Yakima River Basin Study

Wapatox Canal Conveyance Improvements Technical Memorandum

U.S. Bureau of Reclamation
Contract No. 08CA10677A ID/IQ, Task 4.2

Prepared by

Anchor QEA

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Columbia-Cascades Area Office

State of Washington
Department of Ecology
Office of Columbia River

February 2011

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The Mission of the Washington State Department of Ecology is to protect, preserve and enhance Washington's environment, and promote the wise management of our air, land and water for the benefit of current and future generations.

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1.0 Introduction

This technical memorandum describes potential improvements to the Wapatox Canal that are being evaluated as part of the Yakima River Basin Study. It also summarizes potential challenges and benefits if the project moves forward. The canal, which is owned and operated by the U.S. Bureau of Reclamation (Reclamation), diverts water from the lower Naches River at river mile 17.1, northwest of the town of Naches (see Figure 1 at end of this technical memo).

This memorandum, requested by Reclamation as part of the Yakima River Basin Study, describes results of an analysis of possible measures that would increase the efficiency of irrigation diversions from the canal and improve instream flows and habitat conditions in the lower Naches River.

The Wapatox Canal project is one of the structural and operational changes being studied to improve water resources management in the Yakima Basin. The other potential changes are described in other technical memoranda as part of the Yakima River Basin Study.

1.1 Background

The Wapatox Canal is more than 8 miles long and was originally constructed to deliver water to two power plants. Reclamation purchased the power water right from PacifiCorp in March 2003 and discontinued operation of the power plants, with the intention of using as much of the water right as possible to increase flows in the lower Naches River. Reclamation retained responsibility for delivering approximately 50 cubic feet per second (cfs) to Wapatox Ditch Company and some individual small water users who are supplied irrigation water from the Wapatox Canal.

While diversions have been reduced from the peak flow rates (400 to 450 cfs) used for power generation before 2003, records from recent years indicate that Reclamation has typically had to divert as much as 130 to 140 cfs from the lower Naches River to deliver approximately 50 cfs to water users along the Wapatox Canal. The excess water diverted (called “carriage water”) is conveyed through the entire length of the canal and discharged back to the lower Naches River below the Wapatox Power Plant.

Reclamation requested an evaluation of improvements that would either reduce the carriage water diverted to Wapatox Canal or allow consolidation of irrigation diversions from the lower Naches River. As shown in Figure 1, the Naches Selah Irrigation District (NSID) diverts water from the lower Naches River approximately 1.3 miles upstream of the Wapatox Canal diversion. The NSID Canal parallels the Wapatox Canal 30 to 40 feet higher in elevation along the hillsides on the east side of the Naches River Valley.

A 2005 study evaluated the potential for pumping from the Wapatox Canal to the NSID Canal to allow consolidation of the NSID and Wapatox diversions (NSID Conservation Plan Supplement – Wapatox Canal Feasibility Report, J-U-B Engineers 2005). Other potential improvements that have been identified by Reclamation include the following:

- Replacement of the existing Wapatox Canal with a pipeline designed to reduce diversions required to serve irrigators

- Consolidation of downstream diversions, including the City of Yakima and the Gleed Ditch diversions, into the Wapatox Canal diversion to improve river channel and floodplain conditions.

The feasibility of the potential improvements will depend on cost and on the willingness of potential participants such as NSID, the City of Yakima and the Gleed Ditch. The benefits of consolidating diversions will need to outweigh the construction and operations and maintenance costs of the project.

1.2 Existing Diversions and Water Rights

Diversions that could be impacted by one of the Wapatox Canal improvement alternatives include the following:

- NSID (River Mile 18.3)
- Wapatox Canal (River Mile 17.1)
- City of Yakima Water Treatment Plant (WTP) (River Mile 9.7)
- Gleed Ditch (River Mile 9.4)

Table 1 summarizes the existing water rights and flow rates measured at each of these diversions as recorded on Reclamation's Hydromet network of flow monitoring stations.

Table 1. Existing Water Rights, Diversion Flows for NSID, Wapatox Canal, City of Yakima WTP, and Gleed Ditch

Diversion	Water Right Instantaneous Flow Rate, Qi (cfs) [1]	Average May-Aug Recorded Flow Rate 2005-2009 (cfs) [2]	Peak Recorded Flow Rate 2005-2009 (cfs) [2]
NSID	152.8	129.8	141.0
Wapatox Canal – Reclamation	450.0	126.1	144.0
Wapatox Ditch Company	50.0		
Individual Water Users along Wapatox Canal	0.67		
City of Yakima WTP	39.0	21.3	32.3
Gleed Ditch	29.4	33.5	38.6

[1]Source: Ecology, 2010
[2]Source: Reclamation, 2010, using the following flow-monitoring stations on Reclamation's Hydromet network: NSID = Station NSCW (QJ); Wapatox Canal – Reclamation = Station WOPW (QJ); City of Yakima WTP = Station CYDW (QJ); Gleed Ditch = GLEW (QJ)

1.3 Existing Facilities

The existing Wapatox Canal system consists of the following facilities (see Figure 1):

- A diversion structure and headgates at the Naches River adjacent to Highway 12, just south of the Highway 12 bridge over the Naches River

- A fish screen and bypass 1,500 feet downstream of the Naches River on the north side of U.S. Highway 12.
- A trapezoidal, concrete-lined canal varying from 9.2 to 15 feet wide and 5.7 to 6 feet deep
- Culverts, at least three elevated flumes, and other canal structures
- Naches Drop Plant, 5.4 miles downstream of the diversion, with an elevation drop of about 53 feet (not in use; flow bypasses plant)
- Wapatox Power Plant, 8.3 miles downstream of the diversion, with an elevation drop of about 150 feet (not in use; flow bypasses plant)

1.4 Project Purpose

The improvements to the Wapatox Canal are intended to accomplish the following objectives:

- Improve the efficiency of diversions from the lower Naches River
- Reduce diversions and increase flows in the lower Naches River
- Improve floodplain and habitat conditions in the lower Naches River

Improvements to the canal and consolidation of irrigation diversions from the Naches River may also result in additional benefits to irrigators, including upgraded irrigation delivery facilities, the opportunity to abandon existing facilities that are difficult to operate and maintain, and pressurization of deliveries to some water users. These benefits are discussed in more detail below.

2.0 Description of Preliminary Alternatives

The following three preliminary alternatives were identified for an initial screening-level evaluation:

- Pump to NSID from the Wapatox Canal
- Replace the Wapatox Canal with a pipeline sized to serve water users along the canal
- Replace the Wapatox Canal with a pipeline sized to serve water users along the canal, the City of Yakima WTP and Gleed Ditch

A brief analysis was completed of each of these alternatives and reviewed with the YRBWEP workgroup. The alternatives are summarized below.

2.1 Pump to NSID from the Wapatox Canal

This alternative would include construction of a pump station on the Wapatox Canal to deliver up to 136 cfs to the NSID Canal for irrigation use. NSID customers upstream of the pump station would be served from the Wapatox Canal through a separate pump or pumps and a network of delivery pipelines. The existing NSID diversion and a portion of the NSID Canal upstream of the pump station would be abandoned.

This alternative was studied in detail in the 2005 NSID Conservation Plan Supplement to the Wapatox Canal Feasibility Report. The selected improvement project identified in that report

included a pump station near Wenas Grade that would deliver 136 cfs from the Wapatox Canal to the NSID Canal downstream of the Wenas Grade flume.

The following flows were used for analysis of this alternative:

- For Wapatox Ditch Company and individual small water users – 50 cfs at the Wapatox Canal diversion, 40 cfs at the drop plant, 30 cfs below the drop plant, and 15 cfs at the end of the canal
- For NSID – 136 cfs pumped to NSID at the Wenas Grade location
- Total for Wapatox Canal – 186 cfs at the Wapatox Canal diversion, 178 at Wenas Grade, 40 cfs at the drop plant, 30 cfs below the drop plant, and 15 cfs at the end of the canal

Improvements would include the following:

- A pump station designed to deliver 136 cfs at a total dynamic head of 40 feet from the Wapatox Canal to the NSID main canal downstream of the Wenas Grade flume
- A pipeline designed to replace the Wapatox Canal, including 84-inch-diameter pipe from the fish screen to the pump station and 36- to 60-inch-diameter pipe downstream of the pump station
- Additional upgrades to serve NSID customers upstream of the pump station

Benefits of implementing this alternative would include:

- Potentially reducing diversions from the Naches River
- Allowing removal of the NSID diversion at River Mile 18.3, which would reduce or eliminate the work that NSID has to perform in the river each irrigation season to divert water to the NSID Canal
- Improve fish passage conditions
- Allowing NSID to abandon portions of the NSID main canal that are difficult to operate and maintain, including a series of trestles and flumes

Challenges related to implementation of this alternative would include:

- A spill pipeline would need to be constructed from the pump station to the Naches River to discharge excess water from the canal when the pumps shut down
- The improvements would result in the long-term expense of power for pumping

2.2 Pipeline to Serve Water Users along Wapatox Canal

This alternative would consist of replacing the existing Wapatox Canal with a pipeline sized to deliver only the 50 cfs that Reclamation is responsible for delivering to Wapatox Ditch Company and the individual small water users. As currently configured, Reclamation has had to divert up to 140 cfs from the Wapatox Canal to deliver 50 cfs to irrigators. The intent of this alternative would be to design and operate the pipeline to minimize or eliminate carriage water diverted and spilled at the end of the pipeline.

The following flows were used for analysis of this alternative:

- For Wapatox Ditch Company and individual small water users – 50 cfs at the Wapatox Canal diversion, 40 cfs at the drop plant, 30 cfs below the drop plant, and 15 cfs at the end of the canal

Improvements would include the following:

- A pipeline designed to replace the Wapatox Canal, including 60-inch-diameter pipe from the fish screen to the Naches Drop Plant and 36- to 42-inch-diameter pipe downstream of the Naches Drop Plant

Benefits of implementing this alternative would include:

- Improve operations of the Wapatox Canal and reduce operations and maintenance costs
- Reducing diversions from the Naches River by reducing the carriage water needed in the Wapatox Canal, which would provide instream flow benefits for fish habitat

Challenges related to implementation of this alternative would include:

- It would not address water supply or operational issues for neighboring diversions such as the NSID, City of Yakima, and Gleed Ditch diversions
- The City of Yakima would have to divert all of its water directly from the river rather than capturing carriage water spilled from the Wapatox Canal at the tailrace

2.3 Pipeline to Serve Wapatox Canal, City of Yakima, and Gleed Ditch

This alternative would consist of replacing the existing Wapatox Canal with a pipeline sized to deliver flows to the City of Yakima WTP and the Gleed Ditch, in addition to the 50 cfs that Reclamation is responsible for delivering to current water users along the canal. The intent of this alternative would be to design and operate the pipeline to minimize the carriage water needed, and consolidate the City of Yakima and Gleed Ditch diversions into the Wapatox Canal diversion to allow improvements to the floodplain and habitat in the lower Naches River below the Wapatox Canal diversion.

The following flows were used for analysis of this alternative:

- For Wapatox Ditch Company and individual small water users – 50 cfs at the Wapatox Canal diversion, 40 cfs at the drop plant, 30 cfs below the drop plant, and 15 cfs at the end of the canal
- For City of Yakima WTP – 39 cfs delivered through piped connection at end of canal
- For Gleed Ditch – 29.4 cfs delivered through piped connection at end of canal
- Total for Wapatox Canal – 118.4 cfs at the Wapatox Canal diversion, 108.4 cfs at the drop plant, 98.4 cfs below the drop plant, and 83.4 cfs at the end of the canal

Improvements would include the following:

- A pipeline designed to replace the Wapatox Canal, including 72-inch-diameter pipe from the fish screen to the Naches Drop Plant and 60- and 72-inch-diameter pipe downstream of the Naches Drop Plant

- A 42-inch pipeline connecting the Wapatox Canal pipeline to the City of Yakima WTP intake below the Wapatox Power Plant near the bottom of the existing tailrace
- A 36-inch pipeline connecting the Wapatox Canal pipeline to the Gleed Ditch near U.S. Highway 12, approximately 2,000 feet south of the existing tailrace

Benefits of implementing this alternative would include:

- Reducing diversions from the Naches River by reducing the carriage water needed in the Wapatox Canal, which would provide instream flow benefits for fish habitat.
- Consolidation of diversions would allow improvement of floodplain and habitat conditions in the lower Naches River downstream of the Wapatox Canal diversion

Challenges related to implementation of this alternative would include:

- Higher costs due to requirements for larger pipe
- Space and topographical constraints related to installing a pipeline between the existing Wapatox Canal and the Gleed Ditch

3.0 Description of Alternative Selected for Further Study

The initial screening of preliminary alternatives and discussion with the YRBWEP workgroup resulted in the selection of an alternative for further analysis that represents a combination of the preliminary alternatives. The selected alternative includes the following major improvements:

- Pumping to NSID from the Wapatox Canal
- Replacement of the Wapatox Canal with a pipeline or combination of new canal lining and pipeline sized to serve water users along the canal, flows pumped to NSID, and deliveries to the City of Yakima WTP and Gleed Ditch

A more detailed description of the major components of the selected alternative follows. Figure 1 is a plan view of the Wapatox Canal showing the general location and alignment improvements.

3.1 Wapatox Canal Improvements

The selected alternative would include upgrades to the Wapatox Canal designed to accomplish the following objectives:

- Reduce or eliminate the carriage water needed in the Wapatox Canal which is diverted at the head of the canal and then spilled back to the Naches River at the downstream end of the canal
- Reduce or eliminate other canal losses
- Provide sufficient conveyance capacity for deliveries to water users along the Wapatox Canal, NSID, the City of Yakima WTP, and the Gleed Ditch so the diversions can be consolidated into the Wapatox Canal diversion

The potential improvements include piping and/or replacing the lining along portions of the existing Wapatox Canal, as shown in Table 2. The options would include installation of new canal lining from the fish screen to the Wenas Grade Pump Station and replacement of the existing canal with a pipeline downstream of the pump station (Option 1), or replacement of the entire existing canal downstream of the fish screen with a pipeline (Option 2).

Table 2. Potential Alternative Wapatox Canal Improvements

Reach		Option 1		Option 2	
Description	Length (Feet)	Pipe Size (Inches)	Lining (Square Yards)	Pipe Size (Inches)	Lining (Square Yards)
Fish Screen to Wenas Grade	26,690		108,200	96	
Wenas Grade to End of Canal	15,820	60		60	

Option 1 – This option would include replacement of the existing canal lining and canal structures with a new lining and structures from the fish screen to the Wenas Grade Pump Station. The new lining would result in a canal with the same dimensions and capacity as the existing canal. A 60-inch pipeline would be installed downstream of the Wenas Grade Pump Station and would operate under pressure. Maximum static pressure in the pipeline would be approximately 38 psi at the downstream end of the pipeline near the end of the existing canal. Under Option 1, the pipeline would not be designed to spill at the Wapatox Power Plant, as the existing canal currently does. Consequently, the project would need to include a way to spill excess water in the canal that is not delivered to NSID through the Wenas Grade Pump Station or conveyed through the pipeline to water users along the Wapatox Canal, the City of Yakima, or the Gleed Ditch. A 60-inch spill pipeline would be needed to convey excess water from the canal near the Wenas Grade Pump Station to the Naches River.

Option 2 – This option would replace the existing canal from the fish screen to the Wenas Grade Pump Station with a 96-inch-diameter pipeline. This reach of the pipeline would be designed to normally operate under low-pressure conditions (up to 10 psi). Water not conveyed through the pipeline to users would be returned to the river at the pipe inlet, so there would be no need for a separate spill pipeline. A 60-inch pipeline would be installed downstream of the Wenas Grade Pump Station and would operate under pressure. Maximum static pressure in the pipeline would be approximately 38 psi at the downstream end of the pipeline near the end of the existing canal.

3.2 Wenas Grade Pump Station

The selected alternative would include a pump station designed to deliver 136 cfs at a total dynamic head of 40 feet from the Wapatox Canal, upstream of the Naches Drop Plant, to the NSID Canal, downstream of the Wenas Grade flume. The two canals are only separated by about 35 feet of elevation and less than 300 horizontal feet at that location. The pump station and associated improvements would likely include:

- Three vertical turbine pumps, each sized to deliver 45 cfs at 40 feet of total dynamic head
- Variable-frequency drives
- Electrical service
- Pump controls
- A trash-rack and structure designed to divert canal water to a pump sump, if pumping from an open canal; or a 60-inch-diameter pipe connection to a pump sump, if pumping from a pipeline (see Wapatox Canal Replacement)
- A reinforced concrete pump sump
- A metal or concrete masonry unit pump station building
- Discharge pipe, fittings and valves for each pump, including a pump control or check valve, butterfly valve, and pressure switch and gage assembly
- A 60-inch-diameter discharge pipeline from the pump station to the NSID Canal
- A flow meter in a pre-cast vault or manhole structure
- Site improvements, including grading, drainage, access, and security fencing
- A delivery structure at the NSID Canal designed to dissipate energy and convey water to the open canal

3.3 Delivery to NSID Customers Upstream of Wenas Grade

The selected alternative would also need to include a series of small pump stations and delivery pipelines to boost water from the Wapatox Canal to NSID users that draw water from the NSID Canal upstream of the Wenas Grade flume. For this analysis, it was assumed that the total irrigation demand for NSID users upstream of the Wenas Grade flume would be approximately 8 cfs and that lift would typically be about 40 feet. Distribution pipelines would be installed to convey water from each pump station to nearby turnout locations along the existing NSID Canal.

Supplying NSID users upstream of the Wenas Grade flume from the Wapatox Canal would allow NSID to abandon its diversion and portions of the main canal upstream of the Wenas Grade flume. NSID currently has to move and replace rock in the Naches River during each irrigation season to maintain the diversion. Abandoning the diversion would reduce the amount of in-river work required. NSID would also benefit from the opportunity to abandon portions of the NSID Canal upstream of the Wenas Grade flume that are difficult to operate and maintain.

3.4 Delivery to City of Yakima WTP

Capacity would be provided for delivery to the City of Yakima WTP through the improved Wapatox Canal. The WTP intake is located on the west side of U.S. Highway 12 adjacent to the

tailrace from the Wapatox Power Plant. When excess water is spilled from the end of the canal through the tailrace, the City diverts some of the excess water through its intake to the treatment plant. When sufficient flow is not available in the tailrace, the City diverts water directly from the Naches River. The selected alternative would include a piped connection to the WTP intake from the Wapatox Canal pipeline. The connection would consist of 48- and 42-inch-diameter pipe designed for maximum static pressure of approximately 102 psi.

3.5 Delivery to Gleed Ditch

Capacity would also be provided for delivery to the Gleed Ditch from the downstream end of the Wapatox Canal pipeline. The Gleed Ditch diversion is located on the west side of U.S. Highway 12 approximately 2,000 feet south of the Wapatox Power Plant. The selected alternative would include a 36-inch pipeline to the Gleed Ditch from the Wapatox Canal pipeline designed for maximum static pressure of about 103 psi.

4.0 General Considerations for Selected Alternative

Successful implementation of this alternative would require solutions to the following challenges:

- Replacing existing facilities that were constructed many years ago could potentially reveal unexpected complications
- Installation of large-diameter pipelines, which would be difficult and expensive
- Elimination and consolidation of diversions, which would require coordination and cooperation among water users to construct, operate and maintain the improvements and provide consistent water supply to all users
- Space and topographical constraints during installation of a pipeline between the existing Wapatox Canal and the Gleed Ditch
- Long-term expense of power for pumping

Potential benefits of implementing this alternative would include:

- Reducing diversions from the Naches River by reducing the carriage water diverted to the Wapatox Canal, which would provide instream flow benefits for fish habitat
- Removal of the NSID, City of Yakima and Gleed Ditch diversions from the Naches River and consolidation into the existing Wapatox Canal diversion, which could reduce flood levels at the dams removed, allow floodplain processes to develop by not constraining the river, improve fish passage and improve habitat conditions in the Naches River
- Abandoning portions of the NSID Canal that are difficult to operate and maintain
- Decreased operations and maintenance costs of the Wapatox Canal and at diversions removed

5.0 Cost Estimates

Cost estimates for the Wapatox Canal improvements are outlined in a separate memorandum, *Costs of the Integrated Water Resource Management Plan*.

6.0 References

1. Ecology (Washington State Department of Ecology) 2010. Yakima River Basin Water Rights. Microsoft Access database file. Downloaded July 14, 2010.
2. J-U-B Engineers. *Conservation Plan Supplement – Wapatox Canal Feasibility Report. Naches Selah Irrigation District*. December 2005.
3. Reclamation (United States Bureau of Reclamation) 2010. Yakima Hydromet ARCHIVE Data Access. Available for download at http://www.usbr.gov/pn/hydromet/yakima/yakwebarcread.html. Downloaded August 6, 2010

7.0 List of Preparers

NAME	BACKGROUND	RESPONSIBILITY
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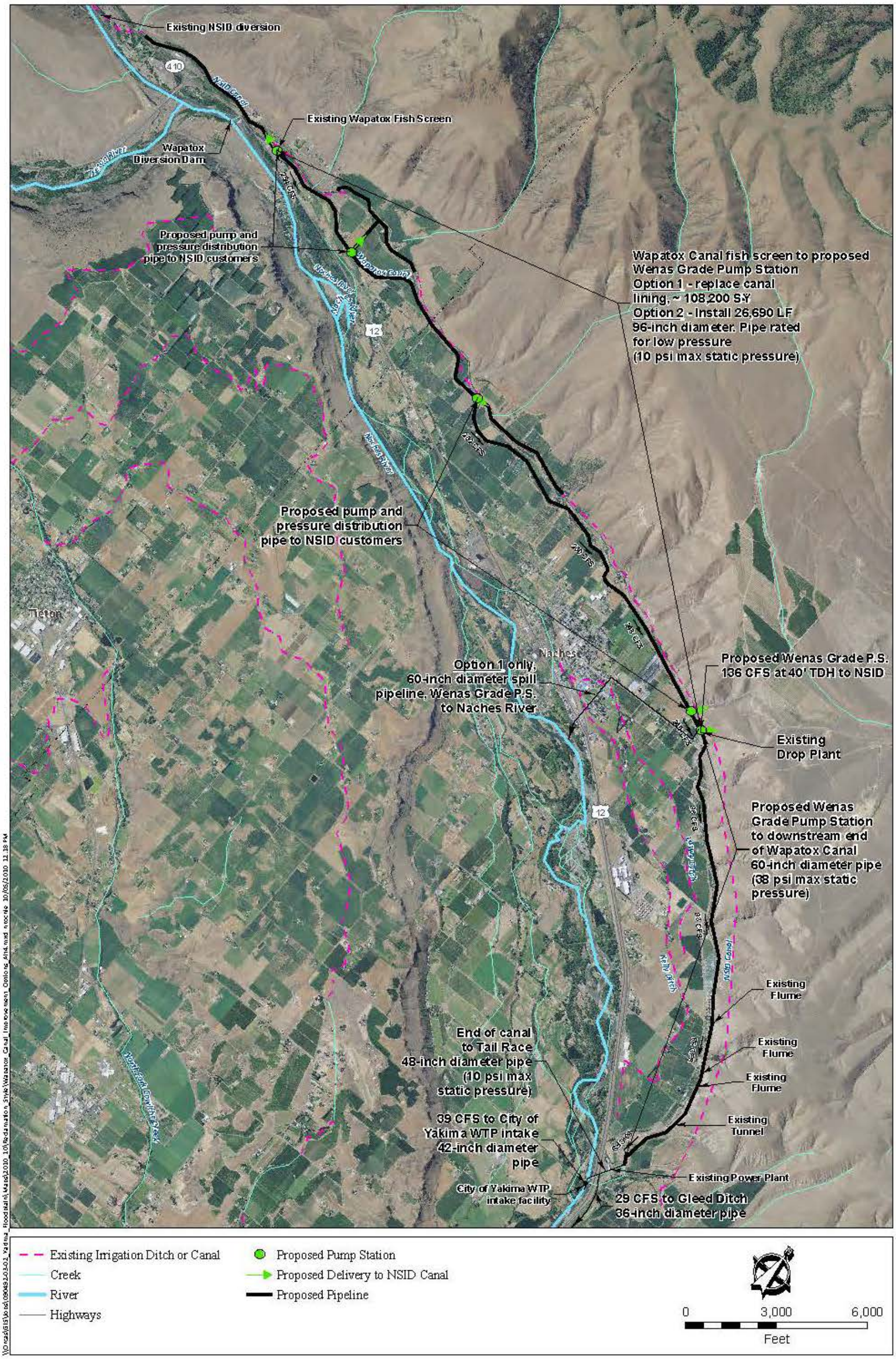

RECLAMATION
Managing Water in the West

Figure 1
Wapatox Pipeline Sized to Serve Wapatox Ditch Co + Pumping to NSID + City of Yakima + Gleed Ditch
Wapatox Canal Improvement Alternatives
Yakima River Basin Study