require special equipment for access and rockfall prevention measures during construction.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Medium	10	Work is unconfined but steep side-slopes and space limitations create some safety risks.
Operations and Maintenance	KK	Routine Visual Observation	6.5	High	39	Vehicular access to this location is not feasible or practical without significant expenditures on access roads.
	LL	Slope Stability Maintenance	5.2	Low	10	Steep side-slopes with rock outcrops. Historically falling rock and debris has not been a significant O&M issue.
	MM	Erosion/Scour Maintenance	5.2	Medium	21	Two steep, narrow drainage crossings create moderate potential for flash flood and debris issues. Periodic maintenance
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	High	35	Long-term vehicle access to this location is not feasible or practical without significant expenditures on access roads.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Medium	16	Lost opportunity for power production at this location. River alignments offer potential to generate power.
		Sum of Scores	100.0		**263**	

Segment Evaluation

	24	Segment ID ->	1X-1Y	Type->	RC Box	Location:
		Length (ft)->	8,356	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from and above the river. An alternative near the river was looked at that would be at high risk.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish). Winter construction reduces potential encounters with bears.
	C	Migratory Birds/Raptors	1.9	High	12	Some areas with few trees but includes cliffs with known Golden Eagle nesting. Area signed "no human disturbance".
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat. Sagebrush and sage habitat was noted in the lower valley alternative.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline and outside of floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep side slopes. Box culvert requires little excavation in canal ROW. Route above river.
	I	Water Quality	1.1	Negligible	0	Above and far from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Far from and above congested area and Hwy 12. Dust from construction not likely to be noticed.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Less potential for cultural resources because of pipeline location farther from river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land scarring has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	High	8	Includes WDFW Oak Creek Wildlife Recreational Area that is protected.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	High	13	Access to the site is poor, side-slopes are steep, and access adjacent to the work is not available.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access. North facing slope.

Segment Evaluation

	24	Segment ID ->	1X-1Y	Type->	RC Box	Location:
		Length (ft)->	8,356	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	**Risk Importance Factor**	**Risk Level**	**Risk Score**	**Risk Level Comments**
Constructability	AA	Soil/Slope Stability	1.5	High	9	High risk of debris slides and falling rock. Steep side slopes.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	High	11	Alignment must incorporate multiple cross-drainage facilities.
	EE	Work Space Constraints	1.5	High	9	Steep side slopes. No space adjacent to the work for materials or equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	High	3	Steep, exposed face may require specialized equipment or materials for construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Medium	11	Steep exposed face may require slope stability and rockfall prevention measures during construction.
	II	YTID Service Interruptions	3.0	High	18	New box culvert along existing alignment creates potential for delays and service interruptions. Historical slides.
	JJ	Public Safety/Worker Safety	2.4	Medium	10	Work is unconfined but steep side-slopes and space limitations create some safety risks.
Operations and Maintenance	KK	Routine Visual Observation	6.5	High	39	Vehicular access to this location is not feasible or practical without significant expenditures on access roads.
	LL	Slope Stability Maintenance	5.2	High	31	Steep exposed face with rock outcrops. O&M for rock and debris fall may be significant.
	MM	Erosion/Scour Maintenance	5.2	High	31	Numerous steep, narrow drainage crossings create potential for flash-flood and debris maintenance
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	High	35	Long-term vehicle access to this location is not feasible or practical without significant expenditures on access roads.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Medium	16	Lost opportunity for power production at this location. River alignments offer potential to generate power.
		Sum of Scores	100.0		**321**	

Segment Evaluation

	25	Segment ID ->	1Y-1Z	Type->	Tunnel Rehab	Location:
		Length (ft)->	2,769	Baseline Cost ($/100-ft) ->	$352,000	Existing tunnel
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Tunnel avoids impacts to ESA habitat and species.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	Tunnel avoids impacts to migratory fish and wildlife. Work can occur outside of the approved fish work window.
	C	Migratory Birds/Raptors	1.9	Negligible	0	Tunnel avoids forrests, and trees/nests are not disturbed.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	No wetlands.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline and outside of floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	No vegetation removal and no erosion potential except for tunnel entrance and exit, and potentially construction access.
	I	Water Quality	1.1	Negligible	0	Above and far from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Far from and above congested area and Hwy 12. Dust from construction not likely to be noticed.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Unlikely to discover cultural resources by using existing tunnel.
	M	Historic Resources	0.9	Medium	3	The existing conveyance is not likely considered a historic resource to be preserved because it lies in a tunnel.
	N	Aesthetics	1.1	Negligible	0	Tunnel is not noticeable - has least impact on visual resources.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	High	13	Access to the site is poor and access inside the tunnel is poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access. North facing slope.

Segment Evaluation

	25	Segment ID ->	1Y-1Z	Type->	Tunnel Rehab	Location:
		Length (ft)->	2,769	Baseline Cost ($/100-ft) ->	$352,000	Existing tunnel
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	Rehabilitation of the existing tunnel may require risky work to support the existing structure during enlargement.
	BB	Subsurface Conditions	2.4	High	14	Working conditions inside the existing tunnel are unknown and potentially hazardous.
	CC	Groundwater	0.9	Low	2	Groundwater conditions in the existing tunnel are unknown, but not likely to be a significant construction obstacle.
	DD	Connections to Existing Facilities	1.9	Medium	7	Tunnel portals transition to existing canal
	EE	Work Space Constraints	1.5	High	9	Very tight work area inside existing tunnel.
	FF	Equipment and Materials	0.6	High	3	Special equipment and materials may be required for tunnel rehabilitation.
	GG	Sequencing/Schedule Constraints	2.2	High	13	Existing tunnel rehab work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	High	17	Tunnel rehab work will require special rock anchoring, demolition, and construction in confined space.
	II	YTID Service Interruptions	3.0	Medium	12	Tunnel rehab creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	High	14	Work inside existing tunnels is higher risk due to confined space and potential for falling debris
Operations and Maintenance	KK	Routine Visual Observation	6.5	High	39	Vehicular access to this location is not feasible or practical without significant expenditures on access roads.
	LL	Slope Stability Maintenance	5.2	Low	10	No known tunnel stability or long-term O&M issues.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	No cross-drainage features at the existing tunnel.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	High	35	Long-term vehicle access to this location is not feasible or practical without significant expenditures on access roads.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Existing tunnel construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Easy dewatering for inspection and maintenance. Interior access and mobility is constrained. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	No lost opportunity for power production at this location
		Sum of Scores	100.0		**265**	

Segment Evaluation

	26	Segment ID ->	1Z-1AA	Type->	RC Box	Location:
		Length (ft)->	473	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Route away from and above the river. Winter construction reduces potential encounters with bears.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work (avoids impacts to migratory fish).
	C	Migratory Birds/Raptors	1.9	High	12	Within one half mile of protected Golden Eagle nesting cliffs.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shoreline and outside of floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep side slopes. Box culvert requires little excavation in canal ROW. Route above river.
	I	Water Quality	1.1	Negligible	0	Above and far from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Far from and above congested area and Hwy 12. Dust from construction not likely to be noticed.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Less potential for cultural resources because of pipeline location farther from river.
	M	Historic Resources	0.9	Medium	3	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in existing canal alignment where land scarring has occurred. Not near public areas.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	High	13	Access to the site is poor, side-slopes are steep, and access adjacent to the work is not available.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access. North facing slope.

Segment Evaluation

	26	Segment ID ->	1Z-1AA	Type->	RC Box	Location:
		Length (ft)->	473	Baseline Cost ($/100-ft) ->	$252,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	High risk of debris slides and falling rock. Steep side slopes.
	BB	Subsurface Conditions	2.4	Low	5	Replacing the existing canal with a box culvert requires little excavation. Subsurface risks are minimal.
	CC	Groundwater	0.9	Negligible	0	Groundwater is not expected to be a significant issue if the existing canal is replaced with a box culvert. Minimal excavation.
	DD	Connections to Existing Facilities	1.9	Medium	7	Box culvert transitions to existing tunnel portals.
	EE	Work Space Constraints	1.5	Medium	6	Steep side slopes. No space adjacent to the work for materials or equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	Medium	2	Steep exposed face may require special equipment for access and rockfall prevention measures during construction.
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	New box culvert would replace existing canal. Work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	Medium	11	Steep exposed face may require special equipment for access and rockfall prevention measures during construction.
	II	YTID Service Interruptions	3.0	Medium	12	New box culvert replaces existing canal, creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Medium	10	Work is unconfined but steep side-slopes and space limitations create some safety risks.
Operations and Maintenance	KK	Routine Visual Observation	6.5	High	39	Vehicular access to this location is not feasible or practical without significant expenditures on access roads.
	LL	Slope Stability Maintenance	5.2	High	31	Steep slopes with high potential for rock fall maintenance.
	MM	Erosion/Scour Maintenance	5.2	Low	10	A few small drainage crossings. Long term O&M is not significant.
	NN	Corrosion Maintenance	1.9	Negligible	0	Corrosion control is negligible for a reinforced concrete box culvert.
	OO	Access Road Maintenance	5.8	High	35	Long-term vehicle access to this location is not feasible or practical without significant expenditures on access roads.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal. The box culvert top would prevent debris, animals from entering.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Box culvert construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Negligible	0	Easy dewatering for inspection and maintenance. Interior access and mobility is favorable. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	No lost opportunity for power production at this location
		Sum of Scores	100.0		**263**	

Segment Evaluation

	27	Segment ID ->	1AA-1AB	Type->	Tunnel Rehab	Location:
		Length (ft)->	3,864	Baseline Cost ($/100-ft) ->	$352,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Tunnel avoids impacts to ESA habitat and species.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	Tunnel avoids impacts to migratory fish and wildlife. Work can occur outside of the approved fish work window.
	C	Migratory Birds/Raptors	1.9	High	12	West entrance of tunnel is within 0.5 miles of protected Golden Eagle nesting cliffs.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	No wetlands.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shorelines area and outside of floodplain.
	G	Land Use	0.6	Negligible	0	Work primarly takes place within District's ROW with minimal land clearing. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	No vegetation removal and no erosion potential except for tunnel entrance and exit, and potentially construction access.
	I	Water Quality	1.1	Negligible	0	Above and far from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Far from and above congested area and Hwy 12. Dust from construction not likely to be noticed.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Unlikely to discover cultural resources by using existing tunnel.
	M	Historic Resources	0.9	Low	2	The existing conveyance is not likely considered a historic resource to be preserved because it lies in a tunnel.
	N	Aesthetics	1.1	Negligible	0	Tunnel is not noticeable - has least impact on visual resources.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12 and congested area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	No permanent easements requried on existing canal alignment. Temporary easements may be required for construction access.
	W	Access Constraints	2.2	High	13	Access to the site is poor and access inside the tunnel is poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	High	9	Work must be completed in the winter. Poor access. North facing slope.

Segment Evaluation

	27	Segment ID ->	1AA-1AB	Type->	Tunnel Rehab	Location:
		Length (ft)->	3,864	Baseline Cost ($/100-ft) ->	$352,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	Rehabilitation of the existing tunnel may require risky work to support the existing structure during enlargement.
	BB	Subsurface Conditions	2.4	High	14	Working conditions inside the existing tunnel are unknown and potentially hazardous.
	CC	Groundwater	0.9	Low	2	Groundwater conditions in the existing tunnel are unknown, but not likely to be a significant construction obstacle.
	DD	Connections to Existing Facilities	1.9	Medium	7	Tunnel portals transition to existing YTID canal
	EE	Work Space Constraints	1.5	High	9	Very tight work area inside existing tunnel.
	FF	Equipment and Materials	0.6	High	3	Special equipment and materials may be required for tunnel rehabilitation.
	GG	Sequencing/Schedule Constraints	2.2	High	13	Existing tunnel rehab work must be carefully scheduled to avoid service interruptions.
	HH	Unique Construction Methods	2.8	High	17	Tunnel rehab work will require special rock anchoring, demolition, and construction in confined space.
	II	YTID Service Interruptions	3.0	Medium	12	Tunnel rehab creates potential for delays and service interruptions.
	JJ	Public Safety/Worker Safety	2.4	High	14	Work inside existing tunnels is higher risk due to confined space and potential for falling debris
Operations and Maintenance	KK	Routine Visual Observation	6.5	High	39	Vehicular access to this location is not feasible or practical without significant expenditures on access roads.
	LL	Slope Stability Maintenance	5.2	Low	10	No known tunnel stability or long-term O&M issues.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	No cross-drainage features at the existing tunnel.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	High	35	Long-term vehicle access to this location is not feasible or practical without significant expenditures on access roads.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Start-up and shutdown would be similar to the existing canal.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Existing tunnel construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Easy dewatering for inspection and maintenance. Interior access and mobility is constrained. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Medium	10	Reconstructing the existing canal eliminates redundancy that could be available if an independent pipeline were constructed.
	UU	Power Production	3.9	Negligible	0	No lost opportunity for power production at this location
		Sum of Scores	100.0		**275**	

Segment Evaluation

	28	Segment ID ->	1B-2A	Type->	River Tunnel	Location:
		Length (ft)->	319	Baseline Cost ($/100-ft) ->	$1,000,000	New tunnel under river west of Trout Lodge.
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	Tunnel crossing under river - easier to permit compared to utility bridges or excavating/filling a trench.
	B	Migratory Fish and Wildlife	1.7	Medium	7	Construction delayed if work exceeds fish work window (likely June 1 to Oct 31); less risk w/tunnel versus trenching.
	C	Migratory Birds/Raptors	1.9	Medium	8	Bald Eagle nests may need protection (Dec-July) during construction but none currently known. No Golden Eagles.
	D	Riparian Habitat	1.8	High	11	Within 100 foot protected riparian area.
	E	Wetlands	2.1	High	12	Known wetlands near Coordinate 1B.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Within 200 foot shorelines protection zone and in floodplains.
	G	Land Use	0.6	High	4	Need new ROW for river crossing and DNR permit. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Tunnel river crossing and stockpiling excavated materials may cause erosion.
	I	Water Quality	1.1	High	6	Crossing in river where frac-out and spills are potential hazard.
	J	Air Quality	0.2	High	1	Human activity within 1/2 mile and next to Hwy 12 where dust from construction may be noticed by the public.
	K	Hazardous Materials	1.6	Medium	6	Human activity within 1/2 mile. Encountering hazardous materials sites possible.
	L	Cultural Resources	2.3	High	14	Tunnelling under river and working on riverbanks has high potential for cultural resources discovery.
	M	Historic Resources	0.9	Low	2	No known historic features at river crossing.
	N	Aesthetics	1.1	Negligible	0	New tunnel will not be noticeable - has least impact on visual resources.
	O	Noise	0.4	Medium	2	Human activity within 1/2 mile and next to Hwy 12 where noise from construction may be noticed by the public.
	P	Transportation/Traffic	0.5	Medium	2	Access to tunnel construction off of Hwy 12, could impact traffic flow.
	Q	Recreation Impacts	1.4	Medium	6	No recreational parks/wildlife refuges assumed. Could impact informal recreational use on river.
	R	Emergency Response	0.6	Medium	3	No additional emergency response public services needed. May impact emergency response time with traffic delays.
	S	Service Impacts	0.4	Medium	2	No need for add'l public services (cable, phone, electric, water). Could be disrupted if located in construction access.
	T	Socio/Economic Impacts	1.5	Medium	6	Socio-economic impacts possible if access to construction site causes delay in deliveries, transport, and services.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement required across Tieton River.
	W	Access Constraints	2.2	Low	4	Access to the site is relatively good from both sides of river.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Low	3	Most of the work could be performed in the summer. Connection to the existing canal would occur in the winter.

Segment Evaluation

	28	Segment ID ->	1B-2A	Type->	River Tunnel	Location:
		Length (ft)->	319	Baseline Cost ($/100-ft) ->	$1,000,000	New tunnel under river west of Trout Lodge.
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	New tunnel under river. Tunnel stability with high groundwater is a significant risk.
	BB	Subsurface Conditions	2.4	Medium	10	Subsurface tunnel conditions are unknown, but site is accessible for geotechnical testing during the pre-design phase.
	CC	Groundwater	0.9	High	6	There is a high likelihood of encountering groundwater when tunneling below the river.
	DD	Connections to Existing Facilities	1.9	Low	4	Pipeline connects to existing YTID canal.
	EE	Work Space Constraints	1.5	Low	3	Mild side slopes. Some space available to stage equipment and store materials adjacent to the tunnel shaft.
	FF	Equipment and Materials	0.6	High	3	Special equipment and materials may be required for tunnel construction.
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Tunnelling work would be scheduled to avoid fish runs, but is otherwise flexible. Connection to existing canal is winter work.
	HH	Unique Construction Methods	2.8	Medium	11	Tunnel work is a proven technology, but tunnel shafts and subsurface conditions require special construction techniques.
	II	YTID Service Interruptions	3.0	Low	6	Connection to existing YTID canal creates potential for service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Medium	10	New tunneling requires work in deep shafts and confined spaces.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, and general condition of tunnel is not possible without shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability or rockfall issues.
	MM	Erosion/Scour Maintenance	5.2	Low	10	Tunnel under the river would be at sufficient depth to avoid erosion. Minimal long-term maintenance required.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Negligible	0	Access is good from headworks. Long-term O&M for access would be negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Medium	13	Tunnel under the river requires mechanical air valves and blowoff for evacuating air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Medium	31	Tunnel under the river requires pumped dewatering. Difficult inside access and mobility. Potential trap for rock and debris.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	No lost opportunity for power production at this location
		Sum of Scores	100.0		**289**	

Segment Evaluation

	29	Segment ID ->	2A-2B	Type->	Pipeline	Location:
		Length (ft)->	5,813	Baseline Cost ($/100-ft) ->	$225,000	New pipeline along Hwy 12 adjacent to Trout Lodge.
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	Route follows river where ESA fish species need to be protected within Hwy 12 ROW.
	B	Migratory Fish and Wildlife	1.7	Medium	7	Not in river work, construction next to Hwy 12, but route is closer to river than some segments.
	C	Migratory Birds/Raptors	1.9	Low	4	Few trees directly on route; forrest land nearby where nests may need protection. Construction can avoid nesting season.
	D	Riparian Habitat	1.8	High	11	Areas within 100 foot protected riparian zone.
	E	Wetlands	2.1	Low	4	Because route follows Hwy 12, wetlands are unlikely but road drainage can create adjacent wetlands.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has areas within the 200-foot shorelines protection zone.
	G	Land Use	0.6	High	4	Need new ROW (likely use Hwy 12 ROW). No known parks/public recreation sites. Informal river use may be blocked during construction.
	H	Erosion/Vegetation Removal	1.1	Medium	4	Next to Hwy 12 but near river. Pipeline on riverside of Hwy 12 more of a concern than other side of road.
	I	Water Quality	1.1	Medium	4	Near river where frac-out and spills are more of a hazard.
	J	Air Quality	0.2	High	1	Goes through development (residences, businesses) along Hwy 12 where construction dust may be noticed by the public.
	K	Hazardous Materials	1.6	High	10	Near human activity (Hwy 2, residences and businesses) with high risk for encountering hazardous materials sites (e.g., USTs).
	L	Cultural Resources	2.3	Low	5	Pipeline excavation is near river but mostly in Hwy 12 ROW, a previously disturbed area.
	M	Historic Resources	0.9	Medium	3	Rim Rock Retreat/Trout Lodge area may have historic resources.
	N	Aesthetics	1.1	Medium	4	Visual scape changes less noticed in Hwy 12 ROW where land scarring has occurred but goes through public areas.
	O	Noise	0.4	High	3	Construction noises more likely heard by the public because of distance from Hwy 12 and goes through human activity area.
	P	Transportation/Traffic	0.5	High	3	Along Hwy 12 where traffic may be delayed or impacted during construction.
	Q	Recreation Impacts	1.4	Medium	6	No recreational parks/wildlife refuges assumed. Informal access to the river occurs in this area.
	R	Emergency Response	0.6	High	4	No additional emergency response public services needed. May impact emergency response time with traffic delays.
	S	Service Impacts	0.4	High	3	No need for add'l public services (cable, phone, electric, water). Could be disrupted if located in construction ROW.
	T	Socio/Economic Impacts	1.5	High	9	Socio-economic impacts possible if construction site causes delay in deliveries, transport, and services.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	High	7	New permanent easement required from state and from local business owners adjacent to Hwy 12.
	W	Access Constraints	2.2	Negligible	0	Access to the site from Hwy 12 is good and access adjacent to the work is good.
	X	Landowner Conflicts	0.7	High	4	High probability of landowner conflicts from business owners and residents near Trout Lodge.
	Y	Utility Conflicts	0.4	High	2	High potential for utility conflicts with overhead power and fiber optics lines near Trout Lodge.
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	29	Segment ID ->	2A-2B	Type->	Pipeline	Location:
		Length (ft)->	5,813	Baseline Cost ($/100-ft) ->	$225,000	New pipeline along Hwy 12 adjacent to Trout Lodge.
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Low	2	This pipeline segement is higher than the water level in the river. The risk of encountering groundwater is low.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Medium	6	Conjested corridor. Limited space to stage equipment and store materials.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Work along Hwy 12 would be scheduled for the summer to avoid traffic impacts
	HH	Unique Construction Methods	2.8	Negligible	0	Open-cut pipeline requires no special construction techniques.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Medium	10	Work along Hwy 12 creates potential for worker and public safety due to traffic on the road.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from Hwy 12.
	LL	Slope Stability Maintenance	5.2	Negligible	0	Buried pipeline along Hwy 12 would have negligible slope stability issues.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Buried pipeline along Hwy 12 would have negligible erosion/scour issues.
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Negligible	0	Access to the site from Hwy 12 is good. Long-term O&M costs would be negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	No lost opportunity for power production at this location
		Sum of Scores	100.0		**207**	

Segment Evaluation

	30	Segment ID ->	2B-2C	Type->	Pipeline	Location:
		Length (ft)->	827	Baseline Cost ($/100-ft) ->	$225,000	New pipeline near Hwy 12 east of Trout Lodge
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	Route follows river where ESA fish species need protection and on riverside of Hwy 12.
	B	Migratory Fish and Wildlife	1.7	Low	3	No in river work but construction corridor is closer to river than some segments. Habitat is poor near Hwy 12.
	C	Migratory Birds/Raptors	1.9	Low	4	Few trees directly on route; forrest land nearby where nests may need protection. Construction can avoid nesting season.
	D	Riparian Habitat	1.8	High	11	Some areas are within the 100 foot protected riparian zone.
	E	Wetlands	2.1	Low	4	Wetlands are unlikely in this disturbed area but segment within 100 foot of river.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has areas within the 200-foot shorelines protection zone, and some areas may be in floodplain.
	G	Land Use	0.6	Medium	3	Need new ROW outside of Hwy 12 ROW. No known parks/public recreation sites. Could impact informal recreational use on river.
	H	Erosion/Vegetation Removal	1.1	Low	2	Next to Hwy 12 but near river and riverside of Hwy 12. Fairly flat stretch.
	I	Water Quality	1.1	Medium	4	Near river where frac-out and spills are more of a hazard.
	J	Air Quality	0.2	Low	0	Next to Hwy 12 where dust from construction may be noticed by the public. No residences/businesses nearby.
	K	Hazardous Materials	1.6	Low	3	Near Hwy 2 where spills may have created hazardous materials sites. Not near residential/business human activity.
	L	Cultural Resources	2.3	Low	5	Pipeline excavation is near river and may be outside of Hwy 12 ROW. Area is disturbed ground.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Low	2	Near Hwy 12 where construction can be noticed by the public. Underground pipeline not seen when construction completed.
	O	Noise	0.4	Low	1	Construction noises may be heard because of proximity to Hwy 12. No residences/businesses in area.
	P	Transportation/Traffic	0.5	Medium	2	Along Hwy 12 where traffic may be delayed or impacted during construction.
	Q	Recreation Impacts	1.4	Medium	6	No recreational parks/wildlife refuges assumed. Informal access to the river occurs in this area.
	R	Emergency Response	0.6	Low	1	No additional emergency response public services needed. May impact emergency response time with traffic delays.
	S	Service Impacts	0.4	Low	1	No need for add'l public services (cable, phone, electric, water). Not likely to be disrupted because segment not in Hwy 12 ROW.
	T	Socio/Economic Impacts	1.5	Low	3	Socio-economic impacts possible if construction site causes delay in deliveries, transport, and services.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement required for pipe installation. Landowner is unknown.
	W	Access Constraints	2.2	Negligible	0	Access to the site from Hwy 12 is good and access adjacent to the work is good.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	30	Segment ID ->	2B-2C	Type->	Pipeline	Location:
		Length (ft)->	827	Baseline Cost ($/100-ft) ->	$225,000	New pipeline near Hwy 12 east of Trout Lodge

		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Low	2	This pipeline segement is higher than the water level in the river. The risk of encountering groundwater is low.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Negligible	0	Flat, open area. Some space available to stage equipment and store materials adjacent to the canal/pipe.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Negligible	0	Work could be completed at any time. No special schedule or sequence is required.
	HH	Unique Construction Methods	2.8	Negligible	0	Open-cut pipeline requires no special construction techniques.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from Hwy 12.
	LL	Slope Stability Maintenance	5.2	Negligible	0	Buried pipeline along Hwy 12 would have negligible slope stability issues.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Buried pipeline along Hwy 12 would have negligible erosion/scour issues.
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Negligible	0	Access to the site from Hwy 12 is good. Long-term O&M costs would be negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	No lost opportunity for power production at this location
		Sum of Scores	100.0		**150**	

Segment Evaluation

	31	Segment ID ->	2C-2D	Type->	River Tunnel	Location:
		Length (ft)->	294	Baseline Cost ($/100-ft) ->	$1,000,000	New tunnel under river east of Trout Lodge
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	Tunnel crossing under river - easier to permit compared to utility bridges or excavating/filling a trench.
	B	Migratory Fish and Wildlife	1.7	Medium	7	Construction delayed if work exceeds fish work window (likely June 1 to Oct 31); less risk w/tunnel versus trenching.
	C	Migratory Birds/Raptors	1.9	Low	4	Bald Eagle nests may need protection (Dec-July) during construction but none currently known. No Golden Eagles.
	D	Riparian Habitat	1.8	High	11	Within 100 foot protected riparian area.
	E	Wetlands	2.1	High	12	Wetlands possible in the riparian area.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Within 200 foot shorelines protection zone and in floodplains.
	G	Land Use	0.6	High	4	Need new ROW for river crossing and DNR permit. May block access to river for informal recreational uses.
	H	Erosion/Vegetation Removal	1.1	High	6	Tunnel river crossing and stockpiling excavated materials may cause erosion.
	I	Water Quality	1.1	High	6	Crossing in river where frac-out and spills are potential hazard.
	J	Air Quality	0.2	Medium	1	Next to Hwy 12 where dust from construction may be noticed by the public.
	K	Hazardous Materials	1.6	Low	3	Near Hwy 12 where spills may have created hazardous materials sites. Not near residential/business human activity.
	L	Cultural Resources	2.3	High	14	Tunnelling under river and working on riverbanks has high potential for cultural resources discovery.
	M	Historic Resources	0.9	Low	2	No known historic features at river crossing.
	N	Aesthetics	1.1	Negligible	0	New tunnel will not be noticeable - has least impact on visual resources.
	O	Noise	0.4	Medium	2	Construction noises may be heard because of proximity to Hwy 12. No residences/businesses in area.
	P	Transportation/Traffic	0.5	Medium	2	Access to tunnel construction off of Hwy 12, could impact traffic flow.
	Q	Recreation Impacts	1.4	Medium	6	No recreational parks/wildlife refuges assumed. Could impact informal recreational use on river.
	R	Emergency Response	0.6	Medium	3	No additional emergency response public services needed. May impact emergency response time with traffic delays.
	S	Service Impacts	0.4	Low	1	No need for add'l public services (cable, phone, electric, water). Could be disrupted if located in construction access.
	T	Socio/Economic Impacts	1.5	Medium	6	Socio-economic impacts possible if access to construction site causes delay in deliveries, transport, and services.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement required for pipe installation across Tieton River.
	W	Access Constraints	2.2	Low	4	Access to both sides of the river is relatively good.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	31	Segment ID ->	2C-2D	Type->	River Tunnel	Location:
		Length (ft)->	294	Baseline Cost ($/100-ft) ->	$1,000,000	New tunnel under river east of Trout Lodge
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	New tunnel under river. Tunnel stability with high groundwater is a significant risk.
	BB	Subsurface Conditions	2.4	Medium	10	Subsurface tunnel conditions are unknown, but site is accessible for geotechnical testing during the pre-design phase.
	CC	Groundwater	0.9	High	6	There is a high likelihood of encountering groundwater when tunneling below the river.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Low	3	Some space available to stage equipment and store materials adjacent to the tunnel shaft.
	FF	Equipment and Materials	0.6	High	3	Special equipment and materials may be required for tunnel construction.
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Tunnel work would be scheduled to avoid fish runs. Otherwise, no sequence or schedule constraints.
	HH	Unique Construction Methods	2.8	Medium	11	Tunnel work is a proven technology, but tunnel shafts and subsurface conditions require special construction techniques.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Medium	10	New tunneling requires work in deep shafts and confined spaces.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, and general condition of tunnel is not possible without shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability or rockfall issues.
	MM	Erosion/Scour Maintenance	5.2	Low	10	Tunnel under the river would be at sufficient depth to avoid erosion. Minimal long-term maintenance required.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Low	12	Access to the site from Hwy 12 is good. Long-term O&M costs would be minimal.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Medium	13	Tunnel under the river requires mechanical air valves and blowoff for evacuating air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Medium	31	Tunnel under the river requires pumped dewatering. Difficult inside access and mobility. Potential trap for rock and debris.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	No lost opportunity for power production at this location
		Sum of Scores	100.0		**280**	

Segment Evaluation

	32	Segment ID ->	2D-1N	Type->	Pipeline	Location:
		Length (ft)->	15,088	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	Route not far from the river (comes within 100 feet).
	B	Migratory Fish and Wildlife	1.7	Medium	7	Looks like pipeline is in river? Certainly within 100 feet. Bears could be encountered in summer. Eagle nest season through July.
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	High	11	Areas within 100 foot protected riparian zone.
	E	Wetlands	2.1	High	12	May have wetlands present that need protection.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has areas within the 200-foot shorelines protection zone and within the floodplain.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Near river. Some areas with steep slopes. Would want to avoid/minimize vegetation removal in riparian areas.
	I	Water Quality	1.1	Medium	4	Near river where frac-out and spills are more of a hazard.
	J	Air Quality	0.2	Medium	1	Not far from Hwy 12 but near and across river where there is poor screening in places.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	Pipeline excavation is near river.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed (not on canal alignment).
	N	Aesthetics	1.1	Medium	4	Visual scape changes more noticed where land scarring is new. Not near residences/businesses but visible from Hwy 12 in places.
	O	Noise	0.4	Negligible	0	Away from Hwy 12 and residences/businesses area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement required for pipe installation. Current landowner is unknown.
	W	Access Constraints	2.2	Low	4	Access to the site is relatively good and access adjacent to the work is fair along most of the segment.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	High	2	High probability of conflict with existing overhead powerline. Powerline would need to be temporarily relocated.
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	32	Segment ID ->	2D-1N	Type->	Pipeline	Location:
		Length (ft)->	15,088	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	**Risk Importance Factor**	**Risk Level**	**Risk Score**	**Risk Level Comments**
Constructability	AA	Soil/Slope Stability	1.5	High	9	Pipeline passes near toe of ancient slide area. More investigation required. A few areas of steep side slopes and falling rock.
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Medium	4	Portions of this alignment are at or below the water surface in the river. Some groundwater management is likely
	DD	Connections to Existing Facilities	1.9	Medium	7	Pipeline design would need to incorporate cross-drainage/scour prevention measures. Pipe connects to existing Windy Pt. Tunnel
	EE	Work Space Constraints	1.5	Medium	6	Steep side slopes. Limited space for staging materials and equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Negligible	0	No sequencing or schedule contraints
	HH	Unique Construction Methods	2.8	Negligible	0	Open-cut pipeline requires no special construction techniques.
	II	YTID Service Interruptions	3.0	Low	6	Connection to existing YTID canal creates potential for service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from maintenance road above pipe.
	LL	Slope Stability Maintenance	5.2	Medium	21	Pipeline passes near toe of ancient slide area. More investigation required. A few areas of steep side slopes and falling rock.
	MM	Erosion/Scour Maintenance	5.2	Medium	21	Pipeline is buried, but several cross-drainage features may require periodic inspection and maintenance.
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Low	12	Long-term access to this location would be good from Windy Pt. Access O&M costs would be minimal.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	No lost opportunity for power production at this location
		Sum of Scores	100.0		**250**	

Segment Evaluation

	33	Segment ID ->	1P-2F	Type->	Pipeline	Location:
		Length (ft)->	4,331	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	No in river work, and route elevated from river. Bears possible in spring, summer, fall.
	B	Migratory Fish and Wildlife	1.7	Medium	7	No in river work.
	C	Migratory Birds/Raptors	1.9	Medium	8	No known Golden Eagles but near cliffs. Forested areas but approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	Low	4	May have areas within 100-feet of river and in riparian habitat.
	E	Wetlands	2.1	Medium	8	Wetlands unlikely but near river.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has areas within the 200-foot shorelines protection zone and in floodplain.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	Near but above river. Some areas below steep slopes.
	I	Water Quality	1.1	Medium	4	Near river where frac-out and spills are more of a hazard.
	J	Air Quality	0.2	Medium	1	Farther from Hwy 12 where dust from construction is less likely to be noticed but near river. Residence across the river.
	K	Hazardous Materials	1.6	Negligible	0	Human activity on other side of river. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	Pipeline excavation is away from river but in floodplain that may have had pre-historic use.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed (not in canal corridor).
	N	Aesthetics	1.1	Medium	4	Visual scape changes more noticed in new route where land scarring is new. Residence across the river.
	O	Noise	0.4	Low	1	Away from Hwy 12 and across the river from a residence. River masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Low	3	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement required for pipe installation. Current landowner is unknown.
	W	Access Constraints	2.2	Medium	9	Access to the site is fair. Access adjacent to the work is fair to poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	33	Segment ID ->	1P-2F	Type->	Pipeline	Location:
		Length (ft)->	4,331	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Low	3	A few areas of steep rock cliff. Potential for falling rock.
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	High	6	Most of this alignment is at or below the water surface in the river. Some groundwater management is likely
	DD	Connections to Existing Facilities	1.9	Low	4	Pipeline connects to existing YTID canal.
	EE	Work Space Constraints	1.5	Low	3	Floodplain. Limited space for staging materials and equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Work in the flood plain would be scheduled to avoid periods of high flow in the river
	HH	Unique Construction Methods	2.8	Medium	11	Deep excavation may be required to avoid river scour.
	II	YTID Service Interruptions	3.0	Low	6	Connection to existing YTID canal creates potential for service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from maintenance road above pipe.
	LL	Slope Stability Maintenance	5.2	Low	10	No significant slope stability O&M is expected.
	MM	Erosion/Scour Maintenance	5.2	Medium	21	Portions of this segment are located in river floodplain. Special erosion protection and maintenance may be required.
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	River alignment provides opportunity to generate hydropower
		Sum of Scores	100.0		**253**	

Segment Evaluation

	34	Segment ID ->	2F-2G	Type->	Pipeline	Location:
		Length (ft)->	852	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Low	4	Segment far above river. Bears possible in spring, summer and fall.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work. Construction corridor approaches river at one point but is elevated above the river.
	C	Migratory Birds/Raptors	1.9	High	12	No known Golden Eagles. Approved land clearing could be done prior to construction if nests need removal.
	D	Riparian Habitat	1.8	Negligible	0	Not in riparian zone.
	E	Wetlands	2.1	Negligible	0	Wetland unlikely in upland areas.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Has an area within the 200-foot shorelines protection zone but outside of floodplain.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	Mild side slopes. Near but above river.
	I	Water Quality	1.1	Medium	4	Above river where frac-out and spills are less of a concern.
	J	Air Quality	0.2	Medium	1	Farther from Hwy 12 where dust from construction is less likely to be noticed. Above river.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Negligible	0	Pipeline excavation is away from river.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Low	2	Visual scape changes more noticed in new route where land scarring is new, above Hwy 12, not near residences businesses.
	O	Noise	0.4	Negligible	0	Away from Hwy 2 and residences/businesses area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement required for pipe installation. Current landowner is unknown.
	W	Access Constraints	2.2	Medium	9	Access to the site is fair. Access adjacent to the work is fair.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.
	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues.
bility	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.

Segment Evaluation

	34	Segment ID ->	**2F-2G**	Type->	**Pipeline**	Location:
		Length (ft)->	**852**	Baseline Cost ($/100-ft) ->	**$225,000**	
		Risk Criterion	**Risk Importance Factor**	**Risk Level**	**Risk Score**	**Risk Level Comments**
Constructa	CC	Groundwater	0.9	Negligible	0	This segemnt is located above the water table in the river. Groundwater is not expected to be a significant issue.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Low	3	Mild side slopes. Some space available to stage equipment and store materials adjacent to the canal/pipe.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Negligible	0	No sequencing or schedule contraints
	HH	Unique Construction Methods	2.8	Negligible	0	Open-cut pipeline requires no special construction techniques.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from maintenance road above pipe.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No know slope stability or rockfall issues. Negligible O&M.
	MM	Erosion/Scour Maintenance	5.2	Low	10	Long-term O&M for drainage crossings is expected to be minimal for a buried pipeline in this area.
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	River alignment provides opportunity to generate hydropower
		Sum of Scores	100.0		**152**	

Segment Evaluation

	35	Segment ID ->	2G-2H	Type->	Pipeline	Location:
		Length (ft)->	4,828	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	**Risk Importance Factor**	**Risk Level**	**Risk Score**	**Risk Level Comments**
Permitting	A	State/Federal Endangered Species	2.2	Low	4	Route avoids river where ESA fish species need to be protected. Bears possible in spring, summer, fall.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work and above river. Construction corridor farther from river than some segments.
	C	Migratory Birds/Raptors	1.9	Medium	8	Few trees/farther from river. Land clearing could be done prior to construction. No known Golden Eagles but near cliffs.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Low	4	Wetlands unlikely. One was noticed near the riverbanks (not adjacent to segment) and below the pipeline route.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	No areas within the 200-foot shorelines protection zone. Outside of the floodplain.
	G	Land Use	0.6	High	4	Need new ROW and could be conflict with private landowner. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	Steep side slopes. Near but above river.
	I	Water Quality	1.1	Negligible	0	Further from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Medium	1	Farther from Hwy 12 where dust from construction is less likely to be noticed but dust may be noticed by nearby residences.
	K	Hazardous Materials	1.6	Low	3	Human activity nearby but potential hazardous materials sites are unlikely along this segment.
	L	Cultural Resources	2.3	Low	5	Pipeline excavation is away from river.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	High	6	Visual scape changes more noticed with new land scarring. May be visible from Hwy 12, river or residences. Potential pipebridge.
	O	Noise	0.4	High	3	Across river from residences but may be on private property where noise might be noticed.
	P	Transportation/Traffic	0.5	Medium	2	Away from Hwy 12 but may impact use of private property roads.
	Q	Recreation Impacts	1.4	Low	3	No recreational parks/wildlife refuges assumed but may impact recreational use by private landowners.
	R	Emergency Response	0.6	Low	1	No need for additional emergency response public services Nearby residences.
	S	Service Impacts	0.4	Low	1	No need for additional public services. Shouldn't affect services to nearby residences.
	T	Socio/Economic Impacts	1.5	Medium	6	Shouldn't interfere with residences access or activities. May have impact on property values.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	High	7	New permanent easement required from private landowner.
	W	Access Constraints	2.2	Medium	9	Access to the site is fair from existing roads. Access adjacent to the work is limited and side-slopes are moderately steep.
	X	Landowner Conflicts	0.7	High	4	High probability of conflicts with existing private landowner near the project site.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	35	Segment ID ->	2G-2H	Type->	Pipeline	Location:
		Length (ft)->	4,828	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	**Risk Importance Factor**	**Risk Level**	**Risk Score**	**Risk Level Comments**
Constructability	AA	Soil/Slope Stability	1.5	Medium	6	Middle of segment climbs a steep rocky slope
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Negligible	0	This segemnt is located above the water table in the river. Groundwater is not expected to be a significant issue.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Medium	6	Steep side slopes. Limited space for materials and equipment. Increases haul distance, reduces efficiency.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Negligible	0	No sequencing or schedule contraints
	HH	Unique Construction Methods	2.8	Medium	11	Large new drainage crossing near the middle of the segment
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from maintenance road above pipe.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No know slope stability issues or long-term O&M requirements.
	MM	Erosion/Scour Maintenance	5.2	Low	10	Minimal long-term maintenance requirements for a buried pipeline in this area.
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	River alignment provides opportunity to generate hydropower
		Sum of Scores	100.0		**203**	

Segment Evaluation

	36	Segment ID ->	2H-2M	Type->	Pipeline	Location:
		Length (ft)->	1,352	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Low	4	Route avoids river where ESA fish species need to be protected. Bears possible in spring, summer, fall.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work and construction corridor farther from river than some segments.
	C	Migratory Birds/Raptors	1.9	Low	4	Few trees and farther from river. Approved land clearing could be done prior to construction. No known Golden Eagles.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	No areas within the 200-foot shorelines protection zone, outside of floodplain.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Low	2	Mild slopes. Above river.
	I	Water Quality	1.1	Negligible	0	Far from river where frac-out and spills are not as hazardous.
	J	Air Quality	0.2	Negligible	0	Farther from Hwy 12 where dust from construction is less likely to be noticed. Above river.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Pipeline excavation is away from river.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Negligible	0	Visual scape changes more noticed in route with new land scarring. Not visible from Hwy 12, river or residences/businesses.
	O	Noise	0.4	Negligible	0	Away from Hwy 12 and residences/businesses area. River masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement required for pipe installation. Current landowner is unknown.
	W	Access Constraints	2.2	Medium	9	Access to the site is fair from existing roads. Access adjacent to the work is limited but new access roads could be constructed.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	36	Segment ID ->	2H-2M	Type->	Pipeline	Location:
		Length (ft)->	1,352	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues.
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Negligible	0	This segemnt is located above the water table in the river. Groundwater is not expected to be a significant issue.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Low	3	Some space for staging materials and equipment.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Negligible	0	No sequencing or schedule contraints
	HH	Unique Construction Methods	2.8	Negligible	0	Open-cut pipeline requires no special construction techniques.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from maintenance road above pipe.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No know slope stability issues or long-term O&M requirements.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Minimal long-term maintenance requirements for a buried pipeline in this area.
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	River alignment provides opportunity to generate hydropower
		Sum of Scores	100.0		**128**	

Segment Evaluation

	37	Segment ID ->	**2M-2N**	Type->	**Pipeline**	Location:
		Length (ft)->	**3,181**	Baseline Cost ($/100-ft) ->	**$225,000**	
		Risk Criterion	**Risk Importance Factor**	**Risk Level**	**Risk Score**	**Risk Level Comments**
Permitting	A	State/Federal Endangered Species	2.2	Low	4	Route follows river where ESA fish species need to be protected, but elevated from river. Bears possible in spring, summer, fall.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work. Construction corridor is close to river but elevated.
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested and near river where nests may occur. Approved land clearing possible prior to construction.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has areas within the 200-foot shorelines protection zone.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	New access roads through virgin lands could cause erosion. Near river.
	I	Water Quality	1.1	Low	2	Further from and above river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Farther from Hwy 12 where dust from construction is less likely to be noticed but near river.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Medium	9	Pipeline is adjacent but above the river.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Medium	4	Visual scape changes more noticed in route with new land scarring.
	O	Noise	0.4	Negligible	0	Away from Hwy 12 and residences/businesses area. River masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement required for pipe installation. Current landowner is unknown.
	W	Access Constraints	2.2	Medium	9	Alignment is x-country through virgin terrain. Access is currently poor but new access roads could be constructed.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	37	Segment ID ->	2M-2N	Type->	Pipeline	Location:
		Length (ft)->	3,181	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues.
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Low	2	This segemnt is located above the water table in the river. Groundwater is not expected to be a significant issue.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Low	3	Some space for staging materials and equipment.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Negligible	0	No sequencing or schedule contraints
	HH	Unique Construction Methods	2.8	Negligible	0	Open-cut pipeline requires no special construction techniques.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from maintenance road above pipe.
	LL	Slope Stability Maintenance	5.2	Low	10	No known slope stability issues or long-term O&M requirements.
	MM	Erosion/Scour Maintenance	5.2	Medium	21	Some maintenance and inspection required for cross-drainage features. Buried pipeline O&M is not expected to be significant.
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	River alignment provides opportunity to generate hydropower
		Sum of Scores	100.0		**182**	

Segment Evaluation

	38	Segment ID ->	2N-2O	Type->	Pipeline	Location:
		Length (ft)->	544	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	High	13	Trenching river crossing requires more mitigation to control turbidity/protect fish. Construction may exceed fish window.
	B	Migratory Fish and Wildlife	1.7	High	10	Construction may exceed approved fish work window - could delay construction.
	C	Migratory Birds/Raptors	1.9	High	12	Forrested and near river where nests may occur. Approved land clearing possible prior to construction. Bears in summer.
	D	Riparian Habitat	1.8	High	11	Areas within 100 foot riparian protection zone.
	E	Wetlands	2.1	High	12	Wetlands may be present.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has areas within the 200-foot shorelines protection zone and in floodplain.
	G	Land Use	0.6	High	4	Need new ROW and DNR permit. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Crossing river channel by trenching. Stockpiling excavated materials may cause erosion.
	I	Water Quality	1.1	High	6	Crossing in river where frac-out and spills are potential hazard.
	J	Air Quality	0.2	Medium	1	Next to Hwy 12 where dust from construction is more likely to be noticed.
	K	Hazardous Materials	1.6	Medium	6	Near Hwy 12 where spills may have created potential hazardous materials sites. Not near residential/business human activity.
	L	Cultural Resources	2.3	High	14	Trenching across river and working on riverbanks has high potential for cultural resources discovery.
	M	Historic Resources	0.9	Low	2	No known historic features at river crossing. Avoids pedestrian bridge crossing.
	N	Aesthetics	1.1	High	6	Visual scape changes more noticed in route with new land clearing. Riverbank/island scarring visible from Hwy 12.
	O	Noise	0.4	Medium	2	Next to Hwy 12 where noise from construction may be noticed by the public.
	P	Transportation/Traffic	0.5	High	3	Access to river crossing construction off of Hwy 12, could impact traffic flow.
	Q	Recreation Impacts	1.4	High	8	Maybe in WDFW recreational area (signs were posted). Could impact informal recreational use on river.
	R	Emergency Response	0.6	Medium	3	No additional emergency response public services needed. May impact emergency response time with traffic delays.
	S	Service Impacts	0.4	Medium	2	No need for add'l public services (cable, phone, electric, water). Could be disrupted if located in construction access.
	T	Socio/Economic Impacts	1.5	Medium	6	Socio-economic impacts possible if access to construction site causes delay in deliveries, transport, and services.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement required for pipe installation across Tieton River. Current landowner is unknown.
	W	Access Constraints	2.2	Low	4	Access is relatively good from the Hwy 12 side.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Low	3	Construction could be performed in the summer except during fish runs.

Segment Evaluation

	38	Segment ID ->	2N-2O	Type->	Pipeline	Location:
		Length (ft)->	544	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Medium	6	Open cut river crossing. Trench slopes must be stabilized during construction.
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	High	6	Open cut river crossing will encounter significant groundwater in the trench.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Low	3	Some space for staging materials and equipment.
	FF	Equipment and Materials	0.6	High	3	Open cut river crossing would require special underwater construction work
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	Open cut river crossing would be scheduled during low river flow and to avoid fish runs.
	HH	Unique Construction Methods	2.8	Medium	11	Open cut river crossing would require special underwater construction work and deep excavation.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Medium	10	Underwater construction may require divers and elevated risk work.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, etc. of river crossing is difficult and may require shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability issues or long-term O&M requirements.
	MM	Erosion/Scour Maintenance	5.2	Low	10	Buried pipeline under river will be deep enough to avoid scour and erosion.
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Negligible	0	Access to this location is good from Hwy 12. Long-term O&M costs would be negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Medium	13	River crossing requires mechanical air valves and blowoff for evacuating air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	River alignment provides opportunity to generate hydropower
		Sum of Scores	100.0		**292**	

Segment Evaluation

	39	Segment ID ->	2O-2P	Type->	Pipeline	Location:
		Length (ft)->	635	Baseline Cost ($/100-ft) ->	$225,000	Short segment adjacent to Hwy 12
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	Route follows river where ESA fish species need protection. Bears not likely next to Hwy 12.
	B	Migratory Fish and Wildlife	1.7	Low	3	No in river work but construction corridor is closer to river than some segments. Habitat is poor near Hwy 12.
	C	Migratory Birds/Raptors	1.9	Low	4	Few trees, none likely removed. Construction may need to be outside of nesting season with proximity to river.
	D	Riparian Habitat	1.8	High	11	Riparian protection zone near coordinate 2O.
	E	Wetlands	2.1	Low	4	Wetlands may be likely near river.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has areas within the 200-foot shorelines protection zone. May have areas in floodplain.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Low	2	Next to Hwy 12 but near river and riverside of Hwy 12. Nearly flat stretch.
	I	Water Quality	1.1	Medium	4	Near river where frac-out and spills are more of a hazard.
	J	Air Quality	0.2	Low	0	Next to Hwy 12 where dust from construction is more likely to be noticed. No residences/businesses nearby.
	K	Hazardous Materials	1.6	Low	3	Near Hwy 2 where spills may have created potential hazardous materials sites. Not near residential/business human activity.
	L	Cultural Resources	2.3	Low	5	Pipeline excavation is near river but mostly in or near Hwy 12 ROW, a previously disturbed area.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Low	2	Visual scape changes less noticed in Hwy 12 ROW where land scarring has occurred. Not near residences/businesses.
	O	Noise	0.4	Low	1	Construction/operational noises may be heard because of proximity to Hwy 12. No residences/businesses in area.
	P	Transportation/Traffic	0.5	Medium	2	Along Hwy 12 where traffic may be delayed or impacted during construction.
	Q	Recreation Impacts	1.4	Medium	6	May have some informal recreational use along the river.
	R	Emergency Response	0.6	Low	1	No additional emergency response public services needed. May impact emergency response time with traffic delays.
	S	Service Impacts	0.4	Low	1	No need for add'l public services (cable, phone, electric, water). May be disrupted if in Hwy 12 ROW.
	T	Socio/Economic Impacts	1.5	Low	3	Socio-economic impacts possible if construction site causes delay in deliveries, transport, and services.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement required for pipe installation adjacent to Hwy 12
	W	Access Constraints	2.2	Negligible	0	Access is good from Hwy 12. Access adjacent to the work is good.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	39	Segment ID ->	2O-2P	Type->	Pipeline	Location:
		Length (ft)->	635	Baseline Cost ($/100-ft) ->	$225,000	Short segment adjacent to Hwy 12
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues.
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Low	2	This segemnt is located above the water table in the river. Groundwater is not expected to be a significant issue.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Negligible	0	Some space for staging materials and equipment.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Negligible	0	No sequencing or schedule contraints
	HH	Unique Construction Methods	2.8	Negligible	0	Open-cut pipeline requires no special construction techniques.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from Hwy 12.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No know slope stability issues for buried pipeline adjacent to Hwy 12.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	No erosions or scour issues expected for buried pipeline adjacent to Hwy 12.
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Negligible	0	Access to this location is good from Hwy 12. Long-term O&M costs would be negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	River alignment provides opportunity to generate hydropower
		Sum of Scores	100.0		**150**	

Segment Evaluation

	40	Segment ID ->	2P-2Q	Type->	Pipeline	Location:
		Length (ft)->	353	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	High	13	Trenching river crossing requires more mitigation to control turbidity/protect fish. Construction may exceed fish window.
	B	Migratory Fish and Wildlife	1.7	High	10	Construction may exceed approved fish work window - could delay construction.
	C	Migratory Birds/Raptors	1.9	High	12	Forrested and near river where nests may occur. Approved land clearing possible prior to construction. Bears in summer.
	D	Riparian Habitat	1.8	High	11	Areas within 100 foot riparian protection zone.
	E	Wetlands	2.1	High	12	Wetlands may be present.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has areas within the 200-foot shorelines protection zone and in floodplain.
	G	Land Use	0.6	High	4	Need new ROW and DNR permit. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Crossing river channel by trenching. Stockpiling of excavated materials may cause erosion.
	I	Water Quality	1.1	High	6	Crossing in river where frac-out and spills are potential hazard.
	J	Air Quality	0.2	Medium	1	Next to Hwy 12 where dust from construction is more likely to be noticed.
	K	Hazardous Materials	1.6	Medium	6	Near Hwy 12 where spills may have created potential hazardous materials sites. Not near residential/business human activity.
	L	Cultural Resources	2.3	High	14	Trenching across river and working on riverbanks has high potential for cultural resources discovery.
	M	Historic Resources	0.9	Low	2	No historical features at river crossing. Avoids pedestrian river crossing.
	N	Aesthetics	1.1	High	6	Visual scape changes more noticed in route with new land clearing. Riverbank/island scarring visible from Hwy 12.
	O	Noise	0.4	Medium	2	Next to Hwy 12 where noise from construction may be noticed by the public.
	P	Transportation/Traffic	0.5	High	3	Access to river crossing construction off of Hwy 12, could impact traffic flow.
	Q	Recreation Impacts	1.4	High	8	Maybe in WDFW recreational area (signs were posted). Could impact informal recreational use on river.
	R	Emergency Response	0.6	Medium	3	No additional emergency response public services needed. May impact emergency response time with traffic delays.
	S	Service Impacts	0.4	Medium	2	No need for add'l public services (cable, phone, electric, water). Could be disrupted if located in construction access.
	T	Socio/Economic Impacts	1.5	Medium	6	Socio-economic impacts possible if access to construction site causes delay in deliveries, transport, and services.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement required for pipe installation across Tieton River. Current landowner is unknown.
	W	Access Constraints	2.2	Low	4	Access is relatively good from the Hwy 12 side.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Low	3	Construction could be performed in the summer except during fish runs.

Segment Evaluation

	40	Segment ID ->	2P-2Q	Type->	Pipeline	Location:
		Length (ft)->	353	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Medium	6	Open cut river crossing. Trench slopes must be stabilized during construction.
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	High	6	Open cut river crossing will encounter significant groundwater in the trench.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Low	3	Some space for staging materials and equipment.
	FF	Equipment and Materials	0.6	High	3	Open cut river crossing would require special underwater construction work
	GG	Sequencing/Schedule Constraints	2.2	Medium	9	Open cut river crossing would be scheduled during low river flow and to avoid fish runs.
	HH	Unique Construction Methods	2.8	Medium	11	Open cut river crossing would require special underwater construction work and deep excavations.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Medium	10	Underwater construction may require divers and elevated risk work.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, etc. of river crossing is difficult and may require shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability issues or long-term O&M requirements.
	MM	Erosion/Scour Maintenance	5.2	Low	10	Buried pipeline under river will be deep enough to avoid scour and erosion.
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Negligible	0	Access to this location is good from Hwy 12. Long-term O&M costs would be negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Medium	13	River crossing requires mechanical air valves and blowoff for evacuating air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	River alignment provides opportunity to generate hydropower
		Sum of Scores	100.0		**292**	

Segment Evaluation

	41	Segment ID ->	2Q-2R	Type->	Pipeline	Location:
		Length (ft)->	7,578	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	Route follows river where ESA fish species need to be protected. Bears in spring, summer, fall.
	B	Migratory Fish and Wildlife	1.7	Medium	7	No in river work and above river. Construction corridor farther from river than some segments.
	C	Migratory Birds/Raptors	1.9	High	12	Trees but farther from river. Approved land clearing could be done prior to construction. Near known Golden Eagles.
	D	Riparian Habitat	1.8	Low	4	No riparian habitat. However, there is sagebrush habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has areas within the 200-foot shorelines protection zone near coordinate 2Q and an area prior to 2R. Areas within floodplain.
	G	Land Use	0.6	High	4	Need new ROW. Within Oak Creek Wildlife Area.
	H	Erosion/Vegetation Removal	1.1	High	6	New access roads through virgin lands could cause erosion. Near river.
	I	Water Quality	1.1	Medium	4	Further from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Low	0	Further from Hwy 12 where dust from construction is less likely to be noticed but near river.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Medium	9	Further from river where finding cultural resources lessens.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	High	6	Visual scape changes more noticed in route with new land clearing through virgin land.
	O	Noise	0.4	Negligible	0	Away from Hwy 12 and residences/businesses area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	High	8	Within Oak Creek Wildlife Area. Posted with WDFW signs.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement required for pipe installation adjacent to the river.
	W	Access Constraints	2.2	Medium	9	Alignment is x-country through virgin terrain. Access is currently poor but new access roads could be constructed.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	41	Segment ID ->	2Q-2R	Type->	Pipeline	Location:
		Length (ft)->	7,578	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues.
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Medium	4	This segemnt is located near the water table in the river. Groundwater may be an issue during construction.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Low	3	Some space for staging materials and equipment.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Negligible	0	No sequencing or schedule contraints
	HH	Unique Construction Methods	2.8	Negligible	0	Open-cut pipeline requires no special construction techniques.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Vehicle access to this location is not feasible unless a new bridge is constructed over the Tieton River. Access by foot.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability issues or long-term O&M requirements.
	MM	Erosion/Scour Maintenance	5.2	Low	10	Some long-term maintenance and inspection of cross-drainage features may be required. O&M for buried pipeline is minimal.
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Vehicle access to this location is not feasible unless a new bridge is constructed over the Tieton River.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	River alignment provides opportunity to generate hydropower
		Sum of Scores	100.0		**216**	

Segment Evaluation

	42	Segment ID ->	2R-2S	Type->	Pipeline	Location:
		Length (ft)->	3,894	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Low	4	Route follows river where ESA fish species need to be protected. Route becomes more elevated. Bears in spring, summer, fall.
	B	Migratory Fish and Wildlife	1.7	Low	3	No in river work but construction corridor is closer to river than some segments. Route is elevated.
	C	Migratory Birds/Raptors	1.9	High	12	Trees but farther from river. Approved land clearing could be done prior to construction. Near known Golden Eagles.
	D	Riparian Habitat	1.8	Low	4	No riparian habitat. However, there is sagebrush habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has areas within the 200-foot shorelines protection zone. May have areas in floodplain.
	G	Land Use	0.6	High	4	Need new ROW. Within Oak Creek Wildlife Area.
	H	Erosion/Vegetation Removal	1.1	High	6	New access roads through virgin lands could cause erosion. Near river.
	I	Water Quality	1.1	Low	2	Further from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Low	0	Further from Hwy 12 where dust from construction is less likely to be noticed but near river.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Medium	9	Further from river where finding cultural resources lessens.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed except for existing canal.
	N	Aesthetics	1.1	High	6	Visual scape changes more noticed in route with new land clearing through virgin land. Some steep areas.
	O	Noise	0.4	Negligible	0	Away from Hwy 12 and residences/businesses area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	High	8	Within Oak Creek Wildlife Area. Posted with WDFW signs.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement required for pipe installation adjacent to the river.
	W	Access Constraints	2.2	Medium	9	Alignment is x-country through virgin terrain. Access is currently poor but new access roads could be constructed.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	42	Segment ID ->	2R-2S	Type->	Pipeline	Location:
		Length (ft)->	3,894	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	**Risk Importance Factor**	**Risk Level**	**Risk Score**	**Risk Level Comments**
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues.
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Medium	4	This segemnt is located near the water table in the river. Groundwater may be an issue during construction.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Negligible	0	Some space for staging materials and equipment.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Negligible	0	No sequencing or schedule contraints
	HH	Unique Construction Methods	2.8	Negligible	0	Open-cut pipeline requires no special construction techniques.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Vehicle access to this location is not feasible unless a new bridge is constructed over the Tieton River. Access by foot.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability issues or long-term O&M requirements.
	MM	Erosion/Scour Maintenance	5.2	Low	10	Some long-term maintenance and inspection of cross-drainage features may be required. O&M for buried pipeline is minimal.
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Negligible	0	Vehicle access to this location is not feasible unless a new bridge is constructed over the Tieton River.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	River alignment provides opportunity to generate hydropower
		Sum of Scores	100.0		**180**	

Segment Evaluation

	43	Segment ID ->	2S-1AB	Type->	New Tunnel	Location:
		Length (ft)->	3,958	Baseline Cost ($/100-ft) ->	$352,000	New tunnel connection from Tieton River to French Canyon Reservoir
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Tunnel avoids impacts to ESA habitat and species.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	Tunnel avoids impacts to migratory fish and wildlife. Work can occur outside of the approved fish work window.
	C	Migratory Birds/Raptors	1.9	High	12	Within 1/2 mile of known Golden Eagles.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	No wetlands.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shorelines area and outside of floodplain.
	G	Land Use	0.6	High	4	Need new ROW. Tunnel entrance within 1/2 mile of known Golden Eagles.
	H	Erosion/Vegetation Removal	1.1	High	6	Access to tunnel site and stockpiling excavated materials may cause erosion, steep hillsides. Above river.
	I	Water Quality	1.1	Negligible	0	Far from river where frac-out and spills are less hazardous.
	J	Air Quality	0.2	Negligible	0	Far from Hwy 12 where dust from construction is not likely to be noticed. Most dust stays within tunnel.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Less likely to discover cultural resources when drilling a new tunnel except for initial shallow excavations.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Negligible	0	New tunnel will not be noticeable - has least impact on visual resources.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	High	8	Within Oak Creek Wildlife Area. Posted with WDFW signs.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement required for tunnel. Current landowner is unknown.
	W	Access Constraints	2.2	Medium	9	Access to the tunnel is currently poor but new roads could be constructed.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	43	Segment ID ->	2S-1AB	Type->	New Tunnel	Location:
		Length (ft)->	3,958	Baseline Cost ($/100-ft) ->	$352,000	New tunnel connection from Tieton River to French Canyon Reservoir

		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	New tunnel. Tunnel stability is a significant risk.
	BB	Subsurface Conditions	2.4	Medium	10	Subsurface tunnel conditions are unknown, but site is accessible for geotechnical testing during the pre-design phase.
	CC	Groundwater	0.9	High	6	The proposed tunnel is located above the river, but the risk of encountering and managing water in a tunnel is significant.
	DD	Connections to Existing Facilities	1.9	Low	4	Tunnel connects to existing outlet at French Canyon Reservoir.
	EE	Work Space Constraints	1.5	Medium	6	No work space inside the tunnel. Some space for staging and storing equipment and materials at tunnel entrance/exit.
	FF	Equipment and Materials	0.6	High	3	Special equipment and materials may be required for tunnel construction.
	GG	Sequencing/Schedule Constraints	2.2	Negligible	0	No sequencing or schedule contraints
	HH	Unique Construction Methods	2.8	Medium	11	New tunnel involves proven technology, but tunnel portals and subsurface conditions may require special construction methods.
	II	YTID Service Interruptions	3.0	Low	6	Connection to existing YTID canal creates potential for service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Medium	10	New tunneling requires work in deep shafts and confined spaces.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, and general condition of tunnel is not possible without shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Low	10	Minimal long-term O&M costs expected with a new tunnel
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Erosion and scour O&M costs are expected to be negligible for a new tunnel.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Vehicle access to this location is not feasible unless a new bridge is constructed over the Tieton River.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Tunnel construction does not require mechanical air valves or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Medium	31	New tunnel may require pumped dewatering. Difficult inside access and mobility. Steep slope and slipery surface.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	River alignment provides opportunity to generate hydropower
		Sum of Scores	100.0		**220**	

Segment Evaluation

	44	Segment ID ->	1D-2E	Type->	Pipeline	Location:
		Length (ft)->	915	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	Coordinate 2E near river where ESA fish species need protection. Bears possible in spring, summer and fall.
	B	Migratory Fish and Wildlife	1.7	Low	3	No in river work but construction corridor approaches river at one point.
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has an area within the 200-foot shorelines protection zone.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	Near river. Slopes are minor.
	I	Water Quality	1.1	Medium	4	Near river where frac-out and spills are more of a hazard.
	J	Air Quality	0.2	Medium	1	Further from Hwy 12 where dust from construction is less likely to be noticed but near river.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	High potential for cultural resources because of pipeline location near river.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Low	2	Visual scape changes more noticed in route with new land clearing near river/Hwy 12. No residences/businesses in area.
	O	Noise	0.4	Medium	2	Not far from Hwy 12. No residences/businesses in area. River masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement required for pipeline installation. Current landowner is unknown.
	W	Access Constraints	2.2	Medium	9	Access to the site is fair. A new road would be required for access adjacent to the work.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	44	Segment ID ->	1D-2E	Type->	Pipeline	Location:
		Length (ft)->	915	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues.
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Negligible	0	This segemnt is located above the water table in the river. Groundwater is not expected to be a significant issue.
	DD	Connections to Existing Facilities	1.9	Low	4	Pipeline connects to existing YTID canal.
	EE	Work Space Constraints	1.5	Low	3	Mild side slopes. Some space available to stage equipment and store materials adjacent to the work.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Work schedule is flexible. Connection to existing canal occurs in the winter.
	HH	Unique Construction Methods	2.8	Negligible	0	Open-cut pipeline requires no special construction techniques.
	II	YTID Service Interruptions	3.0	Low	6	Connection to existing YTID canal creates potential for service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from maintenance road above pipe.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability issues or long-term O&M requirements.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Minimal drainage crossing O&M expected in this area for a buried pipeline
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Negligible	0	After the box culvert is installed, access is good to this location from the headworks. Long term O&M would be negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	No lost opportunity for power production
		Sum of Scores	100.0		**155**	

Segment Evaluation

	45	Segment ID ->	2E-2B	Type->	River Tunnel	Location:
		Length (ft)->	251	Baseline Cost ($/100-ft) ->	$1,000,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	River crossing. Tunnelling under the river eases permitting compared to utility bridges or excavating/filling a trench.
	B	Migratory Fish and Wildlife	1.7	Medium	7	Construction delayed if work exceeds fish work window (likely June 1 to Oct 31); less risk w/tunnel versus trenching.
	C	Migratory Birds/Raptors	1.9	High	12	Bald Eagle nests may need protection (Dec-July) during construction but none currently known. No Golden Eagles.
	D	Riparian Habitat	1.8	High	11	Riparian areas need protection.
	E	Wetlands	2.1	High	12	Wetlands may be present.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has areas within the 200-foot shorelines protection zone.
	G	Land Use	0.6	High	4	Need new ROW and DNR permit. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Crossing river and stockpiling materials may cause erosion.
	I	Water Quality	1.1	High	6	Crossing in river where frac-out and spills are potential hazard.
	J	Air Quality	0.2	Medium	1	Next to Hwy 12 where dust from construction may be noticed.
	K	Hazardous Materials	1.6	Low	3	No nearby human activity.Not far from Hwy 12 but potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	Tunnelling under river and working on riverbanks has high potential for cultural resources discovery.
	M	Historic Resources	0.9	Negligible	0	No historical features at river crossing.
	N	Aesthetics	1.1	Negligible	0	New tunnel will not be noticeable - has least impact on visual resources.
	O	Noise	0.4	Medium	2	Construction noises may be heard because of proximity to Hwy 12. No residences/businesses in area.
	P	Transportation/Traffic	0.5	Medium	2	Access to tunnel construction off of Hwy 12, could impact traffic flow.
	Q	Recreation Impacts	1.4	Low	3	No recreational parks/wildlife refuges assumed. Could impact informal recreational use on river.
	R	Emergency Response	0.6	Negligible	0	No additional emergency response public services needed. May impact emergency response time with traffic delays.
	S	Service Impacts	0.4	Negligible	0	No need for add'l public services (cable, phone, electric, water). Could be disrupted if located in construction access.
	T	Socio/Economic Impacts	1.5	Negligible	0	Socio-economic impacts possible if access to construction site causes delay in deliveries, transport, and services.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New easement required for pipeline installation across the Tieton River. Current landowner is unknown.
	W	Access Constraints	2.2	Low	4	Access from Hwy 12 is good.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	45	Segment ID ->	2E-2B	Type->	River Tunnel	Location:
		Length (ft)->	251	Baseline Cost ($/100-ft) ->	$1,000,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	New tunnel under river. Tunnel stability with high groundwater is a significant risk.
	BB	Subsurface Conditions	2.4	Medium	10	Subsurface tunnel conditions are unknown, but site is accessible for geotechnical testing during the pre-design phase.
	CC	Groundwater	0.9	High	6	There is a high likelihood of encountering groundwater when tunneling below the river.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Low	3	Mild side slopes. Some space available to stage equipment and store materials adjacent to the tunnel shaft.
	FF	Equipment and Materials	0.6	High	3	Special equipment and materials may be required for tunnel construction.
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Tunnelling work would be scheduled to avoid fish runs, but is otherwise flexible.
	HH	Unique Construction Methods	2.8	Medium	11	Tunnel work is a proven technology, but tunnel shafts and subsurface conditions require special construction techniques.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Medium	10	New tunneling requires work in deep shafts and confined spaces.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, and general condition of tunnel is not possible without shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability or rockfall issues.
	MM	Erosion/Scour Maintenance	5.2	Low	10	Tunnel under the river would be at sufficient depth to avoid erosion. Minimal long-term maintenance required.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Negligible	0	After the box culvert is installed, access is good to this location from the headworks. Long term O&M would be negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Medium	13	Tunnel under the river requires mechanical air valves and blowoff for evacuating air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Medium	31	Tunnel under the river requires pumped dewatering. Difficult inside access and mobility. Potential trap for rock and debris.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	No lost opportunity for power production
		Sum of Scores	100.0		**262**	

Segment Evaluation

	46	Segment ID ->	1G-2D	Type->	Pipeline	Location:
		Length (ft)->	331	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	Route follows river where ESA fish species need protection. Bears possible in spring, summer and fall.
	B	Migratory Fish and Wildlife	1.7	Medium	7	No in river work but construction corridor is closer to river than some segments.
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	High	11	Within 100 feet of river and riparian area at Coordinate 2D.
	E	Wetlands	2.1	Medium	8	Wetlands possible near river.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has areas within the 200-foot shorelines protection zone.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	Near river. Slopes are minor but rocks require deep excavation.
	I	Water Quality	1.1	Medium	4	Near river where frac-out and spills are more of a hazard.
	J	Air Quality	0.2	Negligible	0	Across river from Hwy 12 and mostly screened from river, lessening dust observation from the public.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	High potential for cultural resources because of pipeline location near river.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Low	2	Visual scape changes more noticed in route with new land clearing near river. No residences/businesses in area.
	O	Noise	0.4	Negligible	0	Across river from Hwy 12. No residences/businesses in area. River masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement is required for pipeline installation.
	W	Access Constraints	2.2	Low	4	Access to the site is relatively good from existing access roads. Access adjacent to the work may be good.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	46	Segment ID ->	1G-2D	Type->	Pipeline	Location:
		Length (ft)->	331	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues.
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Negligible	0	This segemnt is located above the water table in the river. Groundwater is not expected to be a significant issue.
	DD	Connections to Existing Facilities	1.9	Low	4	Pipeline connects to existing YTID canal.
	EE	Work Space Constraints	1.5	Low	3	Mild side slopes. Some space available to stage equipment and store materials adjacent to the work.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Work schedule is flexible. Connection to existing canal occurs in the winter.
	HH	Unique Construction Methods	2.8	Negligible	0	Open-cut pipeline requires no special construction techniques.
	II	YTID Service Interruptions	3.0	Low	6	Connection to existing YTID canal creates potential for service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from maintenance road above pipe.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability issues or long-term O&M requirements.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Minimal drainage crossing O&M expected in this area for a buried pipeline
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Low	12	Long-term access to this location would be good from Windy Pt. Access O&M costs would be minimal.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	No lost opportunity for power production
		Sum of Scores	100.0		**182**	

Segment Evaluation

	47	Segment ID ->	2F-2I	Type->	Pipeline	Location:
		Length (ft)->	992	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	Route follows river where ESA fish species need protection. Bears possible in spring, summer and fall.
	B	Migratory Fish and Wildlife	1.7	Medium	7	No in river work but construction corridor is closer to river than some segments.
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	High	11	Within 100 feet of river and riparian area at Coordinate 2I.
	E	Wetlands	2.1	Medium	8	Wetlands possible near river.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has areas within the 200-foot shorelines protection zone.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	Near river. Slopes are minor but rocks require deep excavation.
	I	Water Quality	1.1	Medium	4	Near river where frac-out and spills are more of a hazard.
	J	Air Quality	0.2	Negligible	0	Across river from Hwy 12 and mostly screened from river, lessening dust observation from the public.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	High potential for cultural resources because of pipeline location near river.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Low	2	Visual scape changes more noticed in route with new land clearing near river. No residences/businesses in area.
	O	Noise	0.4	Negligible	0	Across river from Hwy 12. No residences/businesses in area. River masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement is required for pipeline installation.
	W	Access Constraints	2.2	Medium	9	Access to the site is fair from existing roads. Access adjacent to the work is fair.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	47	Segment ID ->	2F-2I	Type->	Pipeline	Location:
		Length (ft)->	992	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues.
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Negligible	0	This segemnt is located above the water table in the river. Groundwater is not expected to be a significant issue.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Low	3	Mild side slopes. Some space available to stage equipment and store materials adjacent to the work.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Negligible	0	Work schedule is flexible. No constraints.
	HH	Unique Construction Methods	2.8	Negligible	0	Open-cut pipeline requires no special construction techniques.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from maintenance road above pipe.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability issues or long-term O&M requirements.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Minimal drainage crossing O&M expected in this area for a buried pipeline
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	River alignment provides opportunity to generate hydropower
		Sum of Scores	100.0		**184**	

Segment Evaluation

	48	Segment ID ->	2I-2J	Type->	River Tunnel	Location:
		Length (ft)->	258	Baseline Cost ($/100-ft) ->	$1,000,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	River crossing. Tunnelling under the river eases permitting compared to utility bridges or excavating/filling a trench.
	B	Migratory Fish and Wildlife	1.7	Medium	7	Construction delayed if work exceeds fish work window (likely June 1 to Oct 31); less risk w/tunnel versus trenching.
	C	Migratory Birds/Raptors	1.9	Low	4	Bald Eagle nests may need protection (Dec-July) during construction but none currently known. No Golden Eagles.
	D	Riparian Habitat	1.8	High	11	Riparian areas need protection.
	E	Wetlands	2.1	High	12	Wetlands may be present.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has areas within the 200-foot shorelines protection zone.
	G	Land Use	0.6	Medium	3	Need new ROW and DNR permit. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Crossing river and stockpiling materials may cause erosion.
	I	Water Quality	1.1	High	6	Crossing in river where frac-out and spills are potential hazard.
	J	Air Quality	0.2	Medium	1	Next to Hwy 12 where dust from construction may be noticed.
	K	Hazardous Materials	1.6	Low	3	No nearby human activity. Not far from Hwy 12 but potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	High	14	Tunnelling under river and working on riverbanks has high potential for cultural resources discovery.
	M	Historic Resources	0.9	Negligible	0	No historical features at river crossing.
	N	Aesthetics	1.1	Negligible	0	New tunnel will not be noticeable - has least impact on visual resources.
	O	Noise	0.4	Medium	2	Construction noises may be heard because of proximity to Hwy 12. No residences/businesses in area.
	P	Transportation/Traffic	0.5	Medium	2	Access to tunnel construction off of Hwy 12, could impact traffic flow.
	Q	Recreation Impacts	1.4	Low	3	No recreational parks/wildlife refuges assumed. Could impact informal recreational use on river.
	R	Emergency Response	0.6	Medium	3	No additional emergency response public services needed. May impact emergency response time with traffic delays.
	S	Service Impacts	0.4	Medium	2	No need for add'l public services (cable, phone, electric, water). Could be disrupted if located in construction access.
	T	Socio/Economic Impacts	1.5	Medium	6	Socio-economic impacts possible if access to construction site causes delay in deliveries, transport, and services.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement is required for pipeline installation across Tieton River.
	W	Access Constraints	2.2	Low	4	Access from Hwy 12 is good.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	48	Segment ID ->	2I-2J	Type->	River Tunnel	Location:
		Length (ft)->	258	Baseline Cost ($/100-ft) ->	$1,000,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	New tunnel under river. Tunnel stability with high groundwater is a significant risk.
	BB	Subsurface Conditions	2.4	Medium	10	Subsurface tunnel conditions are unknown, but site is accessible for geotechnical testing during the pre-design phase.
	CC	Groundwater	0.9	High	6	There is a high likelihood of encountering groundwater when tunneling below the river.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Low	3	Mild side slopes. Some space available to stage equipment and store materials adjacent to the tunnel shaft.
	FF	Equipment and Materials	0.6	High	3	Special equipment and materials may be required for tunnel construction.
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Tunnelling work would be scheduled to avoid fish runs, but is otherwise flexible.
	HH	Unique Construction Methods	2.8	Medium	11	Tunnel work is a proven technology, but tunnel shafts and subsurface conditions require special construction techniques.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Medium	10	New tunneling requires work in deep shafts and confined spaces.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, and general condition of tunnel is not possible without shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability or rockfall issues.
	MM	Erosion/Scour Maintenance	5.2	Low	10	Tunnel under the river would be at sufficient depth to avoid erosion. Minimal long-term maintenance required.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Negligible	0	Access is good from Hwy 12. Long-term O&M for access would be negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Medium	13	Tunnel under the river requires mechanical air valves and blowoff for evacuating air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Medium	31	Tunnel under the river requires pumped dewatering. Difficult inside access and mobility. Potential trap for rock and debris.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	River alignment provides opportunity to generate hydropower
		Sum of Scores	100.0		**263**	

Segment Evaluation

	49	Segment ID ->	2J-2K	Type->	Pipeline	Location:
		Length (ft)->	4,487	Baseline Cost ($/100-ft) ->	$225,000	Pressure pipe alignment along Hwy 12 near private residence
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	Route follows river where ESA fish species need protection.
	B	Migratory Fish and Wildlife	1.7	Low	3	No in river work. Construction corridor is close to river only at end coordinates. Poor habitat. Bears in spring, summer and fall.
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	High	11	Within riparian area (100 feet of river) at each end of segment.
	E	Wetlands	2.1	Low	4	Wetlands unlikely adjacent to Hwy 12.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has areas within the 200-foot shorelines protection zone.
	G	Land Use	0.6	Medium	3	Need new ROW and road crossing permit. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Low	2	Next to Hwy 12. Near river. Slopes are minor, stretch nearly flat.
	I	Water Quality	1.1	Medium	4	Certain areas near river where frac-out and spills are more of a hazard.
	J	Air Quality	0.2	High	1	Crosses Hwy 12 and adjacent to highway where construction dust may be noticed by the public. Near residences/access.
	K	Hazardous Materials	1.6	Medium	6	Crosses Hwy 12 and near highway where spills may have created potential hazardous materials sites. Near residences/access.
	L	Cultural Resources	2.3	Low	5	Pipeline excavation is near river but mostly in or near Hwy 12 ROW, a previously disturbed area.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed. Known structures in area.
	N	Aesthetics	1.1	High	6	Visual scape changes likely noticed adjacent to Hwy 12 ROW and from local residences.
	O	Noise	0.4	High	3	Construction noises may be heard because of proximity to Hwy 12. There are residences in area.
	P	Transportation/Traffic	0.5	Medium	2	Along Hwy 12 where traffic may be delayed or impacted during construction.
	Q	Recreation Impacts	1.4	Medium	6	Recreational homes and informal recreational access to the river may be along this segment.
	R	Emergency Response	0.6	Medium	3	No additional emergency response services needed. May impact emergency response time to local residences with traffic delays.
	S	Service Impacts	0.4	Medium	2	No need for add'l public services (cable, phone, electric, water). Services to locals could be disrupted if disturbed.
	T	Socio/Economic Impacts	1.5	Medium	6	Socio-economic impacts possible if construction site causes delay in deliveries, transport, and services or acess to residences.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	High	7	New permanent easement is required from the State of Washington adjacent to Hwy 12
	W	Access Constraints	2.2	Negligible	0	Access from Hwy 12 is good and access adjacent to the work is probably available.
	X	Landowner Conflicts	0.7	Medium	3	Moderate potential for conflicts with the State (Hwy 12) and a nearby private landowner.
	Y	Utility Conflicts	0.4	High	2	High potential for conflict with existing fiber optics cables under Hyw 12.
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	49	Segment ID ->	2J-2K	Type->	Pipeline	Location:
		Length (ft)->	4,487	Baseline Cost ($/100-ft) ->	$225,000	Pressure pipe alignment along Hwy 12 near private residence
		Risk Criterion	**Risk Importance Factor**	**Risk Level**	**Risk Score**	**Risk Level Comments**
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Negligible	0	This segemnt is located above the water table in the river. Groundwater is not expected to be a significant issue.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Low	3	Hwy 12 corridor. Some space available to stage equipment and store materials.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Work along Hwy 12 would be scheduled during the summer to reduce traffic impacts/risks.
	HH	Unique Construction Methods	2.8	Negligible	0	Open-cut pipeline requires no special construction techniques.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Medium	10	Work along Hwy 12 creates potential for worker and public safety due to traffic on the road.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from Hwy 12.
	LL	Slope Stability Maintenance	5.2	Negligible	0	Buried pipeline along Hwy 12 would have negligible slope stability issues.
	MM	Erosion/Scour Maintenance	5.2	Low	10	Buried pipeline along Hwy 12 would have minimal erosion/scour issues.
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Negligible	0	Access is good from Hwy 12. Long-term O&M for access would be negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	River alignment provides opportunity to generate hydropower
		Sum of Scores	100.0		**193**	

Segment Evaluation

	50	Segment ID ->	2K-2L	Type->	River Tunnel	Location:
		Length (ft)->	432	Baseline Cost ($/100-ft) ->	$1,000,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Medium	9	River crossing. Tunnelling under the river eases permitting compared to utility bridges or excavating/filling a trench.
	B	Migratory Fish and Wildlife	1.7	Medium	7	Construction delayed if work exceeds fish work window (likely June 1 to Oct 31); less risk w/tunnel versus trenching.
	C	Migratory Birds/Raptors	1.9	Medium	8	Must protect Bald Eagle nests (Dec-July) during construction (none currently known). No Golden Eagles but near cliffs.
	D	Riparian Habitat	1.8	High	11	Riparian areas need protection.
	E	Wetlands	2.1	High	12	Wetlands may be present.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Has areas within the 200-foot shorelines protection zone.
	G	Land Use	0.6	Medium	3	Need new ROW and DNR permit. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Crossing river and stockpiling materials may cause erosion.
	I	Water Quality	1.1	High	6	Crossing in river where frac-out and spills are potential hazard.
	J	Air Quality	0.2	Medium	1	Crosses Hwy 12 and adjacent to highway where construction dust may be noticed by the public. Not near residences.
	K	Hazardous Materials	1.6	Medium	6	Crosses Hwy 12 and near highway where spills may have created potential hazardous materials sites. Not near residences.
	L	Cultural Resources	2.3	High	14	Tunnelling under river and working on riverbanks has high potential for cultural resources discovery.
	M	Historic Resources	0.9	Negligible	0	No historical features at river crossing.
	N	Aesthetics	1.1	Negligible	0	New tunnel will not be noticeable - has least impact on visual resources.
	O	Noise	0.4	Medium	2	Construction noises may be heard because of proximity to Hwy 12. There are no residences in area.
	P	Transportation/Traffic	0.5	High	3	Crosses Hwy 12 where traffic may be delayed or impacted during construction.
	Q	Recreation Impacts	1.4	Medium	6	No recreational parks/wildlife refuges assumed. Traffic delays could impede access to nearby recreational areas.
	R	Emergency Response	0.6	Medium	3	No additional emergency response services needed. May impact emergency response time with traffic delays.
	S	Service Impacts	0.4	Medium	2	No need for add'l public services (cable, phone, electric, water). Services could be disrupted if disturbed during Hwy crossing.
	T	Socio/Economic Impacts	1.5	Medium	6	Socio-economic impacts possible if construction site causes delay in deliveries, transport, and services..
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement is required to cross the Tieton River. Current landowner is unknown.
	W	Access Constraints	2.2	Low	4	Access from Hwy 12 is good.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	50	Segment ID ->	2K-2L	Type->	River Tunnel	Location:
		Length (ft)->	432	Baseline Cost ($/100-ft) ->	$1,000,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	New tunnel under river. Tunnel stability with high groundwater is a significant risk.
	BB	Subsurface Conditions	2.4	Medium	10	Subsurface tunnel conditions are unknown, but site is accessible for geotechnical testing during the pre-design phase.
	CC	Groundwater	0.9	High	6	There is a high likelihood of encountering groundwater when tunneling below the river.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Low	3	Some space available to stage equipment and store materials adjacent to the tunnel shaft.
	FF	Equipment and Materials	0.6	High	3	Special equipment and materials may be required for tunnel construction.
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Tunnelling work would be scheduled to avoid fish runs, but is otherwise flexible.
	HH	Unique Construction Methods	2.8	Medium	11	Tunnel work is a proven technology, but tunnel shafts and subsurface conditions require special construction techniques.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Medium	10	New tunneling requires work in deep shafts and confined spaces.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, and general condition of tunnel is not possible without shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability or rockfall issues.
	MM	Erosion/Scour Maintenance	5.2	Low	10	Tunnel under the river would be at sufficient depth to avoid erosion. Minimal long-term maintenance required.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Negligible	0	Access is good from Hwy 12. Long-term O&M for access would be negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Medium	13	Tunnel under the river requires mechanical air valves and blowoff for evacuating air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Medium	31	Tunnel under the river requires pumped dewatering. Difficult inside access and mobility. Potential trap for rock and debris.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	River alignment provides opportunity to generate hydropower
		Sum of Scores	100.0		**274**	

Segment Evaluation

	51	Segment ID ->	2L-2M	Type->	Pipeline	Location:
		Length (ft)->	2,290	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Low	4	Route near but above river where ESA fish species need to be protected. Bears possible in spring, summer, fall.
	B	Migratory Fish and Wildlife	1.7	Low	3	No in river work and construction corridor farther from river than some segments. Nearest to river near Coordinate 2L.
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	Low	4	Areas outside 100 foot protected riparian zone but elevation of areas is likely to be in floodplain.
	E	Wetlands	2.1	Low	4	Near the river only at Coordinate 2L. Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	High	8	Within 200-foot shorelines protection zone at coordinate 2L.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Medium	4	Near river. Slopes are minor but rocks require deep excavation.
	I	Water Quality	1.1	Low	2	Near river only at Coordinate 2L, where frac-out and spills are more of a hazard.
	J	Air Quality	0.2	Negligible	0	Farther and elevated from Hwy 12 where dust from construction is less likely to be noticed.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Medium	9	Pipeline excavation is near river.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Medium	4	Visual scape changes more noticed in route with new land clearing on slopes visible from Hwy 12. May not be visible.
	O	Noise	0.4	Negligible	0	Not near Hwy 12. No residences/businesses in area. River masks noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement is required for pipeline installation. Current landowner is unknown.
	W	Access Constraints	2.2	Medium	9	Alignment is x-country on virgin terrain. Access is currently poor but new access roads could be constructed.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Construction could be performed in the summer.

Segment Evaluation

	51	Segment ID ->	2L-2M	Type->	Pipeline	Location:
		Length (ft)->	2,290	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Medium	4	This segment is located in the floodplain. Some groundwater may be encountered during construction.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities.
	EE	Work Space Constraints	1.5	Low	3	Mild side slopes. Some space available to stage equipment and store materials adjacent to the canal/pipe.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Negligible	0	No sequencing or schedule constraints.
	HH	Unique Construction Methods	2.8	Negligible	0	Open-cut pipeline requires no special construction techniques.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from maintenance road above pipe.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability issues or long-term O&M requirements.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Minimal drainage crossing O&M expected in this area for a buried pipeline
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	River alignment provides opportunity to generate hydropower
		Sum of Scores	100.0		**164**	

Segment Evaluation

	52	Segment ID ->	2G-1T	Type->	Pipeline	Location:
		Length (ft)->	1,825	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Low	4	Route avoids river where ESA fish species need to be protected. Bears possible in spring, summer and fall.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work and construction corridor farther from river than some segments.
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shorelines protection zone.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep slopes. High erosion potential.
	I	Water Quality	1.1	Negligible	0	Further from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Farther from Hwy 12 where dust from construction is less likely to be noticed. Above river.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Pipeline excavation is further from river where cultural resources discovery lessens.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	High	6	Visual scape changes more noticed in route with new land clearing on steep slopes visible from Hwy 12.
	O	Noise	0.4	Negligible	0	Away from Hwy 12. No residences/businesses in area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12. No residences/businesses in area.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement is required for pipe installation. Current landowner is unknown.
	W	Access Constraints	2.2	Medium	9	Access to the site is relatively good from existing roads, but slopes are steep.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Low	3	Most of the work could be performed in the summer except for connection to existing canal.

Segment Evaluation

	52	Segment ID ->	2G-1T	Type->	Pipeline	Location:
		Length (ft)->	1,825	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	**Risk Importance Factor**	**Risk Level**	**Risk Score**	**Risk Level Comments**
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Negligible	0	This segemnt is located above the water table in the river. Groundwater is not expected to be a significant issue.
	DD	Connections to Existing Facilities	1.9	Low	4	End of pipeline connects to existing YTID canal.
	EE	Work Space Constraints	1.5	Medium	6	Steep slopes. Limited space available to stage equipment and store materials adjacent to the canal/pipe.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Work schedule is flexible. Connection to existing canal occurs in the winter.
	HH	Unique Construction Methods	2.8	Negligible	0	Open-cut pipeline requires no special construction techniques.
	II	YTID Service Interruptions	3.0	Low	6	Connection to existing YTID canal creates potential for service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from maintenance road above pipe.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability issues or long-term O&M requirements.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Minimal drainage crossing O&M expected in this area for a buried pipeline
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Low	8	Some lost opportunity for power production
		Sum of Scores	100.0		**167**	

Segment Evaluation

	53	Segment ID ->	1U-2H	Type->	Pipeline	Location:
		Length (ft)->	671	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Low	4	Route avoids river where ESA fish species need to be protected. Bears possible in spring, summer and fall.
	B	Migratory Fish and Wildlife	1.7	Medium	7	No in river work and construction corridor farther from river than some segments.
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shorelines protection zone.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	Low	2	Some slope. Deep excavation. Away from river.
	I	Water Quality	1.1	Negligible	0	Further from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Farther from Hwy 12 where dust from construction is less likely to be noticed. Above river.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Pipeline excavation is further from river where cultural resources discovery lessens.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	High	6	Visual scape changes more noticed in route with new land clearing on steep slopes visible from Hwy 12.
	O	Noise	0.4	Negligible	0	Away from Hwy 12. No residences/businesses in area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement is required for pipe installation. Current landowner is unknown.
	W	Access Constraints	2.2	Medium	9	Access to the site from existing roads is fair. Access adjacent to the work would require a new access road.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Low	3	Most of the work could be performed in the summer except for connection to existing canal.

Segment Evaluation

	53	Segment ID ->	1U-2H	Type->	Pipeline	Location:
		Length (ft)->	671	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	Negligible	0	No known slope stability issues
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Negligible	0	This segemnt is located above the water table in the river. Groundwater is not expected to be a significant issue.
	DD	Connections to Existing Facilities	1.9	Low	4	End of pipeline connects to existing YTID canal.
	EE	Work Space Constraints	1.5	Low	3	Mild side slopes. Some space available to stage equipment and store materials adjacent to the canal/pipe.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Work schedule is flexible. Connection to existing canal occurs in the winter.
	HH	Unique Construction Methods	2.8	Negligible	0	Open-cut pipeline requires no special construction techniques.
	II	YTID Service Interruptions	3.0	Low	6	Connection to existing YTID canal creates potential for service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Low	5	All construction work has risks, but unconfined work is lower risk than confined work (tunneling).
Operations and Maintenance	KK	Routine Visual Observation	6.5	Low	13	Visual observation of leakage, settlement, erosion, and general condition may be possible from maintenance road above pipe.
	LL	Slope Stability Maintenance	5.2	Negligible	0	No known slope stability issues or long-term O&M requirements.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Minimal drainage crossing O&M expected in this area for a buried pipeline
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	No lost opportunity for power production
		Sum of Scores	100.0		**159**	

Segment Evaluation

	54	Segment ID ->	2R-1Y	Type->	Pipeline	Location:
		Length (ft)->	715	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Low	4	Away from the river. Bears possible in spring, summer, fall.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	No in river work and construction above and further from river than some segments.
	C	Migratory Birds/Raptors	1.9	Low	4	Forrested land near river where nests may occur. Approved land clearing could be done prior to construction.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	Wetlands unlikely.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shorelines protection zone.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Steep slopes. Deep excavation. Away from river.
	I	Water Quality	1.1	Negligible	0	Further from river where frac-out and spills are less of a hazard.
	J	Air Quality	0.2	Negligible	0	Farther from Hwy 12 where dust from construction is less likely to be noticed. Above river.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Pipeline excavation is further from river where cultural resources discovery lessens.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	High	6	Visual scape changes more noticed in route with new land clearing on steep slopes visible from Hwy 12.
	O	Noise	0.4	Negligible	0	Away from Hwy 12. No residences/businesses in area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New permanent easement is required for pipe installation. Current landowner is unknown.
	W	Access Constraints	2.2	High	13	Access to the site is poor and the alignment is very steep.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Low	3	Most of the work could be performed in the summer except for connection to existing canal.

Segment Evaluation

	54	Segment ID ->	2R-1Y	Type->	Pipeline	Location:
		Length (ft)->	715	Baseline Cost ($/100-ft) ->	$225,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	Steep slope. High risk of rockfall and trench instability
	BB	Subsurface Conditions	2.4	High	14	Deep pipeline excavation. High potential for rock and bolders that will slow construction and increase costs.
	CC	Groundwater	0.9	Medium	4	Steep slope will create potential for water movement along the pipe.
	DD	Connections to Existing Facilities	1.9	Low	4	Ends of tunnel connect to existing YTID canal.
	EE	Work Space Constraints	1.5	High	9	Extremely steep. No space adjacent to the work for staging and storing equipment and materials.
	FF	Equipment and Materials	0.6	Negligible	0	No specialized equipment or materials is required for construction.
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Work schedule is flexible. Connection to existing canal occurs in the winter.
	HH	Unique Construction Methods	2.8	High	17	Very steep alignment will require special equipment trenching equipment and rock-fall prevention methods.
	II	YTID Service Interruptions	3.0	Low	6	Connection to existing YTID canal creates potential for service interruptions.
	JJ	Public Safety/Worker Safety	2.4	High	14	Very steep alignment creates risk to workers from falling rock or overturned equipment.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, and general condition of tunnel is not possible by vehicle. Steep slopes.
	LL	Slope Stability Maintenance	5.2	Low	10	Steep slope will create potential for rockfall and associated O&M costs.
	MM	Erosion/Scour Maintenance	5.2	Low	10	Some routine inpection and O&M required for drainage and erosion control.
	NN	Corrosion Maintenance	1.9	Low	4	Pipeline might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Pipeline has high and low points with mechanical drain and air valves. Startup, shutdown slightly more complex than RC box.
	QQ	Mechanical Maintenance	3.2	Low	6	Pipeline construction requires mechanical air valves and blowoffs to evacuate air and water. Frost protection may be required.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Pipeline may require pumped dewatering for inspection and repair. Interior access and mobility is not favorable. Slipery.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	No lost opportunity for power production
		Sum of Scores	100.0		**239**	

Segment Evaluation

	55	Segment ID ->	3B-3C	Type->	New Tunnel	Location:
		Length (ft)->	2,844	Baseline Cost ($/100-ft) ->	$352,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Tunnel avoids impacts to ESA habitat and species.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	Tunnel avoids impacts to migratory fish and wildlife. Work can occur outside of the approved fish work window.
	C	Migratory Birds/Raptors	1.9	Negligible	0	Tunnel avoids forrests, and trees/nests are not disturbed.
	D	Riparian Habitat	1.8	Low	4	May be on the border of riparian habitat (close to 100 feet from river) with coordinate 3B.
	E	Wetlands	2.1	Negligible	0	No wetlands.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shorelines area except for 3B coordinate area.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Access to tunnel site and stockpiling excavated materials may cause erosion. Near but above river.
	I	Water Quality	1.1	Low	2	Near river where frac-out and spills are more of a hazard.
	J	Air Quality	0.2	Low	0	Across river from Hwy 12 and RimRock Retreat but most dust stays within tunnel.
	K	Hazardous Materials	1.6	Negligible	0	Residences/business across the river. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Less likely to discover cultural resources when drilling a new tunnel except for initial shallow excavations.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Negligible	0	New tunnel will not be noticeable - has least impact on visual resources.
	O	Noise	0.4	Negligible	0	Construction noises not likely heard by the public on Hwy 12 and at Rimrock Retreat because of adjacent river generated noise.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New easement is required for tunnel construction. Current landowner is unknown.
	W	Access Constraints	2.2	Medium	9	Access to the site from existing roads is good. Access inside the tunnel is poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Medium	6	Most of the work could be performed in the summer except for connection to existing canal.

Segment Evaluation

	55	Segment ID ->	3B-3C	Type->	New Tunnel	Location:
		Length (ft)->	2,844	Baseline Cost ($/100-ft) ->	$352,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	New tunnel. Geology is highly variable. Tunnel stability is a significant concern.
	BB	Subsurface Conditions	2.4	High	14	Subsurface tunnel conditions are unknown, and site is very difficult to access for geotechnical testing during pre-design.
	CC	Groundwater	0.9	High	6	The proposed tunnel is located above the river, but the risk of encountering and managing water in a tunnel is significant.
	DD	Connections to Existing Facilities	1.9	Low	4	Ends of tunnel connect to existing YTID canal.
	EE	Work Space Constraints	1.5	High	9	No work space inside the tunnel. Limited staging and storage areas at tunnel entrance and exit.
	FF	Equipment and Materials	0.6	High	3	Specialized tunnel boring equipment is required
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Tunnel schedule is flexible. Connections to existing canal occur in the winter.
	HH	Unique Construction Methods	2.8	Medium	11	New tunnel involves proven technology, but tunnel portals and subsurface conditions may require special construction methods.
	II	YTID Service Interruptions	3.0	Low	6	Connection to existing YTID canal creates potential for service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Medium	10	New tunneling requires work in deep shafts and confined spaces.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, and general condition of tunnel is not possible without shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Negligible	0	Minimal long-term slope stability maintenance required for a new tunnel.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Minimal long-term slope erosion control maintenance required for a new tunnel.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Negligible	0	Access to the tunnel portals is good. Long-term O&M cost for access is negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Startup and shutdown of gravity tunnels would be similar to the existing canal.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Gravity tunnel construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Easy dewatering for inspection and maintenance. Interior access and mobility is constrained. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	No lost opportunity for power production
		Sum of Scores	100.0		**174**	

Segment Evaluation

	56	Segment ID ->	3E-3F	Type->	New Tunnel	Location:
		Length (ft)->	644	Baseline Cost ($/100-ft) ->	$352,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Tunnel avoids impacts to ESA habitat and species.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	Tunnel avoids impacts to migratory fish and wildlife. Work can occur outside of the approved fish work window.
	C	Migratory Birds/Raptors	1.9	Negligible	0	Tunnel avoids forrests, and trees/nests are not disturbed.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	No wetlands.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shorelines area except for 3F coordinate area. Above floodplain.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Access to tunnel site and stockpiling excavated materials may cause erosion. Near but above river.
	I	Water Quality	1.1	Low	2	Further from river where frac-out and spills are less hazardous.
	J	Air Quality	0.2	Low	0	Across river from Hwy 12 but most dust stays within tunnel.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Less likely to discover cultural resources when drilling a new tunnel except for initial shallow excavations.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Negligible	0	New tunnel will not be noticeable - has least impact on visual resources.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New easement is required for tunnel construction. Current landowner is unknown.
	W	Access Constraints	2.2	Medium	9	Access to the site from existing roads is good. Access inside the tunnel is poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Medium	6	Most of the work could be performed in the summer except for connection to existing canal.

Segment Evaluation

	56	Segment ID ->	3E-3F	Type->	New Tunnel	Location:
		Length (ft)->	644	Baseline Cost ($/100-ft) ->	$352,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	New tunnel. Geology is highly variable. Tunnel stability is a significant concern.
	BB	Subsurface Conditions	2.4	High	14	Subsurface tunnel conditions are unknown, and site is very difficult to access for geotechnical testing during pre-design.
	CC	Groundwater	0.9	High	6	The proposed tunnel is located above the river, but the risk of encountering and managing water in a tunnel is significant.
	DD	Connections to Existing Facilities	1.9	Low	4	Ends of tunnel connect to existing YTID canal.
	EE	Work Space Constraints	1.5	High	9	No work space inside the tunnel. Limited staging and storage areas at tunnel entrance and exit.
	FF	Equipment and Materials	0.6	High	3	Specialized tunnel boring equipment is required
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Tunnel schedule is flexible. Connections to existing canal occur in the winter.
	HH	Unique Construction Methods	2.8	Medium	11	New tunnel involves proven technology, but tunnel portals and subsurface conditions may require special construction methods.
	II	YTID Service Interruptions	3.0	Low	6	Connection to existing YTID canal creates potential for service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Medium	10	New tunneling requires work in deep shafts and confined spaces.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, and general condition of tunnel is not possible without shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Negligible	0	Minimal long-term slope stability maintenance required for a new tunnel.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Minimal long-term slope erosion control maintenance required for a new tunnel.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Negligible	0	Access to the tunnel portals is good. Long-term O&M cost for access is negligible.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Startup and shutdown of gravity tunnels would be similar to the existing canal.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Gravity tunnel construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Easy dewatering for inspection and maintenance. Interior access and mobility is constrained. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	No lost opportunity for power production
		Sum of Scores	100.0		**170**	

Segment Evaluation

	57	Segment ID ->	3H-3K	Type->	New Tunnel	Location:
		Length (ft)->	2,529	Baseline Cost ($/100-ft) ->	$352,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Tunnel avoids impacts to ESA habitat and species.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	Tunnel avoids impacts to migratory fish and wildlife. Work can occur outside of the approved fish work window.
	C	Migratory Birds/Raptors	1.9	Negligible	0	Tunnel avoids forrests, and trees/nests are not disturbed.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	No wetlands.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shorelines area and outside of floodplain.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Access to tunnel site and stockpiling excavated materials may cause erosion. Above river.
	I	Water Quality	1.1	Negligible	0	Far from river where frac-out and spills are not as hazardous.
	J	Air Quality	0.2	Low	0	Across river from Hwy 12 but most dust stays within tunnel.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Less likely to discover cultural resources when drilling a new tunnel except for initial shallow excavations.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Negligible	0	New tunnel will not be noticeable - has least impact on visual resources.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New easement is required for tunnel construction. Current landowner is unknown.
	W	Access Constraints	2.2	High	13	Access to the tunnel portals is moderate to poor. Access inside the tunnel is poor
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Medium	6	Most of the work could be performed in the summer except for connection to existing canal.

Segment Evaluation

	57	Segment ID ->	3H-3K	Type->	New Tunnel	Location:
		Length (ft)->	2,529	Baseline Cost ($/100-ft) ->	$352,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	New tunnel. Geology is highly variable. Tunnel stability is a significant concern.
	BB	Subsurface Conditions	2.4	High	14	Subsurface tunnel conditions are unknown, and site is very difficult to access for geotechnical testing during pre-design.
	CC	Groundwater	0.9	High	6	The proposed tunnel is located above the river, but the risk of encountering and managing water in a tunnel is significant.
	DD	Connections to Existing Facilities	1.9	Low	4	Ends of tunnel connect to existing YTID canal.
	EE	Work Space Constraints	1.5	High	9	No work space inside the tunnel. Limited staging and storage areas at tunnel entrance and exit.
	FF	Equipment and Materials	0.6	High	3	Specialized tunnel boring equipment is required
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Tunnel schedule is flexible. Connections to existing canal occur in the winter.
	HH	Unique Construction Methods	2.8	Medium	11	New tunnel involves proven technology, but tunnel portals and subsurface conditions may require special construction methods.
	II	YTID Service Interruptions	3.0	Low	6	Connection to existing YTID canal creates potential for service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Medium	10	New tunneling requires work in deep shafts and confined spaces.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, and general condition of tunnel is not possible without shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Negligible	0	Minimal long-term slope stability maintenance required for a new tunnel.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Minimal long-term slope erosion control maintenance required for a new tunnel.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Long-term access to the tunnel portals would be fair, but would depend on how other project segments are constructed.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Startup and shutdown of gravity tunnels would be similar to the existing canal.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Gravity tunnel construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Easy dewatering for inspection and maintenance. Interior access and mobility is constrained. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Low	8	Some lost opportunity for power production at this location. River alignments offer potential to generate power.
		Sum of Scores	100.0		**203**	

Segment Evaluation

	58	Segment ID ->	3N-3O	Type->	New Tunnel	Location:
		Length (ft)->	3,277	Baseline Cost ($/100-ft) ->	$352,000	New tunnel parallel to existing Windy Pt. Tunnel
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Tunnel avoids impacts to ESA habitat and species.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	Tunnel avoids impacts to migratory fish and wildlife. Work can occur outside of the approved fish work window.
	C	Migratory Birds/Raptors	1.9	Negligible	0	Tunnel avoids forrests, and trees/nests are not disturbed.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	No wetlands.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shorelines area and outside of floodplain.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Access to tunnel site and stockpiling excavated materials may cause erosion.
	I	Water Quality	1.1	Negligible	0	Far from river where frac-out and spills are not as hazardous.
	J	Air Quality	0.2	Low	0	Across river from Hwy 12 but most dust stays within tunnel.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Less likely to discover cultural resources when drilling a new tunnel except for initial shallow excavations.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Negligible	0	New tunnel will not be noticeable - has least impact on visual resources.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away frm Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Low	2	New easement may be required for tunnel construction. Current landowner is unknown.
	W	Access Constraints	2.2	Medium	9	Access to the tunnel portals is fair. Access inside the tunnel is poor
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Low	3	Most of the work could be performed in the summer except for connection to existing canal.

Segment Evaluation

	58	Segment ID ->	3N-3O	Type->	New Tunnel	Location:
		Length (ft)->	3,277	Baseline Cost ($/100-ft) ->	$352,000	New tunnel parallel to existing Windy Pt. Tunnel
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	New tunnel. Geology is highly variable. Tunnel stability is a significant concern.
	BB	Subsurface Conditions	2.4	High	14	Subsurface tunnel conditions are unknown, and site is very difficult to access for geotechnical testing during pre-design.
	CC	Groundwater	0.9	Medium	4	The proposed tunnel is located above the river, but the risk of encountering and managing water in a tunnel is significant.
	DD	Connections to Existing Facilities	1.9	Medium	7	Ends of tunnel connect to existing YTID canal.
	EE	Work Space Constraints	1.5	High	9	No work space inside the tunnel. Limited staging and storage areas at tunnel entrance and exit.
	FF	Equipment and Materials	0.6	High	3	Specialized tunnel boring equipment is required
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Tunnel schedule is flexible. Connections to existing canal occur in the winter.
	HH	Unique Construction Methods	2.8	Medium	11	New tunnel involves proven technology, but tunnel portals and subsurface conditions may require special construction methods.
	II	YTID Service Interruptions	3.0	Low	6	Connection to existing YTID canal creates potential for service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Medium	10	New tunneling requires work in deep shafts and confined spaces.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, and general condition of tunnel is not possible without shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Negligible	0	Minimal long-term slope stability maintenance required for a new tunnel.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Minimal long-term slope erosion control maintenance required for a new tunnel.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Long-term access to the tunnel portals would be fair, but would depend on how other project segments are constructed.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Startup and shutdown of gravity tunnels would be similar to the existing canal.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Gravity tunnel construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Easy dewatering for inspection and maintenance. Interior access is confined space. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Low	8	Some lost opportunity for power production at this location. River alignments offer potential to generate power.
		Sum of Scores	100.0		**196**	

Segment Evaluation

	59	Segment ID ->	3R-3S	Type->	New Tunnel	Location:
		Length (ft)->	2,680	Baseline Cost ($/100-ft) ->	$352,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Tunnel avoids impacts to ESA habitat and species.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	Tunnel avoids impacts to migratory fish and wildlife. Work can occur outside of the approved fish work window.
	C	Migratory Birds/Raptors	1.9	Negligible	0	Tunnel avoids forrests, and trees/nests are not disturbed.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	No wetlands.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shorelines area and outside of floodplain.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Access to tunnel site and stockpiling excavated materials may cause erosion. Above river.
	I	Water Quality	1.1	Negligible	0	Far from river where frac-out and spills are not as hazardous.
	J	Air Quality	0.2	Negligible	0	Far from Hwy 12 where dust from construction is not likely to be noticed. Most dust stays within tunnel.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Less likely to discover cultural resources when drilling a new tunnel except for initial shallow excavations.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Negligible	0	New tunnel will not be noticeable - has least impact on visual resources.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New easement is required for tunnel construction. Current landowner is unknown.
	W	Access Constraints	2.2	High	13	Access to the tunnel portals from existing roads is poor. Access inside the tunnel is poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Medium	6	Most of the work could be performed in the summer except for connection to existing canal.

Segment Evaluation

	59	Segment ID ->	3R-3S	Type->	New Tunnel	Location:
		Length (ft)->	2,680	Baseline Cost ($/100-ft) ->	$352,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	New tunnel. Geology is highly variable. Tunnel stability is a significant concern.
	BB	Subsurface Conditions	2.4	High	14	Subsurface tunnel conditions are unknown, and site is very difficult to access for geotechnical testing during pre-design.
	CC	Groundwater	0.9	High	6	The proposed tunnel is located above the river, but the risk of encountering and managing water in a tunnel is significant.
	DD	Connections to Existing Facilities	1.9	Low	4	Ends of tunnel connect to existing YTID canal.
	EE	Work Space Constraints	1.5	High	9	No work space inside the tunnel. Limited staging and storage areas at tunnel entrance and exit.
	FF	Equipment and Materials	0.6	High	3	Specialized tunnel boring equipment is required
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Tunnel schedule is flexible. Connections to existing canal occur in the winter.
	HH	Unique Construction Methods	2.8	Medium	11	New tunnel involves proven technology, but tunnel portals and subsurface conditions may require special construction methods.
	II	YTID Service Interruptions	3.0	Low	6	Connection to existing YTID canal creates potential for service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Medium	10	New tunneling requires work in deep shafts and confined spaces.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, and general condition of tunnel is not possible without shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Negligible	0	Minimal long-term slope stability maintenance required for a new tunnel.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Minimal long-term slope erosion control maintenance required for a new tunnel.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Startup and shutdown of gravity tunnels would be similar to the existing canal.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Gravity tunnel construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Easy dewatering for inspection and maintenance. Interior access and mobility is constrained. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Low	8	Some lost opportunity for power production at this location. River alignments offer potential to generate power.
		Sum of Scores	100.0		**203**	

Segment Evaluation

	60	Segment ID ->	3N-3Q	Type->	New Tunnel	Location:
		Length (ft)->	1,384	Baseline Cost ($/100-ft) ->	$352,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Tunnel avoids impacts to ESA habitat and species.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	Tunnel avoids impacts to migratory fish and wildlife. Work can occur outside of the approved fish work window.
	C	Migratory Birds/Raptors	1.9	Negligible	0	Tunnel avoids forrests, and trees/nests are not disturbed.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	No wetlands.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shorelines area and outside of floodplain.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Access to tunnel siteand stockpiling excavated materials may cause erosion. Above river.
	I	Water Quality	1.1	Negligible	0	Far from river where frac-out and spills are not as hazardous.
	J	Air Quality	0.2	Negligible	0	Far from Hwy 12 where dust from construction is not likely to be noticed. Most dust stays within tunnel.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Less likely to discover cultural resources when drilling a new tunnel except for initial shallow excavations.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Negligible	0	New tunnel will not be noticeable - has least impact on visual resources.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New easement is required for tunnel construction. Current landowner is unknown.
	W	Access Constraints	2.2	High	13	Access to the tunnel portals from existing roads is poor. Access inside the tunnel is poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Negligible	0	Work could be performed during the summer.

Segment Evaluation

	60	Segment ID ->	3N-3Q	Type->	New Tunnel	Location:
		Length (ft)->	1,384	Baseline Cost ($/100-ft) ->	$352,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	New tunnel. Geology is highly variable. Tunnel stability is a significant concern.
	BB	Subsurface Conditions	2.4	High	14	Subsurface tunnel conditions are unknown, and site is very difficult to access for geotechnical testing during pre-design.
	CC	Groundwater	0.9	High	6	The proposed tunnel is located above the river, but the risk of encountering and managing water in a tunnel is significant.
	DD	Connections to Existing Facilities	1.9	Negligible	0	No connections to existing YTID facilities
	EE	Work Space Constraints	1.5	Medium	6	No work space inside the tunnel. Limited staging and storage areas at tunnel entrance and exit.
	FF	Equipment and Materials	0.6	High	3	Specialized tunnel boring equipment is required
	GG	Sequencing/Schedule Constraints	2.2	Negligible	0	Work could be performed at any time. So schedule constraints.
	HH	Unique Construction Methods	2.8	Medium	11	New tunnel involves proven technology, but tunnel portals and subsurface conditions may require special construction methods.
	II	YTID Service Interruptions	3.0	Negligible	0	No potential for YTID service interruptions
	JJ	Public Safety/Worker Safety	2.4	Medium	10	New tunneling requires work in deep shafts and confined spaces.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, and general condition of tunnel is not possible without shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Negligible	0	Minimal long-term slope stability maintenance required for a new tunnel.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Minimal long-term slope erosion control maintenance required for a new tunnel.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Startup and shutdown of pressure tunnel would be slightly more complex than existing canal.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Pressure tunnel construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Easy dewatering for inspection and maintenance. Interior access and mobility is constrained. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Negligible	0	No lost opportunity for power production at this location.
		Sum of Scores	100.0		**172**	

Segment Evaluation

	61	Segment ID ->	3U-3Y	Type->	New Tunnel	Location:
		Length (ft)->	12,934	Baseline Cost ($/100-ft) ->	$352,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Permitting	A	State/Federal Endangered Species	2.2	Negligible	0	Tunnel avoids impacts to ESA habitat and species.
	B	Migratory Fish and Wildlife	1.7	Negligible	0	Tunnel avoids impacts to migratory fish and wildlife. Work can occur outside of the approved fish work window.
	C	Migratory Birds/Raptors	1.9	Negligible	0	Tunnel avoids forrests, and trees/nests are not disturbed.
	D	Riparian Habitat	1.8	Negligible	0	No riparian habitat.
	E	Wetlands	2.1	Negligible	0	No wetlands.
	F	Streambed/Shoreline Encroachment	1.3	Negligible	0	Beyond 200-foot shorelines area and outside of floodplain.
	G	Land Use	0.6	Medium	3	Need new ROW. No known parks/public recreation sites.
	H	Erosion/Vegetation Removal	1.1	High	6	Access to tunnel site and stockpiling excavated materials may cause erosion, steep hillsides. Above river.
	I	Water Quality	1.1	Negligible	0	Far from river where frac-out and spills are not as hazardous.
	J	Air Quality	0.2	Negligible	0	Far from Hwy 12 where dust from construction is not likely to be noticed. Most dust stays within tunnel.
	K	Hazardous Materials	1.6	Negligible	0	No nearby human activity. Potential hazardous materials sites are unlikely.
	L	Cultural Resources	2.3	Low	5	Less likely to discover cultural resources when drilling a new tunnel except for initial shallow excavations.
	M	Historic Resources	0.9	Negligible	0	No known historic resources to be preserved or displaced/removed.
	N	Aesthetics	1.1	Negligible	0	New tunnel will not be noticeable - has least impact on visual resources.
	O	Noise	0.4	Negligible	0	Construction/operational noises less likely heard because of distance from Hwy 12 and human activity area.
	P	Transportation/Traffic	0.5	Negligible	0	Away from Hwy 12.
	Q	Recreation Impacts	1.4	Negligible	0	No recreational parks/wildlife refuges assumed.
	R	Emergency Response	0.6	Negligible	0	No need for additional emergency response public services.
	S	Service Impacts	0.4	Negligible	0	No need for additional public services.
	T	Socio/Economic Impacts	1.5	Negligible	0	No socio-economic impacts.
	U	Energy Consumption	0.1	Negligible	0	All alternatives have similar energy usage as current canal system.
	V	Easement Acquisition	1.1	Medium	4	New easement is required for tunnel construction. Current landowner is unknown.
	W	Access Constraints	2.2	High	13	Access to the tunnel portals from existing roads is poor. Access inside the tunnel is poor.
	X	Landowner Conflicts	0.7	Negligible	0	No known private property or potential conflicts with adjacent landowners.
	Y	Utility Conflicts	0.4	Negligible	0	No known utility conflicts
	Z	Weather Conditions	1.5	Low	3	Most of the work could be performed in the summer except for connection to existing canal.

Segment Evaluation

	61	Segment ID ->	3U-3Y	Type->	New Tunnel	Location:
		Length (ft)->	12,934	Baseline Cost ($/100-ft) ->	$352,000	
		Risk Criterion	Risk Importance Factor	Risk Level	Risk Score	Risk Level Comments
Constructability	AA	Soil/Slope Stability	1.5	High	9	New tunnel. Geology is highly variable. Tunnel stability is a significant concern.
	BB	Subsurface Conditions	2.4	High	14	Very long tunnel. Subsurface tunnel conditions are unknown, and site is very difficult to access for geotechnical testing.
	CC	Groundwater	0.9	High	6	The proposed tunnel is located above the river, but the risk of encountering and managing water in a tunnel is significant.
	DD	Connections to Existing Facilities	1.9	Low	4	Ends of tunnel connect to existing YTID canal.
	EE	Work Space Constraints	1.5	High	9	No work space inside the tunnel. No staging and storage area at tunnel entrance and exit.
	FF	Equipment and Materials	0.6	High	3	Specialized tunnel boring equipment is required
	GG	Sequencing/Schedule Constraints	2.2	Low	4	Tunnel schedule is flexible. Connections to existing canal occur in the winter.
	HH	Unique Construction Methods	2.8	High	17	Long tunnel. Subsurface conditions may require special construction. Risk of large monetary loss.
	II	YTID Service Interruptions	3.0	Low	6	Connection to existing YTID canal creates potential for service interruptions.
	JJ	Public Safety/Worker Safety	2.4	Medium	10	New tunneling requires work in deep shafts and confined spaces.
Operations and Maintenance	KK	Routine Visual Observation	6.5	Medium	26	Visual observation of leakage, settlement, erosion, and general condition of tunnel is not possible without shutdown, dewatering.
	LL	Slope Stability Maintenance	5.2	Negligible	0	Minimal long-term slope stability maintenance required for a new tunnel.
	MM	Erosion/Scour Maintenance	5.2	Negligible	0	Minimal long-term slope erosion control maintenance required for a new tunnel.
	NN	Corrosion Maintenance	1.9	Low	4	Tunnel might include a steel lining. Periodic inspection and maintenance of a corrosion control system is required.
	OO	Access Road Maintenance	5.8	Medium	23	Long term access to this location is poor without a new Tieton River bridge or access agreement on existing private bridge.
	PP	Start-up, Shut-down Operations	6.5	Low	13	Startup and shutdown of gravity tunnels would be similar to the existing canal.
	QQ	Mechanical Maintenance	3.2	Negligible	0	Gravity tunnel construction requires few if any mechanical air valves, line valves, or blowoffs.
	RR	Periodic Pipe/Canal Maintenance	7.8	Low	16	Easy dewatering for inspection and maintenance. Interior access and mobility is constrained. Minimal annual O&M required.
	SS	Power Failure	1.3	Negligible	0	Loss of power has no significant impact to gravity system.
	TT	Redundancy	2.6	Negligible	0	The existing canal could be used as a redundant feature if maintained for emergency operation.
	UU	Power Production	3.9	Medium	16	Lost opportunity for power production at this location. River alignments offer potential to generate power.
		Sum of Scores	100.0		**213**	

Appendix B
Cost Estimates

Main Canal Replacement
Yakima-Tieton Irrigation District
470080 / Revision 2

Project name	YT ID Main Canal Replacem Yakima WA 98908-8812 USA
Client	Yakima-Tieton ID
Architect	CH2M Hill
Engineer	CH2M Hill
Estimator	Robert Lawson/RDD
Labor rate table	2_Labor Union (2013)
Equipment rate table	1_EqRates_2013b_100%
Job size	1 LS
Duration	30 MO
Bid date	2:00 PM
Project	Y-T ID Canal Replace
Project Number	470080.A3.31.55.07
Market Segment	WBG
Business Group	WBG
Project Conditions	Existing Facilities
Estimate Class 1-5	Class 4
Design Stage	Conceptual
Project Manager	Todd Hunziker/RDD
Design Manager	Todd Hunziker/RDD
Rev No. / Date	2 / Aug 27, 2013
Cost Index	Aug 2013
Estimate No.	2013.5304221
Report format	Sorted by 'Bid Item/CSI Div/Unit Price/Phase' 'Detail' summary
Cost index	Washington-Yakima

Bid Item	CSI Div	Unit Price	Phase	Item	Description	Takeoff Quantity	Crew	Labor Man Hrs	Equip Hours	Material Cost/Unit	Labor Cost/Unit	Equip Cost/Unit	Sub Cost/Unit	Other Cost/Unit	Total Cost/Unit	Total Direct Cost	Grand Total w/Markups
09					**Box Culvert Installation Crew**												
	01				General Requirements												
		01-01-06-02			GC Temporary Facilities & Services												
			01520.013		**Contractor Additional Cost Items**												
				----	Allowance for Winter Working Conditions	100.00 lf				-	-	-	-	250.00	250.00	25,000	43,393
				----	Allowance for Safety Barricades, Netting, Etc	100.00 lf				-	-	-	-	100.00	100.00	10,000	17,357
					Contractor Additional Cost Items	**100.00 LF**								**350.00**	**350.00**	**35,000**	**60,750**
					01-01-06-02 GC Temporary Facilities & Services	100.00 LF								350.00	350.00	35,000	60,750
		01-01-06-03			GC Equip, Tools, & Consumables												
			01543.330		**Equip w/ Operator for Demolition & Hauling**												
				0010	Large Track Excavator - Cat 350, with Operator	1.00 dy	B12D	22.000	10.000	2,250.00	1,141.05	3,067.50	-	-	6,458.55	6,459	11,368
				0025	Medium Rubber Tire Loader - Cat 936, with Operator	1.00 dy	B3C	44.000	10.000		2,084.90	1,912.50	-	-	3,997.40	3,997	6,938
					Equip w/ Operator for Demolition & Hauling	**1.00 LS**		**66.000**	**20.000**	**2,250.00**	**3,225.95**	**4,980.00**			**10,455.95**	**10,456**	**18,306**
			15210.464		**RBC Connections**												
				----	Forklift moving RBC's together	1.00 ea	B14J	11.000	10.000	-	588.79	2,510.00	-	-	3,098.79	3,099	5,379
					RBC Connections	**1.00 LS**		**11.000**	**10.000**		**588.79**	**2,510.00**			**3,098.79**	**3,099**	**5,379**
			r31232.318		**Hauling**												
				0550	Hauling,excavated borrow material,loose cubic yards,10 mile round trip,.6 loads/hr ,base wide rate,12 cy truck,highway haulers,excludes loading	1.00 ea	B34B	11.000	10.000	-	493.86	865.50	-	-	1,359.36	1,359	2,359
				0550	Hauling, RBCs, to POI, 10 mile round trip,.6 loads/hr, highway haulers,excludes loading	1.00 ea	B34B	11.000	10.000	-	493.86	865.50	-	-	1,359.36	1,359	2,359
				0550	Loading, RBC's at staging yard	1.00 ea	B12T	11.000	10.000	-	570.53	973.75	-	-	1,544.28	1,544	2,680
					Hauling	**1.00 LS**		**33.000**	**30.000**		**1,558.25**	**2,704.75**			**4,263.00**	**4,263**	**7,399**
					01-01-06-03 GC Equip, Tools, & Consumables	1.00 LS		110.000	60.000	2,250.00	5,372.99	10,194.75			17,817.74	17,818	31,084
					01 General Requirements	100.00 LF		110.000	60.000	22.50	53.73	101.95		350.00	528.18	52,818	91,835
	31				Earthwork												
		31-20-09-10			Earthworks, Sitework, Backfill												
			r31232.323		**Compaction**												
				9000	Compaction, water for, 3000 gallon truck, 3 mile haul	108.00 ecy	B45	0.915	0.915	1.19	0.44	0.49	-	-	2.11	228	405
					Compaction	**100.00 LF**		**0.915**	**0.915**	**1.29**	**0.47**	**0.53**			**2.28**	**228**	**405**
					31-20-09-10 Earthworks, Sitework, Backfill	100.00 LF		0.915	0.915	1.29	0.47	0.53			2.28	228	405
		31-25-03-00			Earthworks, Structural, Backfill												
			r31232.313		**Backfill**												
				0100	Backfill, heavy soil, by hand, no compaction	108.00 lcy	CLAB1	78.545		-	31.78	-	-	-	31.78	3,432	5,958
				1100	Backfill, 12" layers, compaction in layers, vibrating plate, add to above	108.00 ecy	A1E	9.600	9.600	-	3.88	0.49	-	-	4.38	473	821
					Backfill	**100.00 LF**		**88.145**	**9.600**		**38.52**	**0.53**			**39.05**	**3,905**	**6,778**
			r31232.314		**Backfill, Structural**												
				2000	Backfill, structural, sand and gravel, 80 H.P. dozer, 50' haul, from existing stockpile, excludes compaction	108.00 lcy	B10L	1.178	0.785	-	0.58	0.44	-	-	1.02	110	191
					Backfill, Structural	**100.00 LF**		**1.178**	**0.785**		**0.63**	**0.47**			**1.10**	**110**	**191**
					31-25-03-00 Earthworks, Structural, Backfill	100.00 LF		89.324	10.385		39.15	1.01			40.15	4,015	6,970
					31 Earthwork	100.00 LF		90.238	11.300	1.29	39.62	1.53			42.44	4,244	7,375
	32				Exterior Improvements												
		32-40-00-00			Site Improvements, Base Course												
			r32112.323		**Base Course Drainage Layers**												
				0100	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 6" deep	133.00 sy	B36C	1.064	1.064	6.00	0.43	0.82	-	-	7.24	963	1,728
					Base Course Drainage Layers	**100.00 LF**		**1.064**	**1.064**	**7.98**	**0.57**	**1.09**			**9.63**	**963**	**1,728**
					32-40-00-00 Site Improvements, Base Course	100.00 LF		1.064	1.064	7.98	0.57	1.09			9.63	963	1,728
		32-50-01-00			Site Improvements, Retaining Walls												
			r32321.310		**Retaining Walls, Lock Block Style**												
				1900	Precast retaining walls,concrete, slight slope face,level embankment,to 6'high,includes excavation&backfill,excludes reinforcing	100.00 lf	C17C	230.556	8.333	80.00	132.48	22.57	-	-	235.05	23,505	41,358
					Retaining Walls, Lock Block Style	**100.00 LF**		**230.556**	**8.333**	**80.00**	**132.48**	**22.57**			**235.05**	**23,505**	**41,358**

Bid Item	CSI Div	Unit Price	Phase	Item	Description	Takeoff Quantity	Crew	Labor Man Hrs	Equip Hours	Material Cost/Unit	Labor Cost/Unit	Equip Cost/Unit	Sub Cost/Unit	Other Cost/Unit	Total Cost/Unit	Total Direct Cost	Grand Total w/Markups
					32-50-01-00 Site Improvements, Retaining Walls	100.00 LF		230.556	8.333	80.00	132.48	22.57			235.05	23,505	41,358
		32-50-02-00			Site Improvements, Guard Rails												
			r34711.326		Vehicle Guide Rails												
				0012	Vehicle guide rails, corrugated steel, galvanized steel posts, steel posts 6'-3" O.C, 6" x 8" posts	100.00 lf	B80	3.765	1.882	20.50	1.79	0.89	-	-	23.18	2,318	4,167
					Vehicle Guide Rails	**100.00 LF**		**3.765**	**1.882**	**20.50**	**1.79**	**0.89**			**23.18**	**2,318**	**4,167**
					32-50-02-00 Site Improvements, Guard Rails	100.00 LF		3.765	1.882	20.50	1.79	0.89			23.18	2,318	4,167
					32 Exterior Improvements	100.00 LF		235.385	11.279	108.48	134.83	24.55			267.86	26,786	47,253
	33				Utilities												
		31-20-13-00			Earthworks, Sitework, Fine Grading												
			r31221.610		Finish Grading												
				0011	Fine grading, finish grading granular subbase for highway paving, +/- 1"	160.00 sy	B32C	0.960	0.480	-	0.31	0.29	-	-	0.59	95	165
					Finish Grading	**100.00 LF**		**0.960**	**0.480**		**0.49**	**0.46**			**0.95**	**95**	**165**
			r32112.323		Base Course Drainage Layers												
				0200	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 9" deep	160.00 sy	B36C	1.392	1.392	9.00	0.46	0.89	-	-	10.35	1,656	2,976
					Base Course Drainage Layers	**100.00 LF**		**1.392**	**1.392**	**14.40**	**0.74**	**1.42**			**16.56**	**1,656**	**2,976**
					31-20-13-00 Earthworks, Sitework, Fine Grading	160.00 SY		2.352	1.872	9.00	0.77	1.17			10.95	1,751	3,140
		33-00-20-10			Buried Pipe, Precast Concrete Box Culvert, 10' width												
			r33411.360		Furnish Pre-fab'd RBC Sections												
				0350	Structural precast box culvert, 5' long sections, 10'w x 6'h, excludes excavation or backfill	100.00 lf	B69			570.00			-	-	570.00	57,000	102,926
					Furnish Pre-fab'd RBC Sections	**100.00 LF**				**570.00**					**570.00**	**57,000**	**102,926**
					33-00-20-10 Buried Pipe, Precast Concrete Box Culvert, 10' width	100.00 LF				570.00					570.00	57,000	102,926
					33 Utilities	100.00 LF		2.352	1.872	584.40	1.24	1.88			587.51	58,751	106,067
					09 Box Culvert Installation Crew	**100.00 LF**		**437.975**	**84.451**	**716.67**	**229.42**	**129.90**		**350.00**	**1,425.99**	**142,599**	**252,529**

Partial Totals

Construction Costs	Amount	Totals	Hours	Rate	% of Total
Labor	22,942		437.975 l		9.08%
Material	71,667				28.38%
Subcontract					
Equipment	12,990		84.451 l		5.14%
Other	35,000				13.86%
Total Before Markups	**142,599**	**142,599**			56.47
Project Staff & Home Office OH	4,278			3.000 %	1.69%
Total Overhead	**4,278**	**146,877**			1.69
General Conditions	14,688			10.000 %	5.82%
Total General Conditions	**14,688**	**161,565**			5.82
Material Sales & Use Tax - %	5,017			7.000 %	1.99%
Construction Equip Tax - %					
Total Taxes	**5,017**	**166,582**			1.99
Profit on Previous Subtotal	9,995			6.000 %	3.96%
Total Profit	**9,995**	**176,577**			3.96
Mobilization/Demobilization	7,576			3.000 %	3.00%
Blder's Risk & Gen Liab Ins -%	5,051			2.000 %	2.00%
Payment & Performance Bonds	5,051			2.000 %	2.00%
Total Bonds and Insurances	**17,678**	**194,255**			7.00
Contingency - %	58,276			30.000 %	23.08%
Total Contingency	**58,276**	**252,531**			23.08
Escalation on Estimate Total					
Total Escalation		**252,531**			
Construction Total		**252,531**			

Main Canal Replacement
Yakima-Tieton Irrigation District
470080 / Revision 2

Project name	YT ID Main Canal Replacem Yakima WA 98908-8812 USA
Client	Yakima-Tieton ID
Architect	CH2M Hill
Engineer	CH2M Hill
Estimator	Robert Lawson/RDD
Labor rate table	2_Labor Union (2013)
Equipment rate table	1_EqRates_2013b_100%
Job size	1 LS
Duration	30 MO
Bid date	2:00 PM
Project	Y-T ID Canal Replace
Project Number	470080.A3.31.55.07
Market Segment	WBG
Business Group	WBG
Project Conditions	Existing Facilities
Estimate Class 1-5	Class 4
Design Stage	Conceptual
Project Manager	Todd Hunziker/RDD
Design Manager	Todd Hunziker/RDD
Rev No. / Date	2 / Aug 27, 2013
Cost Index	Aug 2013
Estimate No.	2013.5304221
Report format	Sorted by 'Bid Item/CSI Div/Unit Price/Phase' 'Detail' summary
Cost index	Washington-Yakima

Bid Item	CSI Div	Unit Price	Phase	Item	Description	Takeoff Quantity	Crew	Labor Man Hrs	Equip Hours	Material Cost/Unit	Labor Cost/Unit	Equip Cost/Unit	Sub Cost/Unit	Other Cost/Unit	Total Cost/Unit	Total Direct Cost	Grand Total w/Markups
10					**Pipeline Installation Crew**												
	01				General Requirements												
		01-01-06-03			GC Equip, Tools, & Consumables												
			01543.330		**Equip w/ Operator for Demolition & Hauling**												
				0010	Large Track Excavator - Cat 350, with Operator	1.00 dy	B12D	22.000	10.000	2,250.00	1,141.05	3,067.50	-	-	6,458.55	6,459	11,404
				0025	Medium Rubber Tire Loader - Cat 936, with Operator	1.00 dy	B3C	44.000	10.000		2,084.90	1,912.50	-	-	3,997.40	3,997	6,961
					Equip w/ Operator for Demolition & Hauling	**1.00 LS**		**66.000**	**20.000**	**2,250.00**	**3,225.95**	**4,980.00**			**10,455.95**	**10,456**	**18,365**
			01543.360		**Lifting Equip w/o operator**												
				0015	150 tn Crawler, without Operator	1.00 dy	B12T	22.000	10.000	14,871.97	1,141.05	973.75	-	-	16,986.77	16,987	30,621
					Lifting Equip w/o operator	**1.00 LS**		**22.000**	**10.000**	**14,871.97**	**1,141.05**	**973.75**			**16,986.77**	**16,987**	**30,621**
			15001.140		**Mechanical GCs - Safety**												
				0010	Trench Box, 8' x 24' x 10'	0.05 mo			8.667	-	-	2,300.00	-	-	2,300.00	115	200
					Mechanical GCs - Safety	**1.00 LS**			**8.667**			**115.00**			**115.00**	**115**	**200**
			15210.464		**RBC Connections**												
				4170	Welding Crew (96" CS lapweld joint, 1/2" wall)	1.00 ea	E16	22.000	20.000	-	1,383.43	360.00		-	1,743.43	1,743	3,036
					RBC Connections	**1.00 LS**		**22.000**	**20.000**		**1,383.43**	**360.00**			**1,743.43**	**1,743**	**3,036**
			r31232.318		**Hauling**												
				0550	Hauling, Pipe, to POI, 10 mile round trip,.6 loads/hr, highway haulers,excludes loading	1.00 ea	B34B	11.000	10.000	-	493.86	865.50	-	-	1,359.36	1,359	2,367
				0550	Loading, Pipe at staging yard	1.00 ea	B12T	11.000	10.000	-	570.53	973.75	-	-	1,544.28	1,544	2,689
					Hauling	**1.00 LS**		**22.000**	**20.000**		**1,064.39**	**1,839.25**			**2,903.64**	**2,904**	**5,056**
					01-01-06-03 GC Equip, Tools, & Consumables	**1.00 LS**		**132.000**	**78.667**	**17,121.97**	**6,814.82**	**8,268.00**			**32,204.79**	**32,205**	**57,279**
					01 General Requirements	**100.00 LF**		**132.000**	**78.667**	**171.22**	**68.15**	**82.68**			**322.05**	**32,205**	**57,279**
	33				Utilities												
		31-20-09-10			Earthworks, Sitework, Backfill												
			r03310.535		**Concrete, Ready Mix, CLSM**												
				4350	Struct concrete,ready mix,clsm,struct,1000 psi,includes ash,cement,aggregate,sand,water,delivered,excludes all additives and treatments	110.00 cy				94.50	-	-	-	-	94.50	10,395	18,829
					Concrete, Ready Mix, CLSM	**100.00 LF**				**103.95**					**103.95**	**10,395**	**18,829**
			r31232.313		**Backfill**												
				0100	Backfill, heavy soil, by hand, no compaction	410.00 lcy	CLAB1	298.181		-	31.78	-	-	-	31.78	13,030	22,690
				0900	Backfill, 12" layers, compaction in layers, roller compaction with operator walking, add to above	410.00 ecy	B10A	32.800	21.865	-	4.28	1.16	-	-	5.44	2,231	3,885
					Backfill	**100.00 LF**		**330.981**	**21.865**		**147.86**	**4.76**			**152.61**	**15,261**	**26,576**
			r31232.314		**Backfill, Structural**												
				2020	Backfill, structural, common earth, 80 H.P. dozer, 50' haul, from existing stockpile, excludes compaction	410.00 lcy	B10L	5.047	3.366	-	0.66	0.49	-	-	1.15	472	823
					Backfill, Structural	**100.00 LF**		**5.047**	**3.366**		**2.70**	**2.02**			**4.72**	**472**	**823**
			r31232.323		**Compaction**												
				9000	Compaction, water for, 3000 gallon truck, 3 mile haul	410.00 ecy	B45	3.473	3.473	1.19	0.44	0.49	-	-	2.11	866	1,543
					Compaction	**100.00 LF**		**3.473**	**3.473**	**4.88**	**1.79**	**1.99**			**8.67**	**866**	**1,543**
					31-20-09-10 Earthworks, Sitework, Backfill	**100.00 LF**		**339.501**	**28.704**	**108.83**	**152.35**	**8.77**			**269.95**	**26,995**	**47,770**
		31-20-13-00			Earthworks, Sitework, Fine Grading												
			r31221.610		**Finish Grading**												
				0011	Fine grading, finish grading granular subbase for highway paving, +/- 1"	190.00 sy	B32C	1.140	0.570	-	0.31	0.29	-	-	0.59	113	196
					Finish Grading	**100.00 LF**		**1.140**	**0.570**		**0.59**	**0.54**			**1.13**	**113**	**196**
			r32112.323		**Base Course Drainage Layers**												
				0200	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 9" deep	190.00 sy	B36C	1.653	1.653	9.00	0.46	0.89	-	-	10.35	1,967	3,545
					Base Course Drainage Layers	**100.00 LF**		**1.653**	**1.653**	**17.10**	**0.88**	**1.69**			**19.67**	**1,967**	**3,545**
					31-20-13-00 Earthworks, Sitework, Fine Grading	**190.00 SY**		**2.793**	**2.223**	**9.00**	**0.77**	**1.17**			**10.95**	**2,080**	**3,741**
		32-35-01-00			Site Improvements, Seeding												
			r32921.913		**Mechanical Seeding**												
				0310	Seeding, mechanical seeding, fine grading and seeding, with equipment, includes lime, fertilizer & seed	160.00 sy	B14	7.680	1.280	0.42	2.22	0.37	-	-	3.01	481	842
					Mechanical Seeding	**100.00 LF**		**7.680**	**1.280**	**0.67**	**3.55**	**0.59**			**4.81**	**481**	**842**

Bid Item	CSI Div	Unit Price	Phase	Item	Description	Takeoff Quantity	Crew	Labor Man Hrs	Equip Hours	Material Cost/Unit	Labor Cost/Unit	Equip Cost/Unit	Sub Cost/Unit	Other Cost/Unit	Total Cost/Unit	Total Direct Cost	Grand Total w/Markups
					32-35-01-00 Site Improvements, Seeding	100.00 LF		7.680	1.280	0.67	3.55	0.59			4.81	481	842
		33-00-05-96			Buried Pipe, Carbon Steel, 96"												
			02501.430		96" CS Pipe, 0.5"wall, 1/2" CML, 3/4" CMC												
				5170	96" CS pipe assembly, shop fab, excav/bkfill NOT incl., 1/2" wall	100.00 LF	Pipe 01	84.000	84.000	530.00	51.49	41.07	-	-	622.56	62,256	112,119
					96" CS Pipe, 0.5"wall, 1/2" CML, 3/4" CMC	**100.00 LF**		**84.000**	**84.000**	**530.00**	**51.49**	**41.07**			**622.56**	**62,256**	**112,119**
			02518.025		Grout Pipe Joints												
				0150	Grout joint, I.D., 96" pipe	2.50 ea	Pipe 61	25.000		55.00	696.31	-	-	-	751.31	1,878	3,280
					Grout Pipe Joints	**100.00 LF**		**25.000**		**1.38**	**17.41**				**18.78**	**1,878**	**3,280**
					33-00-05-96 Buried Pipe, Carbon Steel, 96"	100.00 LF		109.000	84.000	531.38	68.90	41.07			641.34	64,134	115,400
					33 Utilities	100.00 LF		458.974	116.207	657.98	226.27	52.65			936.90	93,690	167,753
					10 Pipeline Installation Crew	**100.00 LF**		**590.974**	**194.874**	**829.20**	**294.41**	**135.33**			**1,258.94**	**125,894**	**225,032**

Partial Totals

Construction Costs	Amount	Totals	Hours	Rate	% of Total
Labor	29,441		590.974 l		13.08%
Material	82,920				36.85%
Subcontract					
Equipment	13,533		194.874 l		6.01%
Other					
Total Before Markups	**125,894**	**125,894**			55.94
Project Staff & Home Office OH	3,777			3.000 %	1.68%
Total Overhead	**3,777**	**129,671**			1.68
General Conditions	12,967			10.000 %	5.76%
Total General Conditions	**12,967**	**142,638**			5.76
Material Sales & Use Tax - %	5,804			7.000 %	2.58%
Construction Equip Tax - %					
Total Taxes	**5,804**	**148,442**			2.58
Profit on Previous Subtotal	8,907			6.000 %	3.96%
Total Profit	**8,907**	**157,349**			3.96
Mobilization/Demobilization	6,751			3.000 %	3.00%
Blder's Risk & Gen Liab Ins -%	4,501			2.000 %	2.00%
Payment & Performance Bonds	4,501			2.000 %	2.00%
Total Bonds and Insurances	**15,753**	**173,102**			7.00
Contingency - %	51,930			30.000 %	23.08%
Total Contingency	**51,930**	**225,032**			23.08
Escalation on Estimate Total					
Total Escalation		**225,032**			
Construction Total		**225,032**			

Existing Tunnel Rehabilitation
Yakima-Tieton Irrigation District
470080 / Revision 1

Project name	YT ID Main Canal Replacem Yakima WA 98908-8812 USA
Client	Yakima-Tieton ID
Architect	CH2M Hill
Engineer	CH2M Hill
Estimator	Nick Cavalleri/RDD
Labor rate table	2_Labor Union (2013)
Equipment rate table	1_EqRates_2013b_100%
Job size	1 LS
Bid date	2:00 PM
Project	Y-T ID Canal Replace
Project Number	470080.A3.31.55.07
Market Segment	WBG
Business Group	WBG
Project Conditions	Existing Facilities
Estimate Class 1-5	Class 4
Design Stage	Conceptual
Project Manager	Todd Hunziker/RDD
Design Manager	Todd Hunziker/RDD
Rev No. / Date	1 / Aug. 19, 2013
Report format	Sorted by 'Bid Item/CSI Div/Unit Price/Phase' 'Detail' summary
Cost index	Washington-Yakima

Bid Item	CSI Div	Unit Price	Phase	Description	Takeoff Quantity	Crew	Labor Cost/Unit	Material Cost/Unit	Sub Cost/Unit	Equip Cost/Unit	Total Cost/Unit	Total Amount	Grand Total Unit Price	Grand Total
01				**Existing Tunnel Rehabilitation**										
	01			General Requirements										
		01-01-06-02		GC Temporary Facilities & Services										
			r01542.380	**Temporary Work Platforms**										
				Temporary Work Platforms, 2 ea, 50' x 30', Install and Remove	2.00 ea		-	-	50,000.00	-	50,000.00	100,000	86,719.40 /ea	173,439
				Temporary Work Platforms	**2.00 EA**				**50,000.00**		**50,000.00**	**100,000**	**86,719.40 /EA**	**173,439**
			r01543.350	**Ventilating Blowers and Ducting**										
				Equipment rental, vent blower for tunnel 40 HP	730.00 day		-	-	-	98.80	98.80	72,124	171.36 /day	125,091
				Vent ducting allowance	5,280.00 lf		-	-	20.00	-	20.00	105,600	34.69 /lf	183,151
				Additional Confined Space Operation Allowance	1.00 ls		-	-	150,000.00	-	150,000.00	150,000	260,158.19 /ls	260,158
				Ventilating Blowers and Ducting	**1.00 LS**				**255,600.00**	**72,124.00**	**327,724.00**	**327,724**	**568,400.53 /LS**	**568,401**
			r01552.350	**Temporary Roads**										
				Temporary, roads, gravel fill, 8" gravel depth, excl surfacing, 1/8 Mile Ea, 2 Ea	4,400.00 sy	B14	6.60	10.00	-	1.21	17.81	78,366	31.59 /sy	138,998
				Remove Temporary Roads	1.00 ls			4,000.00	13,125.00		17,125.00	17,125	29,981.39 /ls	29,981
				Temporary Roads	**2.00 EA**		**14,524.40**	**24,000.00**	**6,562.50**	**2,658.82**	**47,745.71**	**95,491**	**84,489.59 /EA**	**168,979**
				01-01-06-02 GC Temporary Facilities & Services	52.80 CLF		550.17	909.09	6,983.43	1,466.70	9,909.38	523,215	17,250.35 /CLF	910,819
				01 General Requirements	52.80 CLF		550.17	909.09	6,983.43	1,466.70	9,909.38	523,215	17,250.35 /CLF	910,819
	02			Existing Conditions										
		02-01-02-99		Selective Demolition, Cut-out, Concrete, Other										
			r31232.318	**Haul and Dispose of Demolished Material**										
				Hauling, demolished material, loose cubic yards, 40 mile round trip, 0.25 loads/hour, 20 C.Y. dump trailer, highway haulers, excludes loading	7,600.00 lcy	B34D	8.98	-	-	18.85	27.82	211,464	48.26 /lcy	366,760
				Tipping Fee	7,600.00 cy		-	10.00	-	-	10.00	76,000	18.04 /cy	137,133
				Haul and Dispose of Demolished Material	**7,600.00 CY**		**8.98**	**10.00**		**18.85**	**37.82**	**287,464**	**66.30 /CY**	**503,894**
			r31711.620	**Demolition of Existing Cast-in-Place Lining, Blasting**										
				Demolition of existing cast-in-place concrete lining Jack Hammer Breaker Crew	7,600.00 cy	B9	220.97	-	-	28.38	249.34	1,894,984	432.45 /cy	3,286,637
				Break Concrete to Loadable Size	7,600.00 cy	B9	110.48	-	-	10.64	121.12	920,539	210.08 /cy	1,596,571
				Tunnel Locomotive for muck cars	152.00 day		480.00	-	-	500.00	980.00	148,960	1,699.70 /day	258,354
				Muck Cars, 5 cy side dump	304.00 day		-	-	-	77.20	77.20	23,469	133.89 /day	40,704
				Load Demolished Material w/ Skid Steer Loader to Muck Cars	7,600.00 cy	CARP3	13.26	-	-	3.20	16.46	125,122	28.55 /cy	217,009
				Load Demolished Material for Haul off	7,600.00 cy	B10U	0.54	-	-	0.88	1.42	10,756	2.45 /cy	18,655
				Demolition of Existing Cast-in-Place Lining, Blasting	**7,600.00 CY**		**354.85**			**56.18**	**411.03**	**3,123,829**	**712.89 /CY**	**5,417,931**
				02-01-02-99 Selective Demolition, Cut-out, Concrete, Other	52.80 CLF		52,368.80	1,439.39		10,799.63	64,607.82	3,411,293	112,155.78 /CLF	5,921,825
				02 Existing Conditions	52.80 CLF		52,368.80	1,439.39		10,799.63	64,607.82	3,411,293	112,155.78 /CLF	5,921,825
	33			Utilities										
		33-00-05-96		Buried Pipe, Carbon Steel, 96"										
			02501.430	**96" CS Pipe, 0.5"wall, 1/2" CML, 3/4" CMC**										
				96" CS pipe assembly, shop fab, 1/2" wall, Jacking Installation	5,280.00 LF	B42	78.92	530.00	-	39.72	648.63	3,424,782	1,162.08 /LF	6,135,789
				Place Pipe Skids in Existing Tunnel	21,120.00 lf	CARP3	16.58	15.00	-	2.50	34.08	719,753	60.16 /lf	1,270,506
				Haul Pipe From Staging Area to POI	5,280.00 lf	B10U	0.50		-	0.83	1.33	7,006	2.30 /lf	12,150
				96" CS Pipe, 0.5"wall, 1/2" CML, 3/4" CMC	**52.80 CLF**		**14,573.66**	**59,000.00**		**5,054.00**	**78,627.66**	**4,151,540**	**140,500.86 /CLF**	**7,418,445**
			02501.440	**96" CS Field Connection**										
				96" CS lapweld joint, 1/2" wall	132.00 ea		-	-	2,600.00	-	2,600.00	343,200	4,509.41 /ea	595,242
				96" CS Field Connection	**52.80 CLF**				**6,500.00**		**6,500.00**	**343,200**	**11,273.52 /CLF**	**595,242**
			02518.025	**Grout Pipe Joints**										
				Grout joint, I.D., 96" pipe	132.00 ea	Pipe 61	696.31	55.00	-	-	751.31	99,173	1,306.91 /ea	172,513
				Grout Pipe Joints	**52.80 CLF**		**1,740.78**	**137.50**			**1,878.28**	**99,173**	**3,267.28 /CLF**	**172,513**
			r31431.313	**Pressure Grout Annular Space**										
				Pressure grout annular space, assumed average of 1' thick	165,000.00 cf	B61	1.73	10.00	-	0.32	12.05	1,988,747	21.60 /cf	3,564,760
				Pressure Grout Annular Space	**52.80 CLF**		**5,406.99**	**31,250.00**		**1,008.68**	**37,665.67**	**1,988,747**	**67,514.38 /CLF**	**3,564,760**
				33-00-05-96 Buried Pipe, Carbon Steel, 96"	52.80 CLF		21,721.43	90,387.50	6,500.00	6,062.68	124,671.61	6,582,661	222,556.05 /CLF	11,750,959
				33 Utilities	52.80 CLF		21,721.43	90,387.50	6,500.00	6,062.68	124,671.61	6,582,661	222,556.05 /CLF	11,750,959
				01 Existing Tunnel Rehabilitation	**52.80 CLF**		**74,640.39**	**92,735.98**	**13,483.43**	**18,329.01**	**199,188.81**	**10,517,169**	**351,962.18 /CLF**	**18,583,603**

Estimate Totals

Construction Costs	Amount	Totals	Rate
Labor	3,941,013		
Material	4,896,460		
Subcontract	711,925		
Equipment	967,772		
Other			
Total Before Markups	**10,517,170**	**10,517,170**	
Project Staff & Home Office OH	315,515		3.000 %
Total Overhead	**315,515**	**10,832,685**	
General Conditions	1,083,268		10.000 %
Total General Conditions	**1,083,268**	**11,915,953**	
Material Sales & Use Tax - %	342,752		7.000 %
Construction Equip Tax - %			
Total Taxes	**342,752**	**12,258,705**	
Profit on Previous Subtotal	735,522		6.000 %
Total Profit	**735,522**	**12,994,227**	
Mobilization/Demobilization	557,508		3.000 %
Blder's Risk & Gen Liab Ins -%	371,672		2.000 %
Payment & Performance Bonds	371,672		2.000 %
Total Bonds and Insurances	**1,300,852**	**14,295,079**	
Contingency - %	4,288,524		30.000 %
Total Contingency	**4,288,524**	**18,583,603**	
Escalation on Estimate Total			
Total Escalation		**18,583,603**	
Construction Total		**18,583,603**	

Appendix C
Summary of Alternatives

Summary of Upper Main Canal Alternatives

Alternative U1

No.	Canal/ Pipe ID	Segment Type	Length (ft)	Baseline Unit Cost ($/100-ft)	Permitting Risk	Construction Risk	O&M Risk	Total Risk Score	Risk Adjust Factor	Adjusted Baseline Unit Cost	Total Cost
1	1A-1B	RC Box	1,213	$ 252,000	75	50	47	171	0.82	$ 207,751	$ 2,520,000
2	1B-1C	RC Box	2,859	$ 252,000	89	68	47	204	0.98	$ 247,355	$ 7,070,000
3	1C-1D	RC Box	2,356	$ 252,000	53	57	57	167	0.80	$ 202,821	$ 4,780,000
4	1D-1E	RC Box	1,013	$ 252,000	32	53	57	142	0.68	$ 172,226	$ 1,740,000
5	1E-1F	RC Box	628	$ 252,000	66	63	58	188	0.90	$ 227,600	$ 1,430,000
6	1F-1G	RC Box	464	$ 252,000	58	53	69	180	0.87	$ 218,171	$ 1,010,000
7	1G-1H	RC Box	912	$ 252,000	34	63	69	166	0.80	$ 201,608	$ 1,840,000
8	1H-1I	RC Box	1,644	$ 252,000	56	67	48	172	0.83	$ 208,311	$ 3,420,000
9	1I-1J	Tunnel Rehab	222	$ 352,000	16	120	101	237	1.08	$ 381,712	$ 850,000
10	1J-1K	RC Box	797	$ 252,000	56	67	58	182	0.88	$ 220,914	$ 1,760,000
11	1K-1L	RC Box	5,012	$ 252,000	30	67	79	176	0.84	$ 212,926	$ 10,670,000
12	1L-1M	RC Box	1,451	$ 252,000	30	64	58	152	0.73	$ 184,577	$ 2,680,000
13	1M-1N	RC Box	5,791	$ 252,000	27	49	69	145	0.70	$ 176,135	$ 10,200,000
58	3N-3O	New Tunnel	3,277	$ 352,000	14	92	90	196	0.89	$ 314,708	$ 10,310,000
Totals		Length->	**27,639**	Risk->	**41**	**64**	**66**	**172**			**$ 60,300,000**

Summary of Upper Main Canal Alternatives

Alternative U2

No.	Canal/ Pipe ID	Segment Type	Length (ft)	Baseline Unit Cost ($/100-ft)	Permitting Risk	Construction Risk	O&M Risk	Risk Score	Risk Adjust Factor	Adjusted Baseline Unit Cost	Total Cost
1	1A-1B	RC Box	1,213	$ 252,000	75	50	47	171	0.82	$ 207,751	$ 2,520,000
28	1B-2A	River Tunnel	319	$ 1,000,000	115	77	97	289	1.32	$ 1,321,170	$ 4,210,000
29	2A-2B	Pipeline	5,813	$ 225,000	105	50	52	207	0.98	$ 220,902	$ 12,840,000
30	2B-2C	Pipeline	827	$ 225,000	72	26	52	150	0.71	$ 159,867	$ 1,320,000
31	2C-2D	River Tunnel	294	$ 1,000,000	106	64	109	280	1.28	$ 1,278,437	$ 3,760,000
32	2D-1N	Pipeline	15,088	$ 225,000	83	62	105	250	1.19	$ 267,143	$ 40,310,000
58	3N-3O	New Tunnel	3,277	$ 352,000	14	92	90	196	0.89	$ 314,708	$ 10,310,000
Totals		Length->	**26,831**	Risk->	**79**	**62**	**87**	**228**			**$ 75,300,000**

Summary of Upper Main Canal Alternatives

Alternative U3

No.	Canal/ Pipe ID	Segment Type	Length (ft)	Baseline Unit Cost ($/100-ft)	Permitting Risk	Construction Risk	O&M Risk	Risk Score	Risk Adjust Factor	Adjusted Baseline Unit Cost	Total Cost
1	1A-1B	RC Box	1,213	$ 252,000	75	50	47	171	0.82	$ 207,751	$ 2,520,000
2	1B-1C	RC Box	2,859	$ 252,000	89	68	47	204	0.98	$ 247,355	$ 7,070,000
3	1C-1D	RC Box	2,356	$ 252,000	53	57	57	167	0.80	$ 202,821	$ 4,780,000
44	1D-2E	Pipeline	915	$ 225,000	53	50	52	155	0.74	$ 165,462	$ 1,510,000
45	2E-2B	River Tunnel	251	$ 1,000,000	100	64	97	262	1.20	$ 1,196,291	$ 3,000,000
30	2B-2C	Pipeline	827	$ 225,000	72	26	52	150	0.71	$ 159,867	$ 1,320,000
31	2C-2D	River Tunnel	294	$ 1,000,000	106	64	109	280	1.28	$ 1,278,437	$ 3,760,000
32	2D-1N	Pipeline	15,088	$ 225,000	83	62	105	250	1.19	$ 267,143	$ 40,310,000
58	3N-3O	New Tunnel	3,277	$ 352,000	14	92	90	196	0.89	$ 314,708	$ 10,310,000
Totals			**27,080**	Risk->	**71**	**64**	**87**	**222**			**$ 74,600,000**

Summary of Upper Main Canal Alternatives

Alternative U4

No.	Canal/ Pipe ID	Segment Type	Length (ft)	Baseline Unit Cost ($/100-ft)	Permitting Risk	Construction Risk	O&M Risk	Risk Score	Risk Adjust Factor	Adjusted Baseline Unit Cost	Total Cost
1	1A-1B	RC Box	1,213	$ 252,000	75	50	47	171	0.82	$ 207,751	$ 2,520,000
2	1B-1C	RC Box	2,859	$ 252,000	89	68	47	204	0.98	$ 247,355	$ 7,070,000
3	1C-1D	RC Box	2,356	$ 252,000	53	57	57	167	0.80	$ 202,821	$ 4,780,000
4	1D-1E	RC Box	1,013	$ 252,000	32	53	57	142	0.68	$ 172,226	$ 1,740,000
5	1E-1F	RC Box	628	$ 252,000	66	63	58	188	0.90	$ 227,600	$ 1,430,000
6	1F-1G	RC Box	464	$ 252,000	58	53	69	180	0.87	$ 218,171	$ 1,010,000
46	1G-2D	Pipeline	331	$ 225,000	74	45	64	182	0.87	$ 194,676	$ 640,000
32	2D-1N	Pipeline	15,088	$ 225,000	83	62	105	250	1.19	$ 267,143	$ 40,310,000
58	3N-3O	New Tunnel	3,277	$ 352,000	14	92	90	196	0.89	$ 314,708	$ 10,310,000
Totals			**27,229**	Risk->	**70**	**65**	**86**	**221**			**$ 69,810,000**

Summary of Upper Main Canal Alternatives

Alternative U5

No.	Canal/ Pipe ID	Segment Type	Length (ft)	Baseline Unit Cost ($/100-ft)	Permitting Risk	Construction Risk	O&M Risk	Risk Score	Risk Adjust Factor	Adjusted Baseline Unit Cost	Total Cost
1	1A-1B	RC Box	1,213	$ 252,000	75	50	47	171	0.82	$ 207,751	$ 2,520,000
55	3B-3C	New Tunnel	2,844	$ 352,000	20	95	58	174	0.79	$ 279,313	$ 7,940,000
3	1C-1D	RC Box	2,356	$ 252,000	53	57	57	167	0.80	$ 202,821	$ 4,780,000
4	1D-1E	RC Box	1,013	$ 252,000	32	53	57	142	0.68	$ 172,226	$ 1,740,000
5	1E-1F	RC Box	628	$ 252,000	66	63	58	188	0.90	$ 227,600	$ 1,430,000
6	1F-1G	RC Box	464	$ 252,000	58	53	69	180	0.87	$ 218,171	$ 1,010,000
7	1G-1H	RC Box	912	$ 252,000	34	63	69	166	0.80	$ 201,608	$ 1,840,000
57	3H-3K	New Tunnel	2,529	$ 352,000	14	100	90	203	0.93	$ 327,226	$ 8,280,000
11	1K-1L	RC Box	5,012	$ 252,000	30	67	79	176	0.84	$ 212,926	$ 10,670,000
12	1L-1M	RC Box	1,451	$ 252,000	30	64	58	152	0.73	$ 184,577	$ 2,680,000
13	1M-1N	RC Box	5,791	$ 252,000	27	49	69	145	0.70	$ 176,135	$ 10,200,000
58	3N-3O	New Tunnel	3,277	$ 352,000	14	92	90	196	0.89	$ 314,708	$ 10,310,000
Totals			**27,490**	Risk->	**30**	**69**	**71**	**171**			**$ 63,400,000**

Summary of Lower Main Canal Alternatives

Alternative L1

No.	Canal/ Pipe ID	Segment Type	Length (ft)	Baseline Unit Cost ($/100-ft)	Permitting Risk	Construction Risk	O&M Risk	Risk Score	Risk Adjust Factor	Adjusted Baseline Unit Cost	Total Cost
15	1O-1P	RC Box	1,054	$ 252,000	25	66	91	182	0.88	$ 220,692	$ 2,330,000
16	1P-1Q	RC Box	632	$ 252,000	24	53	88	165	0.79	$ 200,318	$ 1,270,000
17	1Q-1R	RC Box	2,202	$ 252,000	21	112	109	243	1.17	$ 294,176	$ 6,480,000
18	1R-1S	RC Box	3,808	$ 252,000	17	82	99	198	0.95	$ 239,671	$ 9,130,000
19	1S-1T	RC Box	303	$ 252,000	17	56	78	150	0.72	$ 182,121	$ 550,000
20	1T-1U	RC Box	3,694	$ 252,000	23	63	88	174	0.84	$ 210,797	$ 7,790,000
21	1U-1V	RC Box	3,947	$ 252,000	21	86	127	234	1.13	$ 283,546	$ 11,190,000
22	1V-1W	Tunnel Rehab	1,268	$ 352,000	11	126	118	254	1.16	$ 409,366	$ 5,190,000
23	1W-1X	RC Box	884	$ 252,000	21	99	144	263	1.27	$ 319,299	$ 2,820,000
24	1X-1Y	RC Box	8,356	$ 252,000	37	109	175	321	1.55	$ 389,376	$ 32,540,000
25	1Y-1Z	Tunnel Rehab	2,769	$ 352,000	12	126	127	265	1.21	$ 426,785	$ 11,820,000
26	1Z-1AA	RC Box	473	$ 252,000	28	95	139	263	1.26	$ 318,406	$ 1,510,000
27	1AA-1AB	Tunnel Rehab	3,864	$ 352,000	22	126	127	275	1.26	$ 442,810	$ 17,110,000
Totals		Length->	**33,254**	Risk->	**24**	**99**	**128**	**251**			**$ 109,700,000**

Summary of Lower Main Canal Alternatives

Alternative L2

No.	Canal/ Pipe ID	Segment Type	Length (ft)	Baseline Unit Cost ($/100-ft)	Permitting Risk	Construction Risk	O&M Risk	Risk Score	Risk Adjust Factor	Adjusted Baseline Unit Cost	Total Cost
15	1O-1P	RC Box	1,054	$ 252,000	25	66	91	182	0.88	$ 220,692	$ 2,330,000
33	1P-2F	Pipeline	4,331	$ 225,000	77	69	106	253	1.20	$ 269,571	$ 11,680,000
47	2F-2I	Pipeline	992	$ 225,000	74	36	75	184	0.87	$ 196,873	$ 1,950,000
48	2I-2J	River Tunnel	258	$ 1,000,000	101	64	97	263	1.20	$ 1,202,229	$ 3,100,000
49	2J-2K	Pipeline	4,487	$ 225,000	88	43	62	193	0.92	$ 206,329	$ 9,260,000
50	2K-2L	River Tunnel	432	$ 1,000,000	112	64	97	274	1.25	$ 1,252,704	$ 5,410,000
51	2L-2M	Pipeline	2,290	$ 225,000	50	39	75	164	0.78	$ 175,416	$ 4,020,000
37	2M-2N	Pipeline	3,181	$ 225,000	39	37	106	182	0.87	$ 194,692	$ 6,190,000
38	2N-2O	Pipeline	544	$ 225,000	136	74	82	292	1.38	$ 311,275	$ 1,690,000
39	2O-2P	Pipeline	635	$ 225,000	72	26	52	150	0.71	$ 159,867	$ 1,020,000
40	2P-2Q	Pipeline	353	$ 225,000	136	74	82	292	1.38	$ 311,275	$ 1,100,000
41	2Q-2R	Pipeline	7,578	$ 225,000	78	39	99	216	1.02	$ 230,394	$ 17,460,000
42	2R-2S	Pipeline	3,894	$ 225,000	68	36	75	180	0.85	$ 191,658	$ 7,460,000
43	2S-1AB	New Tunnel	3,958	$ 352,000	35	77	108	220	1.01	$ 353,920	$ 14,010,000
Totals		Length->	**33,987**	Risk->	**68**	**49**	**90**	**207**			**$ 86,700,000**

Summary of Lower Main Canal Alternatives

Alternative L3

No.	Canal/ Pipe ID	Segment Type	Length (ft)	Baseline Unit Cost ($/100-ft)	Permitting Risk	Construction Risk	O&M Risk	Risk Score	Risk Adjust Factor	Adjusted Baseline Unit Cost	Total Cost
15	1O-1P	RC Box	1,054	$ 252,000	25	66	91	182	0.88	$ 220,692	$ 2,330,000
33	1P-2F	Pipeline	4,331	$ 225,000	77	69	106	253	1.20	$ 269,571	$ 11,680,000
34	2F-2G	Pipeline	852	$ 225,000	30	36	86	152	0.72	$ 161,761	$ 1,380,000
35	2G-2H	Pipeline	4,828	$ 225,000	55	62	86	203	0.96	$ 217,016	$ 10,480,000
36	2H-2M	Pipeline	1,352	$ 225,000	18	36	75	128	0.61	$ 137,044	$ 1,850,000
37	2M-2N	Pipeline	3,181	$ 225,000	39	37	106	182	0.87	$ 194,692	$ 6,190,000
60	3N-3Q	New Tunnel	1,384	$ 352,000	14	77	82	172	0.79	$ 277,029	$ 3,830,000
41	2Q-2R	Pipeline	7,578	$ 225,000	78	39	99	216	1.02	$ 230,394	$ 17,460,000
42	2R-2S	Pipeline	3,894	$ 225,000	68	36	75	180	0.85	$ 191,658	$ 7,460,000
43	2S-1AB	New Tunnel	3,958	$ 352,000	35	77	108	220	1.01	$ 353,920	$ 14,010,000
Totals			**32,412**	Risk->	**56**	**53**	**95**	**203**			**$ 76,700,000**

Summary of Lower Main Canal Alternatives

Alternative L4

No.	Canal/ Pipe ID	Segment Type	Length (ft)	Baseline Unit Cost ($/100-ft)	Permitting Risk	Construction Risk	O&M Risk	Risk Score	Risk Adjust Factor	Adjusted Baseline Unit Cost	Total Cost
15	1O-1P	RC Box	1,054	$ 252,000	25	66	91	182	0.88	$ 220,692	$ 2,330,000
16	1P-1Q	RC Box	632	$ 252,000	24	53	88	165	0.79	$ 200,318	$ 1,270,000
17	1Q-1R	RC Box	2,202	$ 252,000	21	112	109	243	1.17	$ 294,176	$ 6,480,000
59	3R-3S	New Tunnel	2,680	$ 352,000	14	100	90	203	0.93	$ 326,530	$ 8,750,000
19	1S-1T	RC Box	303	$ 252,000	17	56	78	150	0.72	$ 182,121	$ 550,000
20	1T-1U	RC Box	3,694	$ 252,000	23	63	88	174	0.84	$ 210,797	$ 7,790,000
53	1U-2H	Pipeline	671	$ 225,000	31	53	75	159	0.75	$ 169,549	$ 1,140,000
36	2H-2M	Pipeline	1,352	$ 225,000	18	36	75	128	0.61	$ 137,044	$ 1,850,000
37	2M-2N	Pipeline	3,181	$ 225,000	39	37	106	182	0.87	$ 194,692	$ 6,190,000
60	3N-3Q	New Tunnel	1,384	$ 352,000	14	77	82	172	0.79	$ 277,029	$ 3,830,000
41	2Q-2R	Pipeline	7,578	$ 225,000	78	39	99	216	1.02	$ 230,394	$ 17,460,000
42	2R-2S	Pipeline	3,894	$ 225,000	68	36	75	180	0.85	$ 191,658	$ 7,460,000
43	2S-1AB	New Tunnel	3,958	$ 352,000	35	77	108	220	1.01	$ 353,920	$ 14,010,000
Totals			**32,583**	Risk->	**43**	**59**	**94**	**195**			**$ 79,110,000**

Summary of Lower Main Canal Alternatives

Alternative L5

No.	Canal/ Pipe ID	Segment Type	Length (ft)	Baseline Unit Cost ($/100-ft)	Permitting Risk	Construction Risk	O&M Risk	Risk Score	Risk Adjust Factor	Adjusted Baseline Unit Cost	Total Cost
15	1O-1P	RC Box	1,054	$ 252,000	25	66	91	182	0.88	$ 220,692	$ 2,330,000
16	1P-1Q	RC Box	632	$ 252,000	24	53	88	165	0.79	$ 200,318	$ 1,270,000
17	1Q-1R	RC Box	2,202	$ 252,000	21	112	109	243	1.17	$ 294,176	$ 6,480,000
59	3R-3S	New Tunnel	2,680	$ 352,000	14	100	90	203	0.93	$ 326,530	$ 8,750,000
19	1S-1T	RC Box	303	$ 252,000	17	56	78	150	0.72	$ 182,121	$ 550,000
20	1T-1U	RC Box	3,694	$ 252,000	23	63	88	174	0.84	$ 210,797	$ 7,790,000
61	3U-3Y	New Tunnel	12,934	$ 352,000	14	102	97	213	0.98	$ 343,244	$ 44,400,000
25	1Y-1Z	Tunnel Rehab	2,769	$ 352,000	12	126	127	265	1.21	$ 426,785	$ 11,820,000
26	1Z-1AA	RC Box	473	$ 252,000	28	95	139	263	1.26	$ 318,406	$ 1,510,000
27	1AA-1AB	Tunnel Rehab	3,864	$ 352,000	22	126	127	275	1.26	$ 442,810	$ 17,110,000
Totals			**30,605**	Risk->	**17**	**100**	**103**	**220**			**$ 102,010,000**

Appendix D
Cowiche Creek Water Rights

Cowiche Creek Water Rights - Subbasin 18

WR_DOC_ID	WR_Doc_NR	Previous Owner	Most Recent Owner	Court Claim #	AF/Year	Priority Date	CFS	Acres	Use	Stream	CCWUA Turnout	CCWUA Turnout Acres	CCWUA Turnout Flow (CFS)
4756899	S4-84064-J	Cowychee Ditch Company	Cowychee Ditch Company	1505	660.00	June 30, 1884	1.58	158.00	I&S	SF			
4756859	S4-84067-J	Walter E. Culbertson	Walter E. Culbertson	8983	60.00	June 30, 1895	0.30	15.00	I&S	SF			
4754944	S4-84039-J	Leo K. Daugherty	Leo & Joyce Daugherty	767	18.64	June 30, 1891	0.09	4.66	I&S	NF			
4755051	S4-84031-J	John Roy Dixon	John R. & Patsy J. Dixon	419	50.80	April 4, 1891	0.29	12.70	I	NF			
4748313	S4-84046-J	Walter H. Eller, Jr.	Walter & Louse Eller, Jr.	02307 (A) 03065	26.00	June 30, 1880	0.13	6.50	I&S	MS			
4756725	S4-84037-J	William G. Evans	William G. & Jeanette M. Evans	1833	80.00	June 30, 1871	0.40	20.00	I&F	SF			
4756739	S4-84038-J	William G. Evans	William G. & Jeanette M. Evans	1833	341.60	June 30, 1872	1.72	85.40	I&F	SF			
4756802	S4-84072-J	William G. Evans	William G. & Jeanette M. Evans	1833	64.80	June 30, 1872	0.33	16.20	I&F	SF			
4756714	S4-84036-J	William G. Evans	William G. & Jeanette M. Evans	1832A	108.00	June 30, 1873	0.54	27.00	I&F	SF			
4756815	S4-84073-J	William G. Evans	William G. & Jeanette M. Evans	1833	361.20	June 30, 1873	1.80	90.30	I&F	SF			
4756684	S4-84027-J	John I. Haas, Inc.	William G. & Jeanette M. Evans	571	62.00	June 30, 1873	0.31	15.60	I&F	SF			
4748334	S4-84048-J	Velma Gustafson	Velma Gustafson & estate	1108	32.00	June 30, 1873	0.16	8.00	I&S	MS			
4756889	S4-84063-J	Craig Scheibner	Richard J. & Juanita Howe	1043	80.00	June 30, 1873	0.40	20.00	I&F	SF			
4755024	S4-84018-J	Erving LaBarr	Erving & Barbara LaBarr	1023	36.00	June 30, 1891	0.18	9.00	I&S	NF			
4748324	S4-84047-J	Bilialdo L. Lamas	Billialdo L. Lamas	650	12.00	June 30, 1891	0.08	4.00	I&F	MS			
4748345	S4-84049-J	Lloyd Garretson Company	Lloyd Garretson Company	1592	47.33	June 30, 1869	0.30	10.00	I&F	MS			
4756630	S4-84051-J	C. James Lust	Carl J. & Arta C. Lust	00430 (A) 00772	298.40	June 30, 1872	1.49	74.60	I&S	SF	1 East Lateral	35.00	0.70
4756826	S4-84074-J	C. James Lust	Carl J. & Arta C. Lust	430 (A) 00772	194.00	June 30, 1873	0.97	48.50	I&S	SF	9 East Lateral	45.00	0.90
4748375	S4-84075-J	C. James Lust	Carl J. & Arta C. Lust	430 (A) 00772	200.00	June 30, 1873	1.00	50.00	I&S	SF	4,5,6,7 East Lateral	74.10	1.49
4748157	S4-84076-J	Michael J. Lust	Carl J. & Arta C. Lust	430 (A) 00772	78.00	June 30, 1873	0.39	19.50	I&S	MS	8 East Lateral	24.50	0.49
4756619	S4-84050-J	C. James Lust	C. James & Darlene F. Lust	00425 & (A) 00744	160.00	June 30, 1870	0.80	40.00	I&S	SF	15 West Lateral	40.00	0.80
4756779	S4-84070-J	C. James Lust	C. James & Darlene F. Lust	00425 & (A) 00744	152.00	June 30, 1871	0.76	38.00	I&S	SF	16 West Lateral	38.00	0.76
4756642	S4-84052-J	Michael J. Lust	Michael Lust	00693 (A) 00745	16.00	June 30, 1873	0.08	4.00	I	SF	10 East Lateral	16.00	0.36
4748180	S4-84013-J	Lance Mifflin	Lance & Eva Mifflin	2017	14.00	June 30, 1889	0.07	3.50	I	MS			
4748387	S4-84053-J	Clifford Mowrey	Clifford & Janet Mowery	318	10.50	June 30, 1880	0.07	3.50	I	MS			
4754992	S4-84023-J	Andrew L. Mullenhoff	Andres & Cyndie Mullenhoff	532	12.00	June 30, 1891	0.06	3.00	I&S	NF			
4754958	S4-84040-J	Gary M. Anderson	Gary & Louise Anderson	767	18.64	June 30, 1891	0.09	4.66	I&S	NF			
4755038	S4-84029-J	Gerald H. Battson	Gerald & Dorothea Battson	1131	18.64	June 30, 1891	0.09	4.66	I&S	NF			
4756568	S4-84015-J	Gerald W. Biggers	Gerald & Pat Biggers	388	24.00	June 30, 1873	0.12	6.00	I	SF			
4748233	S4-84055-J	Chris Billings	Chris & Pat Billings	996	12.00	June 30, 1880	0.06	3.00	I	MS			
4748169	S4-84012-J	Robert C. Breshears	Robert & Loy Breshears	998	11.00	June 30, 1889	0.06	2.75	I&F	MS			
4756850	S4-84066-J	Santos Cantu	Santos & Nickie Cantu	1259	2.00	June 30, 1873	0.01	0.50	I	SF			
4754969	S4-84016-J	Leo Jennings	Mike Casteel	1573	12.00	June 30, 1891	0.06	3.00	I	NF			
4755001	S4-84084-J	John W. Christenson, et al.	John W. & Marilyn Christenson	262	64.00	March 21, 1881	0.32	16.00	I	NF			
4756594	S4-84043-J	David Pellicer	Joseph & Donna Pellicer & Thomas & Kerri Pellicer	1123	0.00		0.00						
4756580	S4-84042-J	Joseph G. Pellicer	Joseph & Donna Pellicer & Thomas & Kerri Pellicer	1123	96.00	June 30, 1873	0.44	24.00	I	SF			
4748222	S4-84054-J	Betty L. Peterson	Betty Peterson & estate	1984	18.00	June 30, 1889	0.10	4.25	I	MS			
4748190	S4-84014-J	Herbert Resen	Herbert & Anne Resen	336	4.00	June 30, 1880	0.03	1.00	I	MS			
4756664	S4-84021-J	James W. Rightmire, Sr.	James. W. Rightmire, Sr. etal	386 (A) 3444 and (A) 6408	68.00	June 30, 1873	0.34	17.00	I	SF			
4748245	S4-84057-J	Patricia A. Schneider	Bob & Patricia Schneider	1617	38.00	June 30, 1873	0.19	9.50	I&S	MS			
4754981	S4-84022-J	Gerardo Borrego	Beverly Fay Smith	1441	20.00	April 4, 1891	0.10	5.00	I&S	NF			
4756695	S4-84028-J	Clark Smith	Clark & Merry Smith, D&D Barnes	1257	28.00	June 30, 1873	0.14	7.00	I	SF			
4756705	S4-84017-J	Snow Mountain Ranch, Inc.	Snow Mountain Ranch	00696 (A) 02340	210.40	June 30, 1873	1.05						
4756768	S4-84069-J	Snow Mountain Ranch, Inc.	Snow Mountain Ranch	00696 (A) 02340	40.00	June 30, 1884	0.20	10.00	I&S	SF	portion already trusted ?		
4748270	S4-84059-J	Squire Ingham Company	Squire Ingham Company	1198	161.00	June 30, 1869	1.05	39.00	I&F	MS			
4748256	S4-84058-J	Martin St. George	Martin & Michelle St. George	1054 (transposes=1045)	16.00	June 30, 1873	0.08	4.00	I&S	MS			
4756932	S4-84030-J	Eugene Wayne Stevenson	Eugene Wayne Stevenson	208	33.00	June 30, 1870	0.17	8.25	I	SF	17 West Lateral	8.25	0.17
4748145	S4-84032-J	Eugene Wayne Stevenson	Eugene Wayne Stevenson	212	136.00	June 30, 1870	0.68	34.00	I	MS	12 West Lateral	31.53	0.63
4748145	S4-84032-J	Eugene Wayne Stevenson	Eugene Wayne Stevenson	212	0.00	June 30, 1870	0.00	0.00	I	MS	2,3 East Lateral	1.75	0.04
4756979	S4-84034-J	David B Dillon	Gail L. & Dona R. Thornton	7108 (9)	20.00	June 30, 1872	0.10	5.00	I	SF	13 West Lateral	5.00	0.10

WR_DOC_ID	WR_Doc_NR	Previous Owner	Most Recent Owner	Court Claim #	AF/Year	Priority Date	CFS	Acres	Use	Stream	CCWUA Turnout	CCWUA Turnout Acres	CCWUA Turnout Flow (CFS)
4756839	S4-84056-J	Jo Ann Tollefson	Jo Ann Tollefson	458	40.00	June 30, 1870	0.20	10.00	I&S	SF	18 West Lateral	10.00	0.20
4756675	S4-84041-J	Allen Wagner	Allen Wagner	1017	2.00	June 30, 1873	0.01	0.50	I	SF			
4756942	S4-84077-J	Israel Alma Parra	Lorne J. & Olivia J. Weitz	1833	61.20	June 30, 1871	0.31	15.30	I	SF			
4756955	S4-84078-J	Israel Alma Parra	Lorne J. & Olivia J. Weitz	1833	58.80	June 30, 1872	0.29	14.70	I	SF			
4748287	S4-84060-J	Lorn J. Weitz	Lorne J. & Olivia J. Weitz	00699 (A) 00743	40.00	??June 30, 1895	0.20	10.00	I&S	MS			
4756607	S4-84044-J	Allen Ray Wilkinson	Allen R. & Wanda L. Wilkerson	8188	20.00	June 30, 1873	0.10	5.00	I&S	SF			
4756968	S4-84079-J	John William Blair	John W. & Wanda S. Blair	13585	7.00	June 30, 1873	0.04	2.00	I&S	SF			
4755012	S4-84085-J	John W. Christenson, et al.	John W. & Marilyn Christenson	262	46.00	July 20, 1881	0.00						
4755060	S4-84080-J	John W. Christenson, et al.	John W. & Marilyn Christenson	262	120.00	June 30, 1874	0.00						
4756790	S4-84071-J	Cowychee Ditch Company	Cowychee Ditch Company	1505	200.00	June 30, 1884	1.00	50.00	I&S	SF			
4748300	S4-84045-J	Fred Cyr	Fred & Rosemary Cyr	1046	10.50	June 30, 1889	0.10	3.50	I	MS			
4748200	S4-84035-J	Wayne K. Kisner	Wayne & Vicki Kisner	00851 (A) 06756	57.50	June 30, 1880	0.32	11.50		MS			
4756753	S4-84068-J	Snow Mountain Ranch, Inc. (C	Snow Mountain Ranch	00696 (A) 02340	100.00	June 30, 1884	0.50	25.00	I&S	SF	portion already trusted ?		
4756991	S4-84033-J	David B Dillon	Gail L. & Dona R. Thornton	7108 (60)	20.00	June 30, 1871	0.10	5.00	I	SF	14 West Lateral	5.00	0.10
4748270	S4-84059-J	Squire Ingham Company	Squire Ingham Company	1198	161.00	June 30, 1869	1.05	39.00	I&F	MS			
4756655	S4-84026-J	Eugene Wayne Stevenson	Eugene Wayne Stevenson	216	236.00	June 30, 1870	1.18	59.00	I	SF	11 West Lateral	59.00	1.18
Totals					5405.95		25.18	1246.03				393.13	7.91

Codes

I = Irrigation Water

S = Stock Water

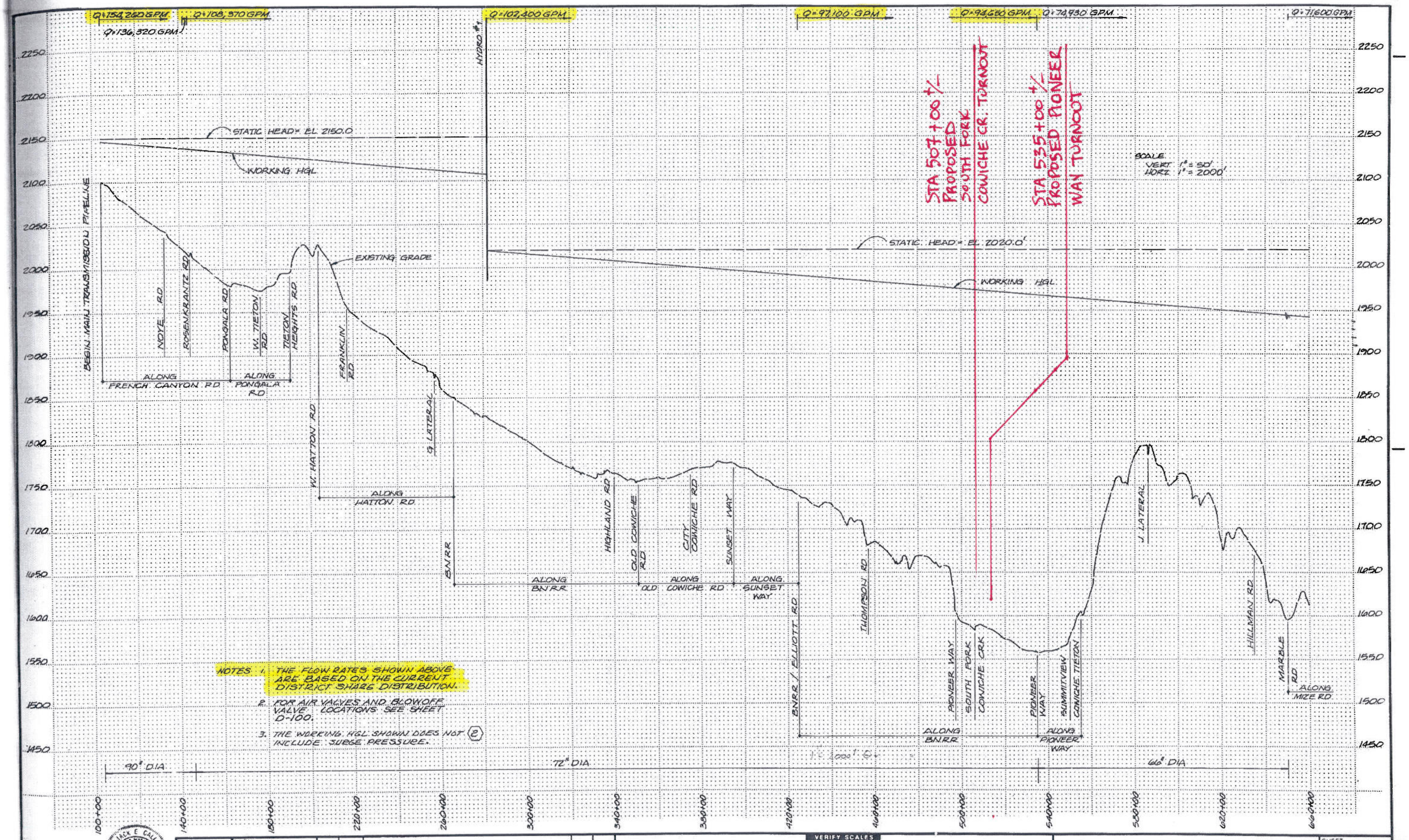
F = Frost Protection Water

MS = Main Stem of Cowiche Creek

SB = South Branch of Cowiche Creek

NB = North Branch of Cowiche Creek

Appendix E
Mainline Hydraulic Profile



NOTES
1. THE FLOW RATES SHOWN ABOVE ARE BASED ON THE CURRENT DISTRICT SHARE DISTRIBUTION.
2. FOR AIR VALVES AND BLOWOFF VALVE LOCATIONS SEE SHEET D-100.
3. THE WORKING HGL SHOWN DOES NOT INCLUDE SURGE PRESSURE.

JACK E. GALE — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER

CH2M HILL

DSGN R.T. STILLMUNKES
DR BISHOP
CHK L.J. FARR
APVD H.O. WILSON

NO	DATE	REVISION	BY	APVD
2	6/83	ADD NOTE 3	RN	HW

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

YAKIMA-TIETON IRRIGATION DISTRICT
YAKIMA, WASHINGTON

MAIN TRANSMISSION PIPELINE

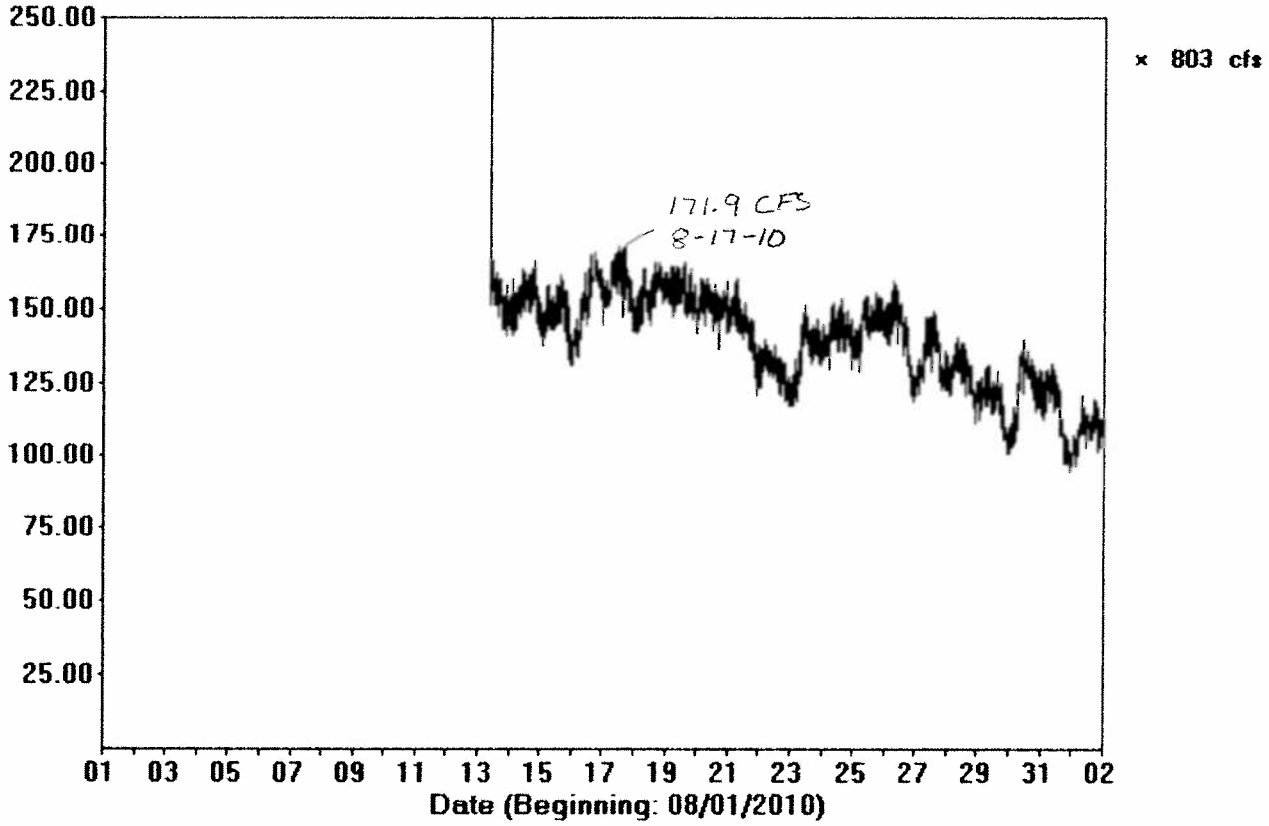
REHABILITATION AND BETTERMENT PROJECT

HYDRAULIC PROFILE

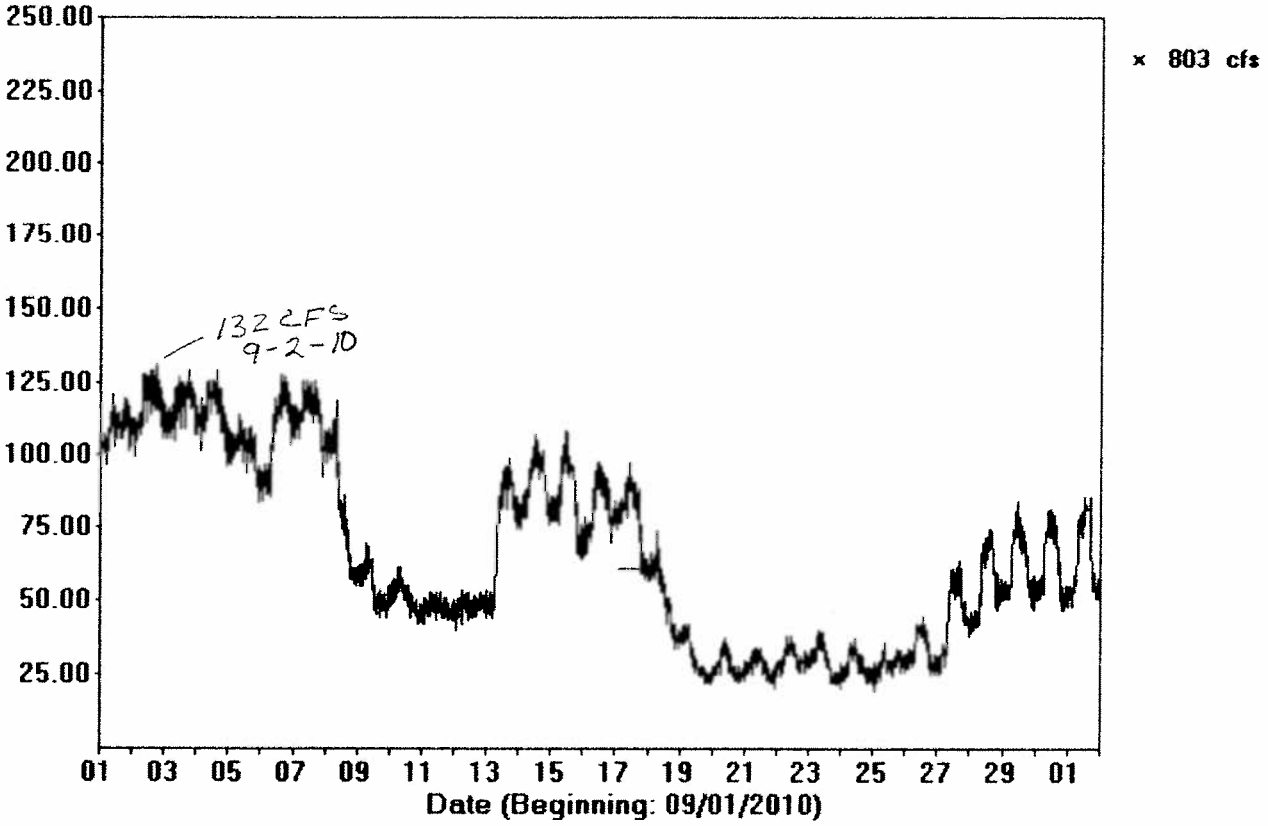
SHEET G-108
4
DATE DEC 1982
PROJ NO S15245.E1

Appendix F
Hydrostation #1 Flow Data

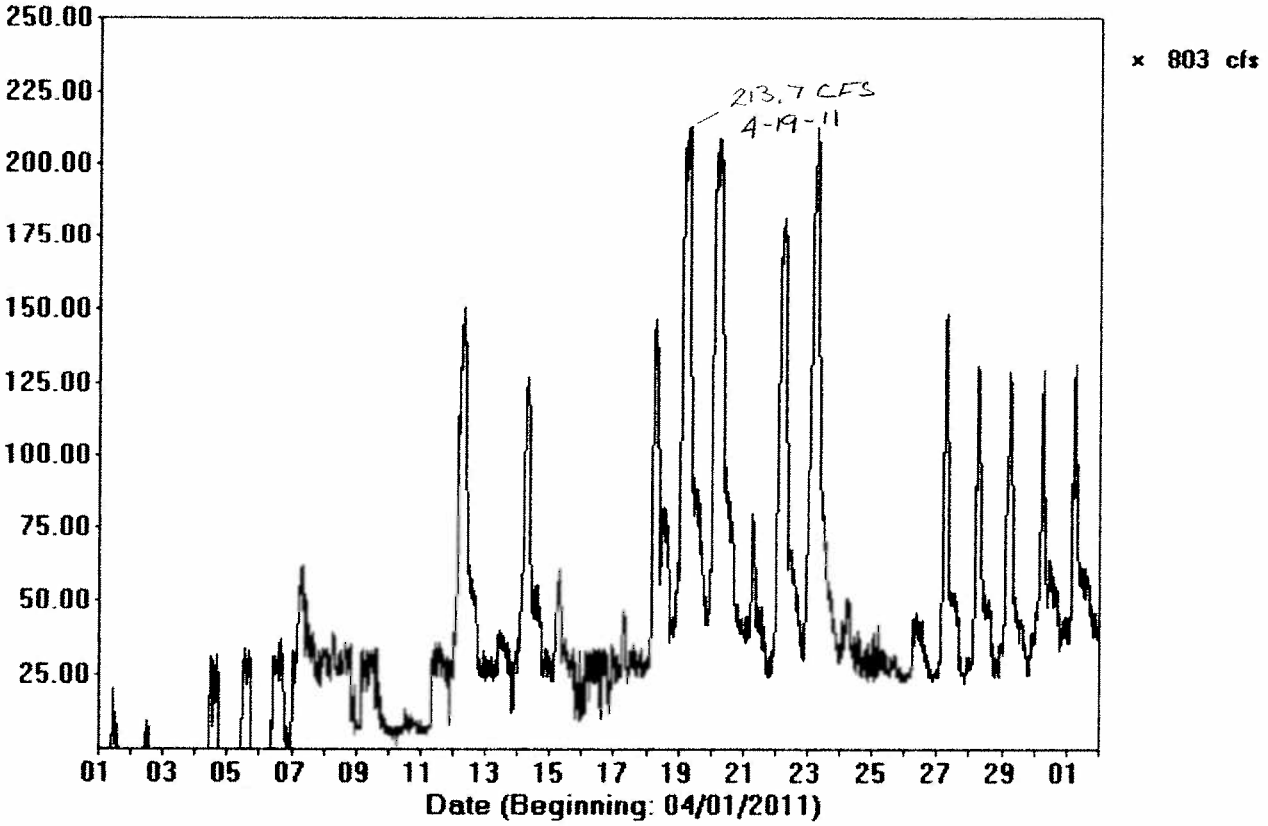
Readings Starting: 08/01/2010



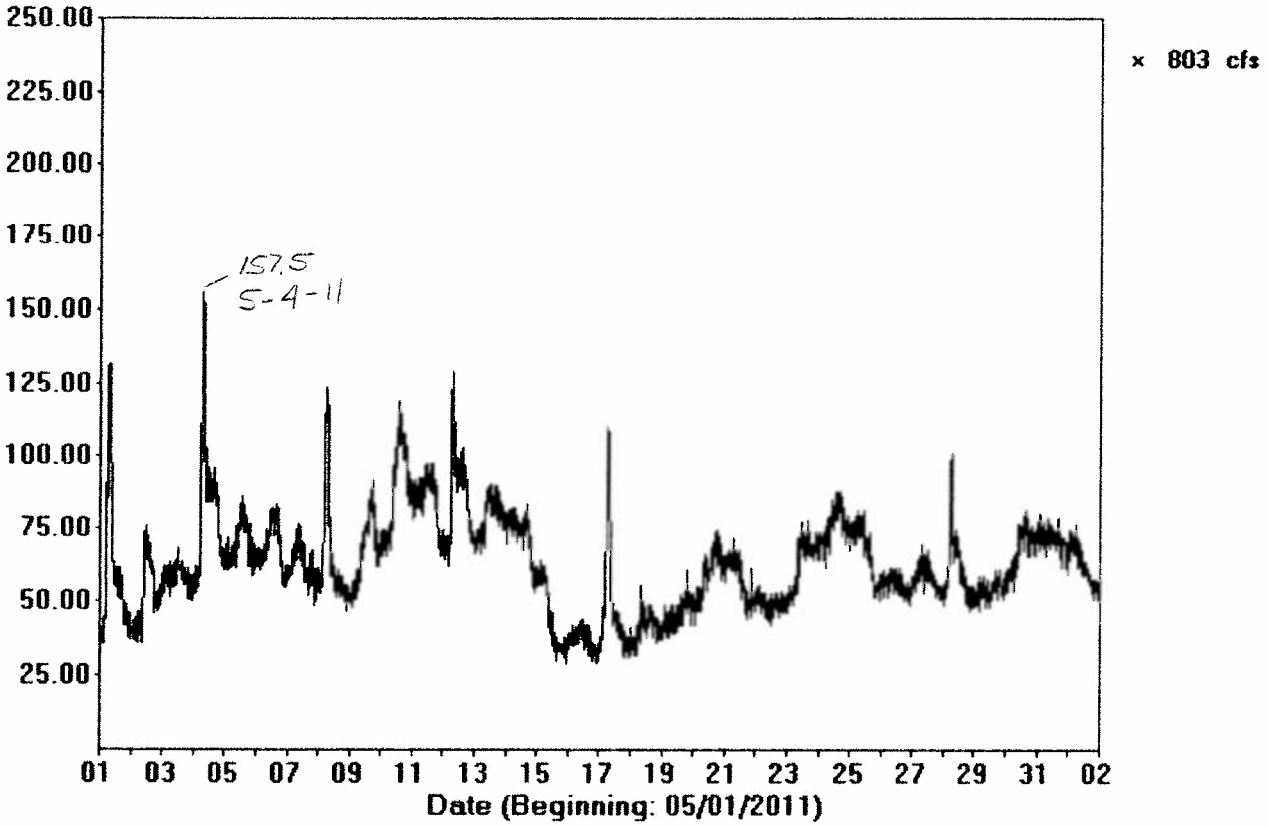
Readings Starting: 09/01/2010



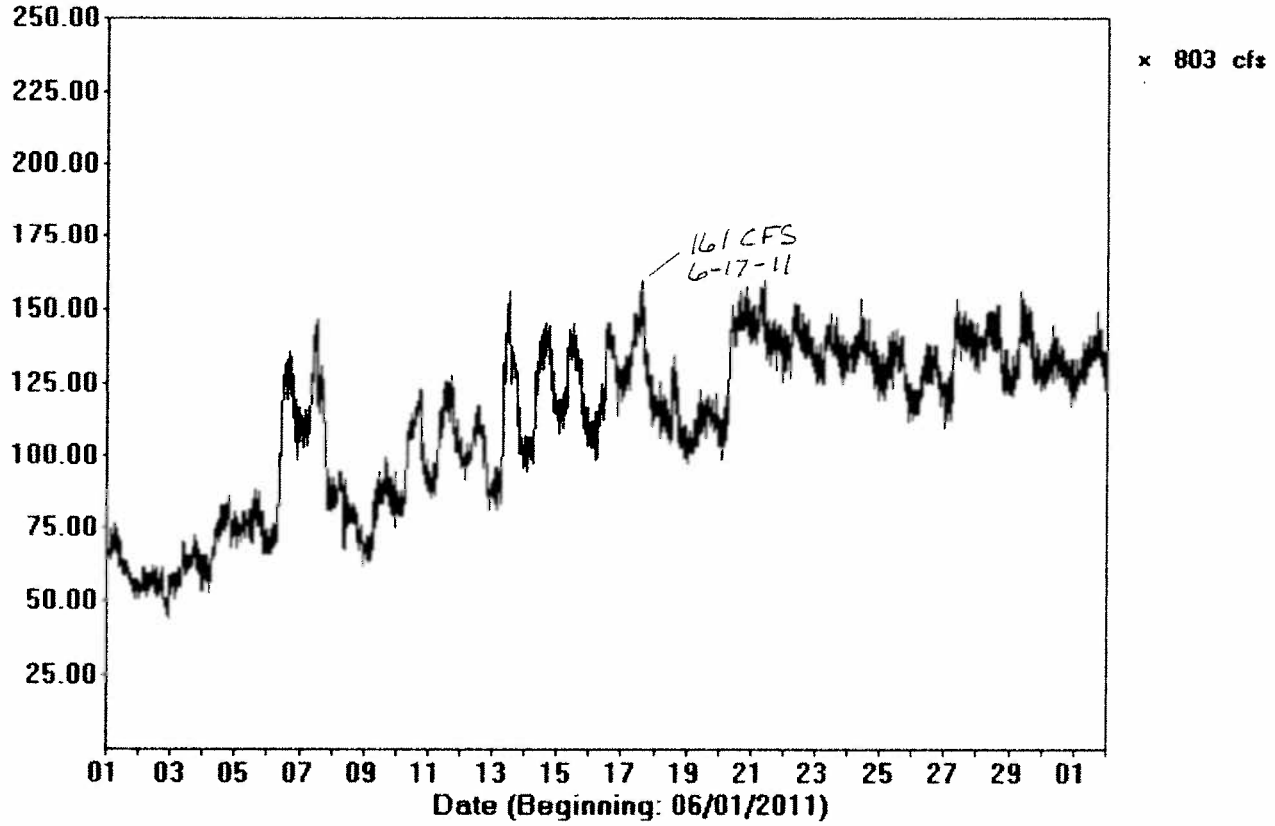
Readings Starting: 04/01/2011



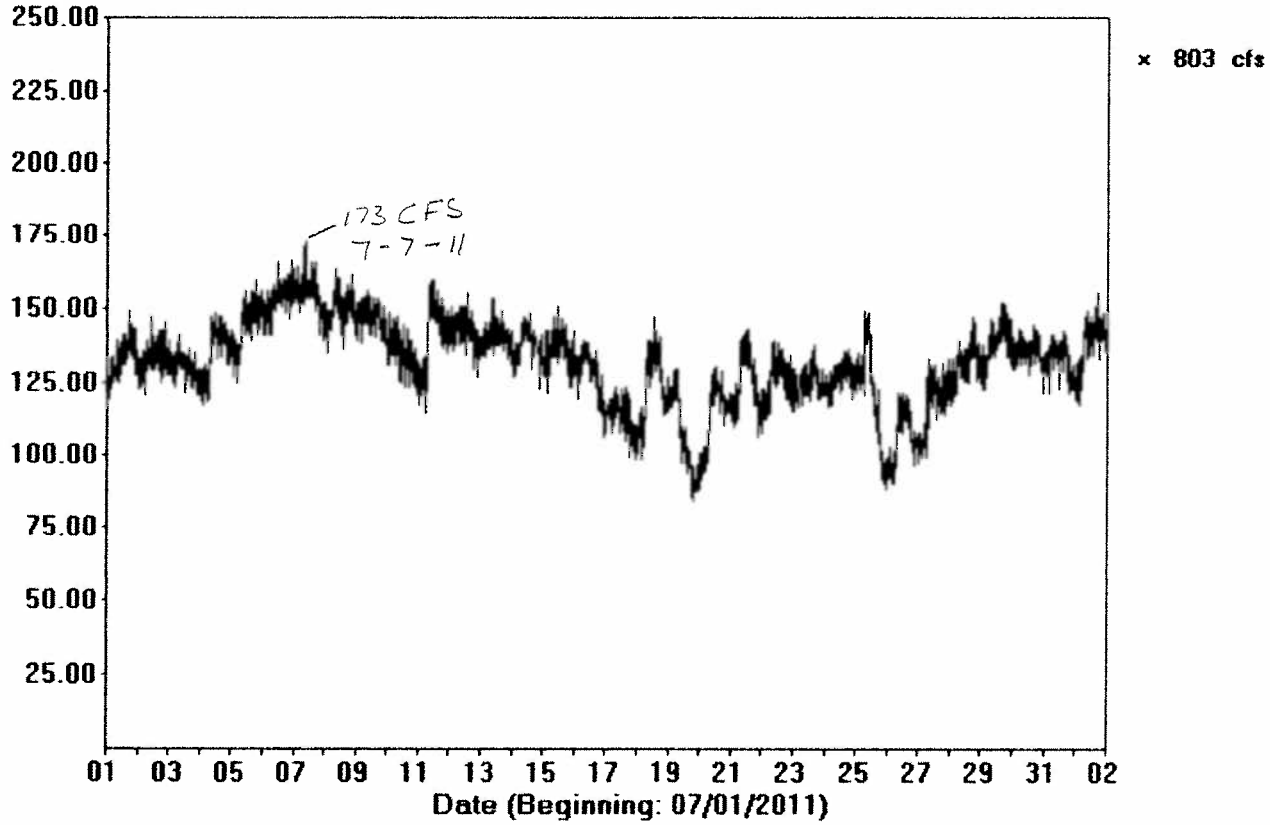
Readings Starting: 05/01/2011



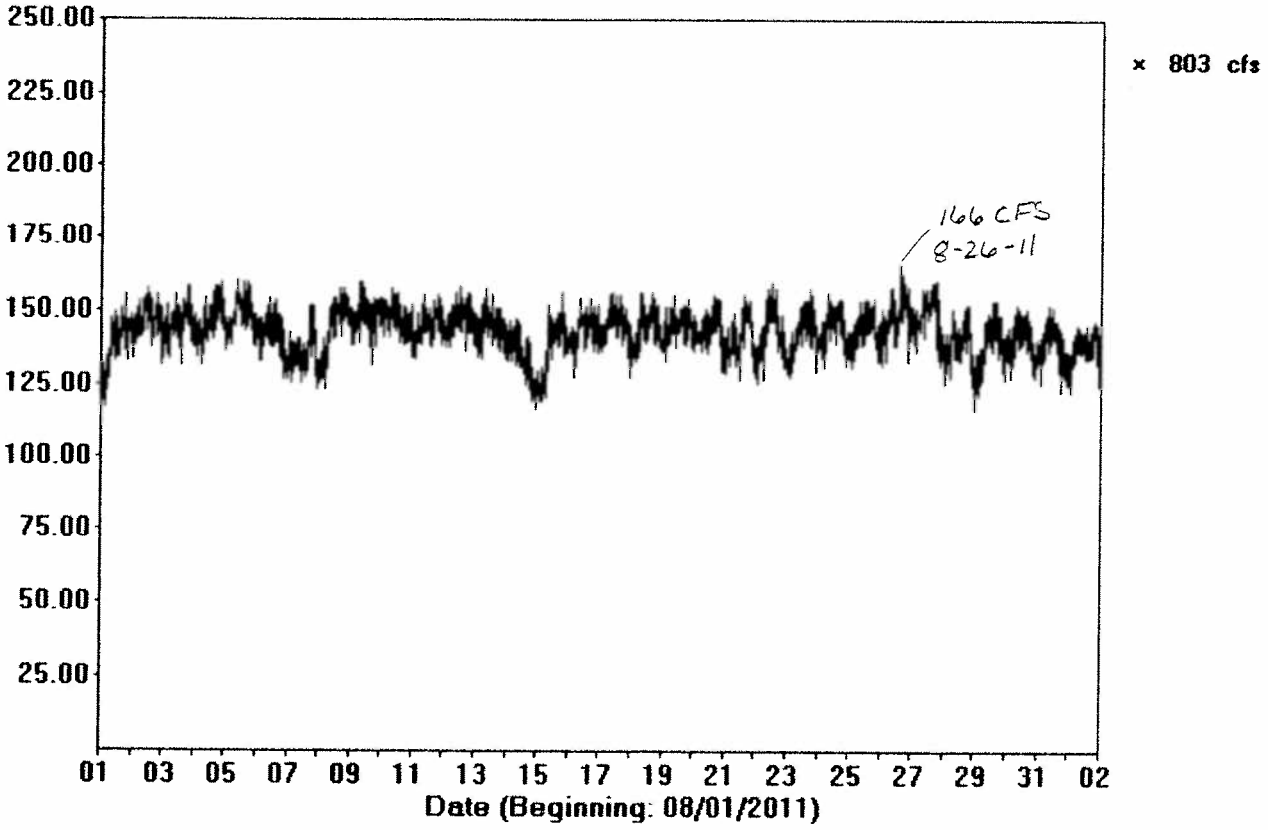
Readings Starting: 06/01/2011



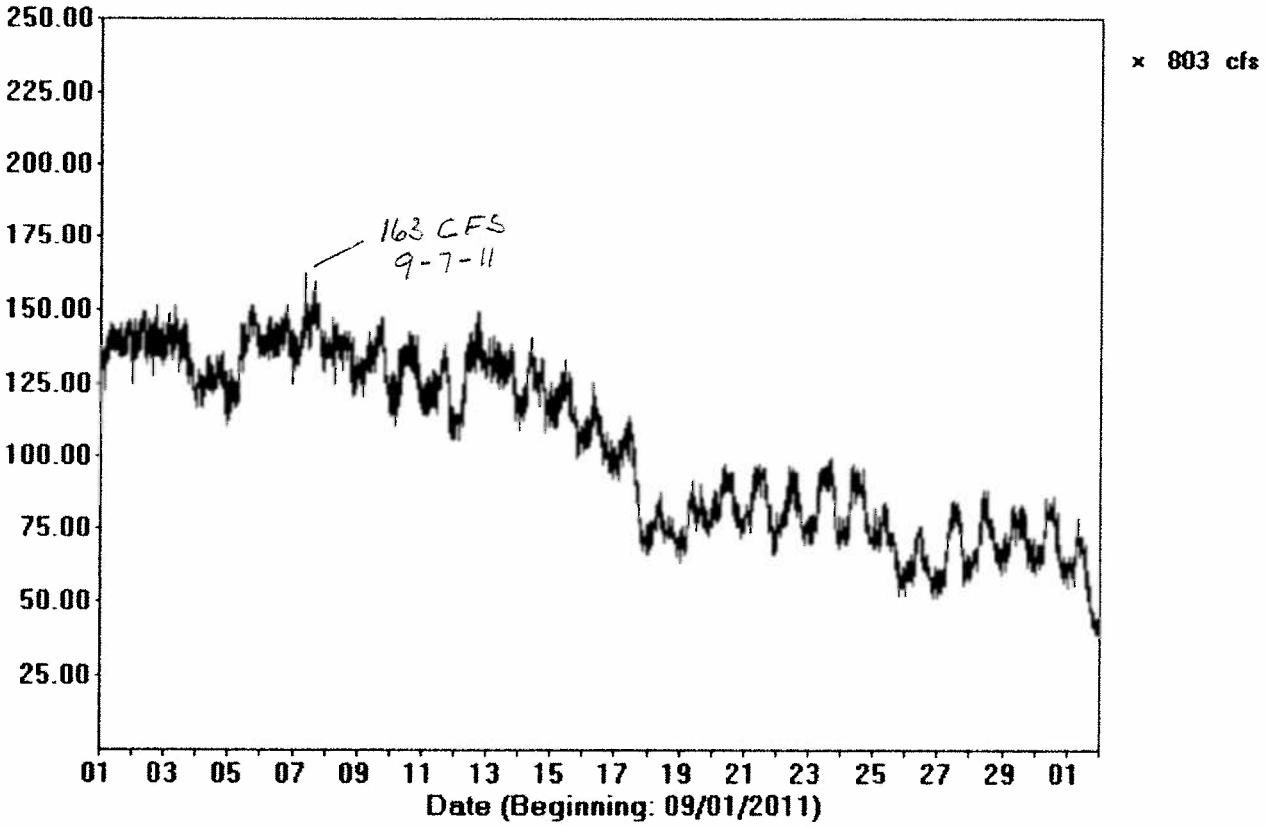
Readings Starting: 07/01/2011



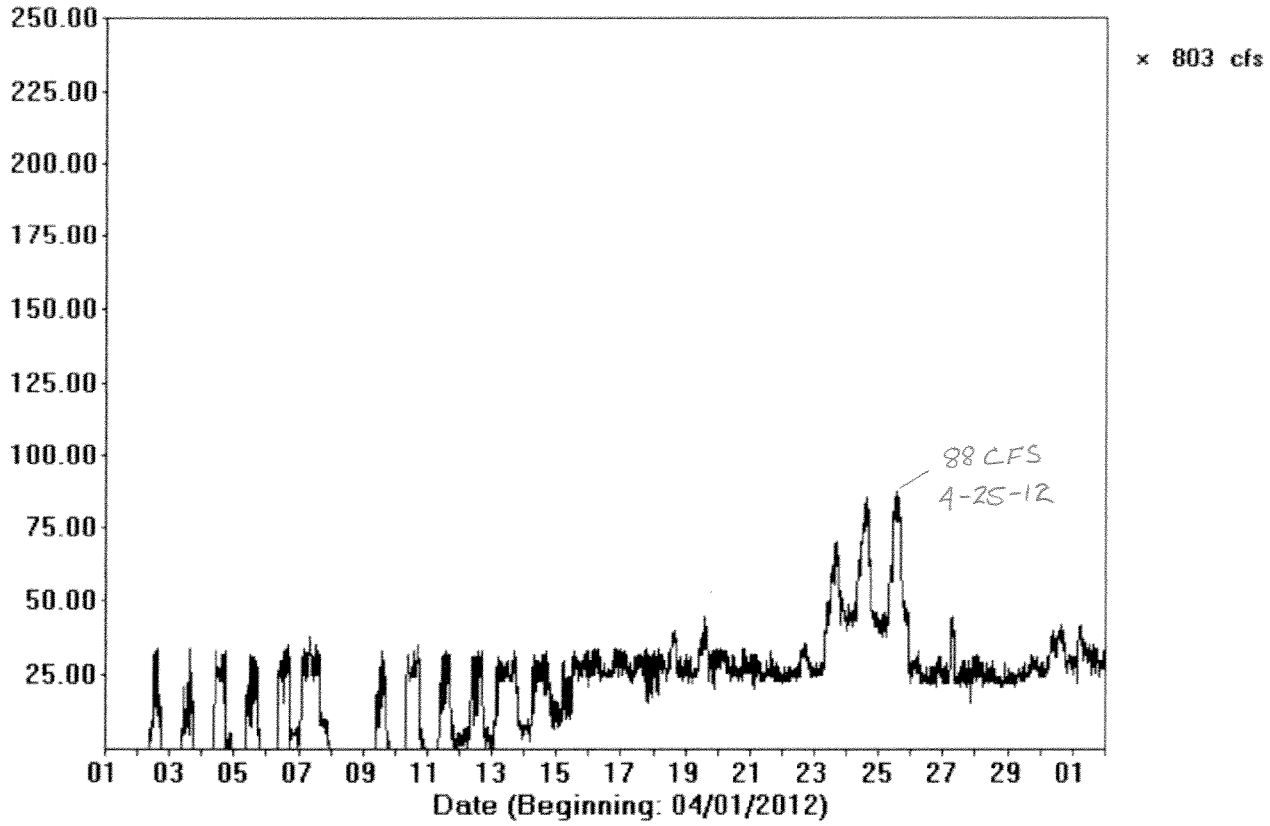
Readings Starting: 08/01/2011



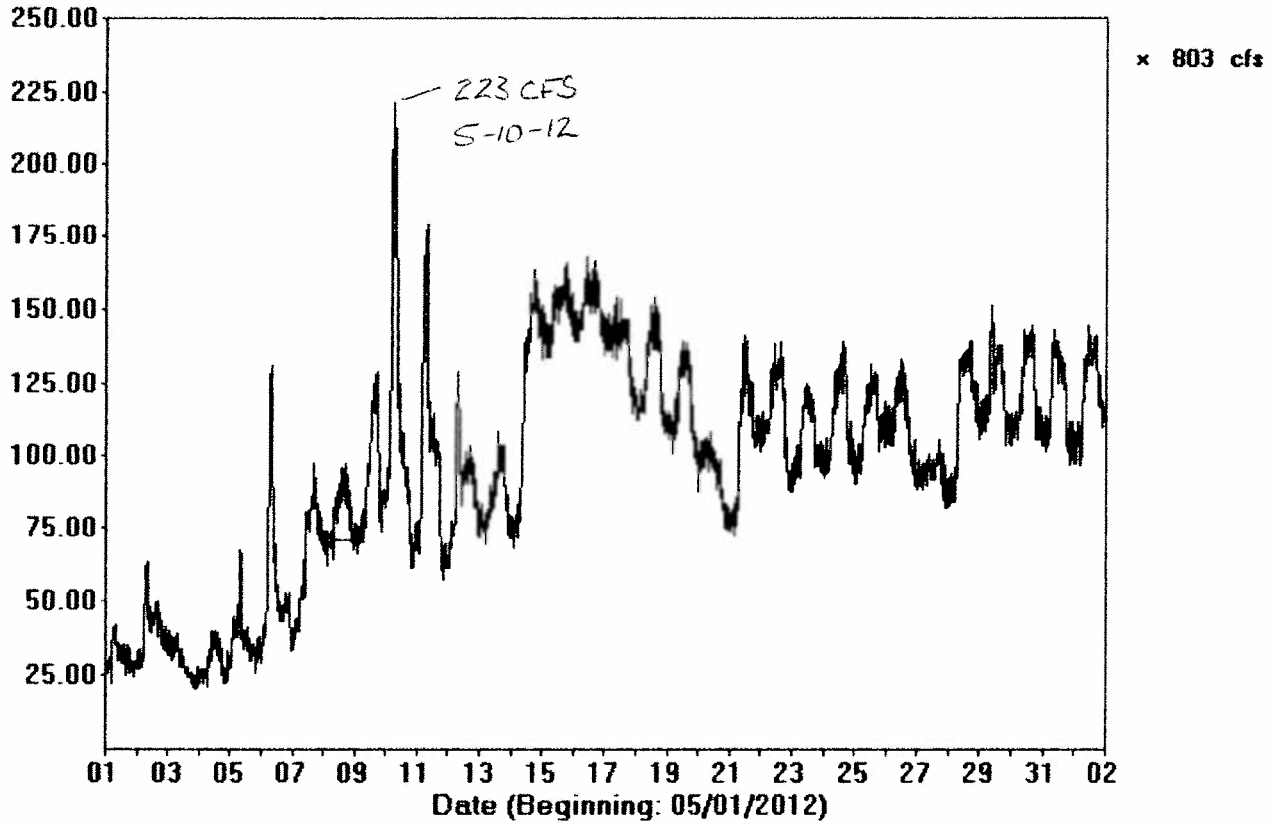
Readings Starting: 09/01/2011



Readings Starting: 04/01/2012



Readings Starting: 05/01/2012



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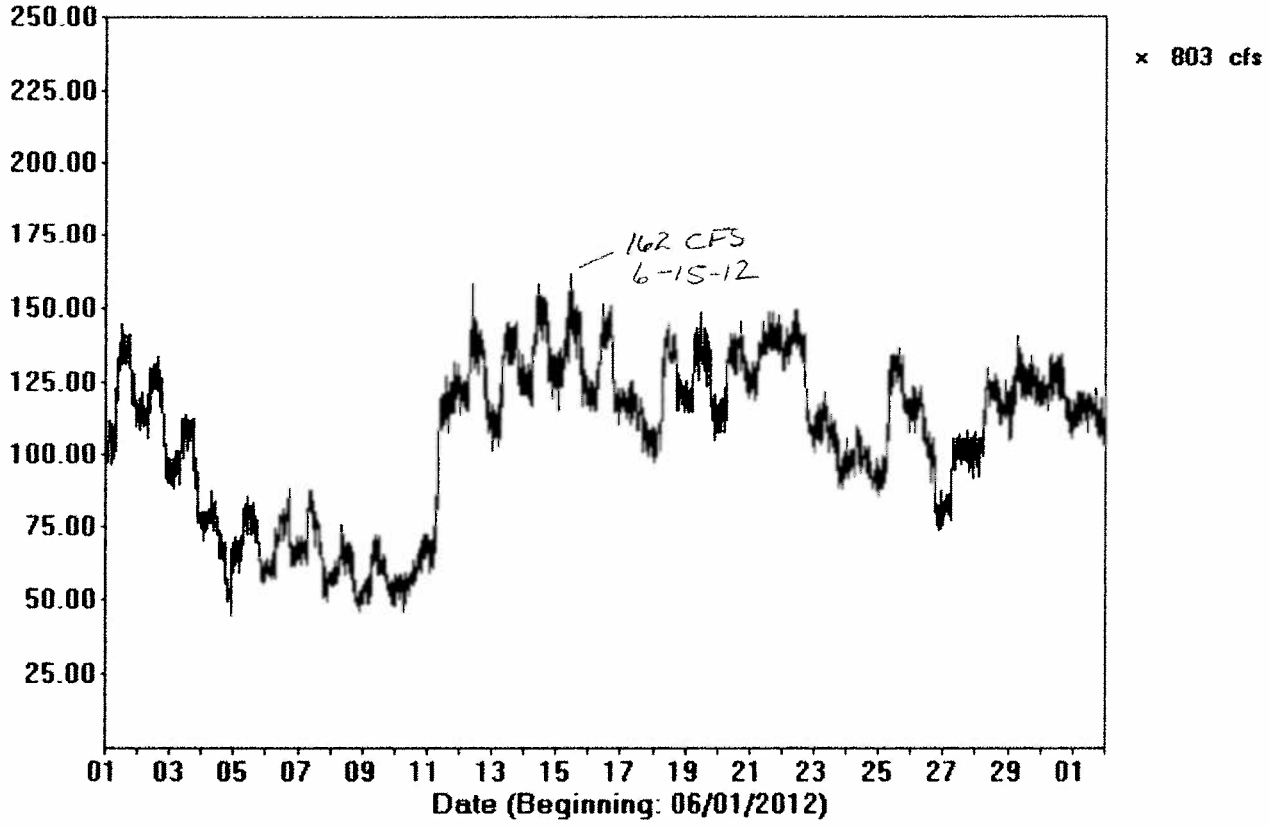
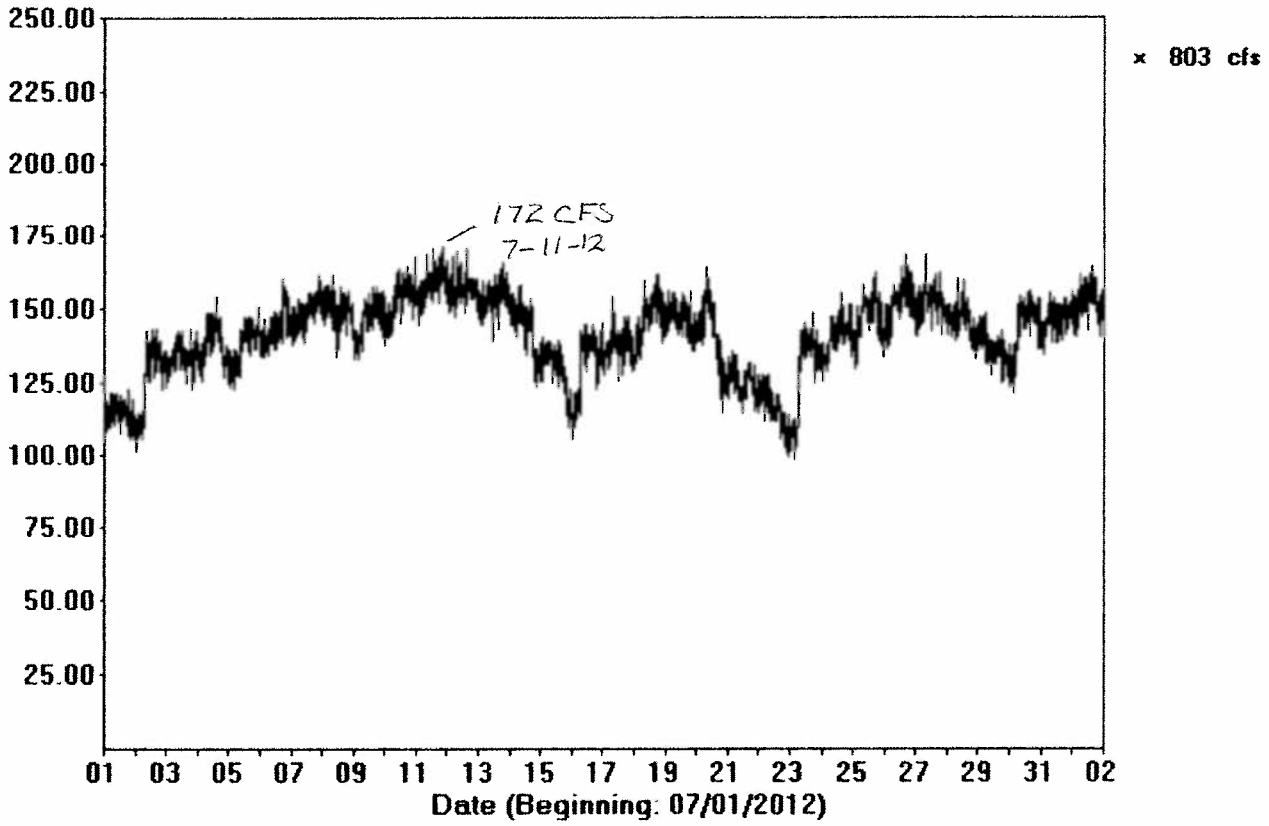


Readings Starting: 07/01/2012



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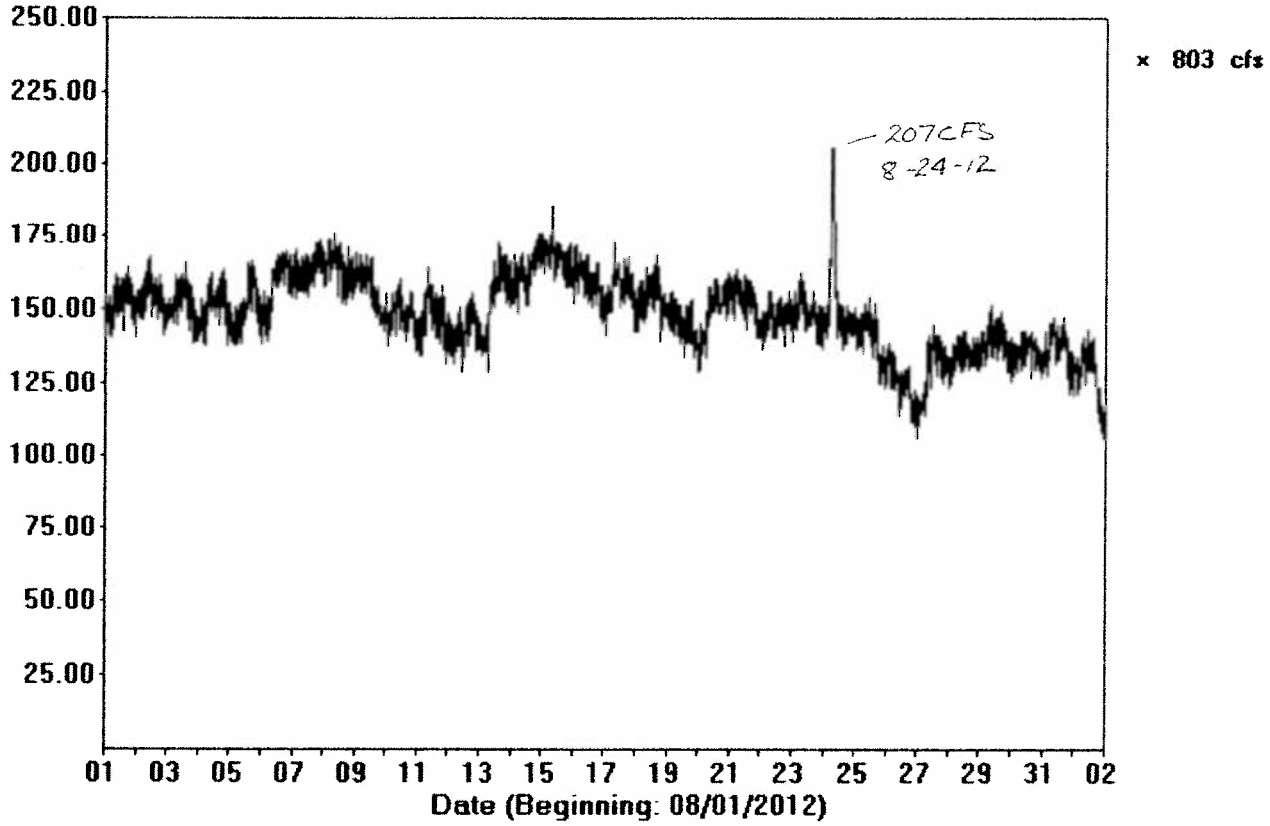
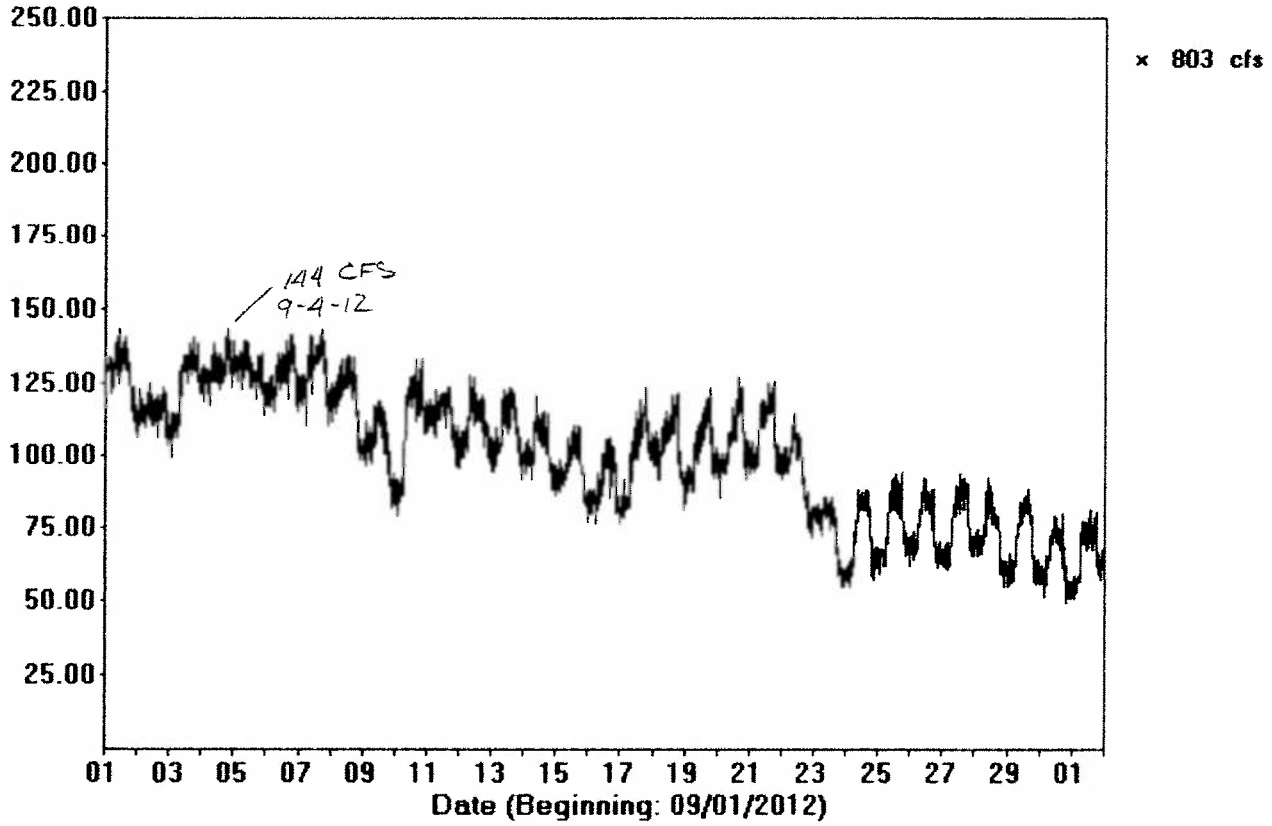


Readings Starting: 09/01/2012



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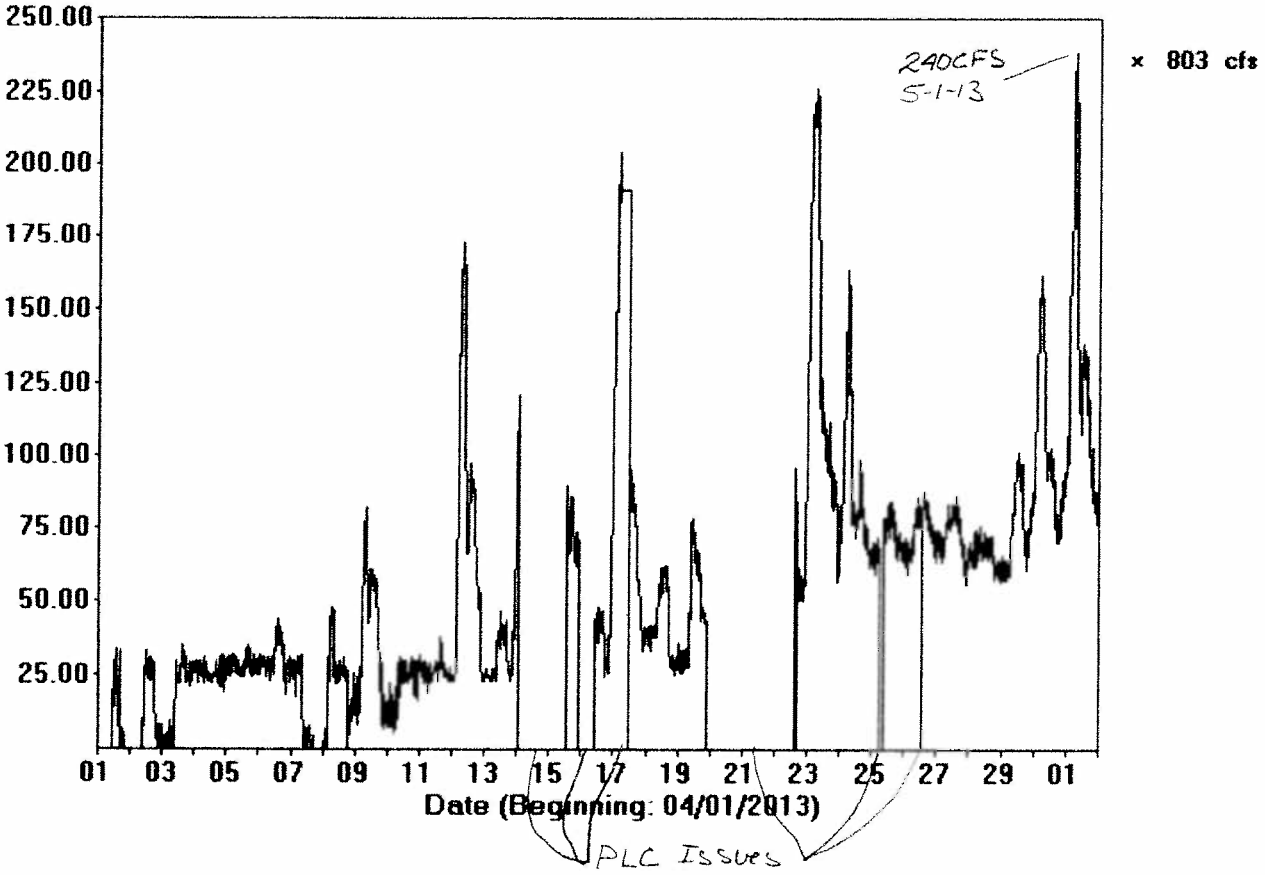

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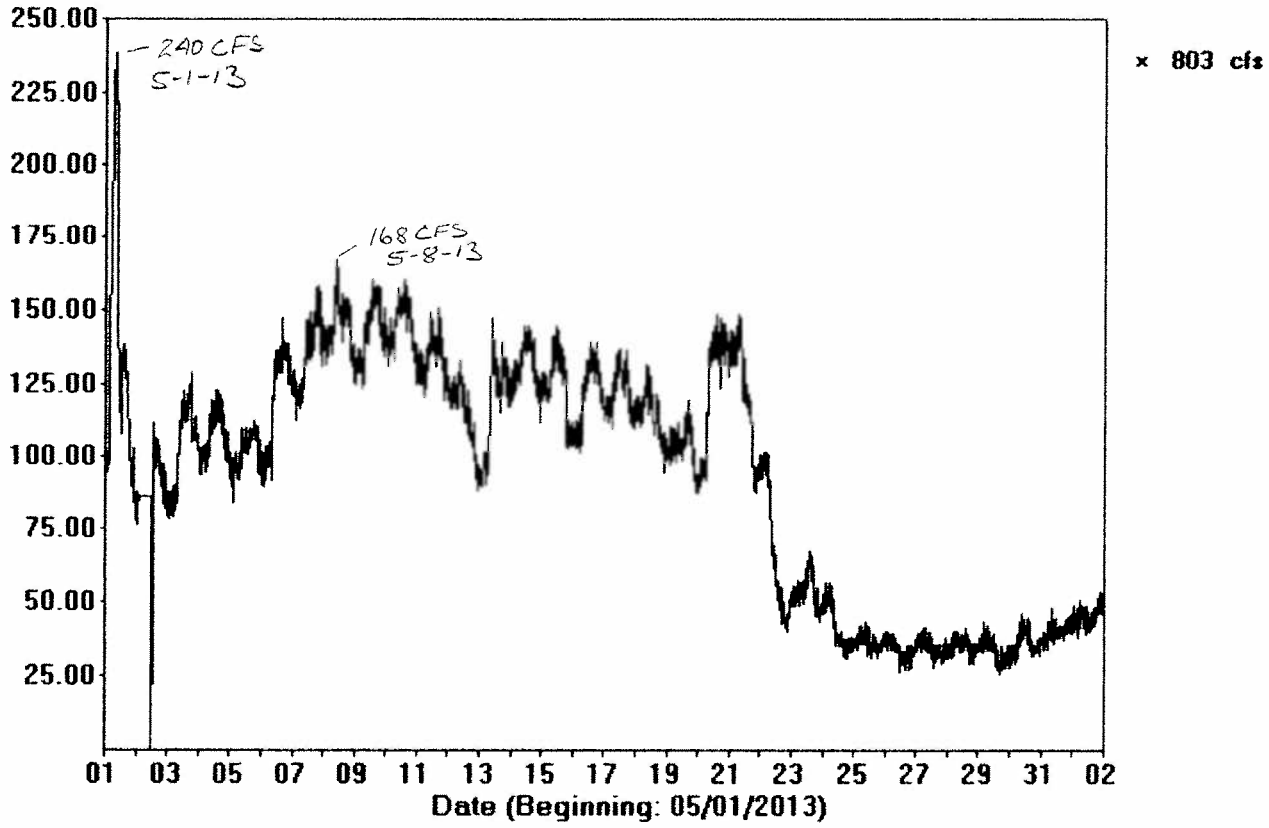

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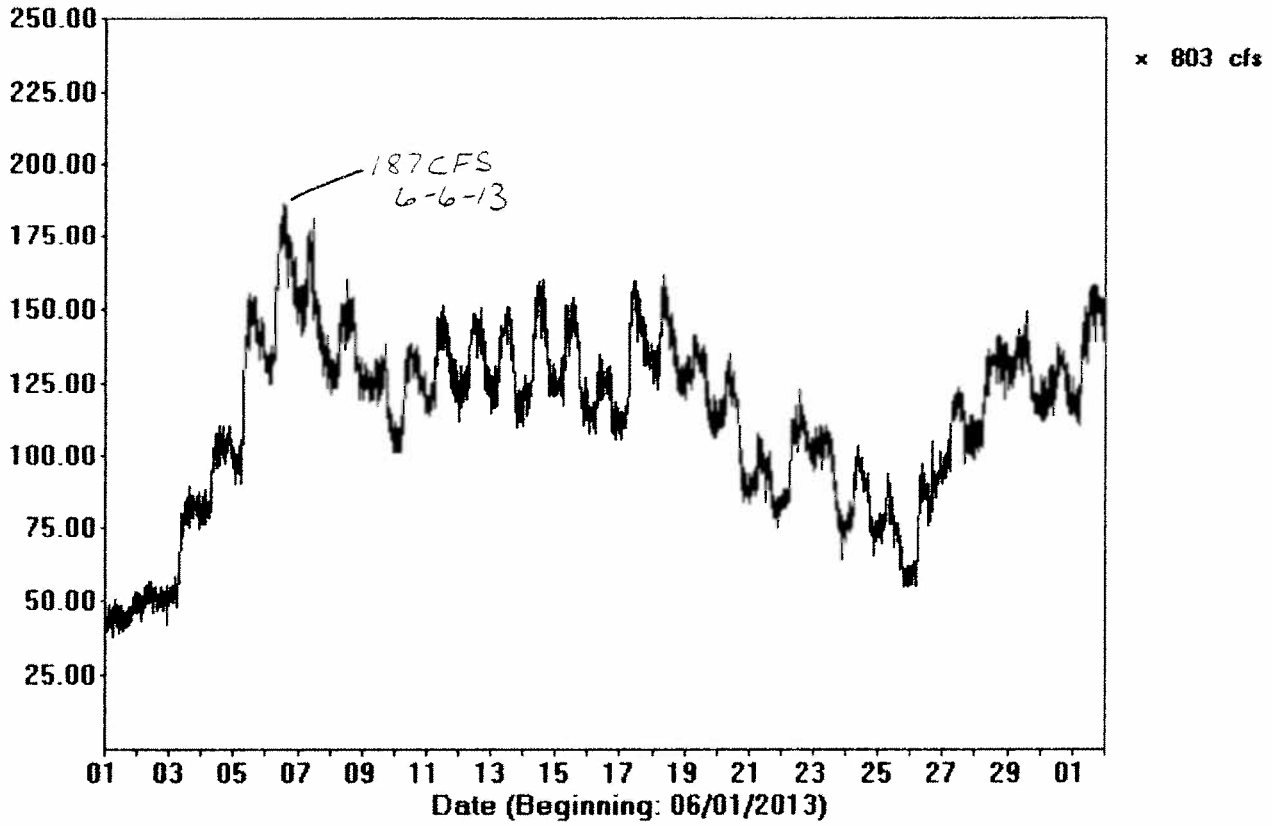

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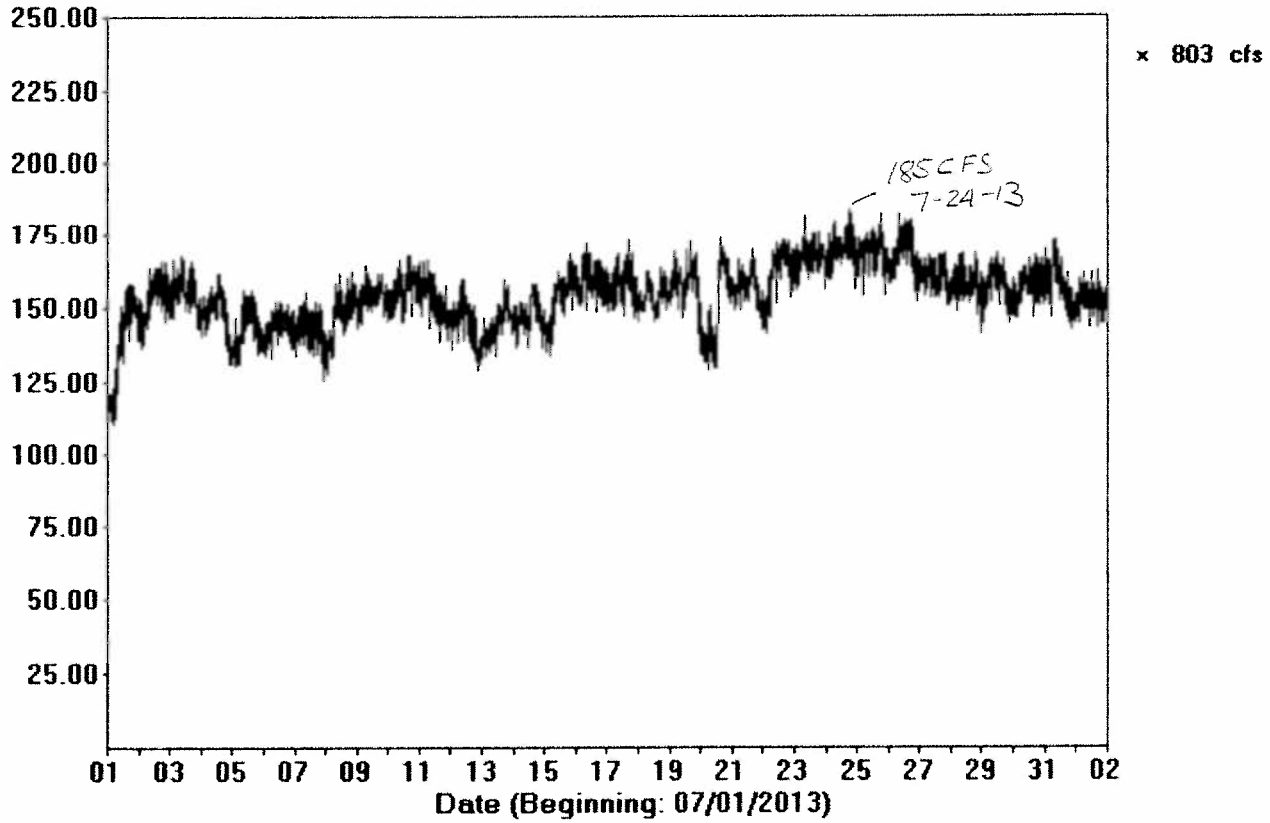
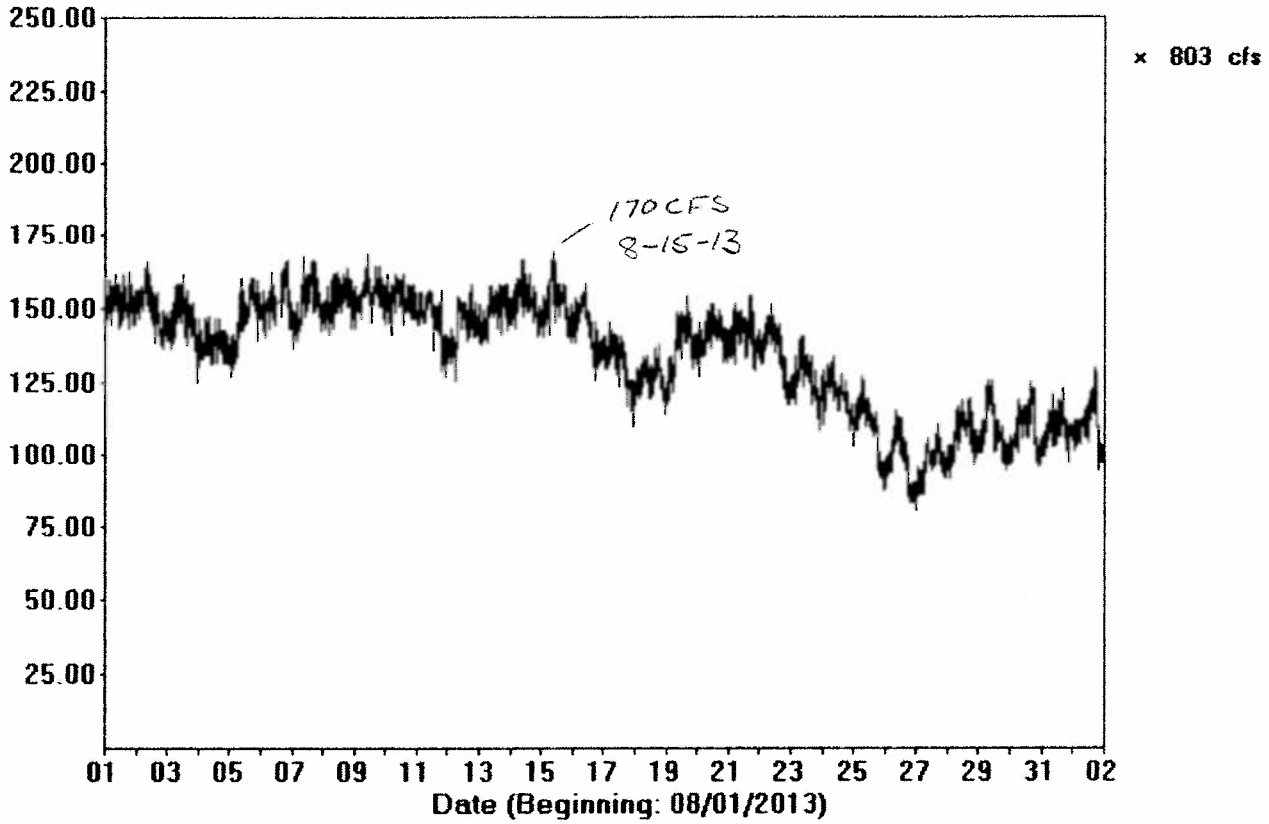


Readings Starting: 08/01/2013



Readings Starting: 09/01/2013