August 2018
Icicle and Peshastin Irrigation Districts

ANCHOR QEA

Comprehensive Water Conservation Plan

Prepared for Icicle and Peshastin Irrigation Districts under the direction of Trout Unlimited

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P.O. Box 371
5594 Wescott Drive
Cashmere, WA 98815-0371

Trout Unlimited
Washington Water Project
103 Palouse Street, Suite 14
Wenatchee, WA 98801

Prepared by
Anchor QEA, LLC
720 Olive Way, Suite 1900
Seattle, WA 98101

Aspect Consulting, LLC
23 S Mission Street
Wenatchee, WA 98801

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ABBREVIATIONS

AC	Commercial Agricultural Lands
Aspect	Aspect Consulting, LLC
BNSF	Burlington-Northern Santa Fe
BPA	Bonneville Power Administration
CCNRD	Chelan County Natural Resources Department
cfs	cubic feet per second
Chelan PUD	Chelan County Public Utility District
CIR	crop irrigation requirement
CMP	corrugated metal pipe
COIC	Cascade Orchard Irrigation Company
CWCP	Comprehensive Water Conservation Plan
Douglas PUD	Douglas County Public Utility District
DSO	Dam Safety Office
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
gpm	gallons per minute
GPS	global positioning system
Grant PUD	Grant County Public Utility District
IEGP	Irrigation Efficiencies Grants Program
IID	Icicle Irrigation District
IID CWCP	*Icicle Irrigation District Comprehensive Water Conservation Plan*
IPID	Icicle and Peshastin Irrigation Districts
IWG	Icicle Work Group
NAD27	North American Datum of 1927
NAIP	National Agriculture Imagery Program
NMFS	National Marine Fisheries Service
NRCS	Natural Resources Conservation Service
OCR	Office of the Columbia River
PEIS	programmatic environmental impact statement
PID	Peshastin Irrigation District
PID CWCP	*Peshastin Irrigation District Comprehensive Water Conservation Plan*
PRCC	Priest Rapids Coordinating Committee
RCO	Washington State Recreation and Conservation Office
Reclamation	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service

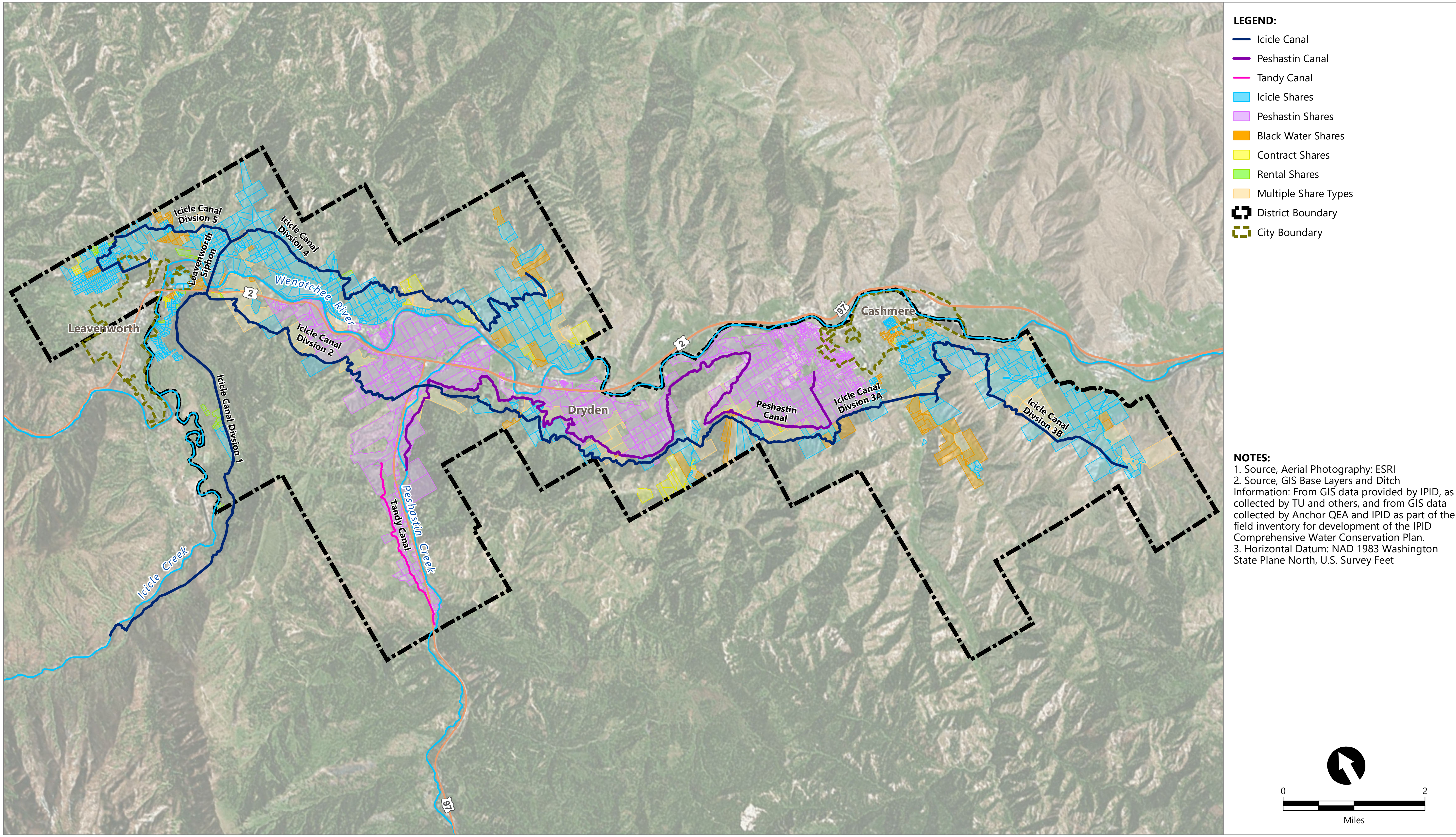
USGS	United States Geological Survey
WDFW	Washington State Department of Fish and Wildlife
WIG	Washington Irrigation Guide
WSCC	Washington State Conservation Commission
WSDA	Washington State Department of Agriculture

1 Introduction

This Comprehensive Water Conservation Plan (CWCP) was prepared for Icicle and Peshastin Irrigation Districts (IPID) by Anchor QEA, LLC, and Aspect Consulting, LLC (Aspect), under the direction of the project sponsor, Trout Unlimited – Washington Water Project. This conservation plan is a consolidated update of the *Icicle Irrigation District Comprehensive Water Conservation Plan* (IID CWCP; Klohn Leonoff Consulting 1993) and the *Peshastin Irrigation District Comprehensive Water Conservation Plan* (PID CWCP; Klohn Lenoff Consulting 1993). The original CWCPs were prepared with funding from Referendum 38, which was passed in 1980 by the Washington State Legislature to fund water supply and water conservation projects. Icicle Irrigation District (IID) and Peshastin Irrigation District (PID) now operate under a common management, and this plan consolidates and updates the original CWCPs to reflect existing infrastructure, the current configuration of the delivery systems, existing district operations, changes in irrigation practices within the IPID service area, and current conservation goals.

IPID delivers water for irrigation to properties located in the Wenatchee Valley between the towns of Leavenworth and Monitor (see Figure 1-1). IPID diverts flow through a diversion on the right bank of Icicle Creek approximately 5.7 miles upstream of its confluence with the Wenatchee River. The Icicle Creek diversion supplies the IID delivery system, which includes approximately 36 miles of canal and pipeline that irrigate approximately 4,300 acres extending from the City of Leavenworth to Monitor on both sides of the Wenatchee River Valley. IPID also diverts flow to the PID delivery system from Peshastin Creek approximately 2.4 miles upstream from its confluence with the Wenatchee River. The Peshastin Creek diversion supplies the PID delivery system, which includes approximately 13 miles of canal and pipeline that irrigate approximately 3,700 acres between Peshastin Creek and Cashmere on the south side of the Wenatchee River Valley. The supply to the PID delivery system is supplemented during the late summer by water from the Icicle Creek diversion through a bifurcation structure at the downstream end of the IID Division 2 Canal.

The 3,700 acres served by PID also includes acreage served by two small ditch systems, the Tandy Ditch and the Gibb Ditch. The Tandy Ditch diverts water from the left bank of Peshastin Creek approximately 4.9 miles upstream of its confluence with the Wenatchee River. The Tandy Ditch delivers water through a mostly closed pipe system. The Gibb Ditch is supplied through the bifurcation structure at the downstream end of the IID Division 2 Canal and delivers water through a network of closed pipelines.



NOTES:

1. Source, Aerial Photography: ESRI
2. Source, GIS Base Layers and Ditch Information: From GIS data provided by IPID, as collected by TU and others, and from GIS data collected by Anchor QEA and IPID as part of the field inventory for development of the IPID Comprehensive Water Conservation Plan.
3. Horizontal Datum: NAD 1983 Washington State Plane North, U.S. Survey Feet

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ANCHOR QEA

Figure 1-1
Location Map
Comprehensive Water Conservation Plan
Icicle and Peshastin Irrigation Districts

1.1 Objectives

The purpose of this plan is to update the information and analyses provided in the original IID CWCP and PID CWCP. The CWCP will be used as a tool by IPID to plan for improvements to the irrigation delivery systems and ensure that water is managed and delivered efficiently. The objectives of improved conservation are to provide greater flexibility and reliability in delivering water to meet irrigator needs and ultimately reduce the amount of water that has to be diverted from natural systems to meet those needs.

This updated CWCP and the recommendations included herein represent one of several projects supported by the Icicle Work Group (IWG), a group of stakeholders working together to identify and evaluate solutions to water supply, habitat, and fish passage issues in the Icicle Creek Subbasin. As the largest water user in the Icicle Creek Subbasin, IPID is a key participant in the IWG. The IWG has established a set of common goals, referred to as Guiding Principles. Irrigation conservation meets multiple prongs of the IWG Guiding Principles, including the following:

- Improved streamflow that will result from more efficient use of water diverted from Icicle Creek and reduced diversion from the creek
- Improved agricultural reliability that will result from more efficient use of water and implementation of the conservation projects identified in this study, including upgrades to existing infrastructure and water supply facilities

The IWG has set a specific target of maintaining flows in lower Icicle Creek of at least 100 cubic feet per second (cfs) during normal and wet years and at least 60 cfs during drought years. To accomplish this, the IWG has identified several projects that will help improve flows in lower Icicle Creek, including irrigation conservation. The IWG has recommended that this plan update be prepared to identify projects that will result in conservation savings of up to 10 cfs and 3,000 acre-feet annually. This plan evaluates conservation projects that will help achieve that goal.

1.2 Related Studies

Table 1-1 provides a summary of existing key studies and documentation related to the operation of the IPID and opportunities for improvements and conservation measures.

Table 1-1
Prior Studies and Related Documents

Date	Study and Relevance	Author
March 1993	*Icicle Irrigation District Comprehensive Water Conservation Plan* The IID CWCP included descriptions of IID's operations and management. The plan summarized IID's water rights, water supply, and water use. It also summarized the condition of the IID's infrastructure and identified deficiencies. A system inventory was completed, water conservation opportunities were identified, and a list of prioritized improvements was provided.	Klohn Leonoff, Inc.
May 1993	*Peshastin Irrigation District Comprehensive Water Conservation Plan* The PID CWCP was prepared concurrently with the IID CWCP and included descriptions of PID's operations and management. The plan summarized the PID's water rights, water supply, and water use. It also summarized the condition of the District's infrastructure and identified deficiencies. A system inventory was completed, water conservation opportunities were identified, and a list of prioritized improvements was provided.	Klohn Leonoff, Inc.
June 2006	*Multi-purpose Water Storage Assessment in the Wenatchee River Watershed* This report, prepared under the direction of the Chelan County Natural Resources Department (CCNRD), identified and evaluated a wide range of potential opportunities for increasing storage in the watershed, including automating and optimizing releases from the IPID-managed Alpine Lakes (Eightmile, Colchuck, Klonaqua, and Square Lakes).	Montgomery Water Group, Inc. (Now Anchor QEA, LLC)
January 2007	*Peshastin Subbasin Needs and Alternatives Study* This report evaluated the primary summertime water needs within the Peshastin Creek Subbasin. Several alternatives were identified for improving water management, including identification of potential storage and water supply improvement projects for PID.	Anchor QEA, LLC
March 2007	*Draft Needs and Alternatives Analysis, Icicle Creek Subbasin Storage Study* This report evaluated the primary summertime water needs within the Icicle Creek Subbasin. Icicle Creek, which is the primary water supply for IPID, was evaluated and needs were identified in four reaches of the creek.	Anchor QEA, LLC
October 2010	*Campbell Creek Reservoir Feasibility Study* This report evaluated the feasibility of an off-channel storage reservoir that would have been partially supplied by pumping from the Tandy Ditch pipeline. The reservoir would have provided storage for release during the late summer to meet irrigation and instream flow needs. The project was determined to not be feasible due to property owner concerns that would have prevented access to the site.	Anchor QEA, LLC
February 2011	*Water Storage Report, Wenatchee River Basin* This report was prepared for the Chelan County Natural Resource Department to further evaluate the potential for improving storage in the Alpine Lakes Wilderness and compared and contrasted potential storage improvements with other water management projects, including potential irrigation conservation projects in the Wenatchee River Basin.	Anchor QEA, LLC

Date	Study and Relevance	Author
September 2012	*Peshastin Irrigation District Pump Exchange Project Appraisal Study* This report provided an appraisal-level assessment of a project that would provide an additional source of supply for PID by pumping from the Wenatchee River near Dryden. The study outlined the project concept, evaluated five alternatives, and provided an appraisal-level opinion of probable project implementation and long-term operating costs.	Anchor QEA, LLC
November 2013	*Eightmile Lake Surveys Technical Memorandum* The memorandum summarized topographic and bathymetric survey data collected by Gravity Consultants at Eightmile Lake in October of 2013. The survey was collected under the direction of Trout Unlimited.	Gravity Consulting, LLC
July 2014	*Draft Icicle Irrigation District Instream Flow Improvement Options Analysis Study* This study, prepared under the direction of Trout Unlimited, included an evaluation of storage volumes and available storage at Eightmile Lake based on the survey that was completed by Gravity Consultants. The study also evaluated potential alternatives for an additional source of supply for IID by pumping from the Wenatchee River. Several alternatives were identified and opinions of probable project implementation and long-term operating costs were provided.	Forsgren Associates, Inc.
March 2015	*Appraisal Study, Eightmile Lake Storage Restoration* This study, prepared under the direction of IWG Member CCNRD, provided an appraisal-level assessment of existing storage conditions and lake operations, identified four alternatives for increasing the useable storage in Eightmile Lake, identified options for optimizing and automating releases from the lake, summarized potential uses and benefits of the water that would be made available, and provided a preliminary review of environmental impacts and permitting.	Anchor QEA, LLC, and Aspect Consulting, LLC
March 2015	*Appraisal Study, Alpine Lakes Optimization and Automation* This study, prepared under the direction of IWG Member CCNRD, provided an appraisal-level assessment of existing control facilities at each of the managed Alpine Lakes, including Eightmile Lake, and provided recommendations for potential equipment and improvements that would be needed to optimize and automate releases from the lakes.	Aspect Consulting, LLC, and Anchor QEA, LLC

Some additional studies pertinent to IPID were prepared concurrent with this CWCP with the support of the IWG. These include the following:

- *Icicle Strategy Programmatic Environmental Impact Statement* (Aspect and Anchor QEA, pending) – The IWG is currently developing a programmatic environmental impact statement (PEIS) for the strategy that has been developed by the IWG to improve the management of water in the Icicle Creek Subbasin. The Icicle Strategy PEIS will evaluate four alternatives and a no-action alternative. The alternatives each include a suite of projects that are collectively intended to meet the guiding principles listed above. The Eightmile Lake Storage Restoration Project will be included as a component of three of the four action alternatives evaluated by the PEIS.

- *Feasibility Study; Eightmile Lake Storage Restoration* (Anchor QEA 2018c) – This study includes a feasibility-level evaluation and design recommendations for implementing improvements that would replace the existing dam and controls at Eightmile Lake with a new dam, low-level outlet, and controls. The project would restore IPID's ability to store and release up to 2,500 acre-feet of water to meet late summer instream and out-of-stream water needs in Icicle Creek. The feasibility study includes preliminary design analysis, feasibility-level design drawings, and an opinion of probable project costs.
- *Feasibility Study; Alpine Lakes Optimization and Automation* (Aspect Consulting 2018) – This study includes a feasibility-level evaluation and design recommendations for implementing improvements that would allow IPID and the U.S. Fish and Wildlife Service to optimize and automate releases from the managed lakes in the Alpine Lakes Wilderness Area, including all of the IPID-managed lakes. The feasibility study includes preliminary design analysis, feasibility-level design drawings, and an opinion of probable project costs.

1.3 Report Organization

The following provides an overview of the information provided in this CWCP.

- **Chapter 2 – Icicle and Peshastin Irrigation Districts Organization** describes IPID statutory authority, provides a short history of each organization and the current effort underway to consolidate the districts, and includes a brief description of the distribution of water and system operations. This chapter also presents IPID assessment rates and budgetary information for 2014, 2015, and 2016.
- **Chapter 3 – Land Use and Land Base** presents a general discussion of existing land uses with the Districts, summarizes existing cropping patterns, and identifies applicable land use planning constraints. The proposed consolidated District boundary is discussed and presented on maps of the service area.
- **Chapter 4 – Water Supply, Water Use, and Water Rights** summarizes IPID's water supply facilities, provides information on IPID's water rights, evaluates water supply availability, and describes existing use and deliveries of irrigation water.
- **Chapter 5 – Existing Facilities and Operations** provides a detailed summary of IPID's existing IPID facilities and presents the results of the system inventory and assessment that was completed as part of this CWCP update. This chapter also summarizes flow measurements completed during 2017, evaluates system efficiency, and provides a water balance model for use in evaluating IPID's delivery system.
- **Chapter 6 – Water Needs and Adequacy of Water Supply** provides a summary of forecasted water supply needs based on future land use, irrigation requirements, on-farm efficiencies, and delivery and diversion requirements. This chapter also evaluates and describes IPID's ability to meet those requirements.

- **Chapter 7 – Evaluation of Opportunities for Improvement** identifies opportunities for water supply and delivery system improvements, identifies the priority of the improvements, and presents opinions of probable implementation costs. This chapter also estimates the water savings associated with the recommended conservation improvements and discusses options for the use of conserved water. A stand-alone memorandum was prepared and is referenced by this chapter that was prepared to evaluate potential for fully replacing the IPID open ditch delivery systems with a pressurized delivery system supplied through pump stations on the Wenatchee River ("IPID Conservation Plan – Full Piping Option" [Anchor QEA 2018a]). This improvement option is referred to herein as the "full piping option."
- **Chapter 8 – Financial Program** discusses potential funding sources and potential impacts on IPID's budgets and rates.
- **Chapter 9 – Comparison of Conservation Program to Other Strategies** provides a comparison of the recommendations presented in this plan to other irrigation efficiency projects, water storage projects, and conservation efforts that have been recently completed or are underway in the Wenatchee River watershed and neighboring watersheds.
- **Chapter 10 – Recommendations** provides a summary of the findings of the CWCP and recommended next steps towards implementation of improvements.
- **Chapter 11 – References** lists the references used in the development of this CWCP.

2 Icicle and Peshastin Irrigation Districts Organization

2.1 Icicle Irrigation District

2.1.1 Location

IID is located in Chelan County, Washington. The District delivers water for irrigation to approximately 4,300 acres, on both sides of the Wenatchee River Valley from Leavenworth to the town of Monitor. The irrigation deliveries support primarily pear and apple orchards. The general location and configuration of IID is shown on the Location Map included as Figure 1-1. Maps showing existing IID infrastructure are provided in Appendix A.

2.1.2 Statutory Basis and History

IID was formed in 1917 by action of the Board of County Commissioners of Chelan County and vote of property owners within the District. The District was formed after a private company owned by a Mr. Black, which had built the Icicle Canal, sold the canal and water rights to property owners within the district. When Mr. Black sold the Icicle Canal and water rights to property owners in the District, he reserved 7.5 cfs of the water rights (or 750 shares) for his later sale. Mr. Black had a contract with IID which allowed owners of shares sold by Mr. Black to be supplied water by the district for the same rates as the rest of the district. Mr. Black was unable to sell all of these shares and some that he did sell later ended up in IID ownership. IID later sold these shares to landowners within the district through contracts similar to those used by Mr. Black. Those shares are referred to as Contract shares. Contract shares are also assessed at the same rate as the rest of the District. Black shares and Contract shares are billed by IPID directly, while normal shares are assessed by Chelan County.

IID and PID share ownership of a portion of the IID canal system and storage reservoirs in the Alpine Lakes Wilderness Area. PID owns 40% of IID Division 1 Canal facilities and some water rights for storage in the Alpine Lakes. The IID Division 1 Canal extends from the intake dam on Icicle Creek to the Leavenworth Siphon (approximately 6.5 miles of canal). PID also owns 50% of the IID Division 2 Canal facilities, which extend from Division 1 to a bifurcation structure at the upstream end of the Peshastin Creek Siphon (approximately 4.1 miles of canal). When needed, water can be delivered from the bifurcation structure to the PID Canal through a pipe that crosses under Peshastin Creek.

2.1.3 Distribution of Water and Operations

The IID system contains approximately 37 miles of canals, pipelines, flumes, and tunnels. The IID Canal delivery system is divided into six divisions, sometimes referred to by operations personnel as beats. These are summarized in Table 2-1.

Table 2-1
Summary of IID Delivery System Configuration

Division	Upstream End	Downstream End	Description
Division 1	Icicle Creek Diversion and Intake Facilities	Leavenworth Siphon	• South Side of Wenatchee River. • Comprises mostly open lined canal, flumes, and tunnels. • A structure draws water off the main canal to the 34-inch-diameter Leavenworth Siphon, which necks down to 30-inch-diameter and crosses the Wenatchee River to serve Divisions 4 and 5 on the north side of the river. • The main canal continues along the hillside on the south side of the Wenatchee River and becomes Division 2.
Division 2	Leavenworth Siphon	Peshastin Siphon	• South side of Wenatchee River. • Comprises a combination of open lined canal, partially lined canal, tunnel, and pipelines. • The Division 2 Bifurcation, at the downstream end of Division 2, has four outlets. – A siphon across Peshastin Creek that delivers the main canal flow to the Division 3A Canal. – A pipeline to the Gibb system, formerly a private ditch company, which is now owned by PID and is supplied with approximately 8 cfs. – A siphon across Peshastin Creek that delivers up to 15 cfs to the Peshastin Canal. During normal operation, water is not supplied to the PID Canal and the siphon spills to Peshastin Creek. – A spill pipe that conveys excess water to Peshastin Creek
Division 3A	Peshastin Siphon	Mission Creek Siphon	• South Side of Wenatchee River. • Comprises a combination of open lined canal, partially lined canal, tunnel, and pipelines.
Division 3B	Mission Creek Siphon	End Spill at Fairview Canyon	• South side of Wenatchee River. • Comprises a combination of open lined canal, pipelines, and a series of siphons. • Ends at Fairview Canyon near Monitor.
Division 4	Posey Weir	End Spill at Williams Canyon	• North side of Wenatchee River. • Comprises a combination of pipelines, siphons, and open lined canal. • Served by a 30-inch pipeline leading from a branch on the Leavenworth Siphon. The Division 4 Canal starts at Posey Weir at the end of the 30-inch pipeline. • Crosses Anderson Canyon and Derby Canyon in siphons before ending at Williams Canyon.
Division 5	Parsons Weir	End Spill in Leavenworth	• North side of Wenatchee River. • Comprises a combination of pipelines, siphons, and open lined canal. • The Division 5 Canal is served by a 24-inch line from the branch and the canal begins at Parsons Weir.

The IID system operates as a continuous flow system. Water is supplied at a rate of approximately 0.015 cfs (6.75 gallons per minute [gpm]) per share (one share is equal to 1 acre) at water user turnout boxes, but in dry years the supply may be reduced to 0.010 cfs (4.5 gpm) per share. A reduction in the water supply rate has been historically required about every 5 or 6 years and is generally limited to a period of 2 to 3 weeks.

Rotation of turnouts has never been required and is not practical on the IID system. It takes most growers anywhere from 12 to 21 days to irrigate their entire orchards with the allotted amount of water supplied by the canal system. Most growers reset their sprinklers every 12 to 24 hours. Many growers need to run 24 hours per set with low volume sprinklers to effectively irrigate their orchards. Spraying is carried out between irrigation sets and takes 1 to 2 days for a 10-acre orchard. During dry spells when all growers require irrigation, the fact that a portion of the users are shut down for spraying enables the system to supply the required water. Per the IPID Manager, Tony Jantzer, the system could not supply all growers simultaneously with their water requirements plus overflow.

Irrigation normally begins between April 15 and May 1 of each year, but may start earlier at the discretion of the IPID Board of Directors. The flows in the canals are normally shut off at the end of September. There are 19 spillways on the IID Canal System. The spillways are used to balance flows. IID operates some spillways continuously and other spillways are used rarely. In dry periods when most users are irrigating, the system is operated so that a small quantity of water is spilling at 8 a.m. By evening, with increased evapotranspiration losses, little if any spills occur.

2.2 Peshastin Irrigation District

2.2.1 Location

PID is located adjacent to IID in Chelan County, Washington. The District delivers water for irrigation to approximately 3,700 acres on the south side of the Wenatchee River between Peshastin Creek and the town of Cashmere. PID also includes areas served by the Tandy and Gibb Ditch systems. These areas that were historically served by private ditch companies are now assessed as part of PID. The irrigation deliveries support primarily pear and apple orchards. The general location and configuration of PID is shown on the Location Map included as Figure 1-1. Maps showing existing PID infrastructure are provided in Appendix A.

2.2.2 Statutory Basis and History

PID was formed in 1917. Originally, PID supplied water to PID, Gibb Ditch, and Tandy Ditch customers from the IID Division 2 Canal. The Icicle Diversion, Division 1, and Division 2 Canals were jointly owned and operated with IID, as they are today. The Peshastin Main Canal was originally owned by a private company and was acquired by PID in the 1940s when the company was dissolved after failing to re-submit their incorporation documents. The Peshastin Canal and associated water rights were transferred to PID. The PID assessment roll includes areas served by the IID Division 2 Canal, areas served by the PID Main Canal, and areas served by the Gibb and Tandy Ditch systems. The upper part of the Tandy Ditch is supplied by a diversion on Peshastin Creek upstream of the Peshastin Canal intake. The lower portion of the Tandy Ditch is supplied from the Icicle Division 2 Canal upstream of the IID Division 2 Bifurcation structure through individual turnouts. The Gibb Ditch is supplied through a single turnout and pipe located at the IID Division 2 Bifurcation structure.

IID and the PID continue to share ownership of the IID Division 1 and 2 Canals and storage reservoirs in the Alpine Lakes Wilderness Area, as described in Section 2.1.2.

2.2.3 Distribution of Water and Operations

The PID distribution system contains approximately 13 miles of canals, pipelines, and flumes. The primary water source for the system is Peshastin Creek. Diversion and intake facilities are located 2.4 miles upstream from the confluence with the Wenatchee River, where water is diverted into the PID Canal on the right bank. The PID Canal crosses the IID Peshastin Creek Siphon about 1 mile downstream of the diversion. Table 2-2 provides a description of the canal system operated by PID.

Table 2-2
Summary of IID Delivery System Configuration

Facility	Upstream End	Downstream End	Description
PID Canal	Peshastin Creek Diversion and Intake Facilities	End Spill at Pioneer Road in Cashmere	• South Side of Wenatchee River. • Generally, the PID Canal parallels the Icicle Division 3A Canal but is located approximately 100 feet lower in elevation. • At Stines Hill, the PID Canal follows contours around the hill, whereas the IID Division 3A Canal is routed through a tunnel. • Comprises mostly open lined, partially lined, and unlined canal with pipelines, flumes, and a siphon. • Includes several thousand linear feet of large steel pipe on grade in the Deadman Hill and Stines Hill areas. • Downstream 2 miles (below Brender Creek Siphon) has been replaced with pipe over the last 10 years.
Tandy Ditch	Peshastin Creek Diversion and Intake Facilities	Near Icicle Division 2 Canal and Bifurcation Structure	• West Side of Peshastin Creek. • The Tandy Ditch includes a segment of open canal extending from the intake facilities to U.S. Highway 97. • The ditch was completely piped from U.S. Highway 97 to the end with PVC pipe and operates as a closed system.

Facility	Upstream End	Downstream End	Description
Gibb Ditch	Weir at Icicle Division 2 Bifurcation Structure	Various Locations	• West Side of Peshastin Creek. • The Gibb Ditch comprises a completely closed network of pipelines that serve acreage southwest of the junction of U.S. Highway 97 and U.S. Highway 2

As noted previously, there is a weir at the bifurcation structure at the end of the IID Division 2 Canal that supplies water to a pipeline connected to the PID Canal. The pipeline, referred to as the Peshastin Crossover, crosses under Peshastin Creek and provides supplemental flow to the PID Canal from the IID Division 2 Canal when flows in Peshastin Creek are low during the late summer. A valve allows IPID to control flow to the PID Canal or to spill water from the pipeline to Peshastin Creek, when supplemental water is not needed in the PID Canal.

Water from the bifurcation is also used to supply approximately 8 cfs each to the Gibb and Tandy systems. An agreement between IID and PID governs the operation of the bifurcation structure at the end of the IID Division 2 Canal. The original contract, dated November 4, 1919, split 75 cfs diverted to the Icicle Canal between IID and PID. IID was allocated 45 cfs and PID was allocated 30 cfs, with both IID and PID receiving 30 cfs of water flow to the IID Division 2 Canal downstream of the Leavenworth Bifurcation. The contract was amended on October 18, 1922, to account for increased diversions. Of the first 75 cfs diverted, IID still has rights to 45 cfs and PID still has rights to 30 cfs. Any diversions in excess of 75 cfs are split, as follows:

- 60% to IID/40% to PID through the IID Division 1 Canal to the Peshastin Bifurcation
- 50% to IID/50% to PID in the IID Division 2 Canal below the Peshastin Bifurcation

Of the flow that PID has a right to in the IID Division 2 Canal, about 8 cfs is used to supply the Tandy Ditch (upstream of the bifurcation) and approximately 8 cfs is supplied to the Gibb Ditch. The remainder is delivered to PID users from the IID Division 2 Canal or conveyed to the PID Main Canal through the PID Crossover pipeline. The IID Manager has indicated that the PID Crossover has a capacity of approximately 15 cfs and that capacity is fully used during the late summer.

Like the IID Canal system, the PID Canal also operates as a continuous flow system as described in Section 2.1.3. It takes most growers in the PID system about 7 to 15 days to irrigate their entire orchards, typically operating their sprinklers on 12- or 24-hour sets. PID operates the following spillways on the PID Canal, as follows:

- Fryburger Spill (Used as the primary operation spill and water level control for the PID Canal)
- Dryden Spill (not currently used)
- Stines Hill Spill
- Brender Spill

- Pipe Spill (At delivery structure at end of gravity pipe south of Tigner Road)
- Pioneer End Spill (Only used to flush the pipeline at the downstream end of the system)

The spillways are used in the same way that the spillways in the IID Canal system are used, to balance flows, as described in Section 2.1.3.

2.3 Management and Consolidation

IID and PID are each operated under the direction of a Board of Directors. For many years, the IID and PID have been jointly managed. The Districts share a manager, operations personnel, some infrastructure, and operating expenses. The Districts are both managed by IPID Manager, Tony Jantzer, and Assistant IPID Manager, Levi Jantzer, under the direction of the Boards of Directors. Secretarial and record keeping duties are currently handled primarily by the Deputy Secretary to the Boards of Directors, who is also a ditch rider. The Districts operate jointly out of an office at the following location:

Icicle and Peshastin Irrigation Districts
5594 Wescott Drive
Cashmere, Washington 98815
(509) 782-2561

The Districts' service areas overlap from Peshastin Creek to Cashmere, and the two canal systems are essentially parallel for approximately 7 miles. Because there is so much overlap in management and operation, IID and PID have been in discussions to merge the two districts. This plan was prepared to reflect likely future district consolidation. A merger of the two districts is expected to simplify management and operations and will allow greater flexibly in use of personnel and allocation of resources. A merger may also allow for consolidation of some infrastructure in the future to provide improved efficiency.

2.3.1 District Consolidation

The merger of the two districts will require review and approval by the Washington State Department of Ecology (Ecology). Ecology requires that petitions be circulated and signed by a sufficient number of members of both districts to indicate support for the merger. IPID is in the process of circulating petitions and gathering signatures from their memberships. A proposed boundary for the consolidated district has been submitted to Ecology for approval that encompasses all parcels with Icicle Shares, Peshastin Shares, Black Shares, and Contract Shares, as shown on Figure 1-1 and on Exhibits 1-7 included in Appendix A. The proposed boundary also encompasses the water right places of use for both the IID and PID water rights. Consolidation will not require changes to water rights or places of use. Water rights will remain intact.

2.4 Rates and Budgets

IID and PID operate under a joint operating agreement. They share operations staff and costs. Both districts have adopted a common rate structure. The current (2017) IPID assessment rates are summarized in Table 2-3. Table 2-4 summarizes rates from each of the past 5 years. Assessment rates are set by the IPID Board of Directors before each calendar year based upon anticipated budget needs for that year.

Table 2-3
2017 IPID Assessment Rates

Classification	Total Number of Shares	Number of Customers with Partial Shares[1]	Sum of Partial Shares	Standard Rate Per Share[2]
Icicle Shares	3,487.57	290	110.73	$111
Black Water Shares	556.50	112	41.79	$111
Contract Shares	174.25	19	5.48	$111
Rental Shares	50.83	21	0.83	$111
Peshastin Shares	3,651.77	467	170.10	$111
TOTALS	**7,920.91[1]**	**909**	**328.93**	

Notes:

1. The number of shares varies based on updates to the Chelan County Assessor's roll. The numbers shown are based on analysis from GIS data of assessed parcels provided in 2017. IPID has indicated that the most recent (2018) Assessor's roll shows a total of 8,037.88 assessed shares.
2. Properties with less than one share are assessed $111.

Table 2-4
IPID Assessment Rates, 2013 to 2017

Classification	Rates Per Share				
	2017	2016	2015	2014	2013
Less than one full share	$111	$101	$101	$101	$101
Icicle Shares	$111	$101	$101	$101	$101
Peshastin Shares	$111	$101	$101	$101	$101
Black Water Shares	$111	$101	$101	$101	$101
Contract Shares	$111	$101	$101	$101	$101

Table 2-5 summarizes the combined IPID estimated and actual budgets for the past 3 years. Categories within Expenses include wages, benefits, supplies, maintenance, services, capital outlay, and other expenses. Wages and benefits are personnel-related expenses. Maintenance categories include material required for the operation, maintenance, and repairs of the distribution system such as cement, pipe, tools, etc. Capital outlay cost are included in the Vehicles and Equipment categories. Other expenses include, but are not limited to, insurance, legal, engineering, utilities, and fuel.

A review of the budget figures shows that the biggest outlay in the budget is for wages and benefits, which account for more than 60% of the total budget. Maintenance and repair costs ranged from 11% to 23% of the total budget. IPID exceeded their estimated budget in 2016. The difference between estimated expenses and revenues was made up by drawing on reserves.

Table 2-5
IPID Proposed vs. Actual Budgets, 2014 to 2016

Category	2016		2015		2014	
	Predicted	Actual	Predicted	Actual	Predicted	Actual
Expenses:						
Wages	$431,000	$410,323	$383,000	$382,270	$386,000	$321,700
Benefits	$42,100	$41,088	$98,100	$69,809	$100,100	$72,712
Other Payroll Expenses	$70,000	$66,941	$65,600	$65,105	$70,600	$63,367
Canal Maintenance/Repairs	$85,000	$184,228	$85,000	$116,615	$82,500	$68,876
Other Maintenance/Repairs	$21,500	$10,776	$20,500	$11,036	$20,000	$9,777
Equipment	$25,000	$27,649	$15,000	$15,335	$15,000	$20,061
Vehicles	$31,000	$32,897	$0	$0	$20,000	$40,016
Other Expenses	$96,700	$90,086	$124,700	$118,356	$125,700	$125,244
Total Expenses	**$802,300**	**$863,988**	**$791,900**	**$778,526**	**$819,900**	**$721,753**
Income:						
Icicle	$452,549	$457,330	$452,427	$466,238	$453093	$461,050
Peshastin	$397,032	$398,701	$396,798	$404,670	$398,475	$407,313
Total Income	**$849,581**	**$856,031**	**$849,225**	**$862,000**	**$851,568**	**$868,363**
Net (Income – Expenses)	**$50,745**	**($7,957)**	**$57,325**	**$83,474**	**$31,668**	**$146,610**

3 Land Base and Land Use

3.1 District Boundaries and Proposed Consolidation

3.1.1 Existing District Mapping

Exhibits 1 through 7 in Appendix A include a series of maps showing existing IID infrastructure, assessed parcels, and the proposed boundary of the consolidated IPID. The parcels shaded on each exhibit are parcels listed in the Chelan County Assessor's database as currently being assessed for IPID, referred to herein as the assessment rolls. The shading indicates the type of irrigation share associated with each parcel. A few parcels have more than one type of share. The shading and types of shares mapped are only accurate to the extent that the assessment rolls are accurate. IPID has indicated that the assessment rolls do not always accurately portray parcels that are or have historically been irrigated by IPID. For example, when a parcel is subdivided, the assessment rolls may not have been updated to distribute the shares between the resulting parcels, even though irrigation water continues to be distributed across all the parcels that resulted from the subdivision. IPID tries to identify discrepancies and works with Chelan County to update the assessment rolls.

IPID boundaries were mapped in 1993 as part of the development of the IID CWCP and PID CWCP based on maps archived at the IPID's office. As part of this update of the conservation plan, boundaries and place of use descriptions on water right documentation were reviewed. The place of use descriptions on IPID's key water right documents are as follows:

- On IID's water right certificate (Ecology No. S4-*35002ABBJWRIS) for its Icicle Creek surface water diversion, the place of use is described as "within the boundaries of the Icicle Irrigation District and the Peshastin Irrigation District." In addition, the water right place of use includes two specific tracts, the Jackson and Gerry Tracts, and allows for water use on "other lands irrigated or which may be irrigated from the IID Canal with so-called Black Water Rights."
- On PID's water right certificate (Ecology No. S4-*00329CWRIS) for its Icicle Creek surface water diversion, the place of use is described as "lands within the boundaries of Peshastin Irrigation District."
- On PID's water right claim (Ecology No. S4-064984CL) for its Peshastin Creek surface water diversion, the place of use is described as "Various parcels of land, as shown on the Peshastin Irrigation District's Assessment Rolls, within the following subdivisions; That portion of Section 29 lying easterly and southerly of Peshastin Creek, N 1/2 of Section 28, S 1/2 of Section 21, SW 1/4 of Section 22, Section 27, SW 1/4 of Section 26, E 3/4 of Section 34, Section 35 and Section 36, being within Township 24N, Range 18E; N 1/2 of Section 2, N 1/2 of Section 1, being within Township 23N, Range 18E; Section 2, S 1/2 of Section 32, being within Township 24N, Range 19E; Section 5, Section 6, N 1/2 of Section 7, N 1/2 of Section 8, being within Township 23N, Range 19E, all being within Chelan County, Washington."

Given the discrepancies in the assessment rolls and lack of consistency in the detail provided on water right documentation, IPID has indicated that they have not historically been able to delineate consistent, well-defined, accurately mapped legal boundaries for the districts. It was not possible within the scope of work of this plan, with readily available information, to verify the legal boundaries of IID and PID based on legal descriptions written for each parcel.

3.1.2 Proposed Consolidation Boundaries

As part of the proposed consolidation of IID and PID, IPID has drawn up a proposed boundary for the combined IPID that they feel includes all lands that have historically been within IPID's service area and have been irrigated with IPID's water rights, plus some buffer area. The boundary was largely drawn along section, half section, or quarter section boundaries. That boundary is shown on the maps provided in Exhibits 1 through 7 in Appendix A. IPID has submitted the boundary to Ecology for review and approval as part of the consolidation effort.

3.2 Soil Cover

Soil cover for the areas irrigated by IPID was evaluated by the United States Department of Agriculture (USDA) Soil Conservation Service (now the Natural Resources Conservation Service [NRCS]) in the 1975 *Soil Survey of Chelan Area, Washington* (NRCS 1975). Detailed soil types and mapping are available from the NRCS Web Soil Survey (NRCS 2017). The predominant soil association found in the area irrigated by IPID is the Burch-Cashmont association. The Brief-Leavenworth association is also found in the area irrigated by IPID. The following provides a general description of these soil associations.

3.2.1 Burch-Cashmont Association

The 1975 *Soil Survey of Chelan Area, Washington* describes the Burch-Cashmont association soils as "dominantly medium-textured and moderately coarse textured, nearly level to strongly sloping soils on terraces, alluvial fans, and foot slopes." The general description indicates that this association is found "on terraces and low, recent alluvial fans and foot slopes along the Columbia and Wenatchee Rivers and near other streams in the valley that extends from Wenatchee to Leavenworth." The description also indicates that "the major soils in the association formed mainly in valley fill and alluvium but have some loess and volcanic ash in the surface layer." The available moisture capacity in the soils ranges from 0.09 to 0.20 inches of water per inch of soil. The predominant soil series within the Burch-Cashmount association is the Burch Series. The Burch Series consists of "well-drained, medium-textured and moderately coarse textured soils that formed in valley fill, chiefly of sandstone origin." A representative profile of Burch Series soils "is dark grayish-brown loam 8 inches thick. The subsoil is brown loam 18 inches thick. The substratum is yellowish-brown very fine sandy loam and loam that extends to a depth of 60 inches or more." The average water holding capacity of the Burch Series is 0.15 inches of water per inch of soil.

3.2.2 Brief-Leavenworth Association

The 1975 *Soil Survey of Chelan Area, Washington* describes the Brief-Leavenworth Association soils as "dominantly moderately coarse textured, nearly level to strongly sloping soils on bottom lands, low terraces, and alluvial fans." The available moisture capacity in the soils range from 0.07 to 0.14 inches of water per inch of soil. The predominant soil series within the Burch-Cashmount association in the area irrigated by IPID is the Leavenworth Series. The Leavenworth Series consists of "moderately well drained, moderately coarse textured and coarse textured soils that formed in recent alluvium from granite, gneiss, schist, and micaceous sandstone rocks." A representative profile of Leavenworth Series soils "is dark-gray fine sandy loam that is gravelly in places. It is 23 inches thick. This is underlain by dark-gray, stratified layers of loamy fine sand and loam that extend to a depth of 60 inches or more."

3.3 Land Use

3.3.1 Acreage in Agricultural Use

The predominant land use within the areas served by IPID is agricultural, primarily apple and pear orchards. Table 3-1 tabulates the acreage in orchards and pasture or lawns, as estimated by reviewing 2016 National Agriculture Imagery Program aerial photography (USDA 2016) and crop survey data from the Washington State Department of Agriculture (WSDA). Total shares and irrigable acreage are summarized by the divisions or reaches of the IID Canal, the PID Canal, the Tandy Ditch, and the Gibb Ditch.

The total shares were estimated through review of IPID assessment rolls obtained from Chelan County in 2017. The IPID assessment rolls include records of each parcel that is assessed by IPID and the number and types of shares of water assessed. One share of water is generally equal to one irrigable acre. The types of shares were summarized in Table 2-1. Based on the assessment rolls, there were approximately 2,088 parcels that assessed by IPID. Those parcels represent approximately 7,921 water shares. The average number of shares per assessed parcel is just under 4 shares. Just under 1,000 parcels have partial shares, indicating that the parcels are less than 1 acre in size. Nearly half of the acreage served by IPID is within the largest 150 parcels.

Irrigable acres were identified using aerial photographs are defined as acreage that was planted and being irrigated at the time the aerial photograph was take, or acreage that has been irrigate historically by deliveries from the IPID system. Estimating irrigable acreage was an iterative process, that included review of mapping and aerial photographs IPID, as discussed later in this chapter.

Table 3-1
Summary to Assessed Parcels and Irrigable Acreage

Reach or Division	Total Shares[1]	Total Irrigable Acreage		
		Orchard	Pasture	Total
IID Division 1	153	0	214	214
IID Division 2	641	592	98	690
IID Division 3A	334	252	104	355
IID Division 3B	1,484	1,217	174	1,392
IID Division 4	1,433	1,373	188	1,561
IID Division 5	573	321	360	681
IID Total	**4,618**	**3,755**	**1,137**	**4,893**
PID Main Canal	2,541	1,952	667	2,619
Tandy Ditch	231	119	101	220
Gibb Ditch	531	496	20	516
PID Total	**3,303**	**2,567**	**788**	**3,355**
IPID Total	**7,921**	**6,322**	**1,925**	**8,247**

Notes:
1. Total shares are from IPID Assessment Rolls; includes total of all types of shares delivered by the reach or division indicated. Some Peshastin, Tandy, and Gibb shares are delivered directly from the IID Division 2 Canal.
2. Total irrigable acreage estimated through review of assessment rolls, aerial photography, and consultation with IPID regarding lands that are irrigated by IPID water that are not within assessed parcel boundaries.

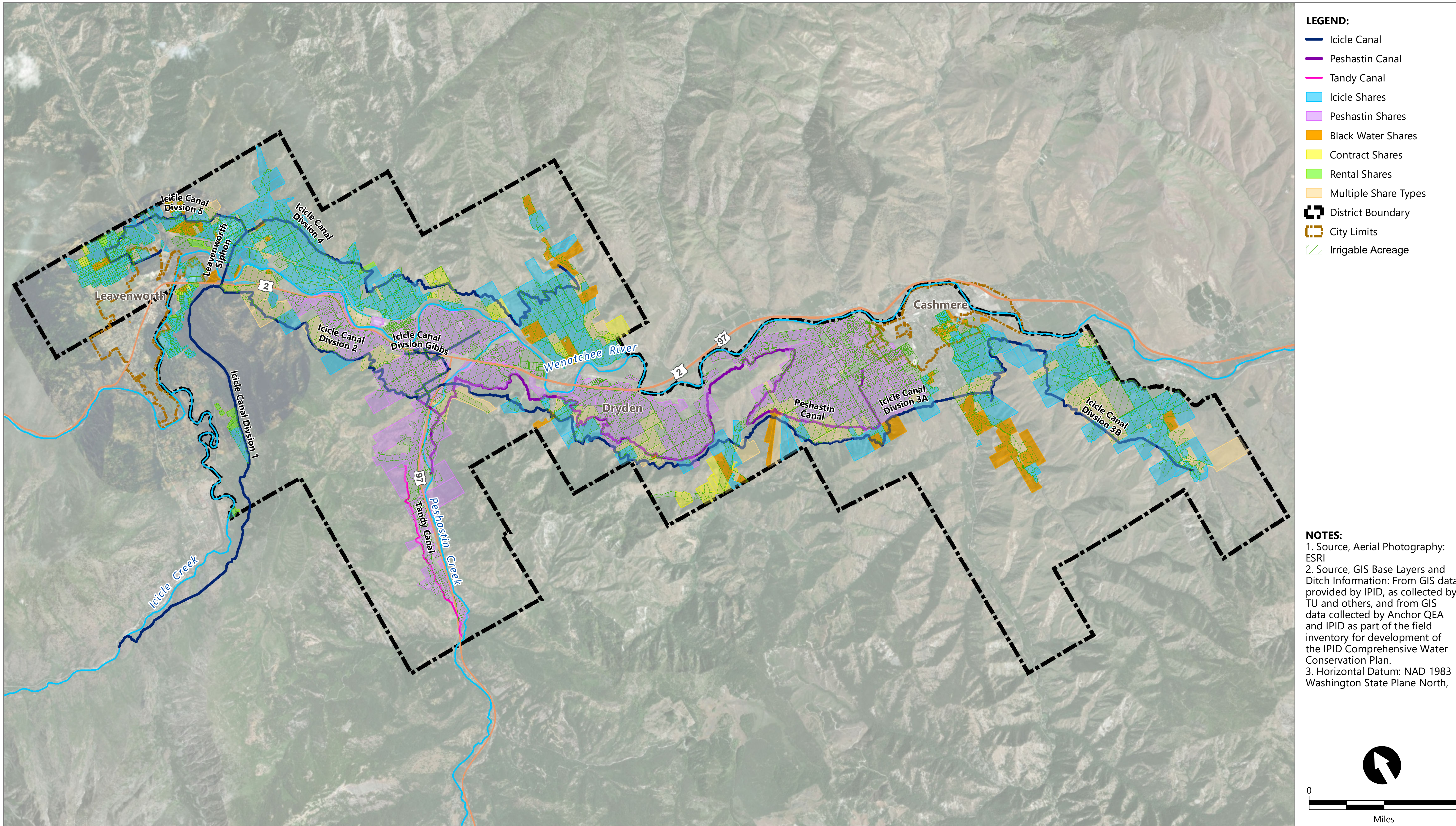
The assessment rolls were originally formulated when IID and PID were formed in 1917 and are maintained by Chelan County. The assessed parcels were mapped over aerial photography and reviewed with IPID. Based on that review, there appear to be some areas within the assessed parcels that are not currently being irrigated and areas outside of the assessed parcels that are currently irrigated with IPID water. The policy of IPID is to provide water at a turnout located adjacent to a canal or lateral at a rate that corresponds to the number of shares served by each turnout. IPID does not directly serve parcels that are not within IPID-assessed parcels; however, some farmers have expanded irrigation beyond parcels that are on the assessment rolls. In addition, there likely may be situations where a parcel has been subdivided, sold, or purchased, but the assessment roll may not have been updated to properly distribute the shares between the resulting parcels, even though irrigation water continues to be distributed across all the parcels.

Because of the large number of assessed parcels and high distribution of smaller parcels, a detailed parcel-by-parcel delineation of irrigable acreage was not feasible based on project constraints. To estimate the irrigable acreage for this conservation plan, an initial delineation was completed to identify contiguous areas of irrigable land. GIS analysis was then performed to distribute the delineated irrigable areas by parcel. Publicly available crop survey data from the WSDA was used to assign crop type and watering method to the irrigable areas within each parcel. The WSDA dataset did not provide complete coverage for all irrigable parcels. For larger parcels, the crop type data was reviewed and refined based on aerial imagery. Because smaller parcels (less than 1 acre) are largely excluded from the WSDA dataset, it was assumed irrigable areas for smaller parcels were pasture/turf (when irrigated) unless observed otherwise in the aerial imagery.

Irrigable areas were delineated on a map based on aerial photographs. Irrigable areas were intended to include lands within IPID assessed parcels that are clearly planted and irrigated and lands that appear to have been irrigated in the past by the IPID delivery systems. The map of irrigable areas and aerial photographs were reviewed with the IPID Manager. Based on his input, the delineated areas were refined to include areas that appear to be irrigated that are outside assessed parcels and areas within assessed parcels that are not fully irrigable. The refined map of irrigable areas is shown in Figure 3-1. Irrigable acres were summarized in spreadsheet format and correlated to different divisions or reaches of the IPID system by parcel. This approach has the potential to slightly over or under allocate irrigable acreage at the parcel level due to the fact that the delineation of irrigable areas was done on a larger scale. However, this approach is accurate enough on the scale of the overall IPID system for estimating irrigable acreage and distributing acreage among reaches of the IPID system for the purposes of conservation planning.

3.3.2 Other Land Uses

The proposed boundary for IPID consolidation is shown in Exhibits 1 through 7 in Appendix A. The boundary includes approximately 32,430 total acres of land. Approximately 8,300 of those acres represent parcels listed on the IPID assessment rolls. As noted in Table 3-1, there are approximately 8,247 acres of irrigable crop land served by IPID. There are a variety of other land uses within the proposed IPID service area boundary. The land uses include fallow lands, forested lands, urban and rural residential lands, non-irrigable lands, and commercial or industrial lands. Roads and public right-of-way also make up a portion of the proposed IPID service area.



NOTES:
1. Source, Aerial Photography: ESRI
2. Source, GIS Base Layers and Ditch Information: From GIS data provided by IPID, as collected by TU and others, and from GIS data collected by Anchor QEA and IPID as part of the field inventory for development of the IPID Comprehensive Water Conservation Plan.
3. Horizontal Datum: NAD 1983 Washington State Plane North,

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ANCHOR QEA

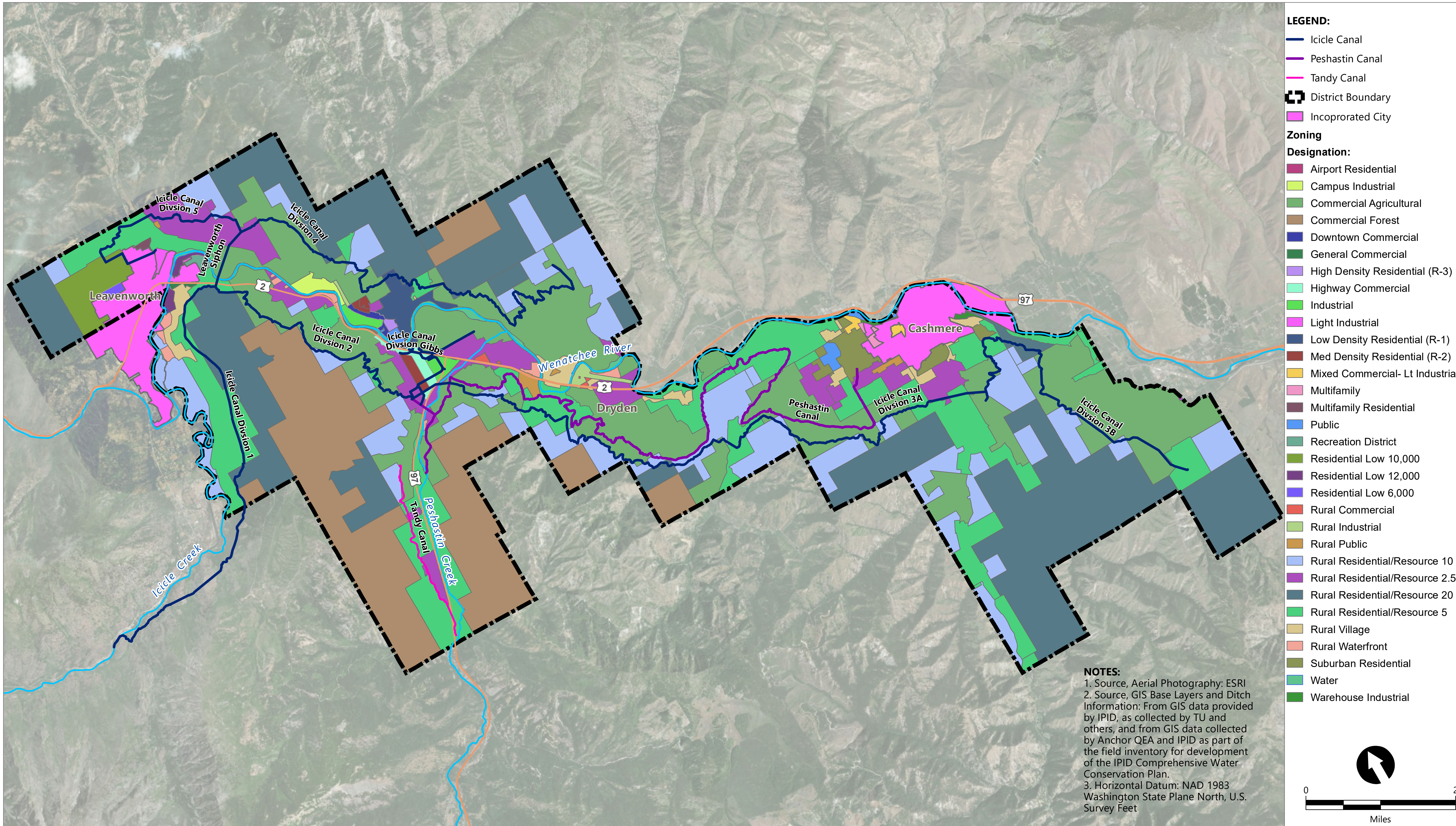
Figure 3-1
Irrigable Acreage Served by IPID
Comprehensive Water Conservation Plan
Icicle and Peshastin Irrigation Districts

3.3.3 Applicable Land Use Plans

The IPID service area is in Chelan County, Washington. Chelan County is responsible for comprehensive land use planning in accordance with Washington State's Growth Management Act. In Chelan County, land use is managed by the Department of Community Development. The County recently adopted an update of the *Chelan County Comprehensive Plan* (Chelan County 2017). The plan provides a framework for land use management throughout the County over the next 20 years (2017 to 2037). The plan lays out a vision and goals for different areas of the County, referred to as Study Areas. The IPID service area is within two Study Areas designated as the Lower Wenatchee River Valley and Upper Wenatchee River Valley. The vision for these areas outlined in the plan includes preservation of open spaces, sustainability of agriculture, maintenance of the high-quality rural lifestyle, and orderly growth and development that will preserve natural resources.

The IPID service area also includes the City of Cashmere and the City of Leavenworth. The *City of Cashmere Comprehensive Land Use Plan* (City of Cashmere 2014) provides a guide for future land uses within the incorporated boundaries of the City of Cashmere. The *City of Leavenworth Comprehensive Plan* (City of Leavenworth 2017) provides a plan for future land use management within the incorporated boundaries of the City of Leavenworth. Proposed land uses within and near the cities will continue to include higher density residential, industrial, and commercial land uses that are not as prevalent in other parts of the IPID service area.

The most significant land use changes, within the proposed IPID service area boundary, are likely to occur within and near the City of Leavenworth and the City of Cashmere. Some subdivision and conversion of agricultural properties to residential uses is anticipated as the population continues to grow within the Wenatchee River Valley. Development will be restricted by local zoning regulations. Zoning within the proposed IPID service area boundary is shown in Figure 3-2. Much of the property within the valley is zoned as Commercial Agricultural Lands or rural residential. These designations typically limit residential development to densities of 1 dwelling unit per 2.5 to 20 acres. Zoning that allows higher density residential development is primarily focused around the cities of Leavenworth and Cashmere. Limited areas of commercial and industrial zoning also exist along U.S. Highways 2 and 97, and near the cities of Leavenworth and Cashmere.



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ANCHOR QEA

Figure 3-2
Zoning within the Proposed IPID Service Area
Comprehensive Water Conservation Plan
Icicle and Peshastin Irrigation Districts

4 Water Rights, Water Supply, and Water Use

4.1 Existing Irrigation District Water Supply Facilities

Exhibits 1 through 7 in Appendix A show existing IPID delivery system facilities. These facilities include canals, siphons and pipelines, tunnels, flumes, diversion and bifurcation structures, head gates, weirs, delivery boxes or turnouts, spills, and fish screens. Landmark surface features are also labeled including rivers, creeks, towns, highways, and other major roads. A more detailed discussion of IPID facilities is included in Chapter 5 of this plan.

4.1.1 Icicle Irrigation District

IID irrigates approximately 4,300 acres extending from the City of Leavenworth to Monitor on both sides of the Wenatchee River Valley. IID facilities include intake facilities on Icicle Creek, approximately 36 miles of canal and pipeline, and related spills, control structures, and turnouts. The diversion dam and intake facilities on Icicle Creek, the IID Division 1 Canal, and the IID Division 2 Canal are jointly owned and operated with PID.

4.1.2 Peshastin Irrigation District

In addition to the facilities that are jointly owned and operated with IID, PID facilities include intake facilities on Peshastin Creek, approximately 13 miles of canal and pipeline, and related spill facilities, control structures, and turnouts. PID also includes the Gibb Ditch and the Tandy Ditch systems.

4.1.2.1 Gibb Ditch

The Gibb Ditch system delivers water through a network of 2.9 miles of closed pipelines supplied through a gate and screened intake box at the bifurcation structure at the downstream end of the IID Division 2 Canal.

4.1.2.2 Overview – Tandy Ditch

The Tandy Ditch system includes approximately 900 feet of open canal and 2.6 miles of closed pipeline, ranging in size from 8- to 20-inch diameter, supplied through intake facilities on Peshastin Creek. Additional supply to some Tandy Ditch shareholders is supplied directly from the IID Division 2 Canal upstream of the bifurcation structure.

4.1.3 Alpine Lakes Water Storage

During the spring and early summer, IPID typically operates its diversion on Icicle Creek within the natural flow variations available in Icicle Creek. However, there are a number of high elevation lakes in the Alpine Lakes Wilderness Area in the upper portion of the Icicle Creek Subbasin that capture and store water. IPID has water rights that allow for storage and release of water from five of these lakes, including the following:

- Colchuck Lake
- Eightmile Lake
- Klonaqua Lake
- Square Lake
- Snow Lakes

IPID operates four of these lakes (Colchuck, Eightmile, Klonaqua, and Square) as reservoirs. Each of these natural lakes has a small dam or low structure with a low-level outlet and control gate that was installed during the early part of the twentieth century, prior to creation of the wilderness area. These structures allow IPID to capture and store water a few feet above what would naturally be the high water level in these lakes during the winter, spring, and early summer. IPID then releases water from the lakes during the late summer, as needed to maintain water supply at the IPID diversion on Icicle Creek, which is 5.7 miles upstream of the confluence of Icicle Creek and the Wenatchee River. In normal and wet years, only one of the lakes is drawn down each to supplement the water supply available from Icicle Creek or perform maintenance. In dry years, multiple lakes are drawn down to meet water supply needs.

IPID also has water rights for water stored in Upper Snow Lake, which is also in the Alpine Lakes Wilderness Area. Upper Snow Lake is operated by the U.S. Fish and Wildlife Service (USFWS) to make supply available for the Leavenworth National Fish Hatchery.

4.2 Water Rights

Water rights and claims associated with IPID are summarized by certificate holder and sorted in chronological order in Table 4-1. The water source, water right certificate or claim number, water right holder, priority date, classification (for Icicle Creek water rights), and the certificated and adjudicated instantaneous and annual water right maximum withdrawal limits are listed. Most of the rights that have IID listed as the certificate holder are shared with PID at a ratio of 60% to 40%. The water rights classifications stem from a Superior Court Decree dated October 28, 1929, regarding the adjudication of rights to use of waters from Icicle Creek and its tributaries, referred to as the "1929 Adjudication." The water rights included in the 1929 Adjudication are summarized in Table 4-2.

Table 4-1
IPID Water Rights Summary

Water Source	Certificate or Claim Number	Certificate Holder	Priority Date	Class[1]	% Owned by IID/PID[2]	Certificated		Adjudicated[1]	
						Qi (cfs)	Qa (acre-feet)	Qi (cfs)	Qa (acre-feet)
IID or Joint IID/PID Water Rights									
Icicle and Snow Creek	S4-35002JC2	IID	April 1, 1910	2	60%/40%	1.7525	---	83.33	---
Icicle and Snow Creek	S4-*35002ABBJ2	IID/PID	April 1, 1910	2	60%/40%	81.5775	---	83.33	---
Klonaqua Lake	1227	IID	August 2, 1926	5	60%/40%	25.00	---	25.00	2,500
Eightmile Lake	1228	IID	August 2, 1926	5	60%/40%	25.00	---	25.00	2,500
Colchuck Lake	1229	IID	August 2, 1926	5	60%/40%	50.00	---	50.00	2,500
Square Lake	5527	IID	August 2, 1926	---	---	10.00	2,000	N/A	N/A
Snow Creek	1591	IID	August 2, 1926	---	60%/40%	25.00	---	N/A	N/A
Snow Lake	1592	IID	October 29,1929	---	60%/40%	25.00	1,000	N/A	N/A
PID Water Rights									
Peshastin Creek	S4-113257CL	PID	---	---	---	3.10	620	N/A	N/A
Peshastin Creek	S4-064984CL	PID	October 1, 1892	---	---	50.00	15,000	N/A	N/A
Peshastin Creek	S4-064986CL	PID	January 1, 1906	---	---	4.40	550	N/A	N/A
Icicle Creek	1082	PID	October 27, 1919	5	60%/40%	34.38	---	34.38	---
Wenatchee River	113	PID	May 17, 1926	---	---	2.40	---	N/A	N/A
Tandy Ditch Water Rights									
Peshastin Creek	S4-050541CL	Tandy Ditch Co.	---	---	---	7.00	1,500	N/A	N/A
Peshastin Creek	S4-050542CL	Tandy Ditch Co.	---	---	---	13.00	6,500	N/A	N/A

Notes:

1. Water right classifications and amounts are listed in a Superior Court Decree dated October 28, 1929, regarding determination of rights to use waters of Icicle Creek and its tributaries, referred to as the 1929 Adjudication.
2. The right was confirmed for withdrawal 83.33 cfs through 1929 Adjudication. The right was subsequently split and a change to place of use was completed for 1.7525 cfs.

Table 4-2
Summary to Icicle Creek Water Rights Classifications from 1929 Adjudication

Class[1]	Water Right Holder	Qi (cfs)	Qa (acre-feet)	Source
1	Cascade Orchards Irrigation Company	12.0	-	Icicle Creek
2	IPID Black	83.33	-	Icicle Creek and Snow Creek
3	Snow Creek Water Company	4.0	-	Snow Creek
4	City of Leavenworth Susie J. Fromm Susie J Fromm	1.52 0.10 0.17	- - -	Icicle Creek Mountain Home Creek Mountain Home Creek and Turner Creek
5	PID IID IID IID	34.38 25.0 25.0 50.0	- 2,500 2,500 2,500	Icicle Creek Klonaqua Lake Eightmile Lake Colchuck Lake
6	Ray Simons Olin Briskey Susie Fromm Susie Fromm	0.17 1.0 0.08 1.0	- - - -	Icicle Creek Icicle Creek Icicle Creek Icicle Creek

Notes:
1. Water right classifications and amounts are listed in a Superior Court Decree dated October 28, 1929, regarding determination of rights to use waters of Icicle Creek and its tributaries, referred to as the 1929 Adjudication.

4.2.1 Icicle Creek

IPID holds Class 2 rights on Icicle Creek for 83.33 cfs, second only in seniority to a 12-cfs water right held by the Cascade Orchard Irrigation Company (COIC). PID holds a Class 5 water right for 34.38 cfs on Icicle Creek. The combined IID and PID water rights allow for a total diversion of up to 117.71 cfs from Icicle Creek and Snow Creek when senior water rights are met.

There are other claims on file and water rights that have been issued since 1929 for use of Icicle Creek Water. Water right claims made and water right certificates issued after the 1929 Adjudication are junior to the IPID water rights included in the 1929 Adjudication. The U.S. Bureau of Reclamation (Reclamation) holds a water right certificate (No. 1824, with a priority date of March 26, 1942) that allows for diversion of 42 cfs from Icicle Creek to supply the Leavenworth National Fish Hatchery, which is operated by the USFWS. The USFWS also leases part of the COIC water right under an agreement with COIC. As part of the agreement, the USFWS uses just under 4 cfs to supplement its surface water supply to the Leavenworth National Fish Hatchery. In return, they share diversion facilities on Icicle Creek with COIC and provide the operation and maintenance of those facilities.

4.2.2 Peshastin Creek

Both the PID and the Tandy Ditch hold water rights that allow for surface water diversions from Peshastin Creek. PID holds water rights that allow for a maximum instantaneous diversion of 57.50 cfs, and withdrawal of up to 16,170 acre-feet annually. The Tandy Ditch, which is now part of PID, holds water rights that allow for a maximum instantaneous diversion of 20 cfs, and withdrawal of up to 8,000 acre-feet annually. PID and the Tandy Ditch are the primary water right holders on Peshastin Creek.

4.2.3 Wenatchee River

PID also holds a water right that allows for diversion of up to 2.4 cfs from the Wenatchee River. The water right, which has a priority date of May 17, 1926, is used to irrigate 60 acres near Dryden.

4.2.4 Alpine Lakes Water Storage

As noted in Section 4.1.3, the IPID water supply from Icicle Creek is augmented by storage water rights in Upper and Lower Snow, Square, Klonaqua, Eightmile, and Colchuck lakes. Water stored in these reservoirs can be released through tributaries to Icicle Creek and diverted into the canal system at the diversion dam when natural stream flows are not sufficient to meet IPID's diversion requirements. The rights allow for storage and release of up to 2,500 acre-feet of water annually each from Klonaqua, Eightmile, and Colchuck lakes. Additional water right certificates were granted to IID for Square Lake, including its tributaries, and Snow Creek after the 1929 Adjudication, and are listed in Table 4-1. They allow for storage and release of up to 2,000 acre-feet of water annually from Square Lake. The USFWS operates reservoirs at Upper and Lower Snow lakes and Nada Lake to supplement water supply to the Leavenworth National Fish Hatchery. IPID also has rights to 1,000 acre-feet of storage annually from Upper and Lower Snow lakes.

IPID is in the process of evaluating potential improvements to water storage in the Alpine Lakes Wilderness Area that would include rebuilding the existing dam at Eightmile Lake, installing automated valves at each lake that could be controlled remotely from IPID's office, and optimizing releases from the lakes to better meet water supply needs and improve instream flows in Lower Icicle Creek. These projects are key components of the Icicle Strategy, which is a suite of projects and actions proposed by the IWG to better manage water in the Icicle Creek Subbasin. As one of the key stakeholders in the IWG and the largest water user on Icicle Creek, IPID has participated actively in evaluating these projects. During the summers in 2016 and 2017, IPID participated in a pilot study to determine whether improved timing and control of releases from these reservoirs has the potential to provide sustained flow benefit in lower Icicle Creek. Personnel were hired to travel to each lake on a weekly basis to adjust the valve or gate to increase or decrease releases to try and maintain flow rates in Icicle Creek that were sufficient to meet water supply needs and meet instream flow targets for lower Icicle Creek. The results of the pilot studies have been promising. As part of the implementation of these studies, IPID made temporary trust water donations to Ecology, which allow a volume of the water released to be designated for use in improving instream flows rather than as additional supply for irrigation. Permanent changes to IPID's storage rights would be required for implementation of the proposed automation and optimization project.

4.3 Water Supply Sources and Availability

4.3.1 Icicle Creek

The primary water source for the IPID delivery system is Icicle Creek. Icicle Creek has a drainage area of roughly 200 square miles and is predominately snowmelt fed. The United States Geological Survey (USGS) StreamStats (USGS 2017) program estimates that the mean annual precipitation in the Icicle Creek Subbasin is approximately 82 inches (rain and snow-water-equivalent) per year and the annual mean snowfall is approximately 210 inches.

Flows in Icicle Creek are monitored at the following locations:

- **USGS Gage No. 12458000** – This gage is located at Latitude 47°32'28", Longitude 120°43'08" (North American Datum of 1927 [NAD27]), approximately 1,000 feet upstream of the IPID diversion. Flows have been monitored at the USGS gage since October 1936.
- **Ecology Gage No. 45B070** – This gage is located near East Leavenworth Road, about 0.5 miles downstream of the primary surface water diversions on Icicle Creek. Flows have only been monitored at this location since May of 2007, and continuous flow data is only available from 2011 to the present.

Flow statistics for daily mean flows recorded at USGS Gage No. 1248000 are plotted in Figure 4-1. The 10%, 50%, and 90% daily mean exceedance values are plotted to show the variability of flows throughout the year. The 10% exceedance represents a wet year, the 90% exceedance represents a dry year, and the 50% exceedance represents the median. These are plotted against the 10%, 50%, and 90% overall exceedance values for the full record of daily mean flows recorded at this gage. Statistical streamflow data were also tabulated, as summarized in Table 4-3 for the months when IPID is typically diverting water from Icicle Creek. As shown on the Figure 4-1 and in Table 4-3, for normal and wetter than normal years, flows at the USGS gage are typically greater than 133 cfs throughout the irrigation season. However, daily mean flows measured at the USGS gage drop below 100 cfs during the late summer in very dry years.

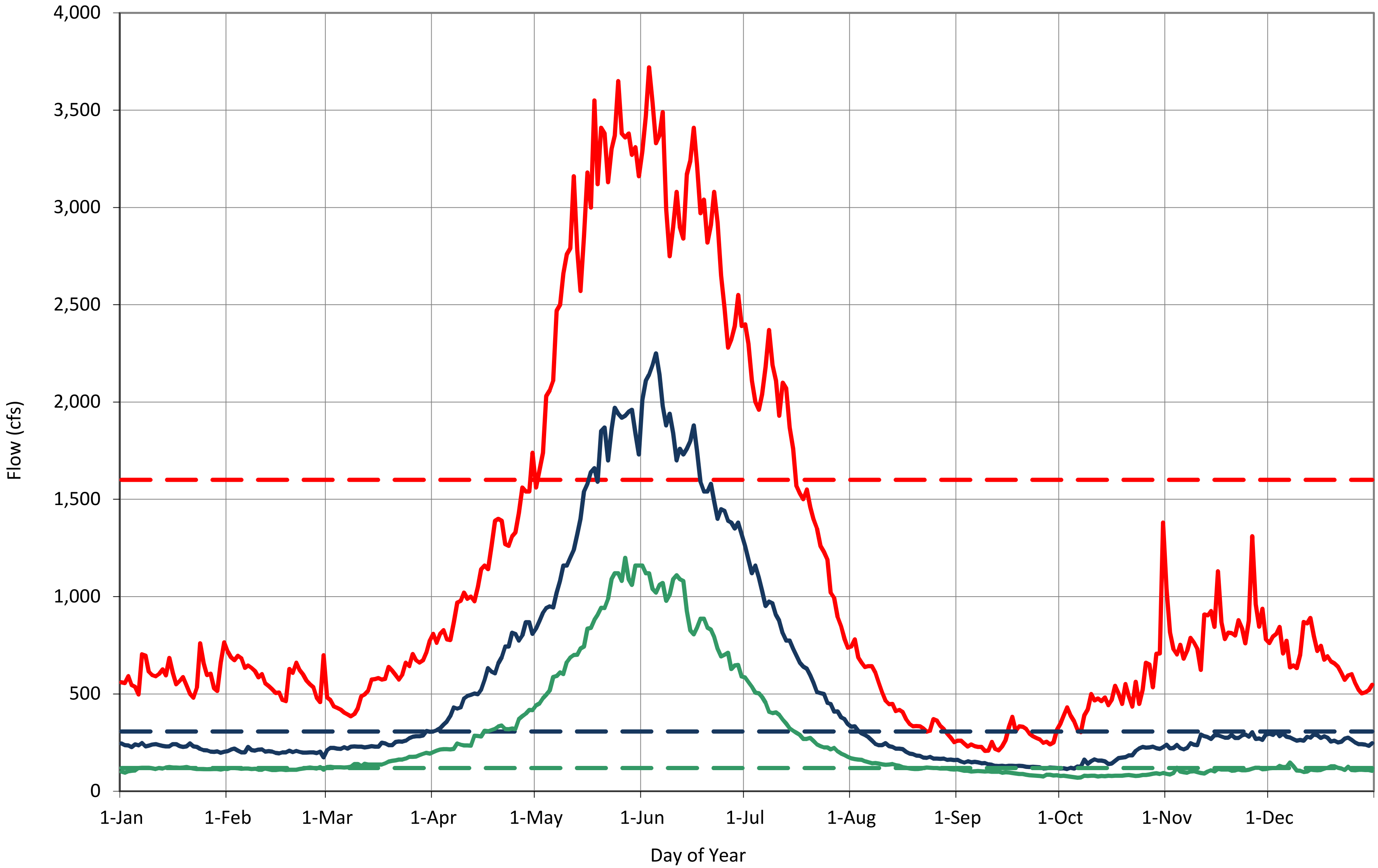
Table 4-3
Discharge Data for USGS Gage at Icicle Creek Above Snow Creek

% Exceedance	Average Mean Daily Discharge (cfs)				
	May	June	July	August	September
95	708	651	262	121	86
90	818	871	336	132	94
80	988	1124	440	160	106
75	1058	1226	488	170	111
50	1469	1704	726	218	133
25	2091	2335	1057	320	175
10	2863	2970	1628	447	263
5	3466	3549	2009	565	339

Flow statistics for daily mean flows recorded at Ecology Gage No. 45B070 are plotted in Figure 4-2. The Ecology gage has a much shorter period of record. It is located downstream of many of the large surface water diversions on Icicle Creek and also reflects inflows from Snow Creek and a few other smaller tributaries. Due to the short period of record, flow exceedance statistics could not be calculated. However, the minimum, maximum, and overall daily mean flow values were plotted to show the range of flows that have been recorded at the gage since 2011. Flows in lower Icicle Creek also fall below 100 cfs during dry years.

4.3.2 Impact of Alpine Lakes on Icicle Creek Water Supply

During the spring and early summer, natural flows in Icicle Creek are typically sufficient to meet water supply needs. During the late summer, as noted in Section 4.2.4, water stored in reservoirs in the Alpine Lakes Wilderness is released to supplement natural flows and sustain IPID's water supply from Icicle Creek. The flow statistics presented in Figure 4-1 and in Table 4-3 reflect those periods in the late summer when IPID has released water from their storage reservoirs in the Alpine Lakes to supplement the natural flow of Icicle Creek. Therefore, the flows recorded do not necessarily reflect natural flow rates. The data reflects IPID operations during low flow periods. Natural flows would be lower in the late summer, especially during dry years. A discussion of the adequacy of the IPID water supply is presented in Chapter 6.



Legend:

USGS Gage No.: 12458000
Period of Record: 10/1936 -10/2014

10% Daily Mean Exceedance
50% Daily Mean Exceedance
90% Daily Mean Exceedance
10% Overall Exceedance
50% Overall Exceedance
90% Overall Exceedance

Figure 4-1
Daily Mean Flow Exceedance Probability
Icicle Creek Above Snow Creek
IPID Comprehensive Water Conservation Plan

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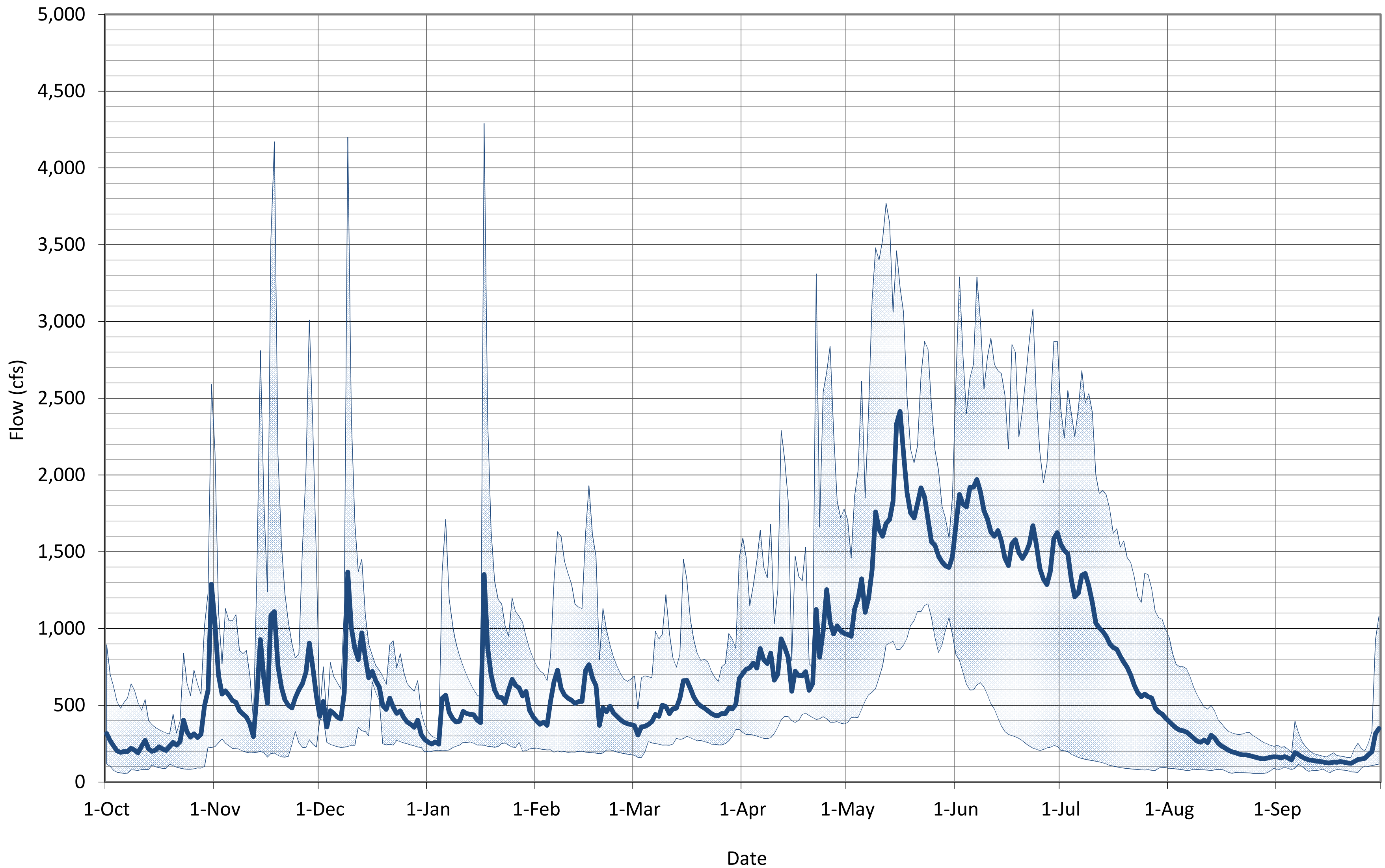


Legend:

ECY No. 45B070
Icicle Creek near Leavenworth

Range of flows (2011-2016)

Figure 4-2
Comparison of Annual Flow Variation
Icicle Creek near Leavenworth, WA
IPID Comprehensive Water Conservation Plan

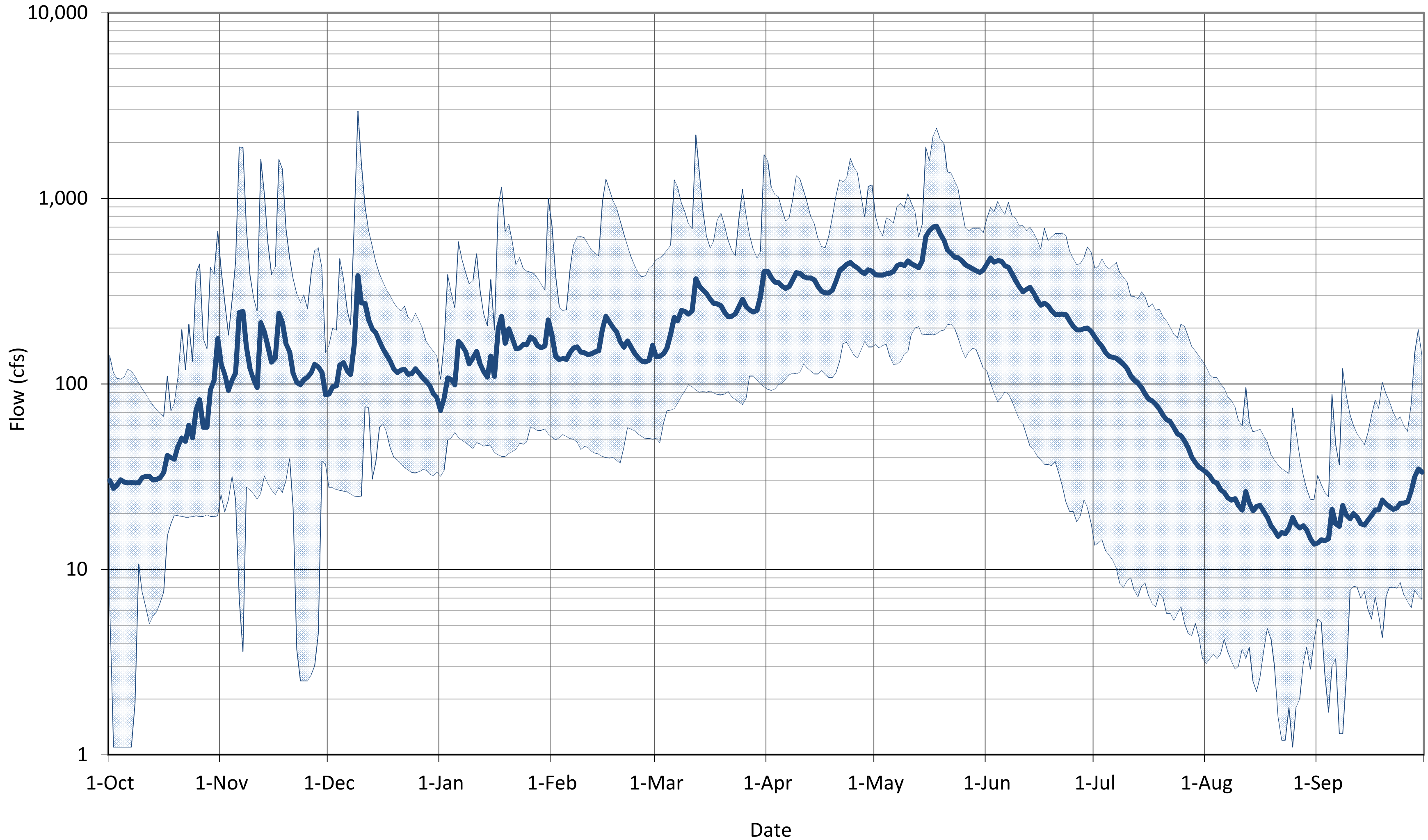
4.3.3 Peshastin Creek

The primary source of supply for the Tandy Ditch and PID delivery systems is Peshastin Creek. IPID diverts water from the right bank of Peshastin Creek to the PID Main Canal approximately 2.4 miles upstream from its Confluence with the Wenatchee River. The Tandy Ditch diverts water from the left bank of a side channel of Peshastin Creek approximately 4.9 miles upstream of its confluence with the Wenatchee River. Peshastin Creek has a drainage area of roughly 136 square miles and drains from the Blewett Pass area and the Stuart Range to the Wenatchee River. The Peshastin Creek Subbasin is lower in elevation than the Icicle Creek Subbasin and has fewer natural lakes, less snowpack, and a lower mean annual precipitation amount of approximately 36 inches. The streamflow is much less dependable than Icicle Creek and is often very low in late summer below the Peshastin diversion dam. PID has agreed to pass at least 3 cfs through its diversion dam in the late summer to maintain a minimum flow in lower Peshastin Creek.

The most continuous flow monitoring on Peshastin Creek has been at Ecology Gage No. 45F070, under Green Bridge Road. The gage is downstream of the PID and Tandy Ditch diversion facilities, so the flows measured represent the flow rate in lower Peshastin Creek after water is diverted by PID and the Tandy Ditch. Flow statistics for daily mean flows recorded at Ecology Gage No. 45F070 are plotted in Figure 4-3. Due to the short period of record, flow exceedance statistics could not be calculated. However, the minimum, maximum, and overall daily mean flow values were plotted to show the range of flows that have been recorded at the gage since 2011. During dry years, it is not uncommon for flows in lower Peshastin Creek, below the PID diversion, to drop below 10 cfs in the late summer.

During the late summer, PID has to supplement supply to the PID Canal with up to 15 cfs from the IID Division 2 canal. The water is conveyed to the PID Canal through a pipeline from the Peshastin Bifurcation structure located at the downstream end of the IID Division 2 Canal. The duration and magnitude of the supplemental supply from the IID Division 2 Canal to the PID Canal depends on flows in Peshastin Creek.

Only sporadic streamflow data has been collected upstream of the diversion. No continuous data is available, so no stream gage records exist that provide an accurate estimate of the reliability of Peshastin Creek as an irrigation source.



Legend:

ECY No. 45F070
Peshastin Creek at Green Bridge Road

Range of flow (2003-2016)

Average

Figure 4-3
Comparison of Annual Flow Variation
Peshastin Creek at Green Bridge Road
IPID Comprehensive Water Conservation Plan

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4.3.4 Wenatchee River

PID has a water right for 2.4 cfs on the Wenatchee River. The Wenatchee River originates from Lake Wenatchee, approximately 20 miles upstream from Leavenworth. Icicle Creek flows into the Wenatchee River near the town of Leavenworth, and Peshastin Creek flows into the Wenatchee River between Peshastin and Dryden. Data from USGS Gage No. 12461000 (Wenatchee River at Dryden, Washington), which is downstream of the confluence with Peshastin Creek, indicate the average daily streamflow in the Wenatchee River at that location is approximately 3,500 cfs. The 90% exceedance statistics indicate that during very dry years, late summer flows may drop below 500 cfs.

4.3.5 Alpine Lakes Storage

IPID normally operates within the natural flows available in Icicle Creek. However, the high elevation lakes described in Section 4.1.3 provide additional storage. Releases are made from these lakes when supplementary water is required. One or more of the lakes can be drawn down every year to supplement IPID water supply, for maintenance, or to supplement water supply for the City of Leavenworth and the U.S. Fish and Wildlife hatchery. In very water short years, water can be withdrawn from most of the lakes. The IPID hold water rights for 2,500 acre-feet each on Colchuck, Eightmile, and Klonaqua lakes; 2,000 acre-feet on Square Lake; and 1,000 acre-feet on Snow Lake. IPID typically releases water from Eightmile Lake first, because it is the easiest lake to access and has the highest probability of refill based on the volume of storage relative to the watershed size and annual runoff. Storage from the other lakes is then released, as needed to sustain irrigation supply from Icicle Creek. The other lakes are operated as needed to meet water supply needs. During drought years, water may be released from all four lakes.

4.4 Irrigation Diversions

4.4.1 Icicle Creek Diversions

Table 4-4 summarizes diversion data for the IPID diversion from Icicle Creek from 2013 through 2017. Figure 4-4 illustrates the variation over the season and the range of diversions through that period. IPID measures diversions at a rated section of reinforced concrete IID Diversion Canal upstream of the rotating drum fish screens. The facility includes a stilling well with a level transducer and a SCADA enabled variable resistor. The stage or water level recorded by the variable resistor is converted to a flow rate that can be downloaded or transmitted via SCADA to a computer at IPID's office in Cashmere. The reading on the instrument is recorded each day. The IPID Manager regularly checks the flow rating by measuring flows in the diversion channel adjacent to the flow monitoring equipment and adjustments are made to ensure that the data accurately reflects what is diverted.

Table 4-4
IPID Diversions from Icicle Creek

Time Period	2013		2014		2015		2016		2017	
	Average Flow (cfs)	Total Volume (acre-feet)	Average Flow (cfs)	Total Volume (acre-feet)	Average Flow (cfs)	Total Volume (acre-feet)	Average Flow (cfs)	Total Volume (acre-feet)	Average Flow (cfs)	Total Volume (acre-feet)
4/1–4/15	0.0	0	0.0	0	33.4	66	0.0	0	0.0	0
4/16–4/30	58.1	923	37.5	892	50.7	1,507	45.0	268	35.9	712
April	**58.1**	**923**	**37.5**	**892**	**49.6**	**1,574**	**45.0**	**268**	**35.9**	**712**
5/1–5/15	64.4	1,917	58.1	1,729	68.3	2,032	71.1	2,115	51.4	1,530
5/16–5/31	63.2	2,004	82.1	2,606	86.1	2,731	81.4	2,582	61.5	1,952
May	**63.8**	**3,921**	**70.5**	**4,335**	**77.5**	**4,763**	**76.4**	**4,698**	**56.6**	**3,482**
6/1–6/15	88.3	2,626	85.2	2,536	91.0	2,707	93.7	2,788	73.9	2,197
6/16–6/30	93.7	2,788	84.4	2,511	97.7	2,907	99.6	2,962	87.6	2,606
June	**91.0**	**5,414**	**84.8**	**5,047**	**94.3**	**5,614**	**96.6**	**5,750**	**80.7**	**4,803**
7/1–7/15	95.1	2,831	87.4	2,601	103.5	3,078	101.5	3,021	88.2	2,624
7/16–7/31	99.4	3,154	87.1	2,763	111.2	3,528	99.4	3,153	96.4	3,060
July	**97.3**	**5,985**	**87.2**	**5,364**	**107.4**	**6,606**	**100.4**	**6,174**	**92.4**	**5,683**
8/1–8/15	101.9	3,033	96.8	2,496	113.2	3,368	105.4	3,136	103.7	3,084
8/16–8/31	96.2	3,052	92.6	2,939	110.2	3,496	114.6	3,638	99.5	3,158
August	**99.0**	**6,086**	**94.5**	**5,435**	**111.6**	**6,864**	**110.2**	**6,774**	**101.5**	**6,242**
9/1–9/15	80.2	2,385	83.9	2,498	91.7	2,729	104.1	3,098	95.1	2,831
9/16–9/31	77.1	1,835	71.8	1,566	73.9	1,466	92.6	2,573	79.3	2,360
September	**78.8**	**4,220**	**78.8**	**4,064**	**84.6**	**4,195**	**98.6**	**5,671**	**87.2**	**5,191**
Total for Season	**84.7**	**26,547**	**79.7**	**25,136**	**91.0**	**29,615**	**95.4**	**29,335**	**80.8**	**26,115**

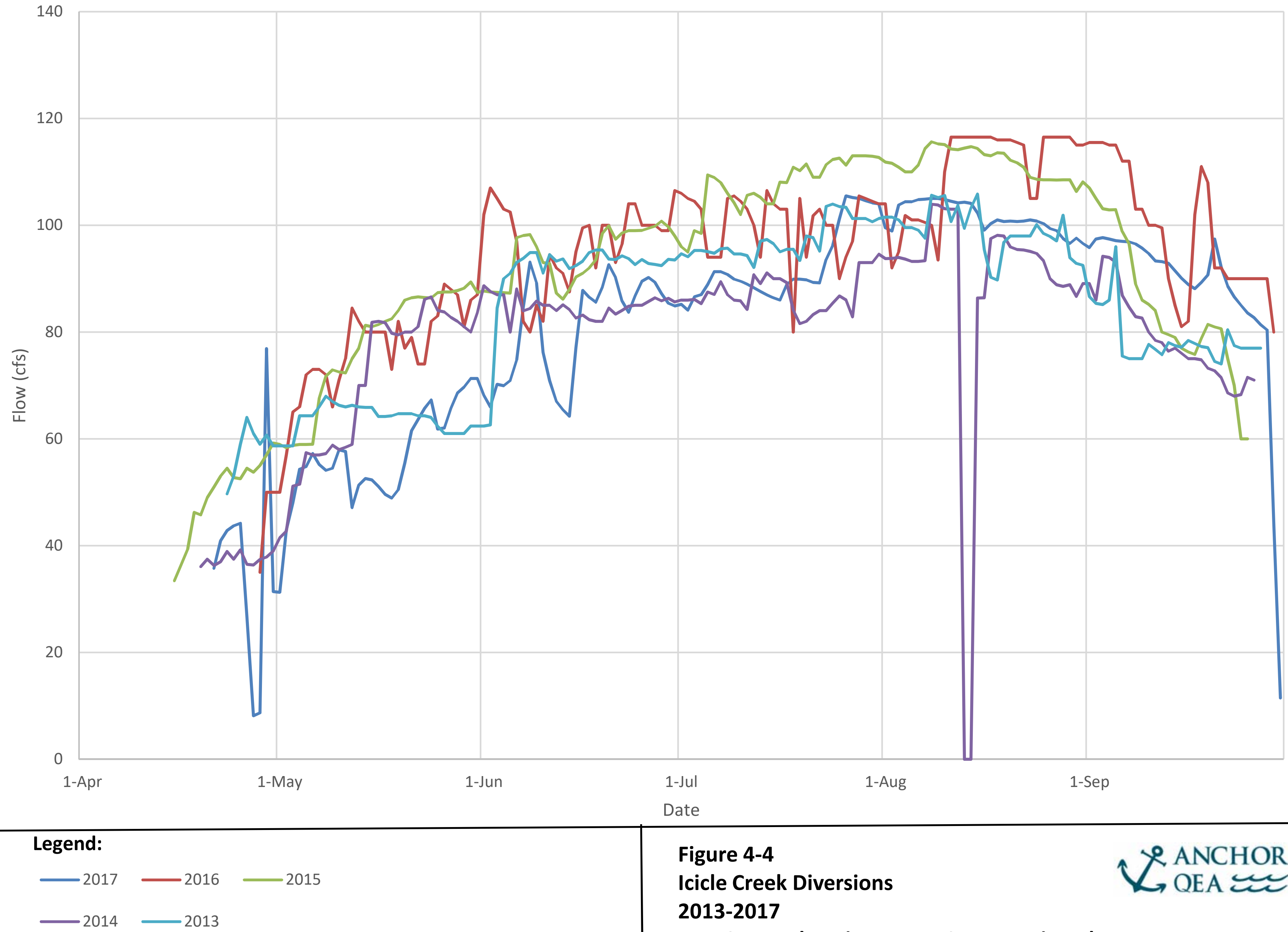


Figure 4-4
Icicle Creek Diversions
2013-2017
IPID Comprehensive Water Conservation Plan

It should be noted that the level transducer measures flow upstream of the fish bypass and the spillway at the fish screens. In addition, IPID regularly adjusts the gates at Snow Creek to regulate flow through the Division 1 Canal. The Snow Creek spill is used as a primary point of control to regulate flow in the system. Those spills are included in the flow rates shown in Table 4-4 and Figure 4-4 as diversions from Icicle Creek, even though those flows are returned to Icicle Creek not far downstream of the point of measurement.

Peak summertime diversions from Icicle Creek typically exceed 100 cfs. During dry years, diversions typically exceed 110 cfs during the late summer. During the period shown, 2015 was a very dry year and average daily diversions exceeded 100 cfs for most of July and August. The totals shown for 2015 include up to 4 cfs of supplemental flow diverted from Snow Creek from late July through early September. IPID typically only captures flow at the Snow Creek pick-up during very dry years to supplement diversions from Icicle Creek.

4.4.2 Peshastin Creek Diversions

Table 4-5 summarizes diversion data for the PID diversion from Peshastin Creek from 2013 through 2017. Figure 4-5 illustrates the variation over the season and the range of diversions through that period. IPID measures diversions at a Parshall flume downstream of PID's fish screen adjacent to Peshastin Creek. A transducer in a stilling well at the flume is connected to IPID's SCADA system. The stage or water level recorded by the transducer is converted to a flow rate that can be downloaded or transmitted via SCADA to a computer at IPID's office in Cashmere.

Peak summertime diversions from Peshastin Creek typically exceed 43 cfs and occur during June and July, before the flow in Peshastin Creek drops off enough to limit diversions. During dry years, diversions typically exceed 45 cfs. Diversion rates from Peshastin Creek are affected by flow availability in Peshastin Creek, timing of the fruit harvest, and reductions in water use following the fruit harvest. Diversions are reduced in August when flows in Peshastin Creek cannot sustain peak diversion rates. During the late summer diversions are supplemented by flows conveyed to the PID Main Canal from the Bifurcation Structure at the downstream end of the IID Division 2 Canal through the Peshastin Crossover pipeline.

Table 4-5
PID Diversions from Peshastin Creek

Time Period	2013		2014		2015		2016		2017	
	Average Flow (cfs)	Total Volume (acre-feet)	Average Flow (cfs)	Total Volume (acre-feet)	Average Flow (cfs)	Total Volume (acre-feet)	Average Flow (cfs)	Total Volume (acre-feet)	Average Flow (cfs)	Total Volume (acre-feet)
4/1–4/15	N/A	N/A	N/A	N/A	15.3	91	N/A	N/A	N/A	N/A
4/16–4/30	N/A	N/A	N/A	N/A	22.4	666	16.3	194	N/A	N/A
April	**N/A**	**N/A**	**N/A**	**N/A**	**21.2**	**757**	**16.3**	**194**	**N/A**	**N/A**
5/1–5/15	N/A	N/A	29.0	459	34.5	1,027	25.9	564	N/A	N/A
5/16–5/31	32.5	710	38.0	1,205	38.8	1,231	29.8	828	29.5	409
May	**32.5**	**710**	**35.0**	**1,664**	**36.7**	**2,258**	**28.1**	**1,392**	**29.5**	**409**
6/1–6/15	37.1	1,103	43.6	1,297	43.7	1,302	37.0	1,102	36.1	1,075
6/16–6/30	41.0	1,221	43.6	1,298	45.1	1,341	37.8	901	41.0	1,219
June	**39.1**	**2,324**	**43.6**	**2,595**	**44.4**	**2,642**	**37.4**	**2,002**	**38.5**	**2,293**
7/1–7/15	40.8	1,213	45.8	1,363	38.8	1,155	41.1	1,060	44.8	1,334
7/16–7/31	41.3	1,311	43.5	1,382	28.4	900	45.2	1,165	43.6	1,383
July	**41.0**	**2,524**	**44.7**	**2,745**	**33.4**	**2,055**	**43.1**	**2,225**	**44.2**	**2,717**
8/1–8/15	34.8	1,035	35.7	849	20.7	615	42.9	935	41.3	1,229
8/16–8/31	24.6	781	32.4	1,028	18.5	588	33.1	919	32.4	1,028
August	**29.5**	**1,816**	**33.8**	**1,877**	**19.6**	**1,203**	**37.4**	**1,854**	**36.7**	**2,257**
9/1–9/15	22.4	623	25.8	768	17.1	510	23.6	514	26.0	773
9/16–9/31	18.3	473	19.4	423	16.1	32	21.6	557	21.1	503
September	**20.5**	**1,095**	**23.1**	**1,191**	**17.1**	**542**	**22.5**	**1,071**	**23.8**	**1,276**
Total for Season	**32.8**	**8,468**	**36.5**	**10,073**	**30.4**	**9,457**	**33.1**	**8,738**	**35.8**	**8,952**

Notes:

1. N/A indicates periods for which data were not available. The lack of data does not indicate that there were no diversions during that period, but likely indicates that the flow measurement device was not working properly. The totals for the season are likely underestimated for seasons where data was not collected in the early part of the season.

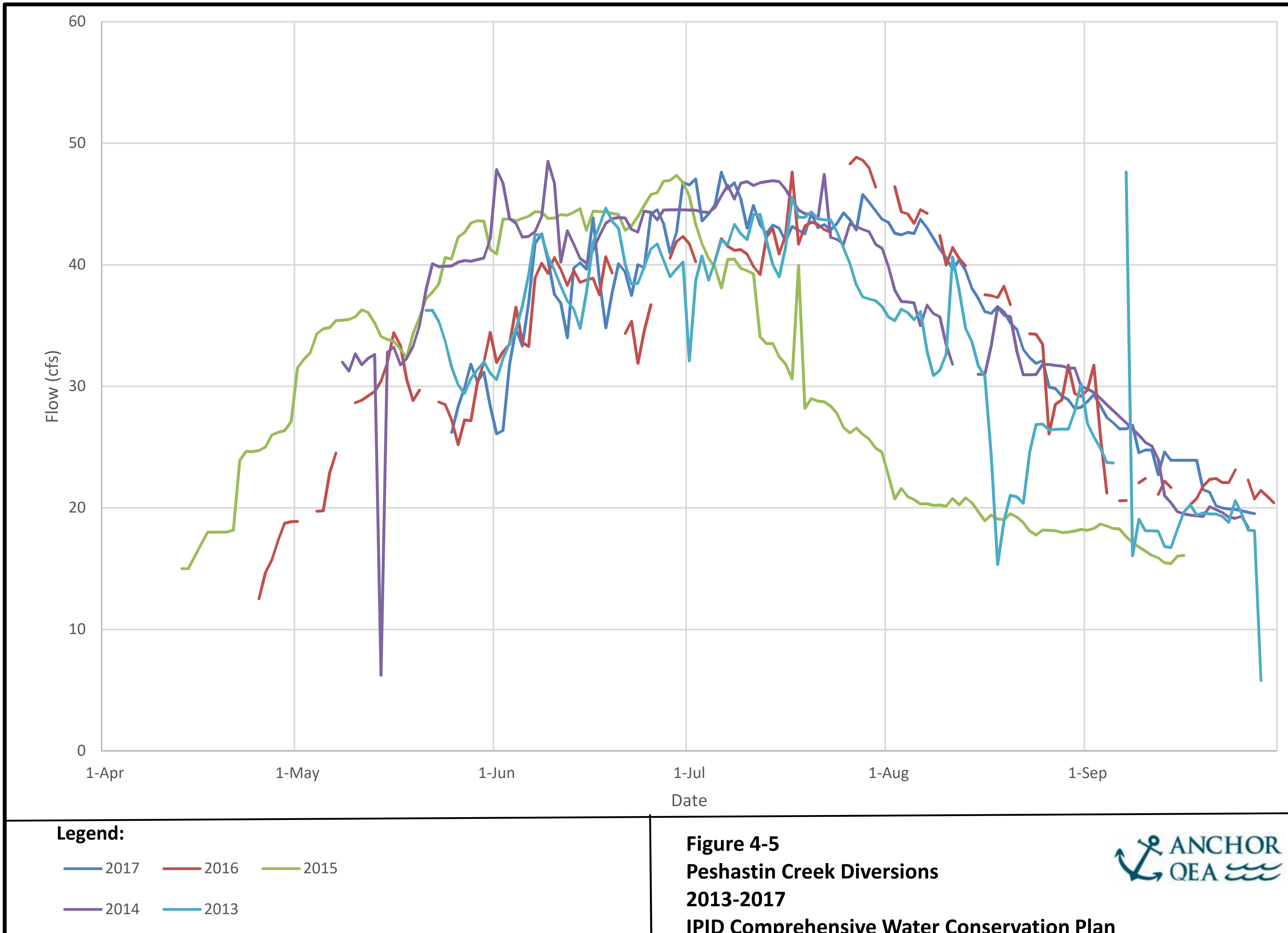


Figure 4-5
Peshastin Creek Diversions
2013-2017
IPID Comprehensive Water Conservation Plan

4.5 Irrigation Delivery System Flows

4.5.1 Staff Gage Readings

The IPID delivery system includes a network of staff gages at weirs, in key canal sections, and at spillways that help IPID staff monitor and regulate flows in the system. IPID staff record levels at key staff gages on a daily or weekly basis. Records are kept in a notebook that is stored in a cabinet at the Peshastin Bifurcation Structure at the downstream end of the IID Division 2 Canal. The cabinet was vandalized early in August 2017 and the notebook was stolen. Consequently, no data from April through July of 2017 is available. Some historical data is on file at IPID offices. IPID has copied some of that data to spreadsheet files for evaluation of stage and depth data. IPID provided data for stage recordings at key locations in the IID Division 1 and 2 Canal systems for review and evaluation. Data included the stage monitored at the weirs in the Peshastin Bifurcation that measure flow to the IID Division 3A Canal, the Peshastin Crossover to the PID Main Canal, and the Gibb Ditch system. Data also included the stage monitored at the weir in the Leavenworth Bifurcation that measures flow to IID Division 4 and 5 Canal systems.

To convert the stage readings to discharge and analyze flow distribution through the canal system, stage-discharge rating curves were derived at key locations in the canal system. Rating curves were derived from flow measurements and surveys of the canal section dimensions and slope, or, where stage readings were taken adjacent weirs, weir equations were used to convert stage readings to flow rates. Rating curves for canal staff gages and weirs are included in Appendix B.

4.5.2 2017 Flow Monitoring

As part of the effort to further understand the distribution of flows in the IPID delivery system, transducers were installed at four key locations during the late summer of 2017, as follows:

- **IID Division 1 Canal Upstream of Leavenworth Bifurcation** – A transducer was installed near a wood bridge over the IID Division 1 Canal upstream of the Leavenworth Bifurcation near Station 330+00 (see Exhibit 2, Appendix A).
- **IID Division 3A Canal Downstream of the Maxwell Siphon** – A transducer was installed at a location that was set up for monitoring in the summer of 2014 downstream of the Maxwell Siphon on the IID Division 3A Canal near Station 725+00 (see Exhibit 4, Appendix A).
- **IID Division 3B Canal Downstream of the Mission Siphon near Butler Road** – A transducer was installed near the existing staff gage where Butler Road crosses the IID Division 3B Canal near Station 1165+00 (see Exhibit 5, Appendix A).
- **PID Canal Near the East Deadman Hill Road Crossing** – A transducer was installed at a location that was set up for monitoring in the summer of 2014 upstream of the east crossing of the PID Canal under Deadman Hill Road near Station 200+00 (see Exhibit 7, Appendix A).

Flow measurements were taken at each location using a velocity meter to help verify the stage-discharge relationship at each location. The stage-discharge rating was then calculated based on the shape of the ditch section and the flow measurement using Manning's equation for open channel flow. The stage-discharge rating for each location was then used to convert the water level data collected with the transducers to flow rates. The resulting stage-discharge ratings and calculated flow rates at each location through the period of monitoring were plotted and included in Appendix C. Transducer data were collected from August 18, 2017, through the end of the irrigation season at the end of September 2018. The IPID Manager indicated that flow rates may have peaked for the season a few days before the transducers were installed.

4.5.3 Summary of Delivery System Flows

Table 4-6 summarizes stage or depth and estimated flow rates from the data recorded and provided by IPID and flow monitoring completed in August and September 2017. Table 4-7 summarizes the same information for the PID delivery system. The stage readings and flow data were averaged on a monthly basis. PID monitors stage at several other key locations, including spills, ditch sections, and flumes. Data beyond what is shown in Tables 4-6 and 4-7 was not provided or evaluated as part of this study. Evaluation of stage and discharge at additional locations could be completed to provide additional definition of flow distribution through the IPID delivery system.

Table 4-6
IID System Flow Distribution – Average Monthly Stage and Flow Estimates

Location	April		May		June		July		August		September	
	Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)
2013												
Icicle Creek Diversion[1]	N/A	58.1	N/A	63.8	N/A	91.0	N/A	97.3	N/A	99.0	N/A	78.8
IID Division 1 – Upstream of Leavenworth Bifurcation[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IID Division 1 – Leavenworth Bifurcation (to Divisions 4 and 5)[3]	0.9	18.4	1.0	20.3	1.3	26.2	1.3	27.2	1.2	24.9	1.0	20.2
IID Division 2 – Peshastin Bifurcation (to Division 3A)[3]	0.8	17.1	1.0	20.3	1.1	22.9	1.2	23.8	1.1	22.8	0.8	15.9
IID Division 2 – Peshastin Bifurcation (to Peshastin Crossover)[3, 4]	0.6	7.4	0.5	3.9	0.6	4.2	0.7	5.0	0.8	8.0	0.7	8.4
IID Division 2 – Peshastin Bifurcation (to Gibb Ditch)[3]	0.4	4.9	0.5	6.1	0.6	7.9	0.6	8.5	0.6	8.0	0.5	6.3
IID Division 3A – Downstream of Maxwell Siphon[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IID Division 3B – Near Butler Road Gage[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2014												
Icicle Creek Diversion[1]	N/A	37.5	N/A	70.5	N/A	84.8	N/A	87.2	N/A	94.5	N/A	78.8
IID Division 1 – Upstream of Leavenworth Bifurcation[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IID Division 1 – Leavenworth Bifurcation (to Divisions 4 and 5)[3]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IID Division 2 – Peshastin Bifurcation (to Division 3A)[3]	0.7	13.7	1.0	21.0	1.2	23.3	1.1	24.2	1.1	22.9	1.0	20.5
IID Division 2 – Peshastin Bifurcation (to Peshastin Crossover)[3, 4]	0.5	4.2	0.6	4.6	0.5	2.3	0.6	2.3	0.7	6.0	0.6	4.6
IID Division 2 – Peshastin Bifurcation (to Gibb Ditch)[3]	0.4	5.6	0.6	8.0	0.7	8.8	0.7	8.9	0.6	8.3	0.5	6.9
IID Division 3A – Downstream of Maxwell Siphon[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IID Division 3B – Near Butler Road Gage[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2015												
Icicle Creek Diversion[1]	N/A	49.6	N/A	77.5	N/A	94.3	N/A	107.4	N/A	111.6	N/A	84.6
IID Division 1 – Upstream of Leavenworth Bifurcation[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IID Division 1 – Leavenworth Bifurcation (to Divisions 4 and 5)[3]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IID Division 2 – Peshastin Bifurcation (to Division 3A)[3]	0.9	17.9	1.1	23.0	1.2	23.3	1.2	23.6	1.1	21.6	1.0	19.2
IID Division 2 – Peshastin Bifurcation (to Peshastin Crossover)[3, 4]	0.4	2.2	0.4	1.2	0.5	1.2	0.8	8.4	1.0	12.7	0.8	11.2
IID Division 2 – Peshastin Bifurcation (to Gibb Ditch)[3]	0.4	5.5	0.6	7.6	0.6	8.7	0.6	8.4	0.6	8.0	0.5	6.9
IID Division 3A – Downstream of Maxwell Siphon[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IID Division 3B – Near Butler Road Gage[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2016												
Icicle Creek Diversion[1]	N/A	45.0	N/A	76.4	N/A	96.6	N/A	100.4	N/A	110.2	N/A	98.6
IID Division 1 – Upstream of Leavenworth Bifurcation[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IID Division 1 – Leavenworth Bifurcation (to Divisions 4 and 5)[3]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IID Division 2 – Peshastin Bifurcation (to Division 3A)[3]	0.6	11.6	1.1	21.3	1.2	23.3	1.2	23.8	1.1	22.9	1.0	19.7
IID Division 2 – Peshastin Bifurcation (to Peshastin Crossover)[3, 4]	N/A	N/A	0.5	2.6	0.5	1.3	0.7	6.3	0.7	7.3	0.7	8.2
IID Division 2 – Peshastin Bifurcation (to Gibb Ditch)[3]	0.4	4.7	0.5	7.4	0.6	8.3	0.6	8.3	0.6	7.8	0.5	6.4

Location	April		May		June		July		August		September	
	Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)
IID Division 3A – Downstream of Maxwell Siphon[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IID Division 3B – Near Butler Road Gage[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2017												
Icicle Creek Diversion[1]	N/A	35.9	N/A	56.6	N/A	80.7	N/A	92.4	N/A	101.5	N/A	87.2
IID Division 1 – Upstream of Leavenworth Bifurcation[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.5	60.9	1.7	29.0
IID Division 1 – Leavenworth Bifurcation (to Divisions 4 and 5)[3]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.3	26.5	1.0	21.1
IID Division 2 – Peshastin Bifurcation (to Division 3A)[3]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.1	23.0	0.9	18.8
IID Division 2 – Peshastin Bifurcation (to Peshastin Crossover)[3, 4]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.6	4.0	0.6	4.3
IID Division 2 – Peshastin Bifurcation (to Gibb Ditch)[3]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.6	8.6	0.5	7.4
IID Division 3A – Downstream of Maxwell Siphon[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.6	20.6	1.4	15.6
IID Division 3B – Near Butler Road Gage[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.0	7.3	0.9	6.7

Notes:
1. Diversion flow records were provided by IPID. Flows are estimated based on a transducer in a rated section of the intake canal upstream of the IPID fish screens at the Icicle Creek Diversion.
2. Stage (depth) is estimated using transducer installed from August 18, 2017, through September 2017. Flow is estimated using stage-discharge rating developed for canal section where transducers were installed.
3. Gage readings at weir were provided by IPID. Flows are calculated using weir ratings based on Cipoletti weir equation.
4. Flow to Peshastin Crossover is estimated by reading the gage on a weir, referred to as the spillway weir, which measures flow to both the Peshastin Crossover and the Gibb Ditch. The Gibb Ditch flow, which is measured at a smaller weir downstream of the spillway weir, is subtracted from the spillway weir flow to estimate the flow to the Peshastin Crossover.

N/A: No data available at this location for this month and year.

Table 4-7
PID System Flow Distribution – Average Monthly Stage and Flow Estimates

	April		May		June		July		August		September	
Location	Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)
2013												
Peshastin Creek Diversion[1]	N/A	N/A	N/A	32.5	N/A	39.1	N/A	41.0	N/A	29.5	N/A	20.5
Inflow from Peshastin Crossover (at Peshastin Bifurcation)[2,3]	0.6	7.4	0.5	3.9	0.6	4.2	0.7	5.0	0.8	8.0	0.7	8.4
PID Canal – Upstream of East Deadman Hill Road Crossing[4]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2014												
Peshastin Creek Diversion[1]	N/A	N/A	N/A	35.0	N/A	43.6	N/A	44.7	N/A	33.8	N/A	23.1
Inflow from Peshastin Crossover (at Peshastin Bifurcation)[2,3]	0.5	4.2	0.6	4.6	0.5	2.3	0.6	2.3	0.7	6.0	0.6	4.6
PID Canal – Upstream of East Deadman Hill Road Crossing[4]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2015												
Peshastin Creek Diversion[1]	N/A	21.2	N/A	36.7	N/A	44.4	N/A	33.4	N/A	19.6	N/A	17.1
Inflow from Peshastin Crossover (at Peshastin Bifurcation)[2,3]	0.4	2.2	0.4	1.2	0.5	1.2	0.8	8.4	1.0	12.7	0.8	11.2
PID Canal – Upstream of East Deadman Hill Road Crossing[4]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2016												
Peshastin Creek Diversion[1]	N/A	16.3	N/A	28.1	N/A	37.4	N/A	43.1	N/A	37.4	N/A	22.5
Inflow from Peshastin Crossover (at Peshastin Bifurcation)[2,3]	N/A	N/A	0.5	2.6	0.5	1.3	0.7	6.3	0.7	7.3	0.7	8.2
PID Canal – Upstream of East Deadman Hill Road Crossing[4]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2017												
Peshastin Creek Diversion[1]	N/A	N/A	N/A	29.5	N/A	38.5	N/A	44.2	N/A	36.7	N/A	23.8
Inflow from Peshastin Crossover (at Peshastin Bifurcation)[2,3]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.6	4.0	0.6	4.3
PID Canal – Upstream of East Deadman Hill Road Crossing[4]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.2	1.8	22.4	16.3

Notes:
1. Diversion flow records were provided by IPID. Flows are estimated based on a transducer in a stilling well at the Parshall Flume located at the Peshastin Creek Diversion.
2. Gage readings at weir were provided by IPID. Flows are calculated using weir ratings based on Cipoletti weir equation.
3. Flow to Peshastin Crossover is estimated by reading the gage on a weir, referred to as the spillway weir, which measures flow to both the Peshastin Crossover and the Gibb Ditch. The Gibb Ditch flow, which is measured at a smaller weir downstream of the spillway weir, is subtracted from the spillway weir flow to estimate the flow to the Peshastin Crossover.
4. Stage (depth) is estimated using transducer installed from August 18, 2017, through September 2017. Flow is estimated using stage-discharge rating developed for canal section where transducers were installed.

N/A: No data available at this location for this month and year.

4.6 Conveyance Losses and Efficiency

Conveyance losses in the canal system can be due to seepage through cracks and joints in the canal lining, infiltration through unlined areas, seepage through cracks and joints in turnout boxes, leaking shutoff gates and valves, evaporation, transpiration by plants or trees that have roots in the canal banks, and seepage that follows root paths in canal banks. Conveyance losses in different canal reaches were estimated by measuring flows at upstream and downstream ends of the discrete reaches of the canal system. Measurements were taken using velocity meters. While taking the flow measurements, turnout boxes were shut off where practical to simplify the measurement procedure. Where turnout boxes could not be shut off, the flows from those turnouts were estimated by measuring head over an orifice or a weir. District staff assisted in the measurement program by turning on and shutting off the turnout boxes, measuring the head in the turnout boxes that were not shut off during the canal measurements, and measuring the head on spillways within each reach. These measurements were used to estimate flows out of the reach of ditch being evaluated.

As part of this evaluation, a rating was developed for IPID of the relationship between the head in the turnout box and the flow rate. That relationship was estimated using weir and orifice equations and dimensions provided by IPID. IPID indicated that each turnout has a plate with a lower orifice that is 0.25 inches wide per share (one share is generally equal to 1 acre) by 2 inches high and an upper orifice that is 0.25 inches wide per share by 1 inch high. There is 1 inches of separation between the top of the lower orifice and the invert of the upper orifice. The calculation was intended to verify IPID's understanding that the orifices were sized to deliver water at a rate 6.75 gpm per share at each customer turnout during normal operating conditions. The results indicate that the water surface in the turnout box would need to be just over 1 inch above the top of the upper orifice to deliver 6.75 gpm per share. The rating curve for the turnout boxes is also included in Appendix B.

Flowrates at the end of the reach and through the turnout boxes and spills were added together and then subtracted from the flowrate measured at the head of the reach to estimate the conveyance losses in each reach of the canal. The total conveyance loss for each reach was also divided by the length of the reach to provide an estimated loss per mile of canal. Flow measurements were originally taken June 27 to 29, 2017. The data were then processed and reviewed with IPID. There were several measurements that did not appear to be accurate or were indicating that excessive loss or gain in a reach of the canal. Additional measurements were taken by IPID on September 27, 2017, to verify flows and conveyance losses through key reaches of the canal where original measurements did not appear to be accurate.

The following sections summarize the conveyances losses and efficiencies measured at key reaches in both the IID and PID canal systems.

4.6.1 Icicle Irrigation District

Table 4-8 summarizes flow measurements and conveyance losses estimated for the IID canal system. Losses greater than 1 cfs per mile of canal were identified in following reaches of the canal system:

- A 5.5-cfs loss (1.8 cfs per mile) was measured in the fully and partially lined canal in Division 1 between the Mountain Home Flume and the Van Brocklin Spill.
- A 1.9-cfs loss (1.4 cfs per mile) was measured in the fully and partially lined canal in Division 2 from Simpson Road to the Peshastin Bifurcation.
- A 0.6-cfs loss (2.8 cfs per mile) was measured in Carson's Pipeline in Division 3A.
- A 1.3-cfs loss (1.3 cfs per mile) was measured in the fully lined canal and pipeline from Carson's Pipeline through the Maxwell Siphon in Division 3A.
- A 1.8-cfs loss (11.9 cfs per mile) was measured in the Sandstone Tunnels in Division 3A.
- A 2.4-cfs loss (1.1 cfs per mile) was measured in the fully and partially lined canal in Division 3A from Tigner Road to the Mission Siphon.

The conveyance losses were reviewed with IPID. IPID repeated measurements through two reaches to verify losses, as follows:

- IPID measurements indicated that the loss in the fully and partially lined canal in Division 1 between the Mountain Home Flume and the Van Brocklin Spill was less than originally estimated. A loss of 0.6 cfs (0.4 cfs per mile) was measured.
- IPID measurements indicated that the loss in the Sandstone Tunnels in Division 3A may not reflect actual conditions. They completed two sets of measurements at the upstream and downstream ends of the tunnels. Both sets of measurements indicated a gain in flow.

4.6.2 Peshastin Irrigation District

Table 4-9 summarizes flow measurements and conveyance losses estimated for the PID canal system. Losses greater than 1 cfs per mile of canal were identified in the following reaches of the canal system:

- An 8.5-cfs loss (6.8 cfs per mile) was measured in the mostly unlined PID canal from the intake to the beginning of the canal lining upstream of the Fryburger Spill. IPID expected loss through this section, but the measured loss is likely higher than the actual loss and is probably due to the difference in accuracy of the intake flume measurement that was recorded at the upstream end of the reach and the velocity meter measurement collected at the downstream end of the reach.
- A 1.2-cfs loss (1.2 cfs per mile) was measured in mostly unlined canal upstream of the Pine Flats Flume.
- A 1.5-cfs loss (1.8 cfs per mile) was measured in the mostly lined canal on Stines Hill downstream of the pipeline that has been installed on the north end of Stines Hill.

Table 4-8
IID Delivery System – Seepage Measurements and Conveyance Losses

Reach	Measurement Location	Measurement Location and Reach Description	Date Measured	Flow Measured (cfs)	Estimated Use (cfs)	Estimated Gain/(Loss) (cfs)	Approximate Station	Reach Length (miles)	Estimated Gain/(Loss) (cfs/mile)
IID Division 1 – First Set of Measurements									
	1	Downstream End of Snow Creek Flume	6/27/2017	73.1			18+00		
A		Fully Lined Canal, Flume, and Rock Tunnels			0.0	5.3		1.8	3.0
	2	Mt. Home Flume Outlet[1]	6/27/2017	78.4			111+00		
B		Fully and Partially Lined Canal			0.0	(5.5)		3.0	(1.8)
	3	Van Brocklin Spill	6/27/2017	72.9			267+50		
IID Division 1 – Follow Up Measurements by IPID									
	1	Downstream End of Snow Creek Flume	9/27/2017	55.8			18+00		
A		Mostly Lined Canal and Rock Tunnels			0.0	(0.6)		1.8	(0.4)
	2	Mt. Home Flume Outlet[1]	9/27/2017	55.1			111+00		
IID Division 2 – First Set of Measurements									
	4	Partially Lined Section Upstream of Division 2 First Tunnel	6/27/2017	40.2			412+00		
C		Rock Tunnel and Fully and Partially Lined Canal			1.1	(0.3)		1.7	(0.2)
	5	Downstream of Partially Lined Section near Simpson Road	6/27/2017	38.8			500+00		
D		Fully and Partially Lined Canal			3.6	(1.0)		0.9	(1.0)
	6	Unlined Canal near Beecher Hill Road	6/27/2017	34.2			550+00		
E		Fully and Partially Lined Canal			1.4	(0.9)		0.4	(2.3)
	7	Peshastin Bifurcation (3A Weir + Spill Weir + Overflow)	6/27/2017	32.0			570+00		
IID Division 3A – First Set of Measurements									
	8	Outlet of Siphon to Division 3	6/27/2017	27.2			601+00		
F		Fully Lined Canal			0.3	1.3		1.1	1.2
	9	Carson's Pipe Inlet	6/27/2017	28.2			658+00		
G		Carson's Pipeline			0.0	(0.6)		0.2	(2.8)
	10	Carson's Pipe Outlet	6/27/2017	27.6			670+00		
H		Fully Lined Canal and Pipeline			0.5	(1.3)		1.0	(1.3)
	11	Outlet of Siphon; Anchor QEA Stilling Well Site	6/27/2017	25.8			721+00		
	12	Sandstone Tunnels Inlet	6/27/2017	26.8			863+00		
I		Sandstone Tunnels			0.7	(1.8)		0.2	(11.9)
	13	Sandstone Tunnels Outlet	6/27/2017	24.2			871+00		
	14	End of Tigner Road	6/29/2017	23.9			956+00		
J		Fully and Partially Lined Canal			1.3	(2.4)		2.3	(1.1)
	15	Mission Siphon Inlet	6/29/2017	20.2			1078+00		

Reach	Measurement Location	Measurement Location and Reach Description	Date Measured	Flow Measured (cfs)	Estimated Use (cfs)	Estimated Gain/(Loss) (cfs)	Approximate Station	Reach Length (miles)	Estimated Gain/(Loss) (cfs/mile)
IID Division 3A – Follow Up Measurements by IPID									
	12	Sandstone Tunnels Inlet	6/27/2017	16.6			863+00		
I		Sandstone Tunnels			0.0	0.2		0.2	1.3
	13	Sandstone Tunnels Outlet	6/27/2017	16.8			871+00		
IID Division 4 – First Set of Measurements									
	16	Downstream of Anderson Canyon Siphon	7/5/2017	15.1			112+00		
K		Partially Lined Canal			0.3	(0.1)		0.3	(0.4)
	17	End of Partial Lined Canal Section at "The Point"	7/5/2017	14.7			130+00		

Table 4-9
PID Delivery System – Seepage Measurements and Conveyance Losses

Reach	Measurement Location	Measurement Location and Reach Description	Date Measured	Flow Measured (cfs)	Estimated Use (cfs)	Estimated Gain/(Loss) (cfs)	Approx. Station	Reach Length (miles)	Estimated Gain/(Loss) (cfs/mile)
PID Main Canal – First Set of Measurements									
	18	Parshall Flume at PID Diversion on Peshastin Creek	6/28/2017	39.2			2+50		
L		Mostly Unlined Canal			1.2	(8.5)		1.2	(6.8)
	19	Beginning of Lined Section	6/28/2017	29.5			68+00		
	21	Outlet of the Pipe, Near Landfill	6/28/2017	27.0			158+00		
M		Pipeline and Some Partially Lined and Unlined Canal			0.4	0.9		0.7	1.2
	22	Eastside of Deadman Hill Road, Upstream of Three Turnouts	6/28/2017	27.5			196+00		
	24	Near Stines Hill Gauge	6/28/2017	21.3			303+00		
N		Mostly Unlined Canal			0.6	(1.2)		1.0	(1.2)
	25	Near 5550 Pine Flats Loop Road	6/28/2017	19.6			355+00		
	26	Lined Canal Downstream of Pipe on Stines Hill	6/28/2017	15.7			446+00		
O		Mostly Fully Lined Canal			0.5	(1.5)		0.8	(1.8)
	27	Near the Point of Stines Hill	6/28/2017	13.7			490+00		

5 Existing Facilities and Operations

5.1 Existing Irrigation District Delivery Facilities

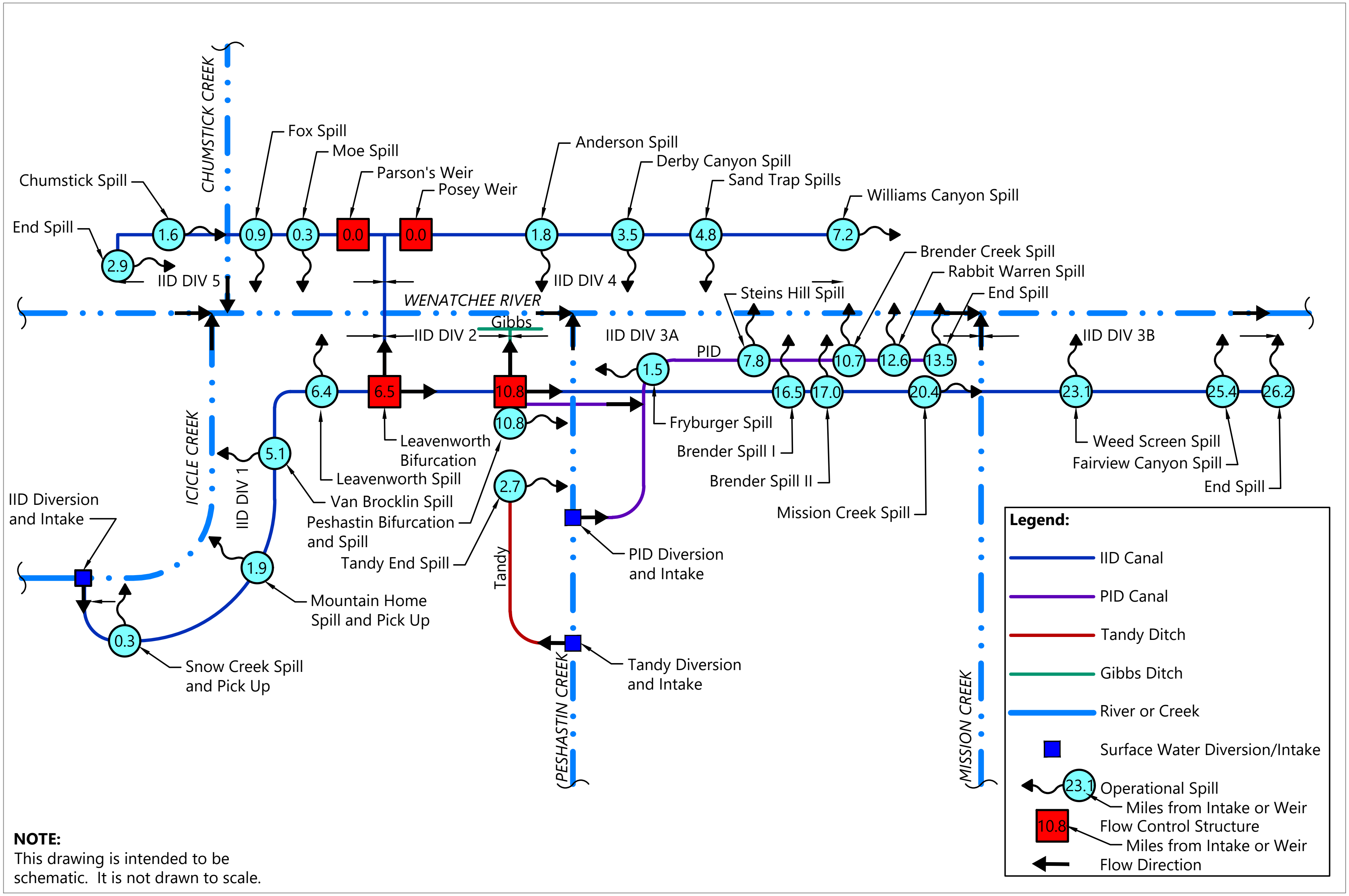
Exhibits 1-7 in Appendix A show the locations of the IPID distribution facilities, including IID facilities, PID facilities, shared facilities, Tandy Ditch facilities, and Gibb Ditch facilities. Figure 5-1 provides a schematic of how the IPID facilities operate, which direction water flows, where operational spills occur, and where the systems are connected with one another. A field inventory of the IPID surface water diversion facilities, canals, spillways, pipelines, turnouts, and other facilities was completed in May 2017. The condition of major components was documented and photographed. The major components were reviewed for their physical characteristics, such as stability, physical condition, and evidence of seepage or leaks. A detailed structural evaluation was not performed and no subsurface or geotechnical investigations or evaluations were performed. Measurements and monitoring were completed, as summarized in Chapter 4, to evaluate flows in different segments of the delivery systems. The capacity was also identified by reviewing past flow measurements and through observations provided by IPID staff. A description of these characteristics is provided in this section.

5.1.1 Overview – Icicle Irrigation District

IID facilities include a diversion dam and intake facilities that divert water from the right bank of Icicle Creek approximately 5.7 miles upstream of its confluence with the Wenatchee River, approximately 36 miles of canal and pipeline that comprise five divisions of the IID delivery system, spill facilities, turnouts, and bifurcation structures that control flow from one division of the delivery system to another. The diversion dam and intake facilities on Icicle Creek, the IID Division 1 Canal, and the IID Division 2 Canal are jointly owned and operated with PID. As noted earlier, IID irrigates approximately 4,300 acres extending from the City of Leavenworth to Monitor on both sides of the Wenatchee River Valley.

5.1.2 Overview – Peshastin Irrigation District

PID facilities include a diversion dam and intake facilities that divert water from the right bank of Peshastin Creek approximately 2.4 miles upstream from its confluence with the Wenatchee River, approximately 13 miles of canal and pipeline that comprise the PID delivery system, spill facilities, turnouts, and flow control structures. PID facilities also include the IID diversion dam and intake facilities on Icicle Creek, the IID Division Canal, and the IID Division 2 Canal, which are jointly owned and operated with IID. Water supply to the PID Canal is supplemented in the late summer with water conveyed through a pipeline, referred to as the "Peshastin Crossover," that crosses under U.S. Highway 97 and Peshastin Creek from the bifurcation structure at the downstream end of the IID Division 2 Canal to the PID Canal. PID irrigates nearly 3,700 acres, which includes areas irrigated by two small canal and pipeline delivery systems, the Tandy Ditch and the Gibb Ditch.



NOTE:
This drawing is intended to be schematic. It is not drawn to scale.

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Filepath: L:\Projects\Trout_Unlimited\IPID_Conservation_Plan_Update_(171070-01.01)\CAD\0170-RP-001-Figure 5-1.dwg Figure 5-1

ANCHOR QEA

Figure 5-1
Schematic of IPID Operations

Comprehensive Water Conservation Plan
Icicle and Peshastin Irrigation Districts

5.1.2.1 Overview – Gibb Ditch

The Gibb Ditch system delivers water through a network of closed pipelines supplied through a gate and screened intake box at the bifurcation structure at the downstream end of the IID Division 2 Canal. The system includes a network of approximately 2.9 miles of closed pipelines ranging in diameter from 3-inch to 14-inch. The Gibb Ditch system irrigates over 500 acres near the junction of U.S. Highway 97 and U.S Highway 2. Some of the Gibb Ditch water users are supplied directly from the IID Division 2 Canal.

5.1.2.2 Overview – Tandy Ditch

The Tandy Ditch system includes a small weir and intake facilities that divert water from a side channel on the left bank of Peshastin Creek approximately 4.9 miles upstream of its confluence with the Wenatchee River. The system includes approximately 900 feet of open canal and 2.6 miles of closed pipeline, ranging in size from 8- to 20-inch diameter. Additional supply to some Tandy Ditch shareholders is supplied directly from the IID Division 2 Canal upstream of the bifurcation structure. The Tandy Ditch irrigates over 200 acres east of Peshastin Creek and south of U.S. Highway 2. Some of the Tandy Ditch water users are supplied directly from the IID Division 2 Canal.

5.2 System Inventory and Assessment of Key Facilities

Table 5-1 summarizes the major canal and pipeline reaches or divisions that comprise the IPID delivery system. The canal stationing shown reflects the stationing provided on Exhibits 1 through 7 in Appendix A. Table 5-1 also lists the approximate length and capacity of each reach or division or reach of the irrigation delivery systems. The number of turnouts served by each reach or division was not evaluated as part of the system inventory. Several turnouts were located and documented prior to or during the system inventory, but not all turnouts have been inventoried. IPID is working separately to complete an inventory of all turnouts. As part of that effort, IPID is photographing and locating each turnout with global positioning system (GPS) software, assessing the physical condition, measuring the weir plate or orifice in each, and identifying which assessed acres are irrigated by each. That effort is ongoing and is planned to be completed in the summer of 2018.

The capacities identified in the 1993 IID CWCP and PID CWCP are generally consistent with the current capacities of the delivery facilities. Capacities were verified primarily through discussions with IPID staff who operate the system and are familiar with system capacity. The flow measurements and monitoring are outlined in Chapter 4.

Table 5-1
IPID Inventory Summary

Division/Reach	Stationing		Length (miles)	Estimated Capacity (cfs)	
	Start (Upstream)	End (Downstream)		Start (Upstream)	End (Downstream)
IID and PID Shared Delivery System Facilities					
1	Sta 0+00	Sta 343+00	6.5	125	100
2	Sta 343+00	Sta 570+00	4.3	75	65
IID Delivery System Facilities					
3A	Sta 570+00	Sta 1078+00	9.6	30	26
3B	Sta 1078+00	Sta 1342+00	5.0	18	N/A
4	Sta 0+00	Sta 409+00	7.7	22	N/A
5	Sta 0+00	Sta 141+00	2.7	9	N/A
PID Delivery System Facilities					
Intake to Dryden Spill	Sta 0+00	Sta 167+00	3.2	50	42
Dryden Spill to Stines Hill Spill	Sta 167+00	Sta 413+00	4.7	42	27
Stines Hill Spill to Tigner Spill	Sta 413+00	Sta 668+00	4.8	27	16
Pressure Pipe to Pioneer End	Sta 668+00	Sta 711+00	0.8	5	N/A
Tandy Ditch and Gibb Ditch Facilities					
Tandy – Open Ditch	Sta 0+00	Sta 9+00	0.2	10	10
Tandy – Closed Pipe	Sta 9+00	Sta 145+00	2.6	8	N/A
Gibb – Closed Pipe	N/A	N/A		8	N/A

The system components were assessed to determine their overall physical condition, as summarized in Table 5-2. Concrete condition was assessed based on observed weathering, cracking, or spalling. Metal and wood structures were assessed based on visible rust or corrosion, leaks, buckling, rotting, and other deterioration. Gates, screens, and pipes were assessed based on their operability and visible rust or corrosion, and leaks. Overall condition was then correlated to a likely timeline that should be considered for repair or replacement.

Table 5-2
Facility Condition Assessment Criteria and Ratings

Condition Description	Observed Condition			Priority and Replacement or Repair Schedule
	Concrete	Metal or Wood Structures	Gates/Screens/Pipes	
Excellent	• Little to no weathering or spalling • Very minor cracks	• Little to no rust • No leaks • No rot	• Operates smoothly • Little to no rust • No leaks	• No Improvement Needed • >25 years
Good	• Minor cracks or weathering	• Minimal rust • Very minor leaks • No rot or deterioration	• Minimal or no surface rust • Operates smoothly • Very minor leaks	• No Improvement Needed • >25 years
Fair	• Moderate weathering or spalling • Moderate cracks	• Moderate rust • In working order • Moderate leaks • Some rot or deterioration	• Operates with some resistance • Moderate leaks	• Low or Low to Medium Priority • 9 to 25 years
Poor	• Significant weathering or spalling • Moderate to large cracks	• Bent or broken • Significant rust • Small holes in structure or pipes • Significant leaks • Moderate rot or deterioration	• Marginally operational • Significant leaks	• Medium Priority • 6 to 8 years
Very Poor	• Severe weathering • Large cracks • Severe spalling	• Broken/Failing • Severe rust • Buckling • Severe leaks • Severe rot or deterioration	• Non-operational • Broken/Failing • Severe leaks	• High Priority, • Next 5 years

5.2.1 Joint Use Division 1 Canal

The IID Division 1 Canal, which is jointly owned and operated by both IID and PID, is located between the intake and diversion facilities on Icicle Creek and the Leavenworth Bifurcation, a distance of approximately 6.5 miles. The key facilities in this reach are summarized in Table 5-3. The following description of this division has been split into three reaches for discussion purposes. The IID Division 1 Canal facilities are shown on Exhibit 2 in Appendix A.

Table 5-3
IID Division 1 Facilities

Facility	Station[1]	Overall Physical Condition	Noted Deficiencies from System Inventory
Diversion Dam	Sta 0+00	Fair-Good	• Weathered concrete
Diversion Canal	Sta 0+00	Fair-Good	• Some spalling and cracked concrete
Head gates and Spillway	Sta 5+00	Fair-Good	• Gates rusted, but in working condition • Some spalling and cracked concrete
Fish Screens	Sta 8+00	Very Poor	• Screens do not meet current standards • Cracked and weathered concrete • Rusted paddlewheels
Snow Creek Spillway	Sta 18+00	Fair-Good	• Weathered concrete
Snow Creek Flume	Sta 18+50	Excellent	
Snow Creek Pick Up	Sta 19+00	Poor	• Broken gate • Sheet metal lining rusted and buckled
Emergency Steel Flume	Sta 55+00	Poor	• Cross-ties bent or broken • Vertical supports appear to be haphazardly placed • Frame rusted
Mountain Home Flume	Sta 101+00	Good	• Liner damaged and patched due to a fire. • Small leaks noted
Mountain Home Spillway and Pick Up	Sta 111+00	Fair	• Concrete weathered, cracked, and undermined in places
Van Brocklin Spillway	Sta 270+00	Good	
Leavenworth Flume	Sta 324+00	Fair	• Frame and plate steel rusted • Liner damaged
Leavenworth Spillway	Sta 340+00	Fair-Good	• Weathered concrete
Leavenworth Bifurcation	Sta 343+00	Fair	• Weathered concrete

Notes:
1. Stationing is approximate and reflects stationing shown on Exhibit 2 in Appendix A.

5.2.1.1 Intake Diversion (Sta 0+00) to Snow Creek Flume (Sta 18+50)

This reach of the IID Division 1 Canal consists of both trapezoidal, concrete-lined sections and rectangular concrete-cribbed flume sections. The facilities within this reach include the following:

Diversion Dam (Sta 0+00)

A concrete diversion dam spans the Icicle Creek channel 5.7 miles upstream of its confluence with the Wenatchee River (see Figure 5-2). The dam provides the hydraulic conditions needed to divert water to IPID through an intake structure on the right bank and to the City of Leavenworth through an intake structure on the left bank. Flow is diverted to the IID Diversion Canal on the right bank through two openings in the intake structure. Stop logs are placed or removed to control flow through the intake structure to the IID Diversion Canal. The intake structure was recently refurbished by placing new concrete to reduce leakage around and under the structure. New stop logs were also installed. IPID reported that the diversion dam is in fair condition. The intake structure and stop logs are new and appear to be in excellent condition. The flow in Icicle Creek was relatively high when conditions were observed in May 2017, and the wall between the creek and the diversion canal was submerged with water flowing around the intake structure into the canal (see Figure 5-3).

Figure 5-2
IPID Diversion Dam on Icicle Creek

Figure 5-3
IPID Intake Structure on Icicle Creek, May 2017, Looking Upstream

Diversion Canal (Sta 0+00)

The IID Diversion Canal conveys water from the intake structure approximately 500 feet along the right bank of Icicle Creek to the diversion flume and spillway. The IID Diversion Canal consists of a rectangular reinforced concrete channel constructed between a steep, rocky incline and Icicle Creek. The channel is in relatively good condition, but is cracked and spalling in places. In addition, IPID has indicated that under high flow conditions, water flows over the wall on the river side of the IID Diversion Canal from Icicle Creek to the canal and the canal is subject to damage due to flooding.

Headworks Flume, Head Gates, and Spillway (Sta 5+00)

The Headworks Flume is a reinforced concrete flume approximately 140 feet long and conveys flow from the IID Diversion Canal to the Fish Screens. Two 70-inch steel slide gates are used to control flow from the IID Diversion Canal to the Fish Screens (see Figure 5-4). Excess flow is spilled through the Headworks Flume Spillway, which consists of two 80-inch openings in the reinforced concrete structure upstream of the head gates. Stop logs control flow through the spillway to Icicle Creek. Some spalling and cracking was observed in the concrete walls of the flume and gate structures. The gates and frames are rusted on the surface but appeared to be in good working condition. The spillway structure concrete was weathered and in fair condition.

Figure 5-4
IPID Headworks Flume, Head Gates, and Spillway

Fish Screens (Sta 8+00)

Downstream from the Headworks Flume, the system transitions to an approximately 30-foot wide rectangular channel that flows through IPID's fish screens (see Figure 5-5). The fish screens are 4-foot diameter rotating drum screens driven by two 8-foot diameter paddle wheels. The paddle wheels are located immediately downstream of the screens. A debris rack spans the channel upstream of the fish screens. A center pier divides the channel into two bays with one screen and paddle wheel assembly in each bay. On the left side of the structure upstream of the fish screens are three 5-foot wide spillway openings controlled by stop logs. The stop logs control the water level upstream of the fish screens. Excess water is spilled back to Icicle Creek. A fish bypass pipe adjacent to the spillway delivers fish and water to a narrow channel that flows back to Icicle Creek.

Figure 5-5
IPID Fish Screens

One spillway pier has been removed and replaced with a structural steel support that has rust on the surface but appears to be in fair condition. The concrete walls of the structure are in poor to fair condition with some shrinkage cracks and erosion occurring at cold joints and at the slab-wall interface. The slab is in poor condition with erosion and cracks in places.

The paddle wheels are rusted and are in poor to fair condition. The rotating drum fish screens are in fair condition, but the fish screen and bypass configuration does not meet current National Marine Fisheries Service (NMFS) and Washington State Department of Fish and Wildlife (WDFW) fish passage guidelines. The fish screens do not have an angled approach to direct fish away from the screens. In addition, flow exiting the bypass pipe impacts the vertical concrete wall of the channel directly in front of the outlet. IPID is currently working with WDFW under a grant from the Bonneville Power Administration (BPA) to evaluate potential alternatives for replacing the existing fish screen structure with one that meets current NMFS and WDFW passage requirements and plan to complete the fish screen replacement project within the next 2 to 3 years.

IPID measures flow in a rated section of the IID Diversion Canal just upstream of the expansion to the fish screens. The facility includes a stilling well with a SCADA enabled variable resistor, which is converted to a flow rate that can be downloaded. The reading on the instrument is written down each day. The IPID Manager regularly checks the flow rating by measuring flows in the diversion channel adjacent to the flow monitoring equipment. The level resistor measures flow upstream of the fish bypass and the spillway at the fish screens.

Snow Creek Spillway (Sta 18+00)

The IPID Manager indicated that the primary control of flow to the Division 1 Canal is provided at the Snow Creek Spillway (see Figure 5-6). The Snow Creek Spillway structure consists of three 5-foot wide openings in the left side of the canal, each controlled by stop logs. Each opening is approximately 4 feet high from the invert of the channel. The spillway apron extends approximately 5 feet, is founded on solid rock, and spills excess water to Snow Creek. Approximately 4 feet downstream of the spillways is a gate structure with two 3-foot wide by 4-foot high steel slide gates. Additional control is available, if needed, by inserting stop logs into steel stop logs guides located approximately 8 feet downstream of the gates.

The concrete gate and spillway walls are in fair condition overall. Some concrete erosion and weathering is occurring at the tops of the walls and at wall cold joints. The slab is rough and pitted but appears to be in fair condition. The slide gates have rust on the surface and on the operators but appear to be in good working condition.

Figure 5-6
Division 1 – Snow Creek Spillway and Gates

Snow Creek Flume (Sta 18+50)

Snow Creek Flume consists of an 8-foot wide by 4-foot deep steel flume structure approximately 67 feet long that conveys the Division 1 Canal across Snow Creek (see Figure 5-7). This structure was replaced in the last 20 years. The steel support posts bear on reinforced concrete pads. Structure and liner appear to be in excellent condition with only surface rust observed.

Figure 5-7
Division 1 – Snow Creek Flume

Snow Creek Pick Up (Sta 19+00)

Just downstream of the Snow Creek Flume is an approximately 4-foot wide, 3-foot deep, 50-foot long steel flume used to convey water diverted from Snow Creek to the Division 1 Canal (see Figure 5-8). A slide gate at the flume inlet controls flow from Snow Creek to the flume. The gate is rusted but in good working condition. An additional slide gate at the downstream end of the flume can be used to control flow to the Division 1 Canal. The steel frame of the downstream gate is rusted and broken. The flume is in very poor condition. The steel sheets lining the bottom and sides of the flume are buckled and rusted.

Figure 5-8
Snow Creek Pick Up

5.2.1.2 Snow Creek Flume (Sta 18+50) to Mountain Home Spillway (Sta 111+00)

The canal through this reach is primarily trapezoidal and concrete-lined or partially lined, with the right (upslope) side of the canal being exposed bedrock along a very steep hillside. Three tunnels exist in this reach. The first tunnel is short (approximately 50 feet long), while the second and third tunnels are approximately 3,600 feet in total length. The canal lining through this reach is in fair condition. The canal in this reach occasionally catches rock falling from the steep rocky hillside upslope of the canal and some erosion has occurred or is occurring on the downhill side of the canal. Rock falls have damaged canal linings and have the potential to block the canal. Downslope erosion in this reach has also undermined the canal in areas. This portion of the IID Division 1 Canal is also downslope of areas that receive heavy snowfall. Historically, IPID has had challenges with ice and snow collecting in the ditch and plugging up the canal. Ice and snow can cause the canal to overflow during the late winter and early spring when rainstorms or warm weather increase the runoff collected and conveyed by the canal. The following facilities are located within this reach.

Emergency Steel Flume (Sta 55+00)

This 4-foot deep by 60-foot long steel flume was constructed in an emergency situation to replace a section of canal that had washed out, and is over 25 years old (see Figure 5-9). The flume is constructed of 1/4-inch plate steel stiffened with 2-inch steel channel vertical piers every 2 feet. Pipe columns support the structure on the left (downhill) side. The top of the flume is tied by 2-inch welded-steel bars spaced about every 4 feet. A series of 3/8-inch diameter cables pinned to rocks above the canal provide additional support for the left (downslope) wall. The right (upslope) wall of the flume appears to be anchored to the old concrete channel.

The structure as a whole is in poor to fair condition. The steel ties across the top of the flume are bent or broken in many places. The steel vertical pipe supports appear to bear on rocks or bare ground below the flume. It appears that after the washout, there was very little competent foundation material left for the supports to bear on, so the spacing and orientation of the supports is not consistent. The frame and steel sheets lining the flume are rusted.

Figure 5-9
Division 1 – Steel Flume

Mountain Home Flume (Sta 101+00)

The Mountain Home Flume is an elevated, rectangular steel flume that is 7 feet wide by 3-1/2 feet deep, and is approximately 576 feet long (see Figure 5-10). The flume walls are plate girders lined with a PVC liner. The flume is supported on structural steel columns which bear on 4-foot diameter, 2-foot deep reinforced concrete footings.

The structure is over 25 years old but is in good condition overall. The liner is in fair condition and was patched in many places due to a fire that passed through the area. Small leaks were noted near the liner seams. The frame and steel plates appear to be in good condition, with only surface rust noted. The concrete footings appear to be in good condition.

Figure 5-10
Division 1 – Mountain Home Flume

5.2.1.3 Mountain Home Spillway (Sta 111+00) to Leavenworth Bifurcation (Sta 343+00)

This reach of canal is primarily trapezoidal in section, with tunnel sections near the downstream end of the reach. The canal appears to be founded on bedrock throughout this reach. The canal through this reach is mostly concrete-lined, or partially lined with the right (upslope) side of the canal being exposed bedrock along a very steep hillside. The concrete quality is uneven through the reach. The slopes on the downhill banks are very steep and appear to be slowly eroding and undercutting support for the canal upstream of the Leavenworth Bifurcation. IPID indicated that a section of the canal (Sta 150+00) has historically had problems with groundwater seepage and surface runoff undermining the canal. The District repaired a portion of the canal damaged by erosion in 2016 by installing a curtain drain in the bank and under the liner to convey runoff and seepage underneath and away from the canal. The IPID Manager indicated that he would also like to continue installing drains in this manner a few hundred feet downstream of where the repair was made to prevent undermining caused by subsurface flow from the hillside above the canal and erosion. This portion of the IID Division 1 Canal is also downslope of areas that receive heavy snowfall. Historically, IPID has had challenges with ice and snow collecting and plugging up the canal. Ice and snow can cause the canal to overflow during the late winter and early spring when rainstorms or warm weather increase the runoff collected and conveyed by the canal. The following facilities are located within this reach.

Mountain Home Spillway and Pick Up (Sta 111+00)

The Mountain Home Spillway is located just downstream of the Mountain Home Flume in the middle of a rectangular shaped, PVC-lined canal section approximately 7 feet wide, 4 feet deep, and 40 feet long (see Figure 5-11). Excess water is spilled at this location to Mountain Home Creek through a 6-foot wide, 4-foot high opening in the downslope wall of the channel. Stop logs control flow through the openings. A 24-inch elevated, corrugated aluminum pipe conveys water from Mt. Home Creek over the top of the canal at this location. Two gates are installed in the aluminum pipe. The gate on the outlet of the pipe releases water to the Mountain Home Creek channel downstream of the canal. A second gate installed in the side of the aluminum pipe allows water to be released from the pipe to the canal.

The concrete canal structure has some cracking and erosion, but is in fair condition. The liner appears to be in fair condition as well. A portion of Mountain Home Creek was observed flowing underneath the canal and spillway structure. The foundation material on the downstream left side of the canal and spillway structure in this location has washed out, leaving it unsupported. There is also a large crack in the concrete wall on the left downstream side of the structure presumably due to the lack of foundational support.

Figure 5-11
Division 1 – Mountain Home Spill

Van Brocklin Spillway (Sta 270+00)

The spillway structure consists of two 5-foot wide openings in the left (downslope) side of a rectangular section of the concrete-lined Division 1 Canal (see Figure 5-12). Upstream of the spillway structure, the canal is partially lined. Flow through the spillway is controlled by stop logs. The spillway apron is approximately 6 inches thick and extends 11 feet from the canal. Steel beams with wooden beams in between span the spillway channel and provide a bridge over the channel on the left (downslope) bank for the ditch maintenance road. The structure appears to be in good condition.

Figure 5-12
Division 1 – Van Brocklin Spill

Leavenworth Flume (Sta 324+00)

The Leavenworth Flume is a 9-foot wide, 4-1/2-foot deep steel flume (see Figure 5-13). The flume is approximately 70 feet long. The flume walls are plate girders with a PVC liner supported on structural steel columns which bear on reinforced concrete footings. The frame and steel plate are in rusted but in fair condition. The PVC liner is in poor to fair condition. It is damaged in some areas and has been patched in others. The concrete footings appear to be in good condition.

Figure 5-13
Division 1 – Leavenworth Flume

Leavenworth Spillway (Sta 340+00)

The canal upstream of the Leavenworth Spillway is adjacent to steep rock outcrop which is weathering and sloughing into the canal (see Figure 5-14). The left wall of the canal transitions into a vertical concrete wall at the spillway. The spillway consists of two 4-foot wide, 4-foot high openings in the left wall of the canal. Stop logs are used to control the spill of excess flow through the openings onto a rock outcrop and down a steep slope under U.S. Highway 2 to the Wenatchee River. The spill is visible from U.S. Highway 2 as it cascades down the steep slope. The spillway apron extends approximately 8 feet and is founded on rock. A concrete gate structure approximately 12 feet downstream of the spillway with a 6-foot wide by 4-foot high steel slide gate allows IPID to control flow through the Division 1 Canal at this location. A welded-steel debris rack protects the gate.

The slide gate and operator appear to be in fair condition, with only surface rust noted. The trash rack is in good condition. The concrete gate structure is weathered an in fair condition, while the concrete spillway structure appears to be in good condition.

Figure 5-14
Division 1 – Leavenworth Spillway

Leavenworth Bifurcation (Sta 343+00)

The Leavenworth Bifurcation is located at the downstream end of the Division 1 Canal and at the upstream end of the Division 2 Canal. It controls flow from the Division 1 Canal to the Division 2 Canal and the Leavenworth Siphon, which delivers water to the Division 4 and 5 Canals. The bifurcation consists of a rectangular concrete box, approximately 7 feet wide by 22 feet long and 6 feet deep, on the left bank of the Division 1 Canal (see Figure 5-15). A 4-foot by 4-foot steel slide gate is located on the downstream end of the right wall of the box and controls flow from the canal into the box. The box invert is approximately 2 feet lower than the canal invert. When the gate is open, water spills into the box, flows over a 5-foot Cipoletti weir located in the box floor flow measurement, then discharges from the box to a 36-inch steel pipe that comprises the upstream end of the Leavenworth Siphon. Approximately 30 feet downstream from the bifurcation box, the water remaining in the Division 1 Canal flows through a concrete gate structure with a 4-foot-wide slide gate that controls flow to the Division 2 Canal.

The concrete bifurcation box is in fair condition. The concrete is weathering in places. Grating over the structure, the Cipoletti weir and debris rack internal to the structure, and the metal slide gates are all rusted, but the weir appears to be in good working condition.

Figure 5-15
Division 1 – Leavenworth Bifurcation

5.2.2 Joint Use Division 2 Canal

The IID Division 2 Canal, which is also jointly owned and operated by both IID and PID, is located between the Leavenworth Bifurcation (Sta 343 + 00) and the Peshastin Bifurcation (Sta 570+00), a distance of approximately 4.3 miles. The primary structure on the Division 2 Canal is the Peshastin Bifurcation at the downstream end of the canal, as summarized in Table 5-4. The IID Division 2 Canal facilities are shown on Exhibit 3 in Appendix A.

Table 5-4
IID Division 2 Facilities

Facility	Station[1]	Overall Physical Condition	Noted Deficiencies from System Inventory
Peshastin Bifurcation	Sta 570+00	Good	• Spalling concrete on the edges and corners of bifurcation structure walls.

Notes:
1. Stationing is approximate

The Division 2 Canal consists mostly of trapezoidal sections of open canal, except for a 500-foot-long tunnel located at approximately Sta 412+00. The canal is either fully or partially lined with concrete. The concrete lining appears to be in fair condition through most of the reach. Some exceptions were noted where the lining was found to be cracked with vegetation growing in the cracks. The canal is located on a bench along a moderately sloped hillside. The bench appears to have an adequate cross section through the reach to support the canal and provide maintenance access. Other problems noted in the field survey were sand build-up and debris in the canal from near Sta 511+00 and Sta 554+00. IPID has also indicated that there is sand build-up and debris in the tunnel at Sta 412+00. Field observations of the key facility on the Division 2 Canal, the Peshastin Bifurcation, are summarized below.

5.2.2.1 Peshastin Spillway and Bifurcation (Sta 570+00)

The Peshastin Bifurcation (see Figure 5-16) is located at the downstream end of the Division 2 Canal and the upstream end of the IID Peshastin Siphon (Division 3A Canal). The bifurcation controls flow from the Division 2 Canal to the IID Peshastin Siphon (Division 3A Canal), the Peshastin Crossover Pipeline, and the Gibb Ditch. Upstream of the bifurcation structure, there is a concrete box on the left side of the canal that was once the inlet to a 16-inch steel spillway pipe. In 1994, the bifurcation structure was completely rebuilt and the spillway was incorporated into the bifurcation structure. Connections to the spillway pipe, the IID Peshastin Siphon (Division 3A), the Peshastin Crossover Pipeline, and the Gibb Ditch were reconfigured when the bifurcation structure was replaced.

Figure 5-16
Division 2 – Peshastin Bifurcation

The existing bifurcation structure is a large reinforced concrete structure. Flow through the bifurcation is controlled by a series of gates and stop logs. The spillway is at the upstream end of the structure. Stop logs are placed in a series of three openings in the left wall of the structure to control the water level in the structure. Excess water flows over the stop logs and into a box that is connected to the 16-inch Peshastin Spill pipeline. A weir wall at the end of the spillway box allows for emergency overflow to another compartment in the box that discharges to a 24-inch steel emergency spill pipeline. That pipeline is connected to the Peshastin Crossover pipeline, which has a valve that can be opened at Peshastin Creek to discharge excess water to the creek.

A debris rack, just downstream of these openings protects gates and weirs in the downstream portion of the bifurcation structure. A series of slide gates in the structure are adjusted to control flow to the Peshastin Siphon, which feeds the IID Division 3A Canal, the Peshastin Crossover, which provides supplement flow to the PID Canal, and the Gibb Ditch system. Three Cipoletti weirs measure flow from the bifurcation to downstream delivery facilities, as follows:

- A 6-foot Cipoletti weir measures flow to the Peshastin Siphon (IID Division 3A Canal).
- A 6-foot Cipoletti weir measures flow to both the Peshastin Crossover and Gibb Ditch.
- A 4-foot Cipoletti weir downstream of the second 6-foot weir measures flow to the Gibb Ditch. Flow to the Peshastin Crossover is estimated as the difference between flows measured at the weir to the Peshastin Crossover and Gibb Ditch and the weir to the Gibb Ditch.

Flow to the Gibb Ditch system discharges through a short segment of 24-inch steel pipe to a 5.75-foot wide, 10-foot long steel box that is approximately 7.5 feet deep with a flat plate screen near the bottom. Debris must be manually shoveled out periodically. An overflow pipe allows for excess water to be spilled from the box. Water is discharged to the Gibb Ditch system through a 16-inch steel pipe.

The facility is generally in good condition. The gates appear to be in good working condition despite some surface rust. Spalling was noted in many places throughout the concrete bifurcation structure. Some notable areas of spalling are on the wall near the 4-foot Cipoletti weir to the Gibb Ditch system, and near south exterior corner of the structure. The IPID Manager believes the spalling likely resulted from placing and curing concrete in freezing weather. The Cipoletti weir plates all appeared to be in good condition.

5.2.3 IID Division 3A Canal

The Division 3A Canal is located between the outlet of the Peshastin Siphon (Sta 601+00) and the Mission Creek Siphon (Sta 1078+00), a distance of approximately 9 miles. The Division 3A Canal has been split into two reaches for discussion purposes in this section. Table 5-5 summarizes the most significant facilities located on the Division 3A Canal. The IID Division 3A Canal facilities are shown in Exhibits 4 and 5 in Appendix A.

Table 5-5
Division 3A Facilities

Facility	Station[1]	Overall Physical Condition	Noted Deficiencies
Peshastin Siphon	Sta 570+00	Unknown	
Peshastin Siphon Outlet	Sta 601+00	Poor to Fair	• Weathered, and cracked concrete
Carson's Pipeline	Sta 658+00	Very Poor	• Subject to hillside movement • Deformed and bucklining in places • Steel pipe is rusted and pitted in places
Maxwell Siphon	Sta 713+00	Fair	• Pipe backs up water
Pine Flats Flume	Sta 839+00	Excellent	
Brender Siphon and Spillway I	Sta 873+00	Poor to Fiar	• Weathered concrete • Pipe rusted through
Brender Spillway II	Sta 900+00	Poor to Fair	• Weathered, concrete • Low capacity, leaks, not used frequently
Mission Creek Spillway and Siphon	Sta 1078+00	Fair	• Weathered and spalling concrete; Pipe covering deteriorated; Pipe separating from structure

Notes:
1. Stationing is approximate

5.2.3.1 Peshastin Siphon (Sta 570+00) to Brender Spillway (Sta 873+00)

This reach comprises primarily trapezoidal canal sections, either fully lined or partially lined with concrete. This reach also includes several segments of 48-inch to 60-inch diameter pipelines, referred to as "Carson's Pipeline", the Maxwell and Brender Creek Siphons, a steel flume, and two short sandstone tunnels. There have been problems in the past with one of the tunnels (Sta 869+00) caving in and debris falling into the canal. Efforts have been made to shore up the ceiling inside with scaffolding. A section of the canal (Sta 658+00) was leaking significantly during the field survey. IPID staff shut off the Division 3A Canal to repair the leak by cutting out a section of liner and re-pouring the concrete in the spring of 2017. The following significant facilities are located within this reach.

Peshastin Siphon (Sta 570+00)

The Peshastin Siphon originates in the bifurcation structure at the downstream end of the IID Division 2 Canal and crosses U.S. Highway 97 and Peshastin Creek before discharging to an outlet structure at the head of an open, concrete-lined section of the Division 3A Canal. The siphon is a partially coated 30-inch steel pipeline. Because it is buried, the condition of the pipe was not observed or documented as part of the field inventory completed in May 2017.

Peshastin Siphon Outlet (Sta 601+00)

The Peshastin Siphon outlets to a concrete structure at the upstream end of a concrete-lined section of the IID Division 3A Canal (see Figure 5-17). The outlet structure is cracked and weathered, and is generally in poor to fair condition.

Figure 5-17
Division 3A – Peshastin Siphon Outlet

Carson's Pipeline (Sta 658+00)

Carson's Pipeline (Sta 658+00 to Sta 690+00) consists of a series buried and partially buried steel pipelines that run along the hillside south of Deadman Hill Road. The hillside is unstable and experienced movement over time. One segment of the pipeline, at Sta 668+00, has buckled due to movement of the hillside. The steel pipeline is rusted and pitted and in generally very poor condition. The District would like to replace the most damaged segment of this pipeline with HDPE pipe from Sta. 668+00 to the outlet of the next segment of Carson's Pipeline (approximately 1,200 feet).

Maxwell Siphon (Sta 713+00)

The Maxwell Siphon conveys flow in the Division 3A Canal under Willis Springs Road in Maxwell Canyon. The inlet to this 30-inch steel siphon consists of an 8-foot by 10-1/2-foot concrete box, 6-1/2 feet deep (see Figure 5-18). The first 300 feet of the siphon is 36-inch uncoated steel pipe as it drops down to the bottom of Maxwell Canyon. IPID reports that the pipe backs up water when the canal is running full and comes close to overtopping the box. The inlet structure and outlet structures are in fair condition. A small leak was noted during the field inventory at the air vent riser just downstream of the inlet.

Figure 5-18
Division 3A – Maxwell Siphon Inlet

Pine Flats Flume (Sta 840+00)

The Pine Flats Flume is constructed of 1/4-inch steel plate supported with horizontal structural steel beam welded to vertical steel posts that bear on reinforced concrete pads (see Figure 5-19). This flume was built by IPID in 2016 to replace an aging wooden box flume and appears to be in excellent condition.

Figure 5-19
Division 3A – Pine Flats Flume

5.2.3.2 Brender Spillway (Sta 873+00) to Mission Spillway (Sta 1078+00)

This reach is primarily open canal with trapezoidal sections that range from unlined, earthen canal to fully lined with concrete. This reach also includes the Brender Siphon, which is approximately 1,000 feet long. The canal is situated on a steep side hill for much of the reach. The canal appears to be cut into bedrock on the hillside; however, a sandy soil layer exists over the bedrock and the downhill canal banks are not entirely bedrock. There is more slope erosion of the sandy soils into the canal noted in the areas of sparser vegetation. The concrete canal lining varies in quality, but in general was found to be in fair condition. The following significant facilities are located in this reach.

Brender Siphon and Spillway I (Sta 873+00)

The Brender Spillway consists of an 8-foot-wide concrete spillway box on the left side of the concrete-lined Division 3A Canal, upstream of the Brender Siphon. The spillway box leads to an 8-inch diameter PVC pipe that drops down the hill and spills excess water from the Division 3A canal into Brender Creek. Immediately downstream of the spillway, the channel transitions into a 4-foot wide by 10.5-foot long by 5-foot deep concrete box that serves as the inlet structure for the Brender Siphon (see Figure 5-20). A trash rack is installed across the entrance to the siphon inlet structure. The siphon is a 30-inch steel pipe that crosses under Brender Creek and Brender Canyon Road.

The open canal lining upstream of the spillway and siphon has cracks in its slab and walls. The spillway and siphon structure is in poor condition with aged, cracked, and deteriorated concrete. The trash rack is rusted but appears to be in fair condition. The steel siphon pipe has holes rusted through the top. IPID reports that flow does not back up enough to spill out of the holes normally. A leak at the first downstream pipe vent was noted.

Figure 5-20
Division 3A – Brender Siphon Inlet

Brender Spillway II (Sta 900+00)

A second spillway is located on Division 3A Canal approximately 1,700 feet downstream of the Brender Siphon outlet (see Figure 5-21). The spillway consists of a series of four openings in the left side of the concrete-lined canal with concrete piers that support stop logs, which control spilling at this location. The IPID Manager indicated that the spillway has limited capacity and is rarely used to manage flows in the Division 3A Canal.

Figure 5-21
Division 3A – Brender Spill II

The concrete portions of this structure are weathered and spalling in places. Some leaking was also noted from the concrete structure at this location during the field inventory in May 2017.

Mission Creek Spillway and Siphon (Sta 1078+00)

The Mission Creek Spillway structure consists of three 4-foot-wide openings in the wall on the left side of the Division 3A Canal (see Figure 5-22). Spilling is controlled by stop logs. Excess water spills over the stop logs into a 3-foot-wide by 18-foot-long spillway box. Water flows from the box to a 30-inch steel pipeline that reduces in size down the slope from the structure and discharges excess water to Mission Creek. An inlet structure immediately downstream of the spillway conveys water to the Mission Creek Siphon. A trash rack is installed across the entrance to the siphon inlet structure, which consists of a 2-1/2-foot-wide, 15-3/4-foot-long, 3-foot-deep concrete box. The Mission Creek Siphon is a 30-inch steel pipe that conveys water down a steep slope and across Mission Creek Canyon. The pipe crosses under Mission Creek and two well-traveled county roads. A 4-foot-wide slide gate installed ahead of the pipe inlet allows IPID to control flow to the siphon.

Figure 5-22
Division 3A – Mission Creek Spill and Siphon Inlet

The siphon and inlet structure are in fair condition with somewhat aged, weathered concrete in places. Some spalling was noted on the walls of the structure. An adhesive or sealant was placed around the pipe penetration on the exterior side of the inlet structure earlier in the 2017 season, but the adhesive had pulled away and cracked, indicating the pipe may be pulling away from the structure. The pipe covering was severely deteriorated.

5.2.4 IID Division 3B Canal

The Division 3B facilities are located between Mission Spillway (Sta 1078+00) and the End Box Spillway at the end of the system (approximately Sta 1363+00), a distance of 5.4 miles. The Division 3B facilities consist of both open canals and numerous pipelines. The pipelines are both gravity flow and siphon pipelines, with sizes varying from 24 to 48 inches in diameter. The canal is situated on a steep side slope and is cut into a sandstone bedrock and overlying sandy soils that are derived from the bedrock. The canal has a trapezoidal cross section and is fully or partially lined with concrete.

The condition of the concrete was noted to be generally in fair condition, except that numerous joints in the lining have weeds growing out of them. Slope stability problems were noted during the survey on the uphill side of the canal, which feed sand and other materials into the canal. IPID reported problems with the flat grade of a 52-inch corrugated metal pipe (CMP) (inlet at approximately Sta 1187+00). Sediment and debris builds up inside the pipeline and must be cleaned out periodically. A concrete box at the pipe inlet is designed to settle out some of the sediment. Significant sediment buildup was noted during the field survey at a concrete access box near Sta 1211+00. Sediment was built up to the springline inside the pipeline. Table 5-6 summarizes the facilities located within Division 3B. Exhibit 3B facilities are shown on Exhibit 5 in Appendix A.

Table 5-6
Division 3B Facilities

Facility	Station[1]	Overall Physical Condition	Noted Deficiencies
Weed Screen Spillway	Sta 1221+00	Fair	• Weathered concrete
Siphon	Sta 1238+00	Very Poor	• Weathered concrete • Problems with leaks
Siphon	Sta 1260+00	Poor	• Weathered concrete
Siphon	Sta 1293+00	Poor	• Weathered concrete
Siphon	Sta 1315+00	Fair	• Weathered concrete
Fairview Canyon Spillway and Siphon	Sta 1342+00	Good	• Leaks near outlet of siphon

Notes:
1. Stationing is approximate

5.2.4.1 Weed Screen Spillway (Sta 1221+00)

The Weed Screen Spillway is at the end of a trapezoidal section of concrete-lined open canal. The concrete canal flows into a reinforced concrete box that serves as a sediment trap. The box is approximately 2 feet wide, 6.75 feet long, and 2 feet deep. An 8-inch steel pipe with a slide gate drains the box into a 4-foot-wide, 5-foot-long, and 6-foot-deep spillway box adjacent to the canal. Water from the upper box then flows through a short segment of concrete-lined canal into a larger box, approximately 15.5 feet long, with a slide gate that drains via a 4-inch steel pipe into the spillway box. The spillway consists of openings in the side of the trapezoidal canal section. Stop logs are used to control flow through the openings to the spillway box. A 30-inch metal pipe conveys water from the box to the Wenatchee River. The pipe reduces in size as it descends the hill to the Wenatchee River.

A 5-foot wide steel slide gate controls flow through the canal approximately 20 feet downstream from the spillway (see Figure 5-23). Water flows under the slide gate into a reinforced concrete structure with an inclined, traveling screen operated by an electrical motor. The screen is used to remove debris from the canal before water continues down the canal to a series of pipelines and siphons that comprise the downstream end of the Division 3B Canal.

The spillway structure is in fair condition with leaks noted in the stop logs. The slide gate is rusted but appears to be in fair condition. The traveling screen appears to be in excellent condition. The concrete canal structure near the screen, gate, and spillway is in poor condition with aged and deteriorated concrete observed on the walls and bed.

Figure 5-23
Division 3B – Weed Screen Spill

5.2.4.2 Siphon (Sta 1238+00)

The first of a series of siphons at the downstream end of the Division 3B Canal consists of a 24-inch steel pipeline that extends under an orchard. The inlet structure for this siphon is a rectangular shaped concrete box with a trash rack installed at the upstream end (see Figure 5-24). The concrete inlet box is deteriorated and in poor condition. The outlet of the siphon flows into a trapezoidal shaped concrete-lined open canal that is in poor to fair condition at the outlet. IPID has indicated that this siphon has limited capacity and is a bottleneck to flow through the rest of the Division 3B Canal. In addition, IPID indicated that the drain valve at the bottom of the siphon rusted to the point where it broke off recently and had to be replaced.

Figure 5-24
Division 3B – Siphon Inlet

5.2.4.3 Siphon (Sta 1260+00)

A second siphon conveys flow under a low area just south of the first siphon. The siphon is also a 30-inch steel pipeline. The inlet and outlet of this 30-inch steel siphon consist of headwalls installed at the beginning and end of trapezoidal sections of concrete-lined canal upstream and downstream of the siphon. The inlet and outlet structures are in poor to fair condition. A portion of the siphon is exposed and appears to be in fair good condition.

5.2.4.4 Siphon (Sta 1293+00)

A third siphon conveys flow under an orchard just south of the second siphon. The siphon is also a 30-inch steel pipeline. The inlet is at a headwall at the downstream end of a concrete-lined canal and is protected by a debris rack. The inlet structure is in fair condition. The outlet structure is a rectangular reinforced concrete box that transitions flow from the siphon to a 30-inch CMP (see Figure 5-25). The outlet structure is also in fair condition.

Figure 5-25
Division 3B – Siphon Transition to CMP

5.2.4.5 Siphon (Sta 1315+00)

A fourth siphon, just downstream of the third, conveys flows under another orchard. The inlet and outlet structures for this 18-inch steel siphon are in fair condition and consist of rectangular shaped concrete boxes that transition flow to and from 30-inch CMP (see Figure 5-26).

Figure 5-26
Division 3B – Siphon Outlet

5.2.4.6 Fairview Canyon Spillway and Siphon (Sta 1342+00)

At Fairview Canyon the Division 3B Canal, which consists of 30-inch CMP, flows into a large reinforced concrete control structure (see Figure 5-27). A 32-inch-wide wood slide gate installed near the middle of the structure controls flow to the inlet of a 16-inch steel siphon that conveys water across Fairview Canyon to a short section of concrete-lined canal that extends to the end spill box near station 1386+00. A screened opening in the left wall of the main compartment of the structure feeds a series of turnout boxes built into the left side of the structure. Stop logs inserted into guides just downstream of the screened turnout opening control flow of excess water to a 12-inch PVC spillway pipe at the downstream end of the structure. IPID has reported problems with leaks near the outlet of the siphon. The concrete flow control structure at the siphon inlet is in excellent condition. The wood slide gate is in good condition.

Figure 5-27
Division 3B – Fairview Canyon Siphon Inlet and Spillway

5.2.5 Leavenworth Siphon to IID Divisions 4 and 5

The Leavenworth Siphon conveys water from the Leavenworth Bifurcation under U.S. Highway 2 and across a pipe bridge over the Wenatchee River to the IID Division 4 and 5 canals. A 36-inch steel pipeline extends down a steep slope from the bifurcation structure under U.S. Highway 2. This segment of pipe was replaced in 2007 and is in good condition. A concrete block was poured around the pipe on the downslope side of U.S. Highway 2 when the pipeline was replaced. The new pipe transitions to an older 34-inch-diameter steel pipe downstream of the block, which extends down the slope and across the suspension-type pipe bridge over the Wenatchee River (see Figure 5-28). The bridge is approximately 270 feet long. The pipeline continues underground across an orchard and splits near North Road into two 30-inch branches, one that conveys water to the IID Division 4 Canal and another that conveys water to the IID Division 5 Canal.

Figure 5-28
Leavenworth Siphon and Pipe Bridge

The pipe on the bridge is rusted and weathered, with rusted restraining couplings. There is a drain for the siphon approximately midway along the bridge that appears to be in good condition. Despite its age, the pipe appears to be in fair to good condition. Most of the pipe, except for the segment under U.S. Highway 2 and the segment on the north side of the Wenatchee River, is exposed.

The suspension bridge appears to be in fair to good condition. The suspension cables appear to be in good condition and are just starting to show rust on the surface as it appears the galvanized coating is wearing. Bridge I-beams appear to be in good condition despite surface rust. The concrete bridge towers are weathered and some small cracks were noted; however, they appear in fair to good condition. The walkway grating and railing that provide maintenance access to the pipe bridge on either side of the pipeline are in poor to fair condition.

The field survey also noted that the east branch of 30-inch steel pipeline, which conveys water to the IID Division 4 Canal, is supported near North Road by a 16-inch steel I-beam, which was installed to replace concrete supports that had failed. The I-beam is supported by railroad ties placed on-grade.

5.2.6 IID Division 4 Canal

The east branch of the Leavenworth Siphon pipeline daylights at a weir structure near North Road referred to as the Posey Weir. The IID Division 4 Canal extends from the Posey Weir to Williams Canyon Spill, a distance of approximately 7.3 miles. The description of the Division 4 facilities has been split into two reaches for discussion purposes. Table 5-7 summarizes the key facilities located within Division 4. Division 4 facilities are shown on Exhibit 3 in Appendix A.

Table 5-7
IID Division 4 Facilities

Facility	Station[1]	Overall Physical Condition	Noted Deficiencies
Posey Weir	Sta 0+00	Excellent	
Anderson Canyon Siphon	Sta 90+00	Fair	• Weathered concrete; some spalling
Steel Pipe Flume	Sta 104+00	Excellent	• Constructed in 2017 • Replaced old wood flume
Manager's Flume	Sta 146+00	Excellent	
Derby Canyon Spillway and Siphon	Sta 187+00	Good	
Sand Trap Spills	Sta 255+00	Poor to Fair	• Weathered concrete; Gate does not operate smoothly; Sediment buildup
Williams Canyon Spillway	Sta 380+00	Fair	• Undersized and occasionally overflows

Notes:

1. Stationing is approximate

5.2.6.1 Posey Weir (Sta 0+00) to Derby Canyon Spill (Sta 187+00)

This reach is approximately 3.5 miles long, and consists primarily of concrete-lined open canal, the Anderson Canyon Siphon, and a new steel pipe flume. The open canal has a trapezoidal section and ranges from low-lying canal that crosses orchards to a channel cut into bedrock hillsides. The canal is mostly fully lined through this reach. Along the steep hillsides upstream of Derby Canyon Spill, slope erosion appears to be present. Maintenance challenges also include keeping the canals clean of debris. The following facilities are located within this reach.

Posey Weir (Sta 0+00)

The 30-inch steel pipeline that comprises the east branch of the Leavenworth Siphon outlet discharges to the Posey Weir, which is designed to measure flow to the Division 4 Canal. The Posey Weir structure consists of a reinforced concrete box with a slide gate installed at the pipe outlet (see Figure 5-29). An 80-inch Cipoletti weir is installed across the outlet of the concrete box. The weir, gate, and concrete structure appear to be in excellent condition.

Figure 5-29
IID Division 4 – Posey Weir

Anderson Canyon Siphon (Sta 90+00)

The Anderson Canyon Siphon is a 30- to 34-inch-diameter steel pipe approximately 800 feet long. A debris rack with wire mesh attached to it protects the siphon inlet. A wood stop plate is placed in the canal upstream of the debris rack to raise the water level for deliveries upstream of the siphon. The siphon inlet and outlet structures are in poor to fair condition with some spalling observed.

Steel Pipe Flume (Sta 104+00)

A 75-foot-long flume crosses a low spot just east of the Anderson Canyon Siphon. When the field inventory was completed in May 2017, the flume was a wood box flume lined with a PVC membrane. The flume was supported by a wood structure. The original wood members were deteriorating and some supports were rotting and in contact with bare ground. IID made temporary repairs to the flume in spring 2017 and replaced it entirely in fall 2017. The new flume is a steel structure that supports a 30-inch steel pipeline (see Figure 5-30). The new structure is in excellent condition.

Figure 5-30
IID Division 4 – New Steel Pipe Flume

Manager's Flume (Sta 146+00)

A short concrete flume, referred to as the Manager's Flume, conveys water across a drainage near the IPID Manager's residence (see Figure 5-31). The flume is a concrete box flume, approximately 39 inches wide, 32 inches deep, and 42 feet long. The flume is in excellent condition.

Figure 5-31
IID Division 4 – Manager's Flume

5.2.6.2 Derby Canyon Spill (Sta 187+00) to Williams Canyon Spill (Sta 380+00)

This reach is approximately 3.7 miles long and consists of a concrete-lined open canal, the Derby Canyon Siphon, and several segments of pipeline. Several long segments of pipe exist along the reach, including segments of relatively new 24- to 36-inch corrugated HDPE pipe, and a 1,600-foot, 30-inch-diameter painted steel pipeline downstream of the Bluff Spill that is supported along a very steep slope above the Wenatchee River. The 30-inch steel pipeline and supports appear to be in good condition; however, the wood pipe saddles are deteriorating. Segments of open canal are primarily trapezoidal in section and are fully lined with concrete for most of this reach. The condition of the concrete was noted to be in fair to good shape for most of the reach, except for joints in the lining that require cleaning and sealing.

Rock and landslides or slumps are a potential problem in this reach because of the location of the canal cut along steep bedrock hillsides. A section of hillside between Sta 294+00 and Sta 300+00 appears to be very susceptible to damage due to landslides. The following key facilities are located within this reach.

Derby Canyon Spillway and Siphon (Sta 187+00)

The canal upstream of the Derby Canyon Spillway transitions into a 4.25-foot-wide, 7-foot-long, 4.25-foot-deep concrete box. A 5-foot-wide opening on the left side of the box with stop logs spills excess water into Derby Canyon. The spillway apron extends approximately 11 feet and is founded on rock. The box narrows into a 3-foot-wide, 6.75-foot-long channel with a trash rack installed that conveys flow to the inlet of a 24-inch steel siphon (see Figure 5-32). The spillway and siphon structures are both in good condition.

Figure 5-32
IID Division 4 – Derby Canyon Siphon Inlet

Sand Trap Spills (Sta 255+00)

The system downstream of the Derby Canyon Spillway consists of a long segment of relatively new 36-inch corrugated HDPE pipe that extends to a series of spills referred to as the Sand Trap Spills. The primary spillway structure is approximately 20 feet long by 3 feet wide with a rectangular cross section. The concrete structure has a 5-foot-wide by 8-inch-deep opening in the middle of the right wall with stop logs. A 12-inch square steel slide gate is located in the center and bottom of the structure. The structure traps sand and loose debris conveyed in the pipeline. The slide gate is opened to flush out sediment and debris trapped in the structure daily.

The concrete structure is in poor to fair condition. The slide gate does not operate smoothly. This area was very problematic before it was piped due to sand washing down from the hillside and filling the canal. A fair amount of sand still enters the pipeline.

Williams Canyon Spillway (Sta 380+00)

The Division 4 Canal terminates at Williams Canyon. A 36-inch corrugated aluminum pipe discharges to a 10-foot by 8-foot concrete box, approximately 4 feet deep at the top of the slope above Williams Canyon Road (see Figure 5-33). Excess flow spills over stop logs installed across the middle of the box into a 14-inch steel spillway pipe. The spillway pipe transitions to concrete pipe and spills to Williams Canyon. A 36-inch corrugated aluminum pipe exits the box and continues for approximately 50 feet before entering a smaller box where flow is transferred to a 12-inch PVC pipe that conveys water north to water users in Williams Canyon.

Figure 5-33
IID Division 4 – Control Structure at Williams Canyon Spillway

The aluminum pipes appear to be in good condition. The concrete walls and slabs of the concrete boxes appear to be in fair to good condition. IPID indicated that this spillway is undersized and overflows sometimes when a nearby water customer shuts down his 5-cfs delivery.

5.2.7 IID Division 5 Canal

The north branch of the Leavenworth Siphon pipeline daylights at a weir structure near North Road referred to as Parson's Weir. The IID Division 5 Canal extends from Parson's Weir to the End Spill near Bergstrasse Road in the City of Leavenworth, a distance of approximately 2.5 miles. Division 5 consists primarily of pipeline and concrete-lined open canal. In the field survey, several segments of pipeline were noted ranging in size from 24- to 30-inch diameter. The Division 5 Canal also includes two siphons. Freeboard appears to be adequate throughout Division 5. The concrete lining varies from new concrete that appears to be in excellent condition to older concrete that is cracking and in poor condition. Table 5-8 summarizes the key facilities located within Division 5. Division 5 facilities are shown on Exhibit 3 in Appendix A.

Table 5-8
Division 5 Facilities

Facility	Station[1]	Overall Physical Condition	Noted Deficiencies
Parson's Weir	Sta 0+00	Fair to Good	• Weathered concrete
Moe Siphon	Sta 18+00	Fair	• IPID reported leaks in this siphon • Spill is in poor to fair condition
Fox Spillway	Sta 58+00	Fair to Good	• CMP inlet and outlet is in poor condition
Chumstick Siphon	Sta 78+00	Poor to Fair	• Weathered concrete • Rusted drain valve that needs to be replaced
End Spillway	Sta 140+00	Very poor	• Spalling, weathered concrete

Notes:
1. Stationing is approximate

5.2.7.1 Parson's Weir (Sta 0+00)

The 30-inch steel pipeline that comprises the north branch of the Leavenworth Siphon outlet discharges to Parson's Weir (see Figure 5-34), which is designed to measure flow to the Division 5 Canal. Flow from the pipeline to Parson's Weir is controlled by a 30-inch gate valve located just upstream of the weir structure. The pipe discharges into an open concrete lined canal with a trapezoidal section. An 8-foot-wide Cipoletti weir is used to measure flow entering the Division 5 canal downstream of the pipe outlet. The concrete canal and weir supports are in fair condition, with minor cracking and weathering observed. IPID has indicated that the weir is only accurate up to approximately 4 cfs. If flows exceed 4 cfs, the weir becomes backwatered.

Figure 5-34
IID Division 5 – Parson's Weir

5.2.7.2 Moe Siphon (Sta 18+00)

The Moe Siphon conveys the Division 5 Canal under an orchard north of North Road. The inlet to the siphon consists of a reinforced concrete structure (see Figure 5-35). Excess water can be spilled through a small pipe that extends through the left wall of the structure. A debris rack protects the siphon inlet. The siphon is a 30-inch-diameter steel pipeline. IPID has reported leaks in the siphon. The inlet structure and siphon are in fair condition.

Figure 5-35
IID Division 5 – Moe Siphon Inlet and Spill

5.2.7.3 Fox Spillway (Sta 58+00)

The Fox Spillway is located in a reinforced concrete box west of Fox Road that connects two segments of 30-inch CMP (see Figure 5-36). An opening in one side of the box conveys excess flow to a 10-inch PVC pipe, which spills into Chumstick Creek. The concrete structure is in fair to good condition. IPID reports the pipes entering and exiting the spillway structure are in poor condition.

Figure 5-36
IID Division 5 – Fox Spillway Box

5.2.7.4 Chumstick Siphon (Sta 78+00)

The Chumstick Siphon conveys the Division 5 Canal across a railroad, Chumstick Creek, and the Chumstick Highway. The siphon inlet is located in a small reinforced concrete structure at the end of a segment of concrete-lined open canal. A trash rack is installed in front of the inlet to the 16-inch steel pipe. The pipe is coated with a tar and wrap coating that has deteriorated where the pipe is exposed. The pipe and inlet and outlet structures are in poor to fair condition. A drain valve is located near Sta 89+00, where the pipe crosses over Chumstick Creek (see Figure 5-37). The drain valve appears to be in poor condition. There is an existing spill at the outlet of the siphon. IPID avoids spilling excess water here due to a previous slope failure caused by the spill that covered Chumstick Highway. IPID would prefer to find a way to spill excess water from the inlet side of the siphon.

Figure 5-37
IID Division 5 – Chumstick Siphon at Chumstick Creek

5.2.7.5 End Spillway (Sta 140+00)

The Division 5 Canal flows into a concrete box structure near Bergstrasse Road in the City of Leavenworth. Flow is diverted from the structure to an adjacent delivery box. Excess water spills over a weir opening in the side of the box to an open, unlined ditch (see Figure 5-38). The ditch conveys excess water east back to Chumstick Creek. The structure appears to be in good working condition hydraulically; however, the concrete is in very poor condition, with heavy spalling.

Figure 5-38
IID Division 5 – End Spill

5.2.8 PID Canal

The PID Canal conveys water from diversion facilities on Peshastin Creek to an end spill near Pioneer Road west of Cashmere. The total length of the system is approximately 13.5 miles. The description of the PID Main Canal has been split into four reaches for discussion purposes. Table 5-9 summarizes the key facilities located within the PID delivery system. The PID delivery facilities are shown on Exhibit 7 in Appendix A.

Table 5-9
PID Canal Facilities

Facility	Station[1]	Overall Physical Condition	Noted Deficiencies
PID Diversion Dam	Sta 0+00	Fair to Good	• Weathered Concrete
Intake and Head Gates	Sta 0+20	Fair to Good	• Minor Concrete Spalling • Steel gate supports and step are rusted
Fish Screens	Sta 2+50	Good	
Peshastin Crossover	Sta 45+00	Poor to Fair	• Pipe is exposed in Peshastin Creek • Valve is exposed in Peshastin Creek

Facility	Station[1]	Overall Physical Condition	Noted Deficiencies
Fryburger Spillway	Sta 77+00	Poor to Fair	• Weathered Concrete; Gate rusted; Walkway supports deteriorating
Stines Hill Flume and Spillway	Sta 413+00	Good to Excellent	
Wood Flume	Sta 545+00	Poor	• Water damaged, flume is deteriorating
Elevated Steel Pipe Flume	Sta 553+00	Excellent	
Weed Screen	Sta 563+00	Good	• Screen water pump fails occasionally, piping downstream needs to be replaced
Brender Creek Spillway and Siphon	Sta 563+00	Fair to Good	• Screen water pump fails occasionally, piping downstream needs to be replaced
Gated Control Box	Sta 667+00	Excellent	
Rabbit Warren	Sta 668+00	Excellent	
End Spill	Sta 711+00	Poor	• Weathered and spalled concrete

Notes:
1. Stationing is approximate

5.2.8.1 Diversion Dam (Sta 0+00) to Bluff Pipeline Inlet (Sta 168+00)

This reach has a length of approximately 3.2 miles and primarily comprises a concrete-lined open canal and the 2,100 feet of 42-inch-diameter steel pipe. A short section of concrete box culvert exists to convey flows under the IID Peshastin Siphon. The first 1.5 miles of canal is low-lying, rectangular concrete-lined canal with gravel and cobbles in the bottom. Heavy vegetative growth was noted along both sides of the canal. The canal transitions to a trapezoidal canal that ranges from fully lined to partially lined or unlined. The concrete lining was noted to be in fair condition, with some cracking or damage to lining noted. Indications that seepage is occurring along unlined or partially lined sections was also noted. The following facilities are located within this reach.

Diversion Dam (Sta 0+00)

A concrete diversion dam spans Peshastin Creek approximately 2.4 miles upstream of its confluence with the Wenatchee River (see Figure 5-39). The dam is approximately 100 feet wide. The spillway is constructed of 24-inch-thick concrete covered with 3/16-inch steel plate armor. On each side of the dam spill, a wingwall extends back into the embankment. The embankment downstream of the dam is concrete lined to prevent erosion. Stop logs can be installed in the dam spillway to raise the water level behind the dam. The dam is showing signs of erosion but is still in fair to good condition and works well hydraulically.

The diversion dam also includes a fishway structure on the left bank. The fishway was rebuilt in 2014 to address issues with erosion and ice flows and to improve fish passage. The fishway is in excellent condition.

Figure 5-39
PID Canal – Peshastin Creek Division Dam

Intake and Head Gates (Sta 0+20)

On the right side of the diversion dam is the inlet structure and head gates for the PID Canal (see Figure 5-40). The inlet structure consists of two 4-foot-wide steel slide gates. Water levels at the gates are sent to IPID's SCADA system. The gates are automated, but IPID does not currently use the system to operate the gates. IPID stated that the transducers are not reliable enough to operate the headworks remotely. The slide gates appear to be in good working condition despite surface rust observed. The concrete gate structure and wing wall are in fair condition with some concrete weathering and minor spalling noted.

Figure 5-40
PID Canal – Intake Structure and Head Gates

Fish Screens (Sta 2+50)

The system upstream of the fish screen is an open unlined canal. The fish screens are located in a reinforced concrete structure. A 12-inch PVC fish bypass pipe conveys water from the upstream side of the screens back to Peshastin Creek. The fish screens include two rotating drum screens (installed in October 1996) driven by an 8-foot-diameter paddle wheel (see Figure 5-41). A debris rack is installed in front of the fish screens. A 5-foot steel Parshall flume is also located in the channel downstream of the fish screen to monitor flow in the canal. A transducer at the Parshall flume is connected to IPID's SCADA system. The entire structure is enclosed within a chain-link fence.

Figure 5-41
PID Canal – Fish Screens

The concrete slab and walls of the fish screen structure appear to be in good condition. The fish screens were installed in October of 1996 and appear to be in excellent condition. The paddlewheel, fencing, and communication equipment all appear to be in good condition.

Peshastin Crossover Pipeline (Sta 45+00)

The PID Peshastin Crossover pipeline originates in the bifurcation at the downstream end of the IID Division 2 Canal and crosses U.S. Highway 97 and Peshastin Creek before discharging to the PID Canal (see Figure 5-42). The pipeline is used to supplement the supply diverted from Peshastin Creek with water diverted from Icicle Creek. The pipeline is a 16-inch steel pipeline. The pipeline was once buried under Peshastin Creek, but has been exposed due to changes made to the creek when the intersection of U.S. Highway 97 and U.S. Highway 2 were reconstructed approximately 10 years ago. The pipeline is now exposed on the bed of Peshastin Creek. A valve is used to flush the pipeline and discharge excess water to Peshastin Creek. That valve is also exposed in Peshastin Creek. Because the pipe and valve are becoming more vulnerable as scour occurs in the Peshastin Creek channel and because it has potential to become a barrier to fish passage, IPID has plans to replace the pipe crossing at the creek with a segment of buried pipeline in the near future (likely 2018).

Figure 5-42
PID Canal – Peshastin Crossover Pipeline at Peshastin Creek

Fryburger Spillway (Sta 77+00)

The Fryburger Spillway is located just upstream of the primary bend in the PID Canal, where it changes direction from flowing north to east. This structure is the main water control facility for the Peshastin Canal. The canal transitions upstream of the Fryburger Spillway from an open concrete-lined canal to a rectangular canal section approximately 8.5 feet wide by 2.5 feet deep. In the rectangular section on the left, there is a spillway opening controlled by a gate that can raise or lower to control spills from the canal (see Figure 5-43). Water spills onto a concrete apron before flowing over a rock outcrop and down to Peshastin Creek. Wood beams span the structure and serve as supports for a walkway for maintenance. Approximately 3 feet downstream from the spillways, a wooden slide gate is installed across the canal to control the upstream water surface elevation. Water levels at the spill are sent to PID's SCADA system.

Figure 5-43
PID Canal – Fryburger Spillway Structure

The concrete spillway structure is in poor to fair condition, with some weathering observed. The spillway gate is in good condition, while the slide gate in the canal is rusted and in poor to fair condition. The walkway supports are deteriorating but appear sound.

5.2.8.2 Bluff Pipeline Inlet (Sta 168+00) to Stines Hill Spill (Sta 413+00)

The Bluff Pipeline is a 42-inch steel pipeline that begins on a steep hillside above the County Landfill below Deadman Hill Road and extends along the steep hillside above the Wenatchee River. This pipeline is the most vulnerable segment of the PID Canal. The reach of the PID Canal between the Bluff Pipeline Inlet and Stines Hill Spill is approximately 4.6 miles in length. Downstream of the Bluff Pipeline, it consists primarily of low lying lined and unlined canal running alongside and through moderately sloped orchards and forested hillside.

Several segments of pipe exist along this reach, including the approximately 2,500 feet of 42-inch-diameter Bluff Pipeline. Past slope failures were observed during the field survey behind two sections of the 42-inch-diameter steel pipe. The pipe section located at Sta 168+00 is exposed over a steep, eroding ravine and is supported by a steel I-beam. The survey noted that the I-beam swayed slightly when pushed by hand presumably because it was not under much load. The pipe is assumed to be primarily supporting its own weight across the failure area. The section of pipe located at

Sta 170+00 is also spanning a slope failure. PID poured concrete footings and installed steel supports, drainage, and some backfill to prevent the pipe from failing. PID plans to install a full concrete retaining wall under the pipe and backfill with gravel prior to the 2018 irrigation season as a more permanent solution. Many other sections of this pipe were noted to be installed along a steep hillside and are at risk of similar failures.

5.2.8.3 Stines Hill Spill (Sta 413+00) to End Spill (Sta 711+00)

This reach of canal is 5.6 miles in length, and consists of trapezoidal open canal and several segments of pipeline, including corrugated HDPE, steel, and PVC pipe. This reach also includes a flume, a weed screen, and the Brender Spills and Siphon. Segments of open canal included concrete-lined, partially lined, and unlined canal. Concrete canal lining was noted to be in poor to fair condition, with numerous cracked and deteriorated sections. Sediment buildup was noted in a 66-inch culvert at Sta 513+00, as well as in the canal upstream of the culvert. IPID has been actively replacing segments of unlined canal with pipe. The canal is now piped from Brender Creek Spillway (Sta 564+00) to the End Spill (Sta 711+00). The following facilities are located within this reach.

Stines Hill Flume and Spillway (Sta 413+00)

Upstream of the Stines Hill Spillway, the concrete-lined canal transitions into a 70-foot-long rectangular steel box flume, 53 inches wide and 36 inches deep. In the middle of the flume, there are three 44-inch-wide openings in the left wall with stop logs (see Figure 5-44). Excess water is spilled downstream of the spillway openings. There is a 36-inch steel slide gate that controls the water level in the canal. Water levels are monitored and sent to PID's SCADA system. The downstream end of the flume structure abuts a concrete box that conveys flow in the canal to a 36-inch HDPE pipe. A trash rack is installed across the box in front of the pipe inlet. The flume, gate, spill structure, and pipe inlet structure are all in good to excellent condition, despite some surface rust observed on the flume.

Figure 5-44
PID Canal – Stines Hill Flume and Spillway

Wood Flume (Sta 545+00)

A segment of concrete-lined canal transitions to an old wood flume at this location. The structure is a 4-foot-wide by 3.5-foot-deep wood box flume, approximately 118 feet long (see Figure 5-45). The inside of the flume is lined with a PVC membrane. The flume invert is 7 feet above the ground surface at its highest point. The system downstream transitions through a rectangular section back into a partially lined open canal.

Figure 5-45
PID Canal – Wood Flume

The flume was in poor condition at the time of the assessment. The sides and bottom of the flume showed signs of water damage and were deteriorating. PID replaced this flume concurrent with preparation of this plan with a low-head (5-pound per square inch [psi]) corrugated HDPE pipeline in the spring of 2018.

Elevated Steel Pipe Flume

Another wood flume was recently replaced by IPID approximately 800 to 900 feet downstream of the first existing wood flume. That flume was replaced by an elevated 36-inch-diameter elevated steel pipeline supported by a steel structure. The structure and pipeline appear to be in excellent condition.

Weed Screen

Just upstream of the Brender Spillway, a segment of lined concrete canal transitions to rectangular reinforced concrete channel. The channel includes stop logs spaced regularly in four places. Stop logs are placed to force water over or under the logs to facilitate settling of sediment and collection of debris and weeds. The concrete-lined canal continues from the downstream end of the structure 10 or 15 feet to another reinforced concrete structure that houses an inclined traveling screen. The screen is powered by an electric motor and is designed to remove weeds and algae before water flows into the Brender Creek Siphon and other pipelines that extend down to the end of the delivery system (see Figure 5-46). The structure and the rectangular settling structure upstream of the weed screen was constructed in 2010 and appear to be in excellent condition. The screen appears to be in good condition. The pump used to spray the debris off the traveling screen fails periodically.

Figure 5-46
PID Canal – Weed Screen Structure at Inlet to Brender Creek Siphon

Brender Creek Spillway and Siphon (Sta 563+00)

A 5-foot-wide spillway chute is constructed in the left wall of the canal just upstream of the weed screen. The chute extends into a 5-foot square spillway box that is 4.5 feet deep. A 5-foot slide gate controls flow into the spillway box. The box conveys water to a 28-inch steel spillway pipe that discharges excess water to Brender Creek. Water levels are monitored at the spill and sent to the PID SCADA system. The Brender Creek Siphon consists of 26-inch steel pipe that extends from an inlet on the downstream side of the weed screen to a reinforced concrete box just south of Brender Canyon Road.

The concrete spillway structure is in good to excellent condition. The gate is also in good condition. IPID reported that approximately 350 feet of the pipeline extending away from the screens needs to be replaced soon. The pipe is failing and holes have been observed in the top of the pipe.

Gated Control Box (Sta 667+00)

The canal flows through two segments of 36-inch pipe from the Brender Siphon to the end of the gravity flow system. The first segment was constructed prior to 2009 and is standard water-tight corrugated HDPE pipe. Approximately 6,000 feet of pipe at the downstream end of the gravity flow system comprises low-head corrugated HDPE pipe, which can accommodate pressures up to 5 psi. This pipe was installed in 2010. At the downstream end of the 36-inch pipeline, water flows into a reinforced concrete box (see Figure 5-47) that controls the flow of water to a pressurized pipeline that extends down the hill to serve customers south of the PID Canal. Stop logs in the middle of the box allow IPID to control the water level in the upstream end of the box. Water is diverted through a screened opening in the left wall of the box to the 10-inch PVC pipeline. A second set of stop logs is placed to ensure that the pipe inlet is continuously submerged. The 10-inch PVC pipeline conveys water under pressure to users south of the PID Canal. Water not diverted to the 10-inch PVC pipeline flows through the box and into a 24-inch corrugated HDPE pipeline that conveys water to the Rabbit Warren structure. The control box is in excellent condition.

Figure 5-47
PID Canal – Gated Control Box

Rabbit Warren (Sta 668+00)

A reinforced concrete structure at the downstream end of the 24-inch corrugated HDPE pipeline is referred to has the “Rabbit Warren” (see Figure 5-48). The structure was constructed when the pipeline was constructed in 2011 and consists of a 12-foot by 6-foot concrete box, approximately 8 feet deep, with nine turnout connections stubbing out directly from the box. A Cipoletti weir with stop logs at the upstream end of the box controls and measures flow through the box. A perforated stainless-steel plate screen is installed horizontally over the inlets to the turnout connections to screen flow to the connections. Stop log guides at the downstream end of the structure control the water level over the turnout connections. Excess water flows over the stop logs and exits the structure through a short segment of 24-inch corrugated HDPE pipe to a concrete chute. The chute was once part of the old ditch system that served customers now served by the pressurized pipeline. The chute and old ditch system now convey excess water all the way down to Pioneer Road were water is discharged back to Brender Creek. The Rabbit Warren structure is in excellent condition.

Figure 5-48
PID Canal – Rabbit Warren

End Spill (Sta 711+00)

The end spill structure is located adjacent to Pioneer Road and conveys excess or flushed water from the PID Canal to Brender Creek. The 10-inch PVC pipeline that delivers water under pressure to customers south of the PID Main Canal transitions to 8-inch HDPE and 8-inch PVC pipeline near Wohlers Road and terminates in a manhole structure just south of the End Spill. A plug valve installed adjacent to the manhole allows IPID to flush the closed pipeline into the manhole. The flushed water then rises and flows down the old ditch and through the end spill structure to Brender Creek. The manhole and pressurized pipeline were installed in 2011. The end spill structure also conveys overflow that is conveyed through the old ditch from the spill at the Rabbit Warren to Brender Creek. The old concrete spillway end spill structure is in poor condition, with spalling and cracked concrete observed.

5.2.9 Gibb Ditch

The Gibb Ditch is a delivery system that consists of closed, pressurized pipelines supplied through a gate and screened intake box at the Peshastin Bifurcation structure at the downstream end of the IID Division 2 Canal. The system includes a network of approximately 2.9 miles of pipelines ranging in diameter from 3-inch to 14-inch. The original system consisted primarily of steel and PVC pipelines. Portions of the system were replaced or realigned when the intersection of U.S. Highway 2 and U.S. Highway 97 were reconfigured. The newest pipe is primarily solid-wall HDPE pipe. When the new pipe was installed, a 3-inch drain line was constructed under Highway 97 with a valve that enables flushing to the Peshastin Creek floodplain on the east side of U.S. Highway 97.

The Gibb Ditch facilities are shown on Exhibit 6 in Appendix A. Because the system is mostly buried, the condition of the pipelines was not documented or observed as part of the system inventory. IPID believes the pipe is generally in good condition.

5.2.10 Tandy Ditch

The Tandy Ditch is a delivery system that comprises approximately 900 feet of concrete-lined open canal and approximately 2.6 miles of closed pipeline, ranging in size from 8- to 20-inch diameter. Additional supply to some Tandy Ditch shareholders is supplied directly from the IID Division 2 Canal upstream of the bifurcation structure. Table 5-10 summarizes the key facilities located within the Tandy Ditch system.

Table 5-10
Tandy Ditch Facilities

Facility	Station[1]	Overall Physical Condition	Noted Deficiencies
Intake	Sta 0+00	Fair	• Weathered concrete • Gate is rusted • Flow observed overtopping structure
Fish Screens	Sta 9+00	Good	
Pipeline/End Spill	Sta 145+00	Good	

Notes:
1. Stationing is approximate

5.2.10.1 Tandy Intake (Sta 0+00)

The intake structure consists of a small lateral weir on the left bank of a side channel of Peshastin Creek, located approximately 4.9 miles upstream of its confluence with the Wenatchee River (see Figure 5-49). Flow is conveyed a short distance to a head gate structure with a 5-foot slide gate before passing through a 4-foot CMP culvert. The system downstream of the culvert consists of a trapezoidal concrete-lined open canal. The lateral weir and slide gate were overtopping during the field survey and flow was passing unchecked around them into the culvert. The weir and slide gate appear to be in fair condition.

Figure 5-49
Tandy Ditch – Intake Facilities

5.2.10.2 Fish Screens (Sta 9+00)

The concrete-lined canal extends approximately 900 feet from the intake along the east side of U.S. Highway 97 to a fish screen structure (see Figure 5-50). The open canal transitions to a rectangular shaped concrete box structure downstream of the intake culvert. A debris rack is located at the upstream end of the facility. A spillway opening is located on the right wall of the structure immediately upstream of a 6-foot slide control gate and traveling screen. Debris from the traveling screen is deposited on a sheet of plywood covering the canal and must be removed periodically. The structure divides into two chutes downstream of the traveling screen. On the left, a 3-foot-diameter rotating drum screen is installed angling downstream and to the right to direct fish to the chute on the right that spills back into Peshastin Creek. The screening facility is enclosed by chain-link fencing.

Figure 5-50
Tandy Ditch – Fish Screens

The concrete structure, rotating drum fish screen, associated gates, and handrailing are all in good condition. The spillway structure, control gate, and traveling screen appear to be in fair to good condition.

5.2.10.3 Pipeline/End Spill (Sta 145+70)

From the fish screens to the end of the system (Sta 145+70), the ditch has been enclosed in 8- to 20-inch PVC pipe. The pipeline includes a series of vents that allow air to escape from the closed pipeline. In addition, there is a meter on the pipeline, but the meter is located downstream of several delivery boxes and does not provide an accurate measurement of the flow being diverted from Peshastin Creek for irrigation. The end spill consists of an 8-inch valve at the end of the piped system that drains to an open ditch. The valve appears to be in good condition.

6 Water Needs and Adequacy of Water Supply

6.1 Future Land Use Trends

As noted in Chapter 3, the *Chelan County Comprehensive Plan* (Chelan County 2017) provides a framework for land use management throughout the County over the next 20 years (2017 to 2037). The IPID service area is within two study areas designated as the Lower Wenatchee River Valley and Upper Wenatchee River Valley. The vision for these areas outlined in the Comprehensive Plan includes preservation of open spaces, sustainability of agriculture, maintenance of the high-quality rural lifestyle, and orderly growth and development that will preserve natural resources. Proposed land uses near Leavenworth and Cashmere will continue to include higher density residential, industrial, and commercial land uses that are not as prevalent in other parts of the IPID service area.

The predominant land use within the IPID service area will remain agricultural, primarily apple and pear orchards. Some orchards and other agricultural properties near Leavenworth and Cashmere have slowly converted to low-density or medium-density residential and that trend is likely to continue over the next 20 years, as the urban areas in and around Leavenworth and Cashmere continue to grow and demand for land for residential development increases. However, low and medium-density residential development on properties irrigated by IPID will still require irrigation water to maintain lawns, pastures, and gardens. IPID does not anticipate a significant decline in the overall demand for irrigation water and the number of acres irrigated over the next 20 years.

Development will be restricted by local zoning regulations, which are subject to change. Zoning within the proposed IPID service area boundary is shown in Figure 3-2 and was summarized in Chapter 3. Most of the IPID service area is still zoned for agricultural and rural residential uses. The zoning restricts the density of residential development in these areas and reflects the land use goals of preservation of open spaces, sustainability of agriculture, maintenance of the high-quality rural lifestyle, and orderly growth and development.

6.2 Irrigation Water Needs

IPID endeavors to deliver enough water at customer turnouts to meet crop irrigation requirements (CIRs) and account for inefficiency of on-site irrigation application systems. The maximum amount of water that is delivered at a customer turnout to meet these needs is often referred to as the water duty. IPID's historical water duty has been 6.75 gpm per share (one share is generally equal to 1 acre) delivered at each customer turnout during normal operating conditions. During drought conditions, deliveries may be reduced to 4.5 gpm per share.

For this analysis, Aspect estimated irrigation water needs using two methods. The first method was based on CIRs (crop demand method) consistent with the Ecology Guide 1210. The second method is based on IPID's maximum water duty and share quantities (share limit method).

6.2.1 Crop Demand Method

This method relies on estimated values for CIRs for orchard and pasture. CIRs represent the actual water that needs to be applied to specific crops to sustain healthy growth, allow for evapotranspiration, and account for leaching and other miscellaneous water requirements that cannot be met by precipitation and water naturally stored in the soil. Average monthly CIRs were estimated for a variety of crops at locations throughout Washington State by the NRCS and are tabulated in Appendix A of the Washington Irrigation Guide (WIG) (NRCS 1997). The CIRs in the WIG are in the process of being updated by personnel from Ecology and Washington State University, but the updated values have not been published yet.

CIRs are included in the WIG for locations at Leavenworth and Wenatchee. The climate (precipitation, average temperatures) varies between Leavenworth and Wenatchee. The area near Leavenworth generally receives more precipitation and has cooler temperatures compared to areas further down the valley. This variability in climate is reflected in the CIR values provided in the WIG. For the sake of estimating overall CIRs and irrigation water needs for IPID, the CIRs were averaged between the values at the Wenatchee and Leavenworth stations, as shown in Table 6-1. For cultivated orchard land use, the crop type “apples with cover” was selected. CIRs for “apples with cover” are slightly higher than CIRs for “pears with cover,” so application of CIRs for apples to orchards in general is conservative. For pasture land use, the crop type “pasture/turf” was selected.

The total irrigation delivery requirements were then estimated by multiplying the CIR by the estimated efficiency of on-site irrigation application, which is a function of the watering method and accounts for water lost through evaporation or seepage/return flow. Overall, IPID water users are using highly efficient on-farm application systems. Most orchards irrigated by IPID use micro-irrigation systems or solid-set sprinkler systems. Based on Table 1 in Ecology Guide 1210, the estimated efficiency for a solid set sprinkler (under tree) is identified as 75%, while the efficiency for micro-spray watering systems is identified as 85%. Table 6-2 summarizes the total irrigation delivery requirements based on CIRs and assumed efficiency of application systems.

The total irrigation delivery requirements, in inches, were then used to estimate the average delivery required per acre of irrigated pasture and orchard for each month. The estimates indicate that during July, which is the month with the peak CIRs, an average orchard within the IPID service area may require deliveries of up to 6.84 gpm per acre if efficient micro-spray systems are used. A delivery in excess of 7 gpm per acre may be required if less efficient water systems are used. This compares to the maximum 6.75 gpm per acre water duty that IPID delivers to its water users during normal (non-drought) operating conditions.

Table 6-1
Crop Irrigation Requirements

Crop Type	Crop Irrigation Requirements (inches)						
	May	June	July	August	September	October	Season
Leavenworth:							
Pasture/Turf	0.00	3.58	6.78	5.05	2.77	0.00	**18.17**
Apples with Cover	0.00	4.52	8.54	6.44	3.60	0.00	**23.11**
Wenatchee:							
Pasture/Turf	4.04	7.09	8.41	5.91	4.12	0.51	**30.08**
Apples with Cover	3.37	8.23	10.55	7.52	5.00	0.47	**35.14**
Average of Leavenworth and Wenatchee:							
Pasture/Turf	2.02	5.34	7.60	5.48	3.45	0.26	**24.13**
Apples with Cover	1.69	6.38	9.55	6.98	4.30	0.24	**29.13**

Notes:
1. Source: WIG, Appendix A (NRCS 1997).

Table 6-2
Total Irrigation Delivery Requirements

Crop Type	Total Irrigation Delivery Requirements						
	May	June	July	August	September	October	Season
Average of Leavenworth and Wenatchee CIRs (inches):							
Pasture/Turf	2.02	5.34	7.60	5.48	3.45	0.26	**24.13**
Apples with Cover	1.69	6.38	9.55	6.98	4.30	0.24	**29.13**
Total Irrigation Requirement (inches) with Solid-Set Sprinkler (75% Efficiency):							
Pasture/Turf	2.69	7.12	10.13	7.31	4.60	0.35	**32.17**
Apples with Cover	2.25	8.51	12.73	9.31	5.73	0.32	**38.84**
Total Irrigation Requirement (inches) with Micro-Spray System (85% Efficiency):							
Pasture/Turf	2.38	6.28	8.94	6.45	4.06	0.31	**28.39**
Apples with Cover	1.99	7.51	11.24	8.21	5.06	0.28	**34.27**
Average Delivery Required (gpm per acre) with Solid-Set Sprinkler (75% Efficiency):							
Pasture/Turf	1.64	4.48	6.16	4.45	2.89	0.21	**3.30**
Apples with Cover	1.37	5.35	7.74	5.66	3.60	0.19	**3.98**
Average Delivery Required (gpm per acre) with Micro-Spray System (85% Efficiency):							
Pasture/Turf	1.45	3.95	5.44	3.92	2.55	0.19	**2.91**
Apples with Cover	1.21	4.72	6.84	4.99	3.18	0.17	**3.51**

6.2.2 Share Limit Method

The share limit method was used to estimate the variability in irrigation based on IPID's historical water duty of 6.75 gpm per share. Delivery at customer turnout boxes can vary seasonally from partial diversion for several hours per day to continuous or near continuous diversion during the peak irrigation season. This method was applied using two separate sets of assumptions to provide a low-end and high-end bookend of water use.

The low-end water use estimate was developed based on matching diversion duration to changes in seasonal CIRs for this area. Using this approach, the magnitude and duration of water use per share was assumed to peak during the month of July. It was assumed that water use would match the peak water duty of 6.75 gpm per share throughout July. The duration of the diversion was then seasonally adjusted for shoulder months proportionate to irrigation demand of those months relative to July. For example, the average CIR for orchard is 6.38 inches in June and 9.55 inches in July. Therefore, the seasonal adjustment for June was estimated at 67% of full time (i.e., a diversion of 6.75 gpm per acre was applied 67% of the time, or 16 hours per day for 30 days, in June).

The high-end water use estimate assumed that water use would match the peak water duty of 6.75 gpm per share through June, July, and August. A seasonal adjustment of 50% was applied to the shoulder months of May and September.

These irrigation estimates based on IPID's historical water duty are summarized in Table 6-3. The results indicated a low-end total annual delivery requirement of 33.48 inches (2.79 acre-feet per acre) and a high-end total annual delivery requirement of 43.85 inches (3.65 acre-feet per acre).

Table 6-3
Total Irrigation Requirements Based on IPID Historical Water Duty

Crop Type	May	June	July	August	September	October	Season
Average CIR, Apples with Cover (inches)	1.69	6.38	9.55	6.98	4.30	0.24	**29.13**
% of Maximum Month	18%	67%	100%	73%	45%	3%	
Maximum Delivery (gpm per share)	6.75	6.75	6.75	6.75	6.75	6.75	
Low – Assumed Seasonal Adjustment	18%	67%	100%	73%	45%	3%	
Total Irrigation Demand (inches)	1.96	7.17	11.10	8.11	4.83	0.28	**33.46**
High – Assumed Seasonal Adjustment	50%	100%	100%	100%	50%	0%	
Total Irrigation Demand (inches)	5.55	10.74	11.10	11.10	5.37	0.00	**43.85**

6.3 Water Balance

6.3.1 Water Balance Model

A spreadsheet model was developed to simulate the flow of water through the IID and PID delivery systems during peak irrigation season conditions with flows diverted to deliver the maximum IPID water duty of 6.75 gpm per acre at all water user turnout boxes. The water balance model was developed as follows:

- **Water Delivery Allocation**: A GIS layer of assessed parcels was provided by IPID. The IID Canal System and the PID Main Canal were split up into reaches, with reach boundaries at major facilities, such as spills or other control structures. The parcels in the database were then each assigned to a reach based on an assumption of where the parcel's turnout box is located. IPID is in the process of confirming which parcels are irrigated through each turnout box. Because that information is not yet available, parcels were assigned to a reach based on type of shares and proximity. The acreage and number of each type of share served by each reach was then summarized. Deliveries were then allocated to each reach based on the number of shares assigned to the reach at a maximum delivery rate of 6.75 gpm per share.
- **Conveyance Loss:** As discussed in Chapter 4, water is lost in the IID and PID delivery systems due to seepage through open and lined canals, leakage through flumes and pipelines, and evaporation. Flow measurements were taken late in June 2017 and late in September 2017 to estimate losses in key reaches of the Canal. Loss calculations were developed for various types of canal conditions (open unlined canals, partially lined canals, fully lined canals, tunnels, flumes, and pipelines) based on the loss rates measured (in terms of cfs lost per length of canal) and a general understanding of typical losses in similar canal systems. The loss calculations were used to estimate losses in each reach of the canal system that was modeled based on the estimated flow rate and canal conditions.
- **Spills and Other Outflows:** The model also includes spills at key locations in the IID and PID delivery systems. A maximum delivery from IID to PID through the Peshastin Crossover of 15 cfs was also assumed.

The water balance spreadsheet is used to calculate flows required through each reach of each canal system, from the bottom of the system to the top, and estimate the inflow to the system needed to supply the calculated outflows. A copy of water balance tables that summarize flows through the system during peak irrigation season conditions, based on 2017 canal conditions, is included in Appendix D. The objective of creating a water balance spreadsheet, beyond characterizing peak existing flow conditions, is to provide a tool for simulating potential improvements to the system and estimate the water savings that could result from those improvements. System improvements and anticipated water savings will be discussed in more detail in Chapter 7.

6.3.2 *Icicle Irrigation District*

The flows modeled in the water balance spreadsheet for each division within the IID Canal System are summarized in Table 6-4. The total deliveries estimated for the IID Canal System, assuming a maximum delivery of 6.75 gpm per share was estimated at 77.43 cfs. Total losses in the canal system were estimated at 19.10 cfs. Total spills were estimated at 6.38 cfs. The total surface water diversion required (assumed to be the flow through the fish screen at the IID intake facilities on Icicle Creek) to support this level of use was estimated to just under 118 cfs.

Table 6-4
Summary of Peak Flow Results from Water Balance Model – IID System

Division	Shares[1]	Deliveries[1] (cfs)	Losses (cfs)	Spills[2] (cfs)	To PID Crossover (cfs)	Total Inflows Required[3] (cfs)
1	153.44	2.31	8.22	4.47	--	**117.66**
2	1172.01	17.62	6.45	0.27	15.00	**66.08**
3A	334.36	5.03	2.58	0.24	--	**30.90**
3B	1,483.65	22.31	0.41	0.34	--	**23.05**
4	1,432.53	21.54	0.96	0.60	--	**23.10**
5	572.86	8.61	0.36	0.31	--	**9.29**
Total	**5,148.86**	**77.43**	**18.99**	**6.24**	**15.00**	**117.66**

Notes:

1. Includes deliveries to all types of shares assumed to be served by the specified division of the IID Canal System at the maximum rate of 6.75 gpm per share. Shares and deliveries to the Gibb Ditch are included with totals for IID Division 2.
2. Does not include diversion canal losses or spills from the diversion canal upstream of the fish screens in totals.
3. Assumed to be flow rate where diversions are measured, upstream of the fish screens in a rated section of the IID Diversion Canal at Icicle Creek.

6.3.3 *Peshastin Irrigation District*

The flows modeled in the water balance spreadsheet for the PID Main Canal system are summarized in Table 6-5. The total deliveries estimated for the PID Main Canal, assuming a maximum delivery of 6.75 gpm per share was estimated at 38.22 cfs. Total losses in the canal system were estimated at 13.17 cfs. Total spills were estimated at 1.16 cfs. The total inflows (assumed to be at the PID intake facilities on Peshastin Creek plus a maximum of 15 cfs inflow from the IID Division 2 Bifurcation via the Peshastin Crossover pipeline) were estimated to be 52.55 cfs.

Table 6-5
Summary of Peak Flow Results from Water Balance Model – PID System

Canal	Shares	Deliveries[1] (cfs)	Losses (cfs)	Spills (cfs)	Inflow from PID Crossover (cfs)	Total Inflows Required from Peshastin Creek (cfs)
PID Canal	2,541.33	38.22	12.93	1.16	15.00	37.30

Notes:
1. Includes deliveries to all shares assumed to be served by the PID Main Canal. Some Peshastin Shares are served from the IID Division 2 Canal, the Gibb Ditch System, and the Tandy Ditch System. Those are not included in these totals.
2. Assumed to be flow rate where diversions are measured in the Parshall Flume at the intake facilities on Peshastin Creek plus 15 cfs conveyed to PID through the Peshastin Crossover from the IID Division 2 Canal.

No water balance was created for the Tandy Ditch System. Although the area served by the Tandy Ditch is part of PID, it is a mostly closed, piped delivery system with separate diversion facilities. Because the key objective of developing the water balance model is to provide a way to estimate water conservation savings from potential improvements, it was determined that there would not be value in including the Tandy Ditch system in these calculations.

6.4 Adequacy of Present Water Supply

Chapter 4 discusses the water supply sources available on Icicle and Peshastin creeks, IPID water rights, and IPID diversions from Icicle and Peshastin creeks.

6.4.1 Icicle Irrigation District

Table 4-4 summarizes IPID diversions from Icicle Creek from 2013 through 2017. During July, the average 2-week diversion ranged from 87.05 cfs (July 16 to 31, 2014) to 111.18 cfs (July 16 to 31, 2015). During August, the average 2-week diversion ranged from 92.62 cfs (August 16 to 31, 2014) to 114.63 (August 16 to 31, 2016). The average daily diversion exceeded 116 cfs for most of August 2016. Average monthly diversions in September ranged from 78.80 cfs in 2013 to 98.59 cfs in 2017. September is the month when natural flows in Icicle Creek are the lowest.

As noted in Section 4.2, the only water right senior to IPID's 83.33-cfs water right on Icicle Creek and Snow Creek is the COIC right of 12 cfs. The Snow Creek Water Company right (which is now owned by IPID) of 4.0 cfs on Snow Creek, the City of Leavenworth right of 1.5 cfs on Icicle Creek, and the Fromm right of 0.27 cfs on Icicle Creek follow the 83 cfs IID right. The 34.38-cfs water right held by PID on Icicle Creek is next in seniority. The flow duration data for Icicle Creek at the USGS gage shows a 5% chance in any given year that average monthly flows will be 262 cfs in July, 121 cfs in August, and 86 cfs in September.

The flow duration data indicate that during most years, there is sufficient flow in Icicle Creek to support IID's average diversions and other senior water rights through the month of July and most of August. During drought years, the data suggest that there may not be enough flow in Icicle Creek to support IPID's diversions and other senior water right holders during late August and September. During drought years, IPID typically releases more water from lakes managed in the Alpine Lakes Wilderness Area to ensure adequate supply. However, managing flows during extended drought conditions is extremely challenging and there have been years, including in 2015, when IPID has had to curtail deliveries during the late summer in response to low flow conditions in Icicle Creek.

As noted earlier, IPID is a key stakeholder in the IWG. One of the guiding principles of the IWG is to restore adequate streamflow to lower Icicle Creek to improve habitat and passage conditions for Endangered Species Act (ESA)-listed fish species. The IWG has set a specific target of maintaining flows in lower Icicle Creek (at Leavenworth National Fish Hatchery) of at least 100 cfs during normal and wet years and at least 60 cfs during drought years. To accomplish this, the IWG has identified several projects that will help improve flows in lower Icicle Creek, including irrigation conservation. Another guiding principle of the IWG is to maintain agricultural reliability. This study and other studies being carried forward by the IWG are intended to improve water resource management in the Icicle Creek Basin to sustain flows in Icicle Creek to improve irrigation water supply reliability and increase instream flows during the late summer to benefit for ESA-listed species and other key water uses.

As noted earlier, IPID does not anticipate a significant decrease in water demand or changes in land use that would reduce water demand. However, the volume of water that has to be diverted from Icicle Creek to meet those demands may be reduced if additional improvements are implemented to further reduce water loss and improve efficiency of the IID delivery system. IPID has been very active over the last 20 years replacing open canals with pipelines and relining canals in the IID delivery system to improve conveyance efficiency. The estimated water savings from the efficiency improvements recommended as part of this CWCP are discussed in Chapter 7.

6.4.2 Peshastin Irrigation District

Table 4-5 summarized PID diversions from Peshastin Creek from 2013 through 2017. During July, the average 2-week diversion ranged from 18.5 cfs (July 16 to 31, 2015) to 42.9 cfs (July 1 to 16, 2016). During August, the average 2-week diversion ranged from 16.1 cfs (August 16 to 31, 2015) to 26.0 cfs (August 1 to 15, 2017). Average monthly diversions in September ranged from 17.1 cfs in 2015 to 23.8 cfs in 2017. Diversions from Peshastin Creek are highly dependent on supply and do not necessarily reflect irrigation demand. Although the Tandy Ditch and PID are the only large surface water diversions from Peshastin Creek, PID typically has to reduce diversions by late July because there is not enough flow in Peshastin Creek to sustain those diversions. PID typically supplements supply from Peshastin Creek with Icicle Creek diversions supplied through the Peshastin Crossover pipeline from the Peshastin Bifurcation and the downstream end of the IID Division 2 Canal. IPID can convey as much as 15 cfs from the Peshastin Bifurcation to the upper end of the PID Main Canal.

As noted in Section 4.2, IPID holds water rights to divert up to 57.4 cfs from Peshastin Creek. The Tandy Ditch holds water rights that allow for diversion of up to an additional 20 cfs from Peshastin Creek. These water rights total 77.4 cfs. Even though PID reduces diversions in the late summer, flows measured in Peshastin Creek downstream of the two diversions regularly fall below 10 cfs during the late summer. For example, during 2015 (an extreme drought year), PID reduced diversions to nearly 20 cfs early in July and to less than 20 cfs in late July. Diversions remained at less than 20 cfs through the end of the summer. Flows measured in Peshastin Creek downstream of the diversions were less than 5 cfs from the end of the July through most of August.

IPID has supported work by Chelan County and others to study the importance of instream flows on habitat and fish passage conditions in lower Peshastin Creek. Those studies have generally indicated that increased late summer instream flows are needed to improve habitat and fish passage conditions for ESA-listed steelhead and bull trout. The potential for using alternative water sources during the late summer has been evaluated and continues to be studied. Options may include pumping late summer flows from the main stem Wenatchee River to allow for a reduction of late summer diversions from Peshastin Creek.

As noted earlier, IPID does not anticipate a significant decrease in water demand or changes in land use that would reduce water demand. However, the volume of water that has to be diverted from Peshastin Creek to meet those demands may be reduced if additional improvements are implemented to further reduce water loss and improve efficiency of the IPID delivery systems. IPID has been very active over the last 20 years replacing open canals with pipelines and relining canals within the PID Canal system to improve conveyance efficiency. The estimated water savings from the efficiency improvements recommended as part of this CWCP are discussed in Chapter 7.

7 Evaluation of Opportunities for Improvements

The following section provides an overview of improvements installed by each irrigation district since the prior conservation plans were completed in 1993. This section also summarizes the evaluation of and recommendations for an improvement plan for each irrigation district that IPID plans to implement over the next 25 years. The improvement plan is designed to increase water use efficiency, add reliability, and improve management of the existing IPID delivery systems.

7.1 Icicle Irrigation District

7.1.1 Status of Improvements Recommended in 1993 Plan

Table 7-1 summarizes the status of improvements recommended in the 1993 IID CWCP. Projects are listed in the order of the priority assigned in the 1993 plan. Many improvements have been implemented over the last 25 years, including upgrades to flumes, spills, and flow control structures; relining of canals; and converting some open canals to pipeline. IID has been particularly active in maintaining and improving the system over the last 10 years. Each fall and spring, IID engages in a very intensive maintenance and improvement period. As a result, several miles of open canal have either been relined or converted to pipelines, and other significant improvements have been constructed that were needed to keep the delivery system operating in a way that meets the needs of the IID shareholders.

7.1.2 Recommended Improvements

Table 7-2 provides a summary of improvements recommended for the IID Delivery System for the next 25 years. Improvements include both structural and non-structural measures. An overview map showing the location of each of the recommended structural improvement projects for both irrigation districts is included as Figure 7-1. Appendix E includes a one-page summary sheet for each of the recommended structural improvement projects organized by division or reach. Each summary sheet includes a more detailed location map for the improvement, a summary of the purpose or deficiency addressed, the estimated water savings that will result from the project, a short description of the project, a summary of probable project costs, and a designated priority and timeline for implementation. Opinions of probable implementation costs were prepared for each structural improvement project. The costs are summarized with the list of projects in Table 7-2 and details are provided in Appendix F.

Improvements were recommended based of the field inventory and assessment of existing irrigation facilities, conveyance efficiency estimates, and discussions with the IPID Manager regarding system maintenance and improvement needs. The priority and timing of each project was also identified in consultation with IPID. Projects were assigned one of the following four levels of priority:

1. High Priority – Projects that are targeted for implementation within the next 5 years
2. Medium Priority – Projects that are targeted for implementation within 6 to 8 years
3. Low to Medium Priority – Projects that are targeted for implementation within 9 to 15 years
4. Low Priority – Projects that are targeted for implementation within 16 to 25 years

Table 7-2 also summarizes identified the priority of each project, the probable project costs, and the anticipated water savings resulting from each project.

7.1.3 Opinions of Probable Project Costs

The costs listed in Table 7-2 and summarized in Appendix F include the following:

- **Materials** – Represents the cost materials delivered to the site of the project. The materials costs include sales tax applied to purchase of materials.
- **Labor/Other** – Represents labor costs, equipment costs, mobilization/demobilization costs, contractor mark-up, and sales tax on these items. These costs are included for all projects separate from the materials costs to give IPID an idea of what it would cost to contract out the work on a project. On many recent improvement projects, IPID has self-performed the work rather than contracting the work, which has significantly reduced the overall cost of these projects.
- **Construction Subtotal** – The construction subtotal is equal to the total of the materials and labor/other costs for a project and represents what would be the total opinion of probable construction cost for a project where the labor and associated costs were contracted.
- **Other Project Costs** – Represents non-construction project costs, including engineering, administration, and permitting. An allowance of 20% was included for engineering, administration, and permitting. Many of the projects IPID has implemented recently, such as lining replacement and canal piping projects, have not required engineering, extensive administration, or permitting.
- **Total Project Cost** – The sum of the construction subtotal and other project costs.

Costs are presented as a range. The low end of the range includes a 15% contingency. The high end of the range includes a 30% contingency. All costs represent 2017 dollars. Costs may vary at the time of implementation based on inflation; materials costs, which can be highly variable; and contracted labor costs.

Table 7-1
Status of Improvements Recommended in 1993 IID CWCP

Division	Station[1]	Facility Description	Recommended Improvement	Priority[1]	Completed[2]
All	Various	Turnouts	Upgrade Turnouts	1	Partially
All	Various	Unlined Canals	Canal Lining of Unlined Areas	2	Partially
All	N/A	Non-Structural	Increase Maintenance	3	Yes
All	N/A	Non-Structural	Merge IPID	4	In Process
IID Div. 1	18+50	Snow Creek Flume	Replace with an Elevated Concrete or Steel Box Flume	5	Yes
IID Div. 1	55+00	Steel Flume	Replace with an Elevated Steel Box Flume	5	No
IID Div. 1	324+00	Leavenworth Flume	Repair or Replace, to Upgrade Structural Integrity	5	Yes – 2017
IID Div. 2	570+00	Peshastin Bifurcation	Repair or Replace, to Improve Control	5	Yes – 1994
IID Div. 3A	839+00	Pine Flats Flume	Repair or Replace, to Upgrade Structural Integrity	5	Yes
IID Div. 3B	1342+00	Fairview Canyon Spillway	Repair or Replace, to Provide More Capacity and Control	5	Yes
IID Div. 3A	873+00	Brender No. 1 Spillway	Repair or Replace, to Upgrade Structural Integrity	5	No
IID Div. 4	0+00	Posey Weir Box	Repair or Replace, to Upgrade Structural Integrity	5	Yes
IID Div. 4	380+00	Williams Canyon Spillway	Repair or Replace	5	Yes
IID Div. 4 and 5	N/A	Leavenworth Siphon	Replace Steel Pipe, U.S. Highway 2 to Wenatchee River Crossing	5	Yes
All	N/A	Non-Structural	Encourage On-farm Water Conservation Practices	6	Partially
All	N/A	Non-Structural	Update Assessment Roll Maps	7	Partially
IID Div. 3, 4, and 5	570+00 to End	Conveyance	Install Closed Conduit System, IID Divisions 3, 4, and 5	8	Partially[4]

Notes:
1. Represents priority assigned to each project in the 1993 IID CWCP.
2. See system maps in Appendix A for stationing and location.
3. Only the dates of completion that are known are provided in this table.
4. IPID has completed piping of some portions of IID Divisions 3, 4, and 5, but has not installed a fully closed conduit system as envisioned by this recommendation from the 1993 IID CWCP.

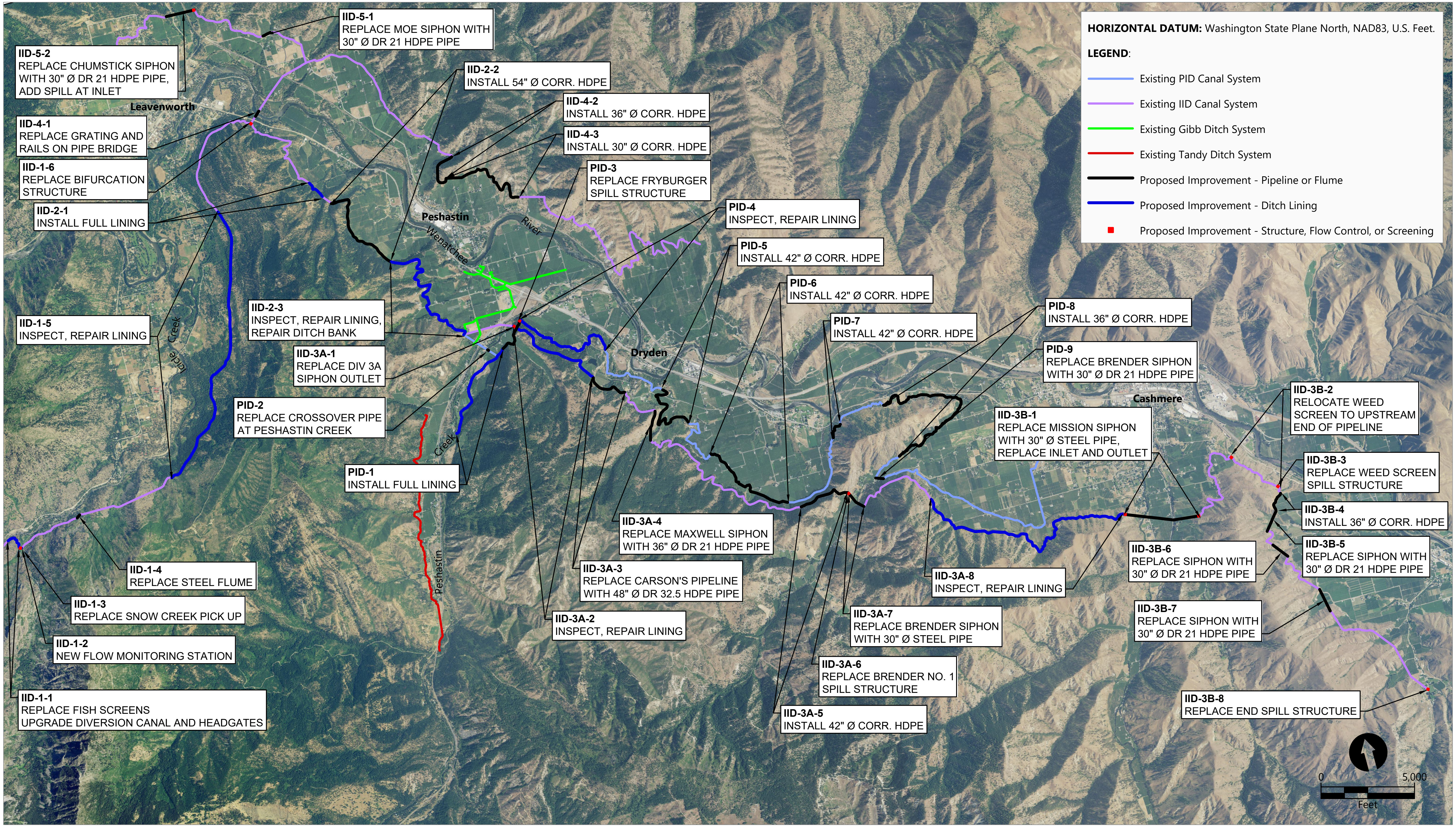
Table 7-2
Summary of Recommended Improvements – IID Delivery System

Project	Division or Reach	Station[1]	Facility Description	Recommended Improvement	Priority[2]	Estimated Water Savings[3] (cfs)	Low Opinion of Cost[4]					High Opinion of Cost[4]				
							Materials[5]	Labor/ Other[6]	Const. Subtotal	Other Costs[7]	Total Project Cost	Materials[5]	Labor/ Other[6]	Const. Subtotal	Other Costs[7]	Total Project Cost
GEN-1[7]	All	Various	Turnouts	Upgrade Turnouts	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GEN-2[7]	All	N/A	Non-Structural	Merge IPID	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GEN-3[7]	All	N/A	Non-Structural	Encourage On-Farm Water Conservation Practices	2	N/A	N/A	N/A	N/A	$8,800	$8,800	N/A	N/A	N/A	$10,000	$10,000
GEN-4[7]	All	N/A	Non-Structural	Continue to Refine District Mapping	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GEN-5[7]	All	N/A	Non-Structural	Improve Automation, Flow Monitoring, and Control	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IID-1-1	1	5+00 to 18+00	Head Gates and Fish Screens	Replace Fish Screens, Upgrade Diversion Canal, Head Gates	1	0	$990,800	$424,600	$1,415,400	$283,100	$1,698,500	$1,120,000	$480,000	$1,600,000	$320,000	$1,920,000
IID-1-2	1	18+50	New Flow Monitoring Station	Install Flow Monitoring Downstream of New Fish Screens	1	0	$3,500	$1,500	$5,000	$1,000	$6,000	$3,900	$1,700	$5,600	$1,100	$6,700
IID-1-3	1	19+00	Snow Creek Pickup	Replace Pick Up Flume with a New Pipeline	2	0	$17,300	$7,500	$24,800	$5,000	$29,800	$19,400	$8,400	$27,800	$5,600	$33,400
IID-1-4	1	55+00	Steel Flume	Replace with an Elevated Steel Box Flume	2	0	$30,300	$13,000	$43,300	$8,700	$52,000	$34,000	$14,600	$48,600	$9,700	$58,300
IID-1-5	1	111+00 to 270+00	Open Canal	Inspect and Repair or Replace Concrete Canal Lining	3	1.5	$715,300	$306,500	$1,021,800	$204,400	$1,226,200	$817,500	$357,600	$1,175,100	$235,000	$1,410,100
IID-1-6	1	343+00	Leavenworth Bifurcation	Repair or Replace, to Upgrade Structural Integrity	4	0	$21,600	$9,300	$30,900	$6,200	$37,100	$24,200	$10,400	$34,600	$6,900	$41,500
IID-2-1	2	400+00 to 412+00	Open Canal	Install Full Concrete Canal Lining on Partially Lined Canal	1	1.1	$52,300	$22,400	$74,700	$14,900	$89,600	$59,700	$26,100	$85,800	$17,200	$103,000
IID-2-2	2	418+00 to 474+00	Open Canal	Replace Open Canal with 54-inch Corrugated HDPE Pipe	2	1.5	$1,680,000	$616,000	$2,296,000	$459,200	$2,755,200	$1,904,000	$672,000	$2,576,000	$515,200	$3,091,200
IID-2-3	2	474+00 to 568+00	Open Canal	Inspect and Repair or Replace Concrete Canal Lining, Repair Ditch Bank where Needed	2	2.0	$409,500	$175,500	$585,000	$117,000	$702,000	$468,000	$204,700	$672,700	$134,500	$807,200
IID-3A-1	3A	601+00	Division 3A Siphon Outlet	Repair or Replace Structure at Siphon Outlet	3	0	$7,800	$3,300	$11,100	$2,200	$13,300	$8,700	$3,700	$12,400	$2,500	$14,900
IID-3A-2	3A	601+00 to 658+00	Open Canal	Inspect and Repair or Replace Concrete Canal Lining, Repair Ditch Bank where Needed	2	0.1	$234,100	$100,300	$334,400	$66,900	$401,300	$267,600	$117,100	$384,700	$76,900	$461,600

Project	Division or Reach	Station[1]	Facility Description	Recommended Improvement	Priority[2]	Estimated Water Savings[3] (cfs)	Low Opinion of Cost[4]					High Opinion of Cost[4]				
							Materials[5]	Labor/ Other[6]	Const. Subtotal	Other Costs[7]	Total Project Cost	Materials[5]	Labor/ Other[6]	Const. Subtotal	Other Costs[7]	Total Project Cost
IID-3A-3	3A	658+00 to 690+00	Steel Pipe (Carson's Pipe) and Open Canal	Replace Existing Steel Pipes and Open Canal with 48-inch DR 32.5 Fused Solid Wall HDPE Pipe	1	0.3	$736,000	$288,000	$1,024,000	$204,800	$1,228,800	$832,000	$320,000	$1,152,000	$230,400	$1,382,400
IID-3A-4	3A	713+00 to 721+00	Maxwell Siphon	Replace 30-inch Steel Siphon with 36-inch DR 21 Fused Solid Wall HDPE Pipe	3	0	$240,000	$88,000	$328,000	$65,600	$393,600	$272,000	$96,000	$368,000	$73,600	$441,600
IID-3A-5	3A	840+00 to 871+00	Open Canal and Sandstone Tunnels	Replace Open Canal with 42-inch Corrugated HDPE Pipe and Extend Through Sandstone Tunnels	1	0.2	$775,000	$279,000	$1,054,000	$210,800	$1,264,800	$868,000	$310,000	$1,178,000	$235,600	$1,413,600
IID-3A-6	3A	873+00	Brender No. 1 Spill	Repair or Replace, to Upgrade Structural Integrity	3	0	$13,000	$5,600	$18,600	$3,700	$22,300	$14,500	$6,200	$20,700	$4,100	$24,800
IID-3A-7	3A	873+00 to 883+00	Brender Siphon	Replace 30-inch Steel Siphon with 30-inch Steel Pipe	3	0	$190,000	$70,000	$260,000	$52,000	$312,000	$220,000	$80,000	$300,000	$60,000	$360,000
IID-3A-8	3A	934+00 to 1078+00	Open Canal	Inspect and Repair or Replace Concrete Canal Lining, Install Full Concrete Canal Lining on Partially Lined Canal	1	0.1	$591,400	$253,500	$844,900	$169,000	$1,013,900	$675,900	$295,700	$971,600	$194,300	$1,165,900
IID-3B-1	3B	1078+00 to 1117+00	Mission Siphon	Replace Existing Steel Siphon with 30-inch Steel Pipe, Replace Inlet and Outlet Structures	4	0	$819,000	$312,000	$1,131,000	$226,200	$1,357,200	$897,000	$351,000	$1,248,000	$249,600	$1,497,600
IID-3B-2	3B	1187+00	Weed Screen	Relocate Weed Screen Upstream to 52-inch Pipeline Inlet	4	0	$13,800	$5,900	$19,700	$3,900	$23,600	$15,500	$6,600	$22,100	$4,400	$26,500
IID-3B-3	3B	1221+00	Weed Screen Spill	Repair or Replace Concrete Structure, Replace Gates	4	0	$19,900	$8,500	$28,400	$5,700	$34,100	$22,300	$9,500	$31,800	$6,400	$38,200
IID-3B-4	3B	1225+00 to 1238+00	Open Canal	Replace Open Canal with 36-inch Corrugated HDPE Pipe	1	0.1	$208,000	$78,000	$286,000	$57,200	$343,200	$234,000	$91,000	$325,000	$65,000	$390,000
IID-3B-5	3B	1238+00 to 1248+00	Siphon	Replace Existing 24-inch Steel Siphon with 30-inch DR 21 Fused Solid Wall HDPE Pipe	1	0	$210,000	$80,000	$290,000	$58,000	$348,000	$230,000	$80,000	$310,000	$62,000	$372,000
IID-3B-6	3B	1260+00 to 1269+00	Siphon	Replace Existing 30-inch Steel Siphon with 30-inch DR 21 Fused Solid Wall HDPE Pipe	2	0	$189,000	$72,000	$261,000	$52,200	$313,200	$207,000	$72,000	$279,000	$55,800	$334,800
IID-3B-7	3B	1293+00 to 1314+00	Siphon	Replace Existing 30-inch Steel Siphon with 30-inch DR 21 Fused Solid Wall HDPE Pipe	2	0	$441,000	$168,000	$609,000	$121,800	$730,800	$483,000	$168,000	$651,000	$130,200	$781,200
IID-3B-8	3B	1363+00	End Spill	Repair or Replace Structure, Replace Gate	2	0	$25,900	$11,100	$37,000	$7,400	$44,400	$29,100	$12,500	$41,600	$8,300	$49,900

Project	Division or Reach	Station[1]	Facility Description	Recommended Improvement	Priority[2]	Estimated Water Savings[3] (cfs)	Low Opinion of Cost[4]					High Opinion of Cost[4]				
							Materials[5]	Labor/ Other[6]	Const. Subtotal	Other Costs[7]	Total Project Cost	Materials[5]	Labor/ Other[6]	Const. Subtotal	Other Costs[7]	Total Project Cost
IID-4-1	4/5	N/A	Leavenworth Siphon	Replace Grating and Guard Rails on Pipe Bridge			$37,100	$15,900	$53,000	$10,600	$63,600	$41,700	$17,900	$59,600	$11,900	$71,500
IID-4-2	4	112+00 to 130+00	Open Canal	Replace Open Canal with 36-inch Corrugated HDPE Pipe			$288,000	$108,000	$396,000	$79,200	$475,200	$324,000	$126,000	$450,000	$90,000	$540,000
IID-4-3	4	130+00 to 187+00	Open Canal	Replace Open Canal with 30-inch Corrugated HDPE Pipe			$741,000	$285,000	$1,026,000	$205,200	$1,231,200	$855,000	$342,000	$1,197,000	$239,400	$1,436,400
IID-5-1	5	28+00 to 35+00	Moe Siphon	Replace Existing 24-inch Steel Siphon with 30-inch DR 21 Fused Solid Wall HDPE Pipe			$147,000	$56,000	$203,000	$40,600	$243,600	$161,000	$56,000	$217,000	$43,400	$260,400
IID-5-2	5	79+00 to 95+00	Chumstick Siphon	Replace Existing 24-inch Steel Siphon with 30-inch DR 21 Fused Solid Wall HDPE Pipe, Replace Inlet Structure, Create Spill Channel from Siphon Inlet to Chumstick Creek			$368,000	$128,000	$496,000	$99,200	$595,200	$416,000	$144,000	$560,000	$112,000	$672,000
Subtotal – High Priority Projects (Target Implementation Next 5 years)					1		$3,604,100	$1,442,900	$5,047,000	$1,009,400	$6,056,400	$4,065,200	$1,622,400	$5,687,600	$1,137,500	$6,825,100
Subtotal – Medium Priority Projects (Target Implementation 6 to 8 years)					2		$3,027,100	$1,163,400	$4,190,500	$847,000	$5,037,500	$3,412,100	$1,269,300	$4,681,400	$946,200	$5,627,600
Subtotal – Low to Medium Priority Projects (Target Implementation 9 to 15 years)					3		$1,681,100	$657,400	$2,338,500	$467,700	$2,806,200	$1,909,700	$743,500	$2,653,200	$530,600	$3,183,800
Subtotal – Low Priority Projects (Target Implementation 16 to 25 years)					4		$1,903,300	$728,700	$2,632,000	$526,400	$3,158,400	$2,138,000	$845,500	$2,983,500	$596,700	$3,580,200
Total					All	7.5	$10,215,600	$3,992,400	$14,208,000	$2,850,500	$17,058,500	$11,525,000	$4,480,700	$16,005,700	$3,211,000	$19,216,700

Notes:
1. See system maps in Appendix A for stationing and location.
2. Priority designations are as follows: 1) High Priority – Projects that are targeted for implementation within the next 5 years; 2) Medium Priority – Projects that are targeted for implementation within 6 to 8 years; 3) Low to Medium Priority – Projects that are targeted for implementation within 9 to 15 years; 4) Low Priority – Projects that are targeted for implementation within 16 to 25 years.
3. Water savings are estimated using water balance spreadsheet model, based on peak use. The total for the system includes estimated water savings throughout the system, including reduced loss in canal sections not recommended for improvement, resulting in reduced flow requirements.
4. Low costs include a 15% contingency. High costs include a 30% contingency.
5. Materials include new materials that would have to be procured and imported to complete the project, including pipe, structural materials, concrete, gates, pipe bedding, structural fill, etc., including sales tax for materials.
6. Labor/Other costs include all other costs that would be included in a construction contract, including labor, equipment, mobilization/demobilization, mark-up, and sales tax on these costs.
7. Other costs include engineering, administration, and permitting costs (assumed to be 20% of the construction subtotal).
8. No opinion of probable costs was developed for general and non-structural measures.
9. All costs are in 2017 dollars. The cost at the time of implementation will vary based on inflation, material prices, and labor costs.
10. The construction subtotal and total project costs reflect the cost that would result from having the project bid and constructed by a contractor. IPID constructs many improvements without an outside contractor. If IPID performs the work, project costs would be closer to the materials cost.



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Filepath: L:\Projects\Trout_Unlimited\IPID_Conservation_Plan_Update_(171070-01.01)\CAD\0170-RP-003-Figure 7-1.dwg Figure 7-1

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Figure 7-1
Proposed Improvement Plan

Comprehensive Water Conservation Plan
Icicle and Peshastin Irrigation Districts

7.1.3.1 Structural Measures

Structural improvement measures include actual upgrades to IPID infrastructure designed to improve efficiency, address structural deficiencies, and improve the control and management of flow through the system. The following summarizes proposed structural improvements to IID delivery infrastructure by canal division. The projects within each division of the IID Delivery System are listed from highest priority to lowest priority.

All Divisions

GEN-1: Upgrade Turnouts (High Priority) – The 1993 IID CWCP recommended upgrading of turnout boxes. IID has replaced or upgraded turnouts on an as-needed basis over the years. IPID is currently engaged in a more focused effort to replace or repair shareholder turnout boxes. They hope to have all turnout boxes upgraded within the next few years. IPID has been collecting the location of each turnout box with a GPS-enabled mobile device, documenting the condition of each box with photographs, and identifying the parcels that each box irrigates. The turnout boxes need to be upgraded to ensure that all have working shutoff gates or valves that positively seal and have appropriately sized orifices or weirs that deliver the right flow rate. These measures will enable IPID personnel to better manage and control water use, especially during dry years when water supply has to be cut back. The upgrade of turnouts is considered a high priority.

Division 1

IID-1-1 and IID-1-2: Replace Fish Screens and Install a New Flow Monitoring Station (High Priority) – WDFW recently secured a grant from the BPA to assist IPID and the City of Leavenworth in developing designs for new screening facilities. The current IID rotating drum fish screens and bypass configuration do not meet current NMFS and WDFW fish passage guidelines. The reach of Icicle Creek that IPID diverts water from is currently only accessible to the most persistent anadromous fish under the right flow conditions. Trout Unlimited is working with stakeholders to plan and design a project that would improve fish passage through the Boulder Field, downstream of IPID's diversion. This would increase accessibility to the IPID diversion by ESA-listed anadromous fish. IPID has requested that these improvements not be made until screening upgrades are made. The preferred solution would relocate screening and bypass facilities further down the canal, near the Snow Creek Flume and Pickup. The head gate structure and diversion channel upstream of the fish screens would also be improved. WDFW is working toward completing fish screen designs in 2018 with an eye on construction in 2019 or 2020.

In conjunction with replacement of the existing fish screens, it is recommended that IPID upgrade and relocate flow monitoring equipment. The current equipment is located upstream of the fish screen in a rated section of the diversion channel. The IPID Manager has to regularly check the rating and make adjustments to account for spills and bypass at the fish screens. Installation of new flow monitoring equipment downstream of the new fish screens in or near the Snow Creek Flume would improve flow monitoring and system management.

IID-1-3: Replace Snow Creek Pickup (Medium Priority) – This project would include replacement of the gate and flume that are used to divert water from Snow Creek into the IID Division 1 Canal. The replacement facilities would include a new gate structure and flume. These facilities are primarily used during drought years to access IPID's storage releases from Upper and Lower Snow Lakes. The project should be targeted for implementation in the next 6 to 8 years.

IID-1-4: Replace Existing Steel Flume (Medium Priority) – This project would replace an aging flume that is in poor condition. The flume and supporting structure both need to be replaced. The new flume would likely consist of an elevated steel box flume with a steel supporting structure. The project should be targeted for implementation in the next 6 to 8 years.

IID-1-5: Repair or Replace Canal Lining (Low to Medium Priority) – The system inventory identified segments of the concrete canal lining through the IID Division 1 Canal that were old, weathered, and cracking in places. IPID has indicated that segments of this canal have failed due to seepage and erosion. Inspection and repair or replacement of canal lining is recommended to reduce conveyance losses, improve efficiency, and reduce risk of failure. Piping of the canal is not a good option in Division 1 because very large pipe would be required to convey high flows. The project should be targeted for implementation in the next 9 to 16 years.

IID-1-6: Repair or Replace Leavenworth Bifurcation (Low Priority) – The Leavenworth Bifurcation structure is old and weathered, with rusty gates and equipment. The structure controls and measures flow from Division 1 to Divisions 2, 4, and 5 and is a critical piece of IPID's infrastructure. Replacement or rehabilitation of the Leavenworth Bifurcation structure is recommended in the next 16 to 25 years.

Division 2

IID-2-1: Install Full Concrete Lining on Partially Lined Canal (High Priority) – There is a segment of canal upstream of the tunnel in the IID Division 2 Canal that is partially lined. Flow measurements indicate that conveyance loss occurs through this segment of the canal. Replacement of existing canal linings with a full concrete lining is recommended within the next 1 to 3 years.

IID-2-2 and IID 2-3: Piping or Repair/Replacement of Canal Lining (Medium Priority) – Flow measurements also indicate that conveyance loss occurs through the Division 2 Canal down to the Peshastin Bifurcation Structure. These projects would include inspection of and repair or replacement of canal linings, or piping segments of the existing canal to reduce conveyance loss and improve efficiency. Implementation of these projects is recommended within the next 6 to 8 years.

Division 3A

IID-3A-3: Replace Carson's Pipeline (High Priority) – The Carson's Pipeline consists of buried and exposed steel pipes that convey water for more than a half-mile along a steep hillside that is prone to landslide activity. The existing pipeline has buckled and is deformed, rusted, and pitted in places. It is recommended that the pipeline be replaced with butt-fused, solid-wall 48-inch DR 32.5 HDPE pipe within the next 5 years.

IID-3A-5: Replace Open Canal with 42-Inch Corrugated HDPE Pipe (High Priority) – IPID is currently working to replace a segment of open canal, upstream of the Sandstone Tunnels in the Division 3A Canal, with 42-inch corrugated HDPE pipe. It is recommended that this project be extended from the Pine Flats Flume through the Sandstone Tunnels within the next 5 years.

IID-3A-8: Repair/Replacement of Canal Lining (High Priority) – Flow measurements indicate that conveyance loss occurs through the Division 3A Canal from the Brender Siphon to the Mission Siphon. The system inventory indicated that the existing canal is fully lined to partially lined, but that linings are old, weathered, and cracked in places. Inspection and repair or replacement of canal linings is recommended within the next 5 years.

IID-3A-2: Repair/Replacement of Canal Lining (Medium Priority) – Flow measurements indicate that conveyance loss occurs through the Division 3A Canal from the Division 3A Siphon Outlet to the Carson's Pipeline. The system inventory indicated that the existing canal is fully lined to partially lined, but that linings are old, weathered, and cracked in places. Inspection and repair or replacement of canal linings is recommended within the next 6 to 8 years.

IID-3A-4: Replace Maxwell Siphon (Low to Medium Priority) – The Maxwell Siphon consists of a 36-inch steel pipeline that is rusted and may be leaking in places. Replacement of the siphon with 36-inch butt-fused, solid-wall DR 21 HDPE pipe is recommended in the next 9 to 15 years.

IID-3A-6 and IID-3A-7: Replace Brender Spill No. 1 and Brender Siphon (Low to Medium Priority) – Brender Spill No. 1 is located at the upstream end of the Brender Siphon. The spill structure is old and weathered, with cracking concrete. The siphon consists of a 30-inch steel pipeline that is rusted, with holes visible on the top of the pipe where it is exposed, and may be leaking in places. Replacement or repair of the reinforced concrete spill structure and replacement of the siphon with 30-inch welded-steel pipe is recommended in the next 9 to 15 years.

IID-3A-1: Repair or Replace Division 3A Siphon Outlet Structure (Low to MediumPriority) – The reinforced concrete structure at the outlet of the Icicle Division 3A (Peshastin) Siphon is old and weathered. Replacement of the structure is recommended in the next 9 to 15 years.

Division 3B

IID-3B-4: Replace Open Canal with 36-Inch Corrugated HDPE Pipe (High Priority) – There is a segment of concrete-lined canal that is old, weathered, and cracking in places downstream of the Weed Screen Spill in Division 3B. IPID has plans to replace the open canal with 36-inch corrugated HDPE pipe within the next 5 years to improve efficiency and reduce maintenance.

IID-3B-5: Replace Existing Siphon (High Priority) – The first siphon downstream of the Weed Screen Spill on the Division 3B Canal consists of 24-inch steel pipe. The existing siphon is old, rusty, and leaking in places. IPID indicated that the drain valve on the siphon rusted off and failed recently. It had to be replaced. The siphon also limits flow capacity to the end of the Division 3B Canal. Replacement of the siphon with 30-inch butt-fused, solid-wall DR 21 HDPE pipe is recommended within the next 5 years.

IID-3B-6 and IID-3B-7: Replace Existing Siphons (Medium Priority) – The next two siphons downstream of IID-3B-5 on the Division 3B Canal consists of 30-inch steel pipe. The existing siphons are old, rusty, and leaking in places. Replacement of the 30-inch steel siphon with 30-inch butt-fused, solid-wall DR 21 HDPE pipe is recommended within the next 5 years.

IID-3B-8: Replace End Spill Structure (Medium Priority) – The reinforced concrete structure that controls spilling from the end of the IID Division 3B Canal is old, weathered, and cracking in places. It is recommended that the structure be replaced within the next 6 to 8 years.

IID-3B-1: Replace Mission Siphon (Low Priority) – The Mission Siphon consists 30-inch steel pipeline that is old and rusted, but in fair condition. The reinforced concrete structures on the siphon inlet and outlet are old, weathered, and cracking in places. Replacement of the siphon with 30-inch steel pipe and replacement of the inlet and outlet structures is recommended in the next 16 to 25 years. Replacement of this siphon is likely to be challenging due to steep slopes, proximity to private property, and roadway and creek crossings.

IID-3B-2 and IID-3B-3: Relocate Weed Screen and Repair or Replace Weed Screen Spill Structure (Low Priority) – IPID has expressed interest in relocating the Weed Screen on the Division 3B Canal. The Weed Screen is downstream of a pipeline and there is interest in screening upstream of the pipeline to reduce the amount of debris that has to be removed from the pipeline. The reinforced concrete Weed Screen Spill structure is also old, weathered, and cracking in places. Relocation of the Weed Screen and repair or replacement of the Weed Screen Spill Structure are recommended within the next 16 to 25 years.

Division 4

IID-4-1: Replace Grating and Rails on Pipe Bridge Over Wenatchee River (High Priority): The Leavenworth Siphon, which delivers water from the Division 1 Canal to the Division 4 and 5 Canals, crosses the Wenatchee River on a pipe bridge. The grating and hand rails on the pipe bridge are old and rusted. The grating is rough with holes in places. It is recommended that the grating and rails on the pipe bridge be replaced within the next 5 years to ensure continued safe access to the infrastructure.

IID-4-2: Replace Open Canal with 36-Inch Corrugated HDPE Pipe (Low Priority) – There is a segment of the Division 4 Canal downstream of a steel flume that was recently constructed near the Anderson Siphon that is partially lined. Measurements indicate that some conveyance loss occurs through this segment of the canal. It is recommended that the open canal be replaced with 36-inch corrugated HDPE pipe within the next 16 to 25 years to reduce conveyance loss and improve efficiency.

IID-4-3: Replace Open Canal with 30-Inch Corrugated HDPE Pipe (Low Priority) – Downstream of the partially lined segment of canal and upstream of the Derby Canyon Siphon, there is a concrete-lined segment of canal. Measurements indicate that some conveyance loss occurs through this segment of the canal. The system inventory indicated that the concrete lining is old, weathered, and cracking in places. It is recommended that the open canal be replaced with 30-inch corrugated HDPE pipe within the next 16 to 25 years to reduce conveyance loss and improve efficiency.

Division 5

IID-5-1: Replace Moe Siphon (Low to Medium Priority) – The Moe Siphon consists 30-inch steel pipeline that is rusted and may be leaking in places. Replacement of the siphon with 30-inch butt-fused, solid-wall DR 21 HDPE pipe is recommended in the next 9 to 15 years.

IID-5-2: Replace Chumstick Siphon and Install Spill at Inlet (Low to Medium Priority) – The Chumstick Siphon consists 30-inch steel pipeline that is rusted and may be leaking in places. Replacement of the siphon with 30-inch butt-fused, solid-wall DR 21 HDPE pipe is recommended in the next 9 to 15 years. In addition, IPID has indicated that the Chumstick Spill is not used because of the risk to downstream properties. IPID would prefer to find a way to spill at the upstream end of the Chumstick Siphon. Siting and constructing a pathway for spilled water to be conveyed safely to Chumstick Creek will be challenging. The siphon inlet is on the opposite side of the Burlington-Northern Santa Fe (BNSF) Railroad than Chumstick Creek, so a pathway would need to be identified for conveying spilled flows across the BNSF right-of-way.

7.1.4 Non-Structural Measures

Non-structural measures are changes in operation and management of the system that do not necessarily involve replacing or repairing infrastructure. The following non-structural improvements are recommended for the IID delivery system:

GEN-2: Merge Icicle and Peshastin Irrigation Districts (High Priority) – As noted in Chapter 2, IPID has been working toward consolidation of IID and PID into one irrigation district, referred to as IPID. IPID is in the process of circulating petitions and gathering signatures from their memberships to support consolidation. A proposed boundary for the consolidated district has been submitted to Ecology. It is recommended that IPID complete the consolidation process in the next 2 years.

GEN-4: Continue to Refine District Mapping (High Priority) – As part of the preparation of this plan, a detailed field inventory of existing district facilities was completed, as outlined in Chapter 5. IPID's GIS database has been updated with information from the inventory. Additional work is ongoing to locate all turnout boxes and identify which parcels are served through each box. IPID intends to continue to refine mapping and maintain up to date maps in a GIS database.

GEN-3: Encourage On-Farm Water Conservation Practices (Medium Priority) – As noted in Chapters 4 and 6, most IID's water use is for irrigation of apple and pear orchards. The orchards typically have very efficient irrigation systems. Most orchards either use solid-set sprinklers or micro-spray systems. IPID does not actively encourage improvement of on-farm irrigation systems to increase efficiency. Most orchardists have improved their on-farm systems as a way of ensuring that their crops are resilient to changing conditions. There may be potential for education and encouragement to further improve the efficiency of on-farm water use. An increase in on-farm efficiencies would allow IPID to operate the canals at lower water levels and reduce the risk of ditch overtopping or other operational issues. IPID could encourage on-farm conservation through educational or training programs in conjunction with the Agricultural Extension Service, Cascadia Conservation District, or other agencies, or IPID could consider requiring that all new sprinkler systems installed meet efficiency standards. Educational and training programs could include supplying farmers with agricultural water supply demand forecasts based on a system such as AgriMet (provided by Reclamation), training farmers in the use of moisture probes to determine soil moisture levels, and assisting farmers in designing irrigation systems to achieve high distribution efficiencies and reduce over irrigation.

GEN-5: Improve automation, flow monitoring, and control (Medium Priority) – IPID has been improving its ability to monitor flows and conditions at surface water diversions and other key structures. However, adjustments are still primarily made manually by ditch riders who monitor the system on a daily basis during the irrigation season. Improved monitoring of flows and conditions at more key locations, in combination with automation of key control gates and other facilities, will allow IPID to better balance inflows with outflows and improve management of the delivery system. Continued efforts to improve automation, flow monitoring, and control of the system will be made over the next 25 years.

7.2 Peshastin Irrigation District

7.2.1 Status of Improvements Recommended in 1993 Plan

Table 7-3 summarizes the status of improvements recommended in the 1993 PID CWCP. Projects are listed in the order of the priority assigned in the 1993 plan. Many improvements have been implemented over the last 25 years, including upgrades to flumes, spills, and flow control structures; relining of canals; and converting some open canals to pipeline. The IID Division 1 and 2 Canal improvements are listed because these facilities are shared between PID and IID. These improvements were listed in both the PID and IID conservation plans. PID has also been very active in maintaining and improving the PID canal system over the last 10 years. Each fall and spring, IPID engages in a very intensive maintenance and improvement period. As a result, several miles of open canal have either been relined or converted to pipelines, including piping of approximately 3 miles of canal at the downstream end of the PID system, from the Brender Siphon to the Pioneer End Spill. Other significant improvements have also been constructed that were needed to keep the delivery system operating at a high level.

7.2.2 Recommended Improvements

Table 7-4 provides a summary of improvements recommended for the PID delivery system for the next 25 years. Improvements include both structural and non-structural measures. An overview map showing the location of each of the recommended structural improvement projects for both irrigation districts is included as Figure 7-1. Appendix E includes a one-page summary sheet for each of the recommended structural improvement projects organized by division or reach. Each summary sheet includes a more detailed location map for the improvement, a summary of the purpose or deficiency addressed, the estimated water savings that will result from the project, a short description of the project, a summary of probable project costs, and a designated priority and timeline for implementation. Opinions of probable implementation costs were prepared for each structural improvement project. The costs are summarized with the list of projects in Table 7-4 and details are provided in Appendix F.

Improvements were recommended based of the field inventory and assessment of existing irrigation facilities, conveyance efficiency estimates, and discussions with the IPID Manager regarding system maintenance and improvement needs. The priority and timing of each project was also identified in consultation with IPID. Projects were assigned priority as summarized in Section 7.1.2. Table 7-4 also identified the priority of each project, the probable project costs, and the anticipated water savings resulting from each project.

7.2.3 Opinions of Probable Project Costs

Opinions of probable project costs were developed that include the same items summarized for the PID delivery system in Section 7.1.3. Costs are presented as a range. The low end of the range includes a 15% contingency. The high end of the range includes a 30% contingency. All costs represent end of 2017 dollars. Costs may vary at the time of implementation based on materials costs, which can be highly variable, and contracted labor costs.

Table 7-3
Status of Improvements Recommended in 1993 PID CWCP

Division	Station[1]	Facility Description	Recommended Improvement	Priority[1]	Completed[2]
All	Various	Turnouts	Upgrade Turnouts	1	Partially
IID Div. 1	18+50	Snow Creek Flume	Replace with an Elevated Concrete or Steel Box Flume	2	Yes
IID Div. 1	55+00	Steel Flume	Replace with an Elevated Steel Box Flume	2	No
IID Div. 1	324+00	Leavenworth Flume	Repair or Replace, to Upgrade Structural Integrity	2	Yes
IID Div. 2	570+00	Peshastin Bifurcation	Repair or Replace, to Improve Control	2	Yes – 1994
PID	77+00	Fryburger Spillway	Repair or Replace, to Upgrade Structural Integrity	2	No
PID	413+00	Stines Hill Flume and Spillway	Replace with an Elevated Steel or Concrete Flume or Pipe	2	Yes
All	N/A	Not Facility Specific	Increase Maintenance	3	Yes
All	N/A	Not Facility Specific	Merge IPID	4	In Process
All	Various	Unlined Canals	Canal Lining of Unlined Areas	5	Partially
All	N/A	Non-Structural	Encourage On-Farm Water Conservation Practices	6	Partially
All	N/A	Non-Structural	Update Assessment Roll Maps	7	Partially
PID	413+00 to End	Conveyance	Closed Conduit System, Stines Hill to Pioneer End Spill	8	Partially
PID	77+00 413+00	Upstream of Fryburger Spillway, Upstream of Stines Hill Spillway	Re-Regulating Reservoirs	9	No

Notes:
1. Represents priority assigned to each project in the 1993 PID CWCP.
2. See system maps in Appendix A for stationing and location.
3. Only the dates of completion that are known are provided in this table.

Table 7-4
Summary of Recommended Improvements – PID Delivery System

						Estimated Water Savings[3]	Low Opinion of Cost[4]					High Opinion of Cost[4]				
Project	Division or Reach	Station[1]	Facility Description	Recommended Improvement	Priority[2]	(cfs)	Materials[5]	Labor/ Other[6]	Const. Subtotal	Other Costs[7]	Total Project Cost	Materials[5]	Labor/ Other[6]	Const. Subtotal	Other Costs[7]	Total Project Cost
GEN-1[7]	All	Various	Turnouts	Upgrade Turnouts	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GEN-2[7]	All	N/A	Non-Structural	Merge IPID	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GEN-3[7]	All	N/A	Non-Structural	Encourage On-farm Water Conservation Practices	2	N/A	N/A	N/A	N/A	$8,800	$8,800	N/A	N/A	N/A	$20,000	$20,000
GEN-4[7]	All	N/A	Non-Structural	Continue to Refine District Mapping	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GEN-5[7]	All	N/A	Non-Structural	Improve Automation, Flow Monitoring, and Control	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PID-1	Peshastin	2+50 to 58+00	Open Canal	Install Full Concrete Canal Lining on Unlined and Partially Lined Canal	1	2.6	$193,400	$82,900	$276,300	$55,300	$331,600	$221,000	$96,700	$317,700	$63,500	$381,200
PID-2	Peshastin	45+00	Peshastin Crossover	Replace Crossover Pipeline at Peshastin Creek with 16-inch Steel Pipe	1	0	$15,500	$6,700	$22,200	$4,400	$26,600	$17,400	$7,500	$24,900	$5,000	$29,900
PID-3	Peshastin	79+00	Fryburger Spill	Repair or Replace, to Upgrade Structural Integrity	1	0	$13,000	$5,600	$18,600	$3,700	$22,300	$14,500	$6,200	$20,700	$4,100	$24,800
PID-4	Peshastin	79+00 to 142+00	Open Canal	Inspect and Repair or Replace Concrete Canal Lining	2	0.1	$160,800	$68,900	$229,700	$45,900	$275,600	$183,700	$80,400	$264,100	$52,800	$316,900
PID-5	Peshastin	192+00 to 247+00	Open Canal	Replace Open Canal with 42-inch Corrugated HDPE Pipe	2	2.8	$1,375,000	$495,000	$1,870,000	$374,000	$2,244,000	$1,540,000	$550,000	$2,090,000	$418,000	$2,508,000
PID-6	Peshastin	297+00 to 345+00	Open Canal	Replace Open Canal with 42-inch Corrugated HDPE Pipe	2	1.7	$1,200,000	$432,000	$1,632,000	$326,400	$1,958,400	$1,344,000	$480,000	$1,824,000	$364,800	$2,188,800
PID-7	Peshastin	403+00 to 413+00	Open Canal, Upstream of Stines Hill Spill	Replace Open Canal with 42-inch Corrugated HDPE Pipe	2	0.4	$1,200,000	$432,000	$1,632,000	$326,400	$1,958,400	$1,344,000	$480,000	$1,824,000	$364,800	$2,188,800
PID-8	Peshastin	443+00 to 545+00	Open Canal	Replace Open Canal with 36-inch Corrugated HDPE Pipe	3	1.9	$1,632,000	$612,000	$2,244,000	$448,800	$2,692,800	$1,836,000	$714,000	$2,550,000	$510,000	$3,060,000
PID-9	Peshastin	565+00 to 568+00	Brender Siphon	Replace Existing 24-inch Steel Siphon with 30-inch DR 21 Fused Solid Wall HDPE Pipe	3	0	$63,000	$24,000	$87,000	$17,400	$104,400	$69,000	$24,000	$93,000	$18,600	$111,600
Subtotal – High Priority Projects (Target Implementation Next 5 years)					1		$221,900	$95,200	$317,100	$63,400	$380,500	$252,900	$110,400	$363,300	$72,600	$435,900
Subtotal – Medium Priority Projects (Target Implementation 6 to 8 years)					2		$3,935,800	$1,427,900	$5,363,700	$1,081,500	$6,445,200	$4,411,700	$1,590,400	$6,002,100	$1,210,400	$7,212,500
Subtotal – Low to Medium Priority Projects (Target Implementation 9 to 15 years)					3		$1,695,000	$636,000	$2,331,000	$466,200	$2,797,200	$1,905,000	$738,000	$2,643,000	$528,600	$3,171,600
Subtotal – Low Priority Projects (Target Implementation 16 to 25 years)					4		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total					All	10.6	$5,852,700	$2,159,100	$8,011,800	$1,611,100	$9,622,900	$6,569,600	$2,438,800	$9,008,400	$1,811,600	$10,820,000

Notes:
1. See system maps in Appendix A for stationing and location.
2. Priority designations are as follows: 1) High Priority – Projects that are targeted for implementation within the next 5 years; 2) Medium Priority – Projects that are targeted for implementation within 6 to 8 years; 3) Low to Medium Priority – Projects that are targeted for implementation within 9 to 15 years; 4) Low Priority – Projects that are targeted for implementation within 16 to 25 years.
3. Water savings estimated using water balance spreadsheet model, based on peak use. The total for the system includes estimated water savings throughout the system, including reduced loss in canal sections not recommended for improvement resulting in reduced flow requirements.
4. Low costs include a 15% contingency. High costs include a 30% contingency.
5. Materials include new materials that would have to be procured and imported to complete the project, including pipe, structural materials, concrete, gates, pipe bedding, structural fill, etc., including sales tax for materials.
6. Labor/Other costs include all other costs that would be included in a construction contract, including labor, equipment, mobilization/demobilization, mark-up, and sales tax on these costs.
7. Other costs include engineering, administration, and permitting costs (assumed to be 20% of the construction subtotal).
8. No opinion of probable costs was developed for general and non-structural measures.
9. All costs are in 2017 dollars. The cost at the time of implementation will vary based on inflation, material prices, and labor costs.
10. The construction subtotal and total project costs reflect the cost that would result from having the project bid and constructed by a contractor. IPID constructs many improvements without an outside contractor. If IPID performs the work, project costs would be closer to the materials cost.

7.2.4 *Structural Measures*

Structural improvement measures include actual upgrades to IPID infrastructure designed to improve efficiency, address structural deficiencies, and improve the control and management of flow through the system. The following summarizes proposed structural improvements to PID delivery infrastructure. The projects are listed from highest priority to lowest priority.

GEN-1: Upgrade Turnouts (High Priority) – The 1993 PID CWCP recommended upgrading turnout boxes. PID has replaced or upgraded turnouts on an as-needed basis over the years. IPID is currently engaged in a more focused effort to replace or repair shareholder turnout boxes. They hope to have all turnout boxes upgraded within the next few years. IPID has been collecting the location of each turnout box with a GPS-enabled mobile device, documenting the condition of each box with photographs, and identifying the parcels that each box irrigates. The turnout boxes need to be upgraded to ensure that all have working shutoff gates or valves that positively seal and have appropriately sized orifices or weirs that deliver the right flow rate. These measures will enable IPID personnel to better manage and control water use, especially during dry years when water supply has to be cut back. The upgrade of turnouts is considered a high priority.

PID-1: Install Full Lining in Canal Downstream of Diversion (High Priority) – The existing canal is open and unlined or only partially lined for approximately 1 mile downstream of the diversion facilities and fish screen on Peshastin Creek. Significant conveyance losses were measured through this segment of the canal. Full lining of this portion of the PID Main Canal is recommended to reduce conveyance loss and improve efficiency.

PID-2: Replace Peshastin Crossover Pipeline at Peshastin Creek (High Priority) – The Peshastin Crossover pipeline delivers Icicle Creek water from the IID Division 2 Bifurcation to the PID Main Canal. The water supply from Icicle Creek is critical to meeting late summer water deliveries from the PID Main Canal. Due to changes in Peshastin Creek and construction on the adjacent U.S. Highway 97, the pipeline is now exposed on the bed of Peshastin Creek. A relief valve used to spill excess water to Peshastin Creek is also exposed in the creek. The infrastructure is at risk of being damaged by debris and ice flows. It also creates conditions that are not ideal for fish passage. IPID has plans to replace the portion of the Peshastin Crossover pipeline that crosses the creek within the next year. A scour analysis was completed to identify the minimum depth at which the pipeline should be buried to prevent future exposure (Anchor QEA 2018b). It was recommended that at least 4 feet of cover be maintained where the new pipe crosses under Peshastin Creek.

PID-3: Repair or Replace Fryburger Spill Structure (High Priority) – The Fryburger Spill is a reinforced concrete structure with gates that act as the primary flow control on the PID Main Canal. The concrete structure is old and weathered, but in fair condition. The gate that controls flow through the canal is rusted and in poor condition. It is recommended that the structure be replaced within the next 5 years.

PID-4: Repair or Replace Canal Lining (Medium Priority) – The open canal downstream of Fryburger Spill is also old, weathered, and cracking in places. Inspection and repair or replacement of canal lining is recommended to reduce conveyance losses and improve efficiency within the next 6 to 8 years.

PID-5, PID-6, and PID-7: Replace Segments of Open Canal with 42-Inch Corrugated HDPE Pipe (Medium Priority) – IPID has identified several segments of the PID Main Canal that are unlined or where concrete lining is old, weathered, and cracking. Conveyance losses were identified in these segments of the canal. Replacement of segments of the PID Main Canal from Dryden down to the Stines Hill Spill is recommended to reduce conveyance losses and improve efficiency within the next 6 to 8 years.

PID-8: Replace Open Canal with 36-Inch Corrugated HDPE Pipe (Low to Medium Priority) – IPID would like to replace the open canal with piping around the north and east sides of Stines Hill. The PID Main Canal is fully piped from Brender Spill down to the end of the system. This project would result in most of the system being piped from Stines Hill Spill down to the end of the system. Replacement of open canal between Stines Hill Spill and the flumes upstream of the Brender Spill is recommended to reduce conveyance losses and improve efficiency within the next 9 to 15 years.

PID-9: Replace Brender Siphon (Low to Medium Priority) – The Brender Siphon on the PID Main Canal consists 24-inch steel pipeline that is rusted and failing. Holes have been observed in the top of the pipe. Replacement of the siphon with 30-inch butt-fused, solid-wall DR 21 HDPE pipe is recommended in the next 9 to 15 years.

7.2.5 Non-Structural Measures

Non-structural measures are changes in operation and management of the system that do not necessarily involve replacing or repairing infrastructure. The following non-structural improvements are recommended for the PID delivery system:

GEN-2: Merge Icicle and Peshastin Irrigation Districts (High Priority) – As noted in Chapter 2, IPID has been working toward consolidation of IID and PID into one irrigation district, referred to as IPID. IPID is in the process of circulating petitions and gathering signatures from their memberships to support consolidation. A proposed boundary for the consolidated district has been submitted to Ecology. It is recommended that IPID complete the consolidation process in the next 2 years.

GEN-4: Continue to Refine District Mapping (High Priority) – As part of the preparation of this plan, a detailed field inventory of existing district facilities was completed, as outlined in Chapter 5.

IPID's GIS database has been updated with information from the inventory. Additional work is ongoing to locate all turnout boxes and identify which parcels are served through each box. IPID intends to continue to refine mapping and maintain up to date maps in a GIS database.

GEN-3: Encourage On-Farm Water Conservation Practices (Medium Priority) – As noted in Chapters 4 and 6, most of PID's water use is for irrigation of apple and pear orchards. The orchards typically have very efficient irrigation systems. Most orchards either use solid-set sprinklers or micro-spray systems. IPID does not actively encourage improvement of on-farm irrigation systems to increase efficiency. Most orchardists have improved their on-farm systems as a way of ensuring that their crops are resilient to changing conditions. There may be potential for education and encouragement to further improve the efficiency of on-farm water use. An increase in on-farm efficiencies would allow IPID to operate the canals at lower water levels and reduce the risk of ditch overtopping or other operational issues. IPID could encourage on-farm conservation through educational or training programs in conjunction with the Agricultural Extension Service, Cascadia Conservation District, or other agencies, or IPID could consider requiring all new sprinkler systems installed meet efficiency standards. Educational and training programs could include supplying farmers with agricultural water supply demand forecasts based on a system such as AgriMet (provided by Reclamation), training farmers in the use of moisture probes to determine soil moisture levels, and assisting farmers in designing irrigation systems to achieve high distribution efficiencies and reduce over-irrigation.

GEN-5: Improve Automation, Flow Monitoring, and Control (Medium Priority) – IPID has been improving its ability to monitor flows and conditions at surface water diversions and other key structures. However, adjustments are still primarily made manually by ditch riders who monitor the system on a daily basis during the irrigation season. Improved monitoring of flows and conditions at more key locations, in combination with automation of key control gates and other facilities, will allow IPID to better balance inflows with outflows and improve management of the delivery system. Continued efforts to improve automation, flow monitoring, and control of the system will be made over the next 25 years.

7.2.6 Gibb Ditch

No specific improvements were identified for the Gibb Ditch system. The general and non-structural improvements noted for the IID and PID delivery systems would apply. Much of the system was replaced less than 20 years ago and is in good condition. Older pipe in the system may need to be monitored and replaced when excessive leakage or failures occur.

7.2.7 Tandy Ditch

No specific improvements were identified for the Tandy Ditch system. The general and non-structural improvements noted for the IID and PID delivery systems would apply. Most of the open ditch system was replaced with a closed pipe system less than 20 years ago and the system appears to be in in good condition. There is approximately 900 feet of open canal immediately downstream of the fish diversion and fish screen that may need to be monitored. Lining or piping may be appropriate for this canal if improved efficiency is desired.

7.3 Estimated Water Savings

Estimated water savings from the proposed projects are listed in Table 7-5. Water savings represent the reduction in peak water diversions and flow rates modeled in the water balance spreadsheet as a result of a particular project. Many of the projects listed were not estimated to save water. These include projects like structure replacements, flume replacement, siphon replacements, and piping projects where very little or no loss was identified through existing facilities. The upgrades are recommended primarily based on the age and condition of these facilities, rather than the potential to conserve water. However, IPID may find that replacement or upgrade of these facilities does increase water use efficiency. The projects that will result in the greatest water savings include replacement of lining or installing pipelines in open canals where high conveyance losses were observed and estimated by the water balance model. Much of IPID's system is relatively efficient, so the opportunities for significant water savings are less prevalent than in systems that consist of mostly unlined, open canals with high conveyance losses.

The water savings result in lower peak flows in both the improved reach of the canal system and segments of the canal system upstream of the improvement. Consequently, water savings result for both the improved reach of the canal system and upstream of the improvement because water loss is related to both the condition of the canal and the flow in the canal. The total water savings listed for each division or reach and the total listed for all canals includes water savings that result from reducing the overall flow rates through the canal system. The total cost of each project is also listed in terms of cost of the project per cfs of water savings. Grant funding for efficiency projects is often tied to water savings that result in a reduction of surface water diversions and a corresponding increase in instream flows. Typical thresholds for outside funding are $500,000 to $1,000,000 per cfs of instream flow benefit.

Table 7-5
Potential Water Savings

Project	Reach or Division	Description	Peak Water Savings (cfs)	Total Opinion of Probable Project Cost ($)		Total Opinion of Probable Project Cost ($ per cfs)	
				Low	High	Low	High
IID-1-1	1	Replace Fish Screens, Upgrade Diversion Canal and Head Gates	0.0	$0	$0	N/A	N/A
IID-1-2	1	Install Flow Monitoring Downstream of New Fish Screens	0.0	$6,000	$6,700	N/A	N/A
IID-1-3	1	Replace Pick Up Flume with a New Pipeline	0.0	$29,800	$33,400	N/A	N/A
IID-1-4	1	Replace with an Elevated Steel Box Flume	0.0	$52,000	$58,300	N/A	N/A
IID-1-5	1	Inspect and Repair or Replace Concrete Canal Lining	1.5	$1,226,200	$1,410,100	$798,555	$918,319
IID-1-6	1	Repair or Replace, to Upgrade Structural Integrity	0.0	$37,100	$41,500	N/A	N/A
Subtotal	**1**	**IID Division 1 Improvements**	**1.8**	**$1,351,100**	**$1,550,000**	**$754,021**	**$865,022**
IID-2-1	2	Install Full Concrete Canal Lining on Partially Lined Canal	1.1	$89,600	$103,000	$78,366	$90,085
IID-2-2	2	Replace Open Canal with 48-Inch Corrugated HDPE Pipe	1.5	$2,755,200	$3,091,200	$1,861,774	$2,088,820
IID-2-3	2	Inspect and Repair or Replace Concrete Canal Lining	1.4	$702,000	$807,200	$499,057	$573,844
Subtotal	**2**	**IID Division 2 Improvements**	**4.7**	**$3,546,800**	**$4,001,400**	**$759,022**	**$856,307**
IID-3A-1	3A	Repair or Replace Structure at Siphon Outlet	0.0	$13,300	$14,900	N/A	N/A
IID-3A-2	3A	Inspect and Repair or Replace Concrete Canal Lining	0.0	$401,300	$461,600	$10,322,250	$11,873,288
IID-3A-3	3A	Replace Existing Steel Pipes with 48-Inch HDPE Pipe	0.3	$1,228,800	$1,382,400	$3,849,014	$4,330,140
IID-3A-4	3A	Replace 30-Inch Steel Siphon with 36-Inch HDPE Pipe	0.0	$393,600	$441,600	N/A	N/A
IID-3A-5	3A	Replace Open Canal with 42-Inch Corrugated HDPE Pipe	0.2	$1,264,800	$1,413,600	$8,174,942	$9,136,699
IID-3A-6	3A	Repair or Replace, to Upgrade Structural Integrity	0.0	$22,300	$24,800	N/A	N/A
IID-3A-7	3A	Replace 30-Inch Steel Siphon with 30-Inch Steel Pipe	0.0	$312,000	$360,000	N/A	N/A

Project	Reach or Division	Description	Peak Water Savings (cfs)	Total Opinion of Probable Project Cost ($)		Total Opinion of Probable Project Cost ($ per cfs)	
				Low	High	Low	High
IID-3A-8	3A	Inspect and Repair or Replace Concrete Canal Lining	0.1	$1,013,900	$1,165,900	$13,256,989	$15,244,426
Subtotal	**3A**	**IID Division 3A Improvements**	**0.6**	**$4,650,000**	**$5,264,800**	**$7,774,189**	**$8,802,054**
IID-3B-1	3B	Replace Existing Steel Siphon with 30-Inch Steel Pipe	0.0	$1,357,200	$1,497,600	N/A	N/A
IID-3B-2	3B	Relocate Weed Screen Upstream to 52-Inch Pipeline Inlet	0.0	$23,600	$26,500	N/A	N/A
IID-3B-3	3B	Repair or Replace Concrete Structure, Replace Gates	0.0	$34,100	$38,200	N/A	N/A
IID-3B-4	3B	Replace Open Canal with 36-Inch Corrugated HDPE Pipe	0.0	$343,200	$390,000	$11,044,873	$12,550,992
IID-3B-5	3B	Replace Existing 24-Inch Steel Siphon with 30-Inch HDPE Pipe	0.0	$348,000	$372,000	N/A	N/A
IID-3B-6	3B	Repair or Replace Structure, Replace Gate	0.0	$44,400	$49,900	N/A	N/A
Subtotal	**3B**	**IID Division 3B Improvements**	**0.0**	**$2,150,500**	**$2,374,200**	**$68,136,627**	**$75,224,357**
IID-4-1	4/5	Replace Grating and Guard Rails on Pipe Bridge	0.0	$63,600	$71,500	N/A	N/A
IID-4-2	4	Replace Open Canal with 36-Inch Corrugated HDPE Pipe	0.2	$475,200	$540,000	$1,948,268	$2,213,941
IID-4-3	4	Replace Open Canal with 30-Inch Corrugated HDPE Pipe	0.1	$1,231,200	$1,436,400	$8,779,318	$10,242,537
Subtotal	**4**	**IID Division 4 Improvements**	**0.4**	**$1,770,000**	**$2,047,900**	**$4,524,723**	**$5,235,130**
IID-5-1	5	Replace Existing 24-Inch Steel Siphon with 30-Inch HDPE Pipe	0.0	$243,600	$260,400	N/A	N/A
IID-5-2	5	Replace Existing 24-Inch Steel Siphon with 30-Inch HDPE Pipe,	0.0	$595,200	$672,000	N/A	N/A
Subtotal	**5**	**IID Division 5 Improvements**	**0**	**$838,800**	**$932,400**	**N/A**	**N/A**
PID-1	Peshastin	Install Full Concrete Canal Lining on Open Canal	2.6	$331,600	$381,200	$127,926	$147,060
PID-2	Peshastin	Replace Crossover Pipeline at Peshastin Creek	0.0	$26,600	$29,900	N/A	N/A
PID-3	Peshastin	Repair or Replace, to Upgrade Structural Integrity	0.0	$22,300	$24,800	N/A	N/A
PID-4	Peshastin	Inspect and Repair or Replace Concrete Canal Lining	0.1	$275,600	$316,900	$3,356,789	$3,859,821

Project	Reach or Division	Description	Peak Water Savings (cfs)	Total Opinion of Probable Project Cost ($)		Total Opinion of Probable Project Cost ($ per cfs)	
				Low	High	Low	High
PID-5	Peshastin	Replace Open Canal with 42-Inch Corrugated HDPE Pipe	2.8	$2,244,000	$2,508,000	$815,500	$911,441
PID-6	Peshastin	Replace Open Canal with 42-Inch Corrugated HDPE Pipe	1.7	$1,958,400	$2,188,800	$1,122,136	$1,254,152
PID-7	Peshastin	Replace Open Canal with 42-Inch Corrugated HDPE Pipe	0.4	$1,958,400	$2,188,800	$4,969,660	$5,554,326
PID-8	Peshastin	Replace Open Canal with 36-Inch Corrugated HDPE Pipe	1.9	$2,692,800	$3,060,000	$1,402,988	$1,594,305
PID-9	Peshastin	Replace Existing 24-Inch Steel Siphon with 30-inch HDPE Pipe	0.0	$104,400	$111,600	N/A	N/A
Subtotal	**Peshastin**	**Peshastin Improvements**	**10.6**	**$9,614,100**	**$10,810,000**	**$903,492**	**$1,015,878**
Total	**All**	**All Improvements**	**18.1**	**$23,921,300**	**$26,980,700**	**$1,319,677**	**$1,488,456**

7.4 Other Projects Under Consideration

In addition to the projects listed in Tables 7-2 and 7-4, IPID is considering other projects that could improve system operations, water supply reliability, and offer benefits to instream flows in Peshastin Creek and Icicle Creek. These projects are summarized in this section. Some of the projects have been studied in detail, as noted below. Others are still very conceptual.

7.4.1 IPID Full Piping Option

As part of the analysis of the IPID system, IPID requested that a very cursory analysis be completed to determine the order-of-magnitude costs associated with a project that would shift surface water diversions from Icicle Creek and Peshastin Creek to the Wenatchee River. The proposed improvement concept would increase flows and benefit fish passage and habitat conditions in the lowest 5.7 miles of Icicle Creek and the lowest 2.4 miles of Peshastin Creek. The proposed improvement concept would not eliminate the need for or reduce reliance on storage operated by IPID in the Alpine Lakes Wilderness Area. Releases from the lakes will be required to sustain water supply no matter where IPID diverts water.

Anchor QEA prepared a memorandum, "IPID Conservation Plan – Full Piping Option" (Anchor QEA 2018a) that summarizes the initial evaluation of this option. That memorandum is included as Appendix G. A stand-alone memorandum was prepared because this project would replace the need for the other potential conservation and improvement projects listed in Tables 7-2 and 7-4. Most of those projects would likely not be needed if the "full piping option" project was pursued as the preferred option for future improvement of IPID. However, the full piping option represents a very large project that would take several years to implement. So, the projects identified as high and medium priority in this plan may still require implementation, depending on the purpose of the project and the condition of the facility being replaced or improved.

The project would include construction of three pump stations, two booster pump stations, a re-regulating pond, and a regulating pond. The project would require approximately 9,760 total horsepower of pump and more than 39 miles of delivery pipelines ranging in diameter from 8-inch to 48-inch diameter. The concept-level opinion of the probable costs associated with the project ranges from $72.4 million to $83.7 million (2017 dollars). The opinion of annual operating costs ranges from $775,000 to $821,000 (2017 dollars). The scope of the memorandum was limited to a very cursory review of this concept. Additional study would be needed to further understand costs, limitations, system configuration, and other variables.

7.4.2 IPID Pump Exchange Project

A feasibility study is currently underway to evaluate potential for construction of a pump station as an alternate source of supply for IPID on the Wenatchee River near Dryden. An appraisal level study was prepared by Anchor QEA (Anchor QEA 2012) that identified five alternatives for delivering water to the PID and IID canals from a pump station on the right bank of the Wenatchee River near Dryden. The pump station would be used during the late summer to reduce diversions from Peshastin Creek and Icicle Creek to improve instream flows for the benefit of fish passage and habitat conditions. The feasibility study that is currently underway will develop the concept to the 30% design level and will include geotechnical analysis and topographic survey. The goal will be to better understand the costs and potential benefits of the project.

The project would deliver water to the PID Canal near Deadman Hill Road south of Dryden. Water would be delivered to the IID Canal downstream of the Maxwell Siphon. The primary benefit to IPID would be redundant supply. The most vulnerable section of the PID Main Canal includes a pipeline that is exposed above an unstable hillside adjacent to the Wenatchee River, just south of Dryden. The project would deliver water to the PID Canal downstream of that pipeline, which would represent a significant improvement in water supply reliability for PID.

If the project was designed to deliver up to 25 cfs from the Wenatchee River to the PID Main Canal and 25 cfs to the IID Division 3A Canal, the most recent study done indicates the cost to implement the project would be approximately $8.15 million (2014 dollars). Additional information on this project is available from the *Peshastin Irrigation District Pump Exchange Project Appraisal Study* (Anchor QEA 2012) and the *Summary of Additional Analysis, Icicle and Peshastin Irrigation Districts Pump Exchange* (Anchor QEA 2015).

7.4.3 Eightmile Lake Storage Restoration Project

The infrastructure IPID owns and operates to capture and release water from Eightmile Lake is aging and in need of rehabilitation. Erosion of the earthen embankment portion of the dam structure has reduced the useable storage capacity. Improvements are needed to restore the useable storage capacity of Eightmile Lake to 2,500 acre-feet, which is the volume allowed for storage and release by IPID's water right for the lake. In addition, the gate that controls flow through the low-level outlet is in disrepair and the dam structure has deteriorated. Improvements are needed to ensure efficient control and release of water stored in the lake to meet downstream water supply and instream flow needs. As a result, IPID has been working with Chelan County and others to investigate the feasibility of a project that would replace the low-level outlet pipeline, dam structure, and other appurtenances.

A feasibility study is nearly complete that includes evaluation and feasibility-level designs for a project that would replace the existing dam and controls at Eightmile Lake with a new dam, low-level outlet, and controls. The proposed project would restore IPID's ability to store and release up to 2,500 acre-feet of water from Eightmile Lake to maintain water supplies diverted from Icicle Creek, meet late summer instream flow goals, and help shore up water supply for other out-of-stream needs. The *Feasibility Study, Eightmile Lake Storage Restoration* (Anchor QEA and Aspect 2017) was prepared concurrent with this conservation plan.

During development of the Feasibility Study, two issues became much more urgent and are putting the infrastructure at Eightmile Lake at increased risk:

- The low-level outlet pipe has collapsed in multiple locations, which has recently reduced the capacity of the pipeline and limits the rate at which IPID can release water to Icicle Creek.
- A fire in the summer of 2017 burned vegetation down to the shoreline of Eightmile Lake. The Ecology Dam Safety Office (DSO) has expressed concern that the near-term hydrology of the watershed above Eightmile Lake may change dramatically due to the fire, increasing peak runoff to Eightmile Lake and putting the dam and outlet infrastructure at risk.

If the low-level outlet pipe is not replaced or repaired before the next big drought cycle, IPID will likely not be in a position to meet the irrigation water supply needs of the IPID water users. In addition, if a peak runoff event occurs in the Eightmile Lake watershed, DSO is concerned that the flows could cause further damage to what remains of the embankment and dam at Eightmile Lake, or even cause these facilities to fail.

To respond to these key issues, IPID is proposing to replace the low-level outlet pipe, dam, and other infrastructure at the lake under an emergency declaration. IPID will be working with its consultant team and Ecology DSO to develop the designs for the project and secure permits, including a Dam Construction Permit. The feasibility study estimates that implementation of this project will cost just under $3 million (2017 dollars).

7.4.4 Alpine Lakes Optimization and Automation

IPID operates four lakes in the Alpine Lakes Wilderness Area as reservoirs. Each lake has a small dam and low-level outlet controls that allow IPID to capture and release water. Water released during the late summer sustains flows in Icicle Creek to allow IPID to maintain diversions for irrigation. A feasibility study is nearly complete that includes evaluation and feasibility-level designs for a project that would allow IPID to optimize and automate releases from these lakes. IPID currently operates control valves and gates at each lake manually. Because the lakes are remote and difficult to access, IPID is not able to adjust releases from these lakes to match diversion and flow needs in Icicle Creek. The proposed project would equip the outlet facilities at each lake with automated controls and telemetry equipment that would allow for IPID to control releases remotely from the IPID office in Cashmere. The *Feasibility Study, Alpine Lakes Optimization and Automation* (Aspect and Anchor QEA 2017) was prepared concurrent with this conservation plan.

The proposed project will improve management of IPID's storage in the Alpine Lakes Wilderness Area and will allow for releases that benefit instream flow and other out-of-stream water needs. The opinion of probable implementation costs for automation of the releases for the four lakes operated by IPID and from the Snow Lakes (operated by USFWS) is approximately $876,000 (2017 dollars).

7.4.5 PID Pipeline Vulnerability Improvements

As noted in Section 7.4.2, the most vulnerable piece of PID's infrastructure is a pipeline that is exposed in two places over a steep, unstable hillside adjacent to the Wenatchee River, immediately south of the town of Dryden. Although specific improvements are recommended in Tables 7-2 and 7-4 to address this vulnerability, IPID has been considering options and will likely be completing additional studies to determine how to provide additional reliability for this part of the system. If the pipe failed, water supply would not be available to water users served from the PID Main Canal downstream of this location. Options that may be considered by IPID would include the following:

- Establish an alternate supply through a pump station on the Wenatchee River, which is the pump exchange project summarized in Section 7.4.2.
- Construct a small booster pump station upstream of the vulnerable pipeline, on the open canal near the west crossing of Deadman Hill Road over the canal. Boost water through a new pipeline up and over Deadman Hill Road to the open canal near the east crossing of Deadman Hill Road. If feasible, install micro-hydroelectric turbine facilities on the downhill side of the pipeline to recover some of the energy required to pump water over the hill.
- Bore a pipe through the hillside from the upstream side vulnerable pipeline to the open canal near the east crossing of Deadman Hill Road. This appears to be a high-risk and very expensive option.
- Tunnel through the hill from the upstream side vulnerable pipeline to the open canal near the east crossing of Deadman Hill Road.
- Open cut further into the hillside and bury the pipe in the hillside. This option would be risky due to the instability of the hillside and would be challenging because of the limited access to the pipeline at this location.

Evaluation of these options is beyond the scope of this conservation plan. It is recommended that IPID complete an alternatives evaluation to better understand the costs, benefits, and risks associated with all reasonable approaches to solving this problem. The alternatives evaluation will provide the information IPID needs to choose the appropriate course of action.

8 Funding and Implementation

IPID rates and budgeting information are presented in Chapter 2 of this plan. Improvements to the IPID delivery systems have been funded through a variety of sources, including grants from various entities and from IPID's operating budget for maintenance and repairs. As noted previously, IPID engages in an aggressive off-season maintenance routine after shutting down the irrigation system in the fall and prior to starting up the system in the spring. Each year, they complete piping and lining projects, replace existing structures, and implement other upgrades. Construction of these improvements by IPID staff reduces the cost of upgrades significantly, but IPID staff have limited time and resources to complete improvements.

The recommended improvement program outlined in Chapter 7 represents a significant amount of work that is above and beyond what IPID can complete on their own during the off-season with the staff and resources they have available. To complete the projects recommended, IPID will need to identify and secure grant and/or low-interest loan funding, as they have done in the past, to fund and complete projects. This section outlines some of the funding programs available to irrigation districts to make delivery system upgrades. Most of the funding programs require demonstrated water savings that can be put into trust to improve instream flows to benefit passage and habitat conditions for ESA-listed fish. In order to secure funding, IPID will need to demonstrate how the proposed project provides benefit to ESA-listed fish or other resources.

8.1 Potential Funding Sources

The following summarizes potential funding sources that IPID may consider for funding conservation plan improvements. The funding programs all have unique timelines, matching requirements, expectations, and limits that should be considered when pursuing funding.

8.1.1 Washington State Department of Ecology, Office of Columbia River

The Ecology, Office of Columbia River (OCR) is charged with "aggressively pursuing water solutions that concurrently meet water needs for families, industry, and farms (out-of-stream), and ecosystems and fish (instream)." OCR was created by the Washington State Legislature with six primary directives:

- Find sources of water for pending water-right applications.
- Develop water sources for new municipal, domestic, industrial, and irrigation needs.
- Issue water supply and demand reports.
- Secure alternatives to groundwater for agricultural users in the Odessa Subarea.
- Find a new uninterruptible supply of water for those whose rights are curtailed on the Columbia mainstem when minimum flows are forecast to be unmet.
- Make water available for instream benefits when needed most.

OCR is funded by the legislature and is actively implementing projects with that funding throughout the Columbia River Basin to achieve those directives. OCR has joined with Chelan County in leading the IWG. Through its participation in the IWG, OCR has funded several studies and design work for IPID for potential water supply and storage improvement projects. Improving irrigation efficiency is a key component of the Icicle Strategy, and IPID is the largest water user on Icicle Creek. Future funding of the most effective irrigation efficiency measures may be available through funding provided to the IWG process from OCR.

Future funding from OCR is likely to require demonstrated potential for effective contribution toward achieving the IWG's guiding principles, which include both agricultural reliability and improved instream flows in Icicle Creek. The recommended improvement plan targets improvements that would reduce water loss and increase efficiency to improve agricultural reliability and increase instream flows. Funding would likely require that water savings be put into trust to ensure that instream flow benefits were realized.

8.1.2 Direct Legislative Appropriation

The Washington State Legislature has the ability to directly appropriate funds for specific projects that are determined to benefit the public. Funding for specific water supply projects in the Columbia River Basin is typically included in legislative funding allocated to OCR for administration. However, legislative funding does not have to come through OCR. Legislative funding for improvements would require the support of legislators that represent the IPID service area. Like OCR funds, any project that is funded through a direct legislative appropriation is likely to require demonstrated water savings and the ability to benefit both agricultural reliability and natural resources.

8.1.3 Salmon Recovery Funding

The Washington State Recreation and Conservation Office (RCO) is responsible for administering salmon recovery funding appropriated by the Washington State Legislature. In 1999, the Washington State Legislature created the Salmon Recovery Funding Board. The Salmon Recovery Funding Board provides grants for projects that protect and enhance salmon habitat. Projects that improve fish passage and habitat by restoring flows or by removing fish barriers or impacts are considered for funding.

Salmon recovery grants are funded through an open, public process. Project applications for salmon recovery funding are typically due each year in February. Local and regional scientific panels and citizen committees review the applications and rank projects for funding. The program funded approximately $18 million of projects through its 2017 grant cycle. Grants typically require a minimum of a 15% match by the project sponsor.

IPID is currently completing a feasibility study for the proposed pump exchange project at Dryden with salmon recovery funding secured by the Chelan County Natural Resources Department. Applications and information for future funding opportunities can be found at the RCO web site: https://www.rco.wa.gov/grants/eval_results.shtml.

8.1.4 Priest Rapids Coordinating Habitat Subcommittee

The Priest Rapids Coordinating Committee (PRCC) was convened by Grant County Public Utility District (Grant PUD), as required under the Biological Opinion for the Priest Rapids hydroelectric project, which Grant PUD owns and operates on the main stem Columbia River. The PRCC is comprises representatives from NOAA Fisheries, USFWS, WDFW, the Colville Confederated Tribes, the Yakama Nation, Confederated Tribes of the Umatilla Reservation, and Grant PUD staff. The PRCC Habitat Subcommittee is charged with development and implementation of projects designed to improve passage and habitat conditions for spring Chinook salmon and steelhead in Columbia River tributaries.

Applicants for PRCC Habitat Funds complete a project specification sheet to demonstrate that the project will meet the goals of the funding, which is to improve passage and habitat conditions for spring Chinook salmon and steelhead in Columbia River tributaries. Funding is open, meaning it does not follow a specific application cycle. Project sponsors are encouraged to demonstrate matching funds.

8.1.5 Habitat Conservation Plan Tributary Funds

The Chelan County Public Utility District (Chelan PUD) and the Douglas County Public Utility District (Douglas PUD) "fund and support sustainable long-term, cost-effective projects that protect and restore Plan Species habitats" and "foster partnerships with those that implement such projects". The funding is intended to support implementation of projects that support the goals in the Habitat Conservation Plan for the Douglas PUD's Wells Dam and the Chelan PUD's Rock Island and Rocky Reach Dams on the main stem Columbia River. The program is designed to provide funding in an "effective way to accomplish projects that rely on local volunteer organizations."

Applicants for tributary funds fill out a funding application that is reviewed by the tributary committee, which consists of representatives from Chelan PUD, Douglas PUD, WDFW, NOAA Fisheries, USFWS, the Colville Confederated Tribes, the Yakama Nation, and a facilitator consultant. Similar to PRCC funds, application for tributary funds is open (there is no application cycle). Project sponsors are encouraged to demonstrate matching funds.

8.1.6 Irrigation Efficiency Grants Program

The Washington State Conservation Commission (WSCC) administers a grant program called the Irrigation Efficiencies Grants Program (IEGP) designed to provide an effective, voluntary way for agricultural water users to improve irrigation efficiency and augment flows in streams to benefit passage and habitat conditions for ESA-listed fish species. Grants are provided for on-farm upgrades and conveyance system improvements.

Local conservation district staff work with program participants to design and implement solutions that improve irrigation efficiency. Funding is appropriated by Ecology and administered through the WSCC. Applicants must have a valid water right in one of 16 identified fish-critical basins. The Wenatchee River Basin is one of those basins. Cascadia Conservation District works with water users in the Wenatchee River Basin to identify solutions and administer irrigation efficiency funds.

As part of the funding process, Ecology provides a detailed review and assessment of the applicant's water rights and ability to save water through the proposed project. Water savings are then put into trust in exchange for project funding. The program pays up to 85% of the total cost of project implementation, up to a maximum of $400,000. The applicant must demonstrate the ability to match by funding the remaining 15%. Similar to PRCC and habitat tributary funds, application for IEGP funding is open (there is no application cycle). Applications and additional program information are available at the WSCC web site, here: http://scc.wa.gov/iegp/

Additional information can also be requested from Mike Cushman at Cascadia Conservation District (MikeC@cascadiacd.org; 509-436-1601).

8.1.7 U.S. Bureau of Reclamation

Reclamation funds irrigation improvement projects in the Columbia River Basin, both as a cost sharing partner and through grant funding. IPID worked with Reclamation in 2009 through 2011 to design and construct pipelines in the lowest mile of the PID delivery system. Reclamation worked through a local project sponsor, the CCNRD, to fund the design and help implement the project. Reclamation has funded similar projects that achieve their goals of restoring and enhancing fish passage in tributaries to the Columbia River as mitigation for the impacts of Grand Coulee Dam on ESA-listed species in the Columbia River system.

Reclamation also administers a grant program referred to as WaterSMART. WaterSMART grants provide cost-shared funding for projects that conserve water, increase energy efficiency and use renewable energy in water management, or support environmental benefits. Three types of grants are offered:

- Water and Energy Efficiency Grants
- Water Marketing Strategy Grants
- Small-Scale Water Efficiency Project Grants

A funding announcement is released by Reclamation annually. Applications for funding are typically due in the late spring or early summer. The WaterSMART program funded 43 projects for a total of

$20.9 million in 2017. The projects funded in 2017 included canal lining and piping projects, automated gates and controls, and installation of advanced metering. Projects are typically funded based on a 50/50 cost share with the local project sponsor. Projects are selected through a competitive evaluation process and are typically targeted for completion within 2 to 3 years. Additional information is available at:

https://www.usbr.gov/watersmart/

9 Comparison of Conservation Program to Other Strategies

This section compares the cost of the improvement projects recommended in this CWCP to other projects that have been implemented in the Wenatchee River Watershed or strategies that are currently being considered for improving streamflow and water management in the watershed. Projects were compared on a basis of the cost per cfs of water made available to benefit instream flows or other water needs through improved water use efficiency or improved water management.

Table 9-1 summarizes projects that have been studied or implemented within the Wenatchee Watershed over the last 10 years. These projects have been studied at different times to different levels of detail. The source of the cost information and the time basis for the opinion of probable cost for each project is provided in Table 9-1. The costs were all inflated to 2017 dollars to provide a consistent comparison with the costs of the improvement projects outlined in this CWCP using the Reclamation's *Construction Cost Trends* (Reclamation 2018). The costs are assumed to include all project implementation costs, but do not include operations and maintenance costs or any life cycle replacement costs. The potential flow benefit that could be made available by each project is also listed and the cost per cfs of flow benefit is provided for comparison.

The comparison is sorted by project type. Four types of projects were evaluated: storage projects, irrigation efficiency projects, pump exchange projects, and hatchery efficiency projects. The most cost-effective projects that have been studied for implementation include automation and optimization of the managed reservoirs in the Alpine Lakes Wilderness Area, the Leavenworth Nation Fish Hatchery Effluent Pump Back project, Eightmile Lake Storage Restoration project, and Upper and Lower Snow Lakes Storage Enhancement project. These projects all offer significant flow benefit (15 to 30 cfs) at a cost of less than $100,000 per cfs of benefit. As noted previously, funding entities have typically look at the cost per cfs of flow benefit when evaluating the potential to fund a project. The upper end of cost for projects that are attractive to funding entities is typically in the $500,000 to $1,000,000 range. Other projects that have been studied that fit within that range include the three conceptual storage projects that have only been identified conceptually, the COIC Irrigation Efficiency project, the IPID Full Piping Option (see Appendix G), gravity piping of the Wenatchee-Chiwawa Irrigation District, the IPID Pump Exchange project at Dryden, and installation of circular tanks at Leavenworth National Fish Hatchery.

Two irrigation efficiency projects have been funded and constructed in the basin recently. Costs for the PID piping project, which replaced the lowest mile of the PID delivery system with pipe, were roughly $850,000 per cfs benefit in 2017 dollars. The costs for the Pioneer Water Users Association project, which replaced a gravity and open ditch system with a pressurized system served through a pump station on the Wenatchee River, were roughly $233,000 per cfs benefit when it was constructed ($243,000 per cfs benefit in 2017 dollars).

Table 9-1
Potential Water Savings

Project	Reference Document	Status	Year of Study	Project Type	Peak Flow Benefit (cfs)	Probable Project Cost from Reference ($)	Probable Project Cost Inflated to 2017[1] ($)	2017 Cost ($ per cfs)
Mill Creek Instream Reservoir	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	18.9	$6,703,000	$8,827,000	$467,037
Negro Creek Instream Reservoir	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	5.9	$3,471,000	$4,571,000	$774,746
Little Camas Creek Reservoir	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	12.9	$7,443,000	$9,801,000	$759,767
SW Eagle Creek Tributary Lakes	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	0.6	$860,000	$1,132,000	$1,886,667
Eagle Creek Tributary Lakes	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	1.0	$1,263,000	$1,663,000	$1,663,000
Campbell Creek Off-Channel Reservoir	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	7.1	$9,800,000	$12,905,000	$1,817,606
Upper Wenatchee to Chumstick (Option 1)	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	3.2	$4,518,000	$5,949,000	$1,859,063
Upper Reach Mission Creek Lakes	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	0.5	$1,259,000	$1,658,000	$3,316,000
Nahahum Canyon Off-Channel Reservoir	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	2.3	$4,226,000	$5,565,000	$2,419,565
Ingalls Creek Off-Channel Reservoir	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	3.5	$6,645,000	$8,750,000	$2,500,000
East Van Creek Off-Channel Reservoir	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	1.3	$3,026,000	$3,985,000	$3,065,385
Tronsen Creek Off-Channel Reservoir	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	2.4	$8,629,000	$11,363,000	$4,734,583
East Fork Mission Creek Reservoir	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	1.2	$5,494,000	$7,235,000	$6,029,167
Williams Canyon Off-Channel Reservoir	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	0.9	$4,980,000	$6,558,000	$7,286,667
Derby Canyon Off-Channel Reservoir	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	0.2	$1,824,000	$2,402,000	$12,010,000
Typical 5 AF Reservoir	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	0.1	$633,000	$834,000	$11,914,286
Ollala Canyon Off-Channel Reservoir	*Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed*	Concept	2006	Storage	0.1	$1,614,000	$2,125,000	$21,250,000
Campbell Creek Off-Channel Reservoir	*Campbell Creek Reservoir Feasibility Study*	Feasibility-level	2010	Storage	16.0	$18,380,000	$21,443,000	$1,340,188
Upper and Lower Snow Lakes Storage Enhancement	*Water Storage Report, Wenatchee River Basin*	Concept	2011	Storage	18.0	$1,228,000	$1,361,000	$75,611
Eightmile Lake Storage Restoration	*Feasibility Study; Eightmile Lake Storage Restoration*	Feasibility-level	2017	Storage	21.0	$2,974,000	$2,974,000	$141,619
Alpine Lakes Storage Automation and Optimization	*Feasibility Study; Alpine Lakes Optimization and Automation*	Feasibility-level	2017	Storage	30.0	$876,000	$876,000	$29,200
PID Piping Project	Project Bids and Design Estimate	Constructed	2011	Irrigation Efficiency	1.2	$920,000	$1,020,000	$850,000
Pioneer Water Users Association	Project Sponsor Provided Information	Constructed	2014	Irrigation Efficiency	15.0	$3,500,000	$3,646,000	$243,000
Wenatchee-Chiwawa Irrigation District, Gravity Pipe	*Wenatchee-Chiwawa Irrigation District Appraisal Study*	Appraisal-level	2014	Irrigation Efficiency	7.2	$4,070,000	$4,240,000	$588,889
COIC Irrigation Efficiency Project	*Cascade Orchards Irrigation Company - Conceptual Design Update*	Appraisal-level	2014	Irrigation Efficiency	11.9	$4,643,000	$4,837,000	$406,471
IPID Full Piping Project	*IPID Conservation Plan – Full Piping Option*	Concept	2017	Irrigation Efficiency	117.0	$83,710,000	$83,710,000	$715,470
IPID Pump Exchange at Dryden - 50 cfs	*Summary of Additional Analysis, IPID Pump Exchange*	Appraisal-level	2015	Pump Exchange	50.0	$8,150,000	$8,580,000	$171,600
LNFH Effluent Pump Back - 15 cfs	*2015 Emergency Effluent Pump Back Evaluation, LNFH Effluent Pump Back*	Appraisal-level	2016	Pump Exchange	15.0	$839,000	$867,000	$57,800
LNFH Effluent Pump Back - 28 cfs	*2015 Emergency Effluent Pump Back Evaluation, LNFH Effluent Pump Back*	Appraisal-level	2016	Pump Exchange	28.0	$998,000	$1,032,000	$36,857
LNFH Circular Tanks	*Leavenworth Fisheries Complex Planning Report*	Concept	2016	Hatchery Efficiency	20.0	$6,400,000	$6,616,000	$330,800

Notes:
1. Project costs were inflated from the year the opinion of cost was developed to 2017 using Reclamation's Construction Cost Trends.

10 Recommendations

This updated IPID CWCP is intended to be a tool that IPID can use to plan for improvements to the irrigation delivery systems and ensure that water is managed and delivered efficiently. Improved efficiency of water use will provide greater flexibility and reliability in delivering water to meet shareholder needs. Improved efficiency will also reduce the amount of water that has to be diverted from natural systems to meet those needs. Reducing diversions will provide benefits to other uses of water in the Icicle and Peshastin Creek Subbasins within the Wenatchee River Watershed.

This CWCP includes a prioritized set of recommendations for improvement and management of the irrigation district for the next 25 years. The key recommendations are as summarized as follows:

- **High Priority (Next 1 to 5 Years):**
  - Continue to inventory and upgrade, as needed, turnout boxes, weirs, and valves throughout both the IID and PID delivery systems.
  - Continue to work toward completing the merger of the two irrigation districts.
  - Continue to refine and maintain IPID mapping. The mapping that was completed as part of the system inventory for this CWCP is available to IPID and will continue to be used to improve documentation of the existing irrigation delivery systems.
  - Complete replacement of the fish screens at the IPID diversion on Icicle Creek. As part of that project, upgrade the head gates, diversion canal, and flow monitoring equipment to ensure efficient diversion and improved monitoring of diversions.
  - Complete inspection and repair or replacement of canal lining in high priority segments of the canal system. Where appropriate, replace open canals with piping. Canal segments targeted as high priority include:
    - IID Division 2, from Station 400+00 to Station 412+00, upstream of the tunnel.
    - IID Division 3A, Carson's Pipeline.
    - IID Division 3A, from Station 840+00 to Station 871+00, including the open canal upstream of the sand tunnels and the sand tunnels.
    - IID Division 3A, from Station 934+00 to Station 1078+00, including open canal downstream between Brender Spill No. 2 and the Mission Siphon.
    - IID Division 3B, from the Weed Screen Spill to the first siphon downstream of the Weed Screen Spill
    - PID Canal, from the diversion to the Fryburger Spill.
  - Replace key siphons and structures, including:
    - IID Division 3B Siphon downstream of the Weed Screen Spill.
    - PID Fryburger Spill.
    - PID Crossover under Peshastin Creek.

- **Medium Priority (Next 6 to 8 Years):**
  - Reevaluate efforts to encourage on-farm conservation. Target those efforts on non-orchard users that may not be using water as efficiently as orchard users.
  - Improve automation, flow monitoring, and control by installing automated control gates on key spills, installing transducers to measure flows at key control locations, and establishing remote control of key facilities.
  - Replace the Snow Creek pickup gate and flume.
  - Replace the temporary steel flume that was installed near the upstream end of the IID Division 1 Canal.
  - Complete inspection and repair or replacement of canal lining in medium priority segments of the canal system. Where appropriate, replace open canals with piping. Canal segments targeted as medium priority include:
    - IID Division 2, from Station 418+00 to Station 568+00, downstream of tunnel.
    - IID Division 3A, from the Division 3A Siphon outlet to Carson's Pipeline.
    - PID Main Canal, where unlined, partially lined, or fully lined but cracking from Dryden down to the Stines Hill Spill.
  - Replace siphons and structures, including:
    - IID Division 3B Siphons from Station 1260+00 to 1314+00.
    - IID Division 3B End Spill.
- **Low to Medium Priority (Next 9 to 15 Years):**
  - Complete inspection and repair or replacement of canal lining in low to medium priority segments of the canal system. Where appropriate, replace open canals with piping. Canal segments targeted as low to medium priority include:
    - IID Division 1, from the Mountain Home Spill to the Van Brocklin Spill.
    - PID Main Canal, from Station 443+00 to 545+00, around the north and east sides of Stines Hill.
  - Replace siphons and structures, including:
    - IID Division 3A Siphon Outlet.
    - IID Division 3A Maxwell Siphon.
    - IID Division 3A Brender Spill and Siphon.
    - IID Division 5 Moe Siphon.
    - IID Division 5 Chumstick Siphon.
- **Low Priority (Next 16 to 25 Years):**
  - Complete inspection and repair or replacement of canal lining in low priority segments of the canal system. Where appropriate, replace open canals with piping. Canal segments targeted as low priority include:
    - IID Division 4, from Station 112+00 to 187+00.
  - Replace siphons and structures, including:

- IID Leavenworth Bifurcation.
- IID Division 3B Mission Siphon, with inlet and outlet structures.
- Weed screen (relocate the weed screen to the upstream side of the 52-inch pipeline in Division 3B at Station 1187+00).
- IID Division 3B Weed Screen Spill.
- Leavenworth Siphon (replace grating and rails on pipe bridge).

An opinion of costs was developed for each project. Overall, the recommended improvement plan includes $17.1 to $19.2 million for projects in the IID delivery system and $9.6 to $10.8 million for projects in the PID delivery system. The costs of the projects, subtotaled by priority, are as follows:

- High Priority (Next 1 to 5 Years): $6.4 to $7.3 million
- Medium Priority (Next 6 to 8 Years): $11.5 to $12.8 million
- Low to Medium Priority (Next 9 to 16 Years): $5.6 to $6.4 million
- Low Priority (Next 16 to 25 Years): $3.2 to $3.6 million

These costs represent the total project costs, which assume that IPID will contract out construction of the projects and that projects will incur costs associated with engineering, permitting, and administration. If IPID self-performs the work, as they have done in the past, there will be a significant cost savings. IPID will need to weigh staffing and resources with the need to complete projects before infrastructure fails or becomes inefficient.

It is recommended that IPID consider pursuing outside funding for key projects. Projects that will likely receive greatest consideration by potential funding partners will be those projects that offer the greatest water savings, which would then be used to improve instream flows. It is recommended that IPID review project priorities, determine which projects are most likely to receive funding, and work with a local project sponsor, such as other members of the IWG, to secure funding for key improvements that have potential to provide the largest conservation savings.

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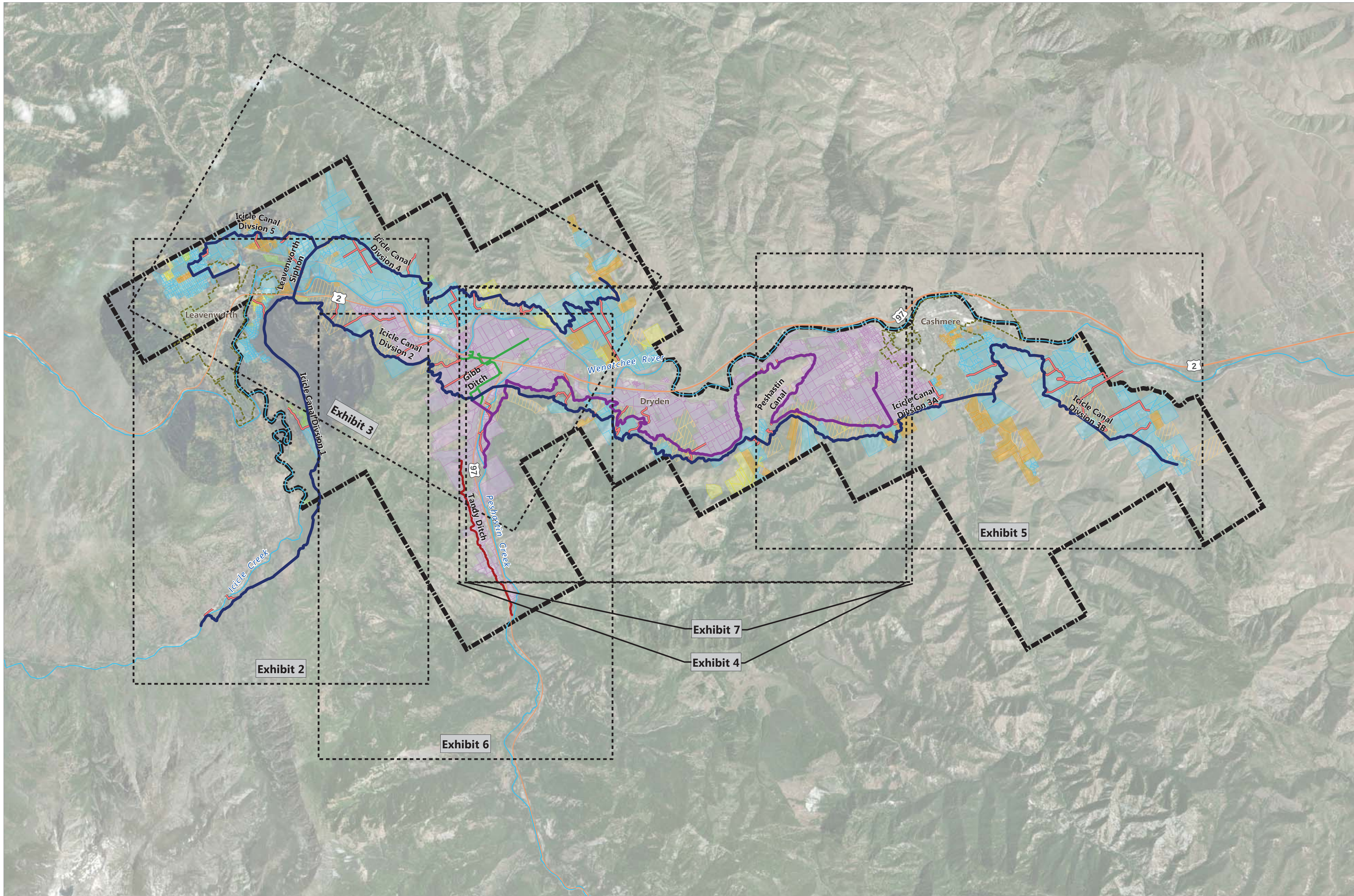
Appendix A
Existing Irrigation Infrastructure Maps



LEGEND:

- Icicle Canal
- Peshastin Canal
- Tandy Ditch
- Gibb Ditch
- Ditch Access Route
- Icicle Shares
- Peshastin Shares
- Black Water Shares
- Contract Shares
- Rental Shares
- Multiple Share Types
- District Boundary
- City Boundary

NOTES:

1. Source, Aerial Photography: ESRI
2. Source, GIS Base Layers and Ditch Information: From GIS data provided by IPID, as collected by TU and others, and from GIS data collected by Anchor QEA and IPID as part of the field inventory for development of the IPID Comprehensive Water Conservation Plan.
3. Horizontal Datum: NAD 1983 Washington State Plane North, U.S. Survey Feet

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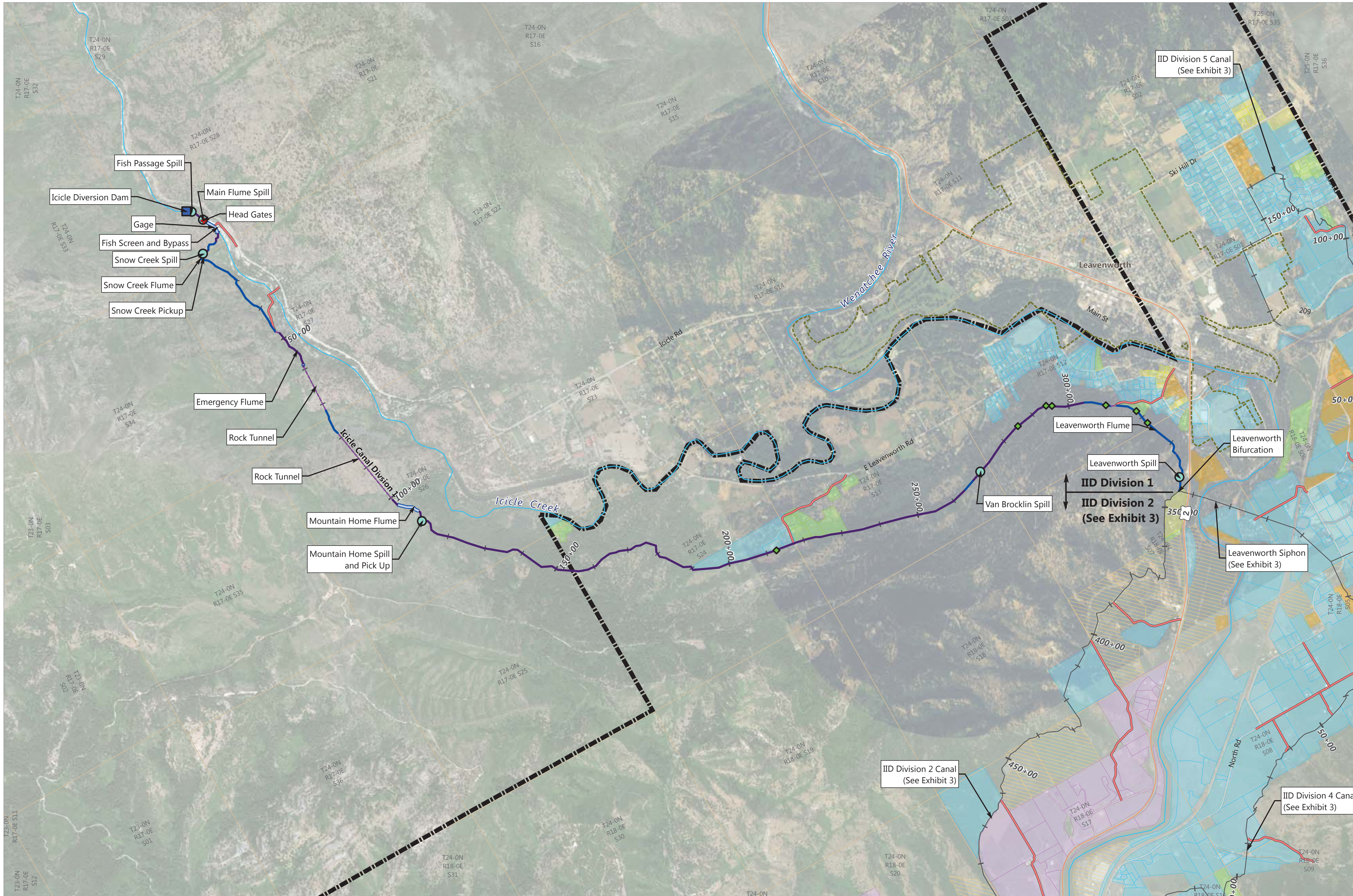
ANCHOR QEA

Exhibit 1
Overall Index Map
Comprehensive Water Conservation Plan
Icicle and Peshastin Irrigation Districts

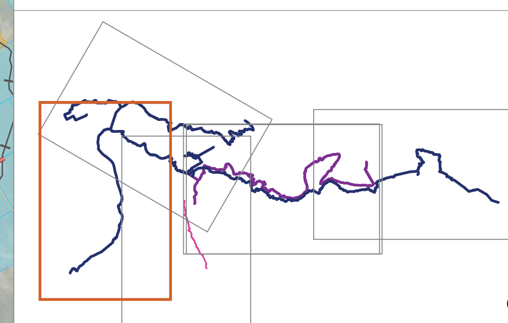


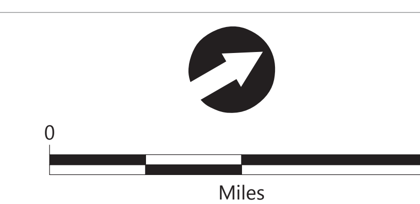
LEGEND:

- Flow Control
- Headgate
- Weir
- Delivery Box
- Spill
- Diversion Structure
- Air Vent
- Fully-lined Concrete Canal
- Partially-lined Concrete Canal
- Unlined Canal
- Pipe or Siphon
- Tunnel
- Flume
- Ditch Access Route
- Icicle Shares
- Peshastin Shares
- Black Water Shares
- Contract Shares
- Rental Shares
- Multiple Share Types
- District Boundary
- City Boundary
- Section Boundary

NOTES:

1. Source, Aerial Photography: ESRI
2. Source, GIS Base Layers and Ditch Information: From GIS data provided by IPID, as collected by TU and others, and from GIS data collected by Anchor QEA and IPID as part of the field inventory for development of the IPID Comprehensive Water Conservation Plan.
3. Horizontal Datum: NAD 1983 Washington State Plane North, U.S. Survey Feet





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ANCHOR QEA

Exhibit 2
Icicle Division 1 Canal
Comprehensive Water Conservation Plan
Icicle and Peshastin Irrigation Districts

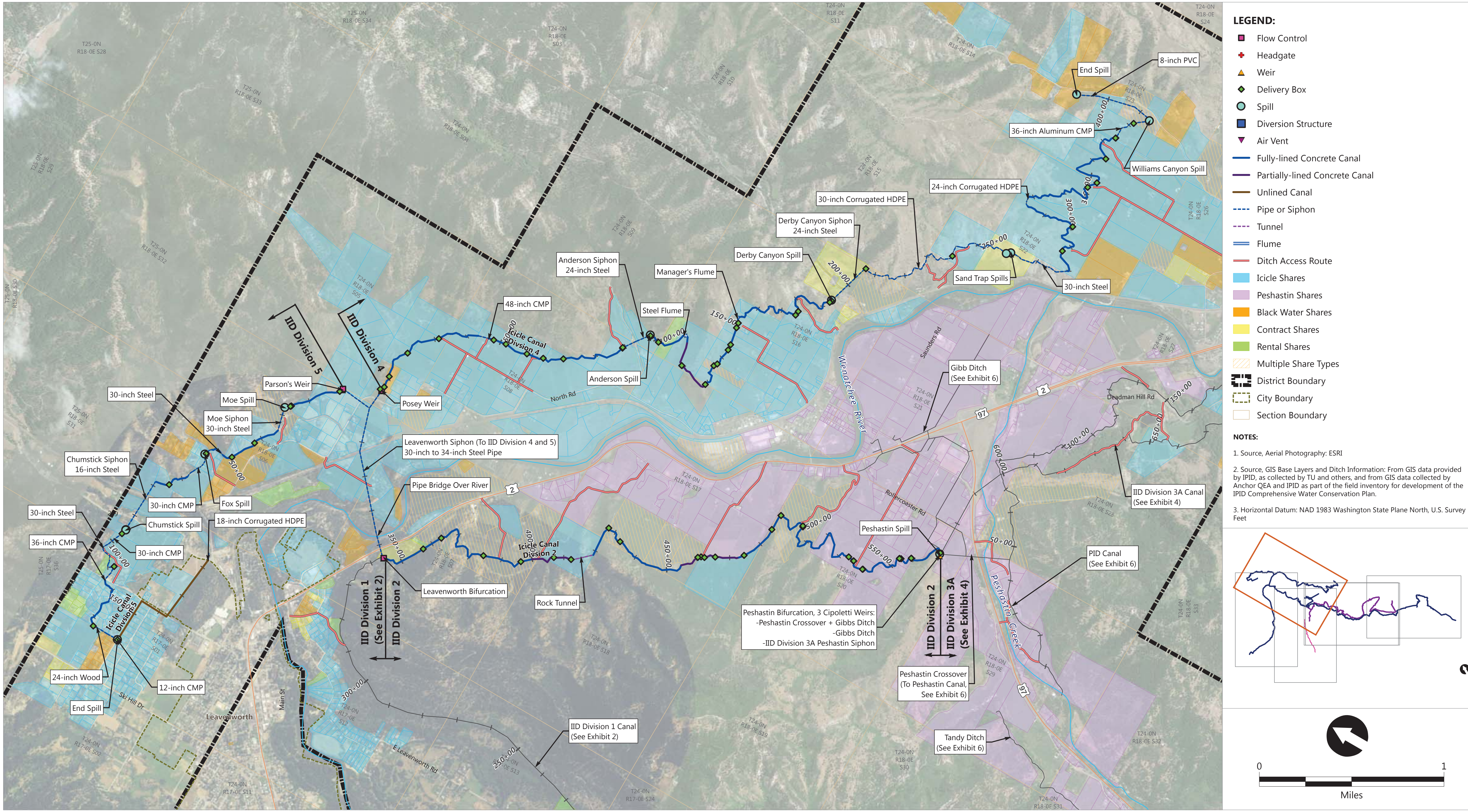

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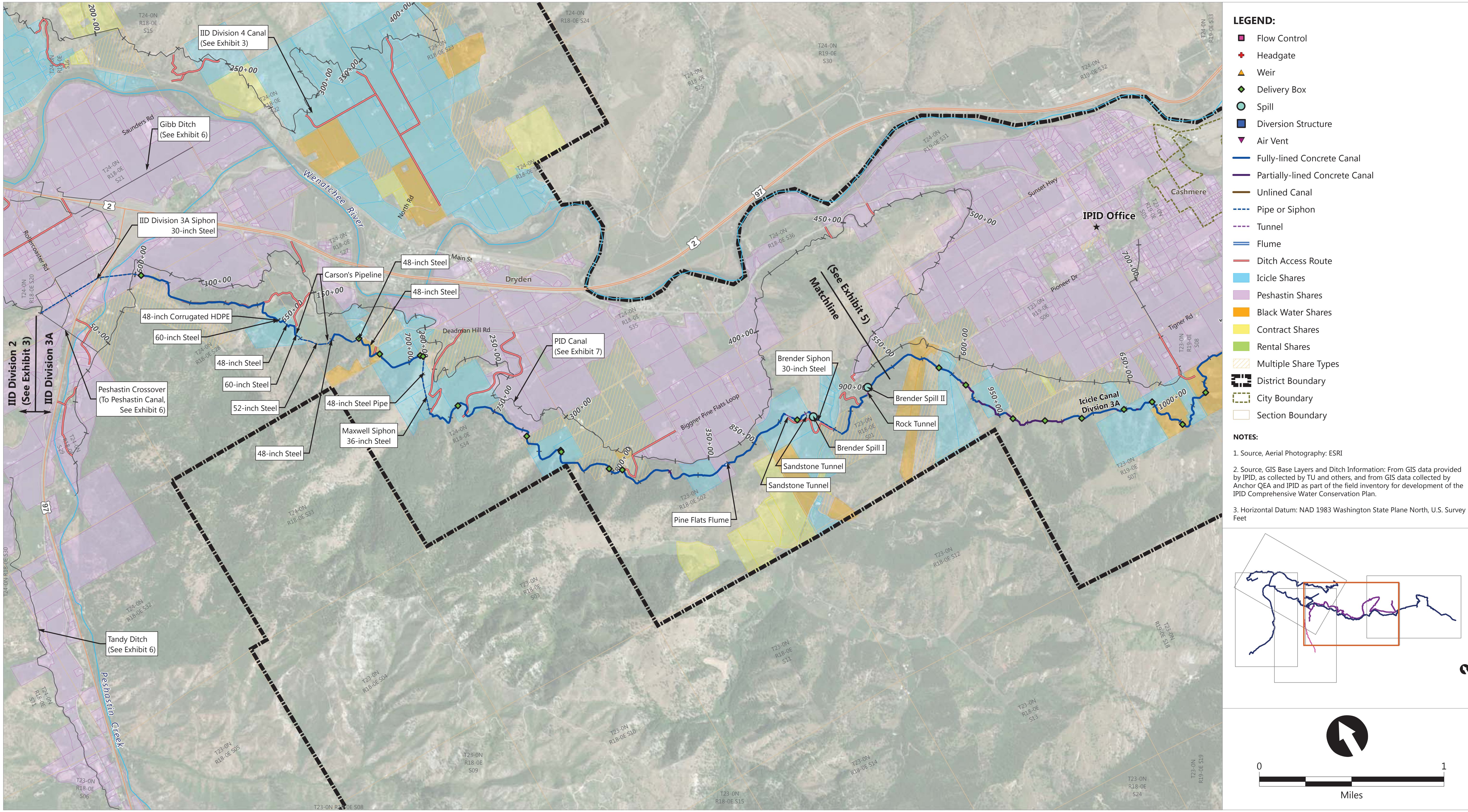
Exhibit 3
Icicle Division 2, 4, and 5 Canals
Comprehensive Water Conservation Plan
Icicle and Peshastin Irrigation Districts



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ANCHOR QEA

Exhibit 4
Icicle Division 3A Canal
Comprehensive Water Conservation Plan
Icicle and Peshastin Irrigation Districts

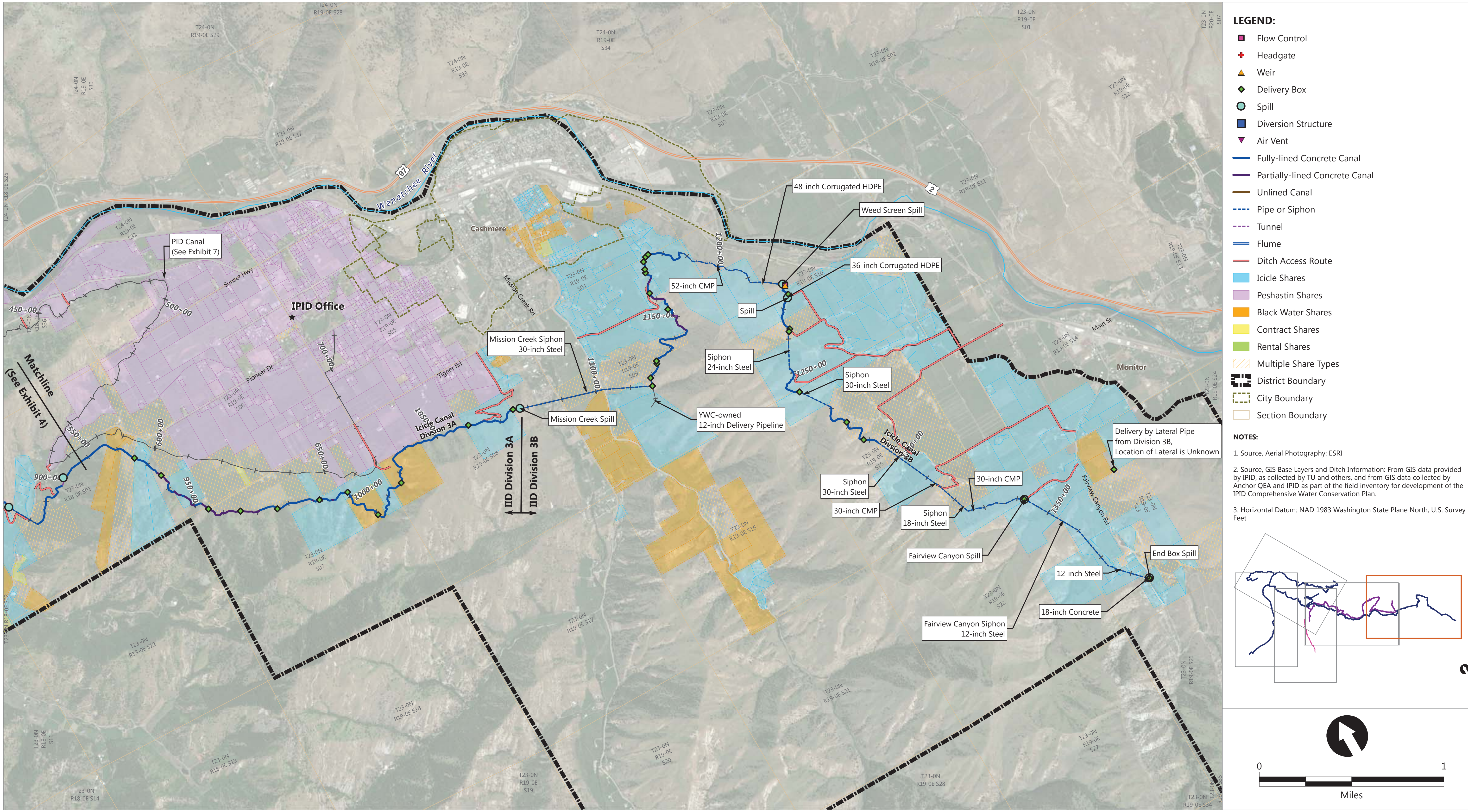

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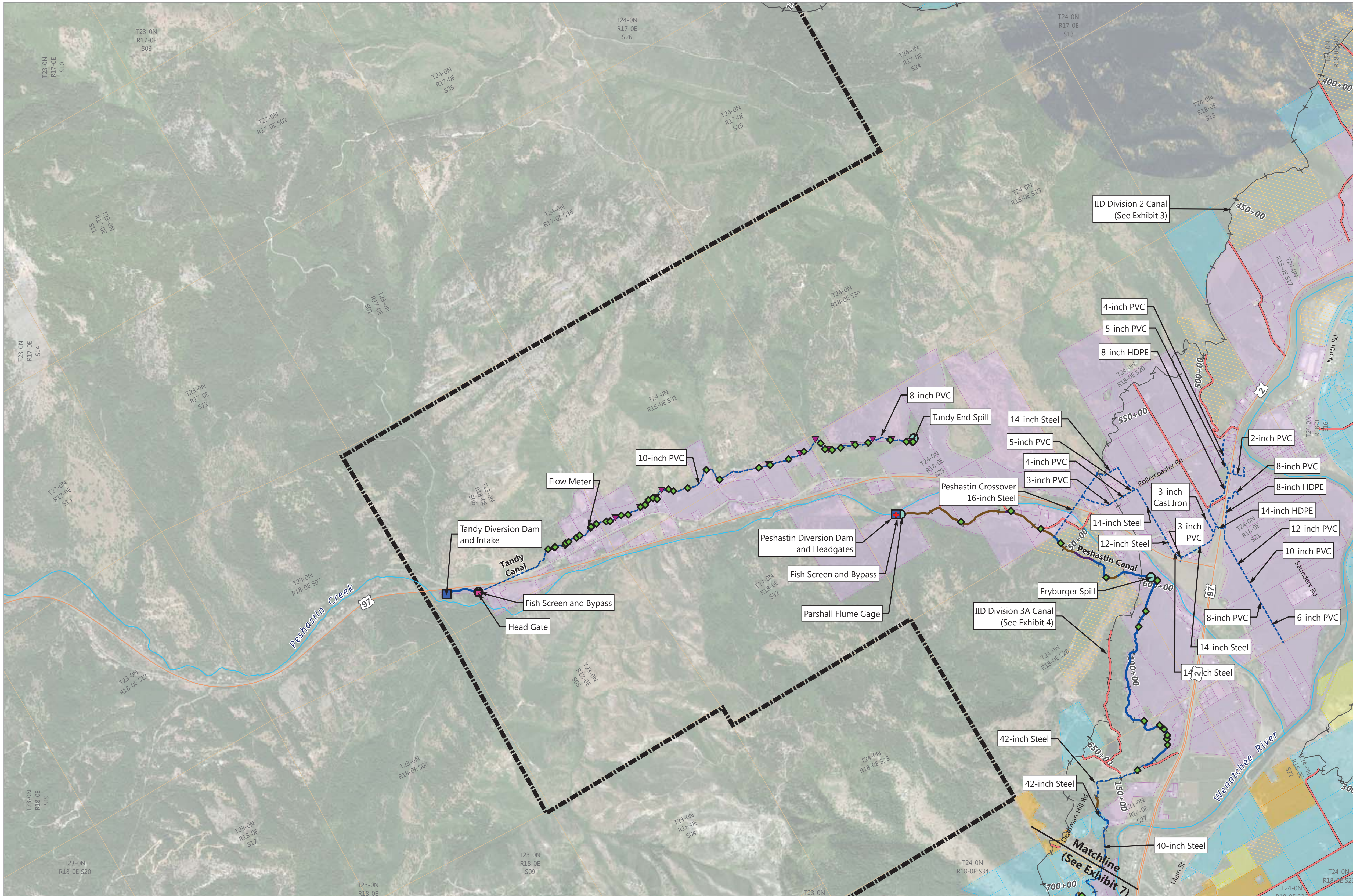
Exhibit 5
Icicle Division 3A and 3B Canals
Comprehensive Water Conservation Plan
Icicle and Peshastin Irrigation Districts

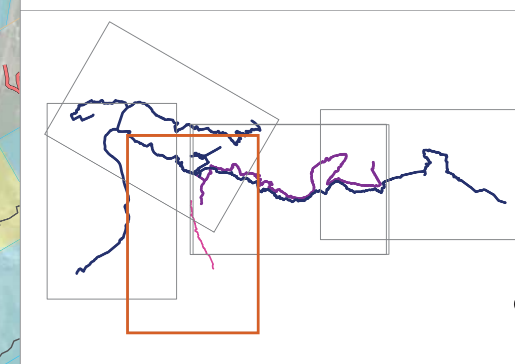


LEGEND:

- Flow Control
- Headgate
- Weir
- Delivery Box
- Spill
- Diversion Structure
- Air Vent
- Fully-lined Concrete Canal
- Partially-lined Concrete Canal
- Unlined Canal
- Pipe or Siphon
- Tunnel
- Flume
- Ditch Access Route
- Icicle Shares
- Peshastin Shares
- Black Water Shares
- Contract Shares
- Rental Shares
- Multiple Share Types
- District Boundary
- City Boundary
- Section Boundary

NOTES:

1. Source, Aerial Photography: ESRI
2. Source, GIS Base Layers and Ditch Information: From GIS data provided by IPID, as collected by TU and others, and from GIS data collected by Anchor QEA and IPID as part of the field inventory for development of the IPID Comprehensive Water Conservation Plan.
3. Horizontal Datum: NAD 1983 Washington State Plane North, U.S. Survey Feet



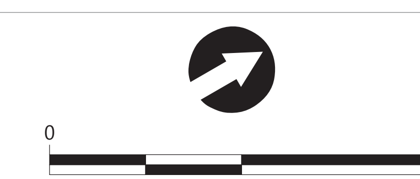


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Exhibit 6
Tandy Ditch, Gibb Ditch, and Peshastin Canal
Comprehensive Water Conservation Plan
Icicle and Peshastin Irrigation Districts

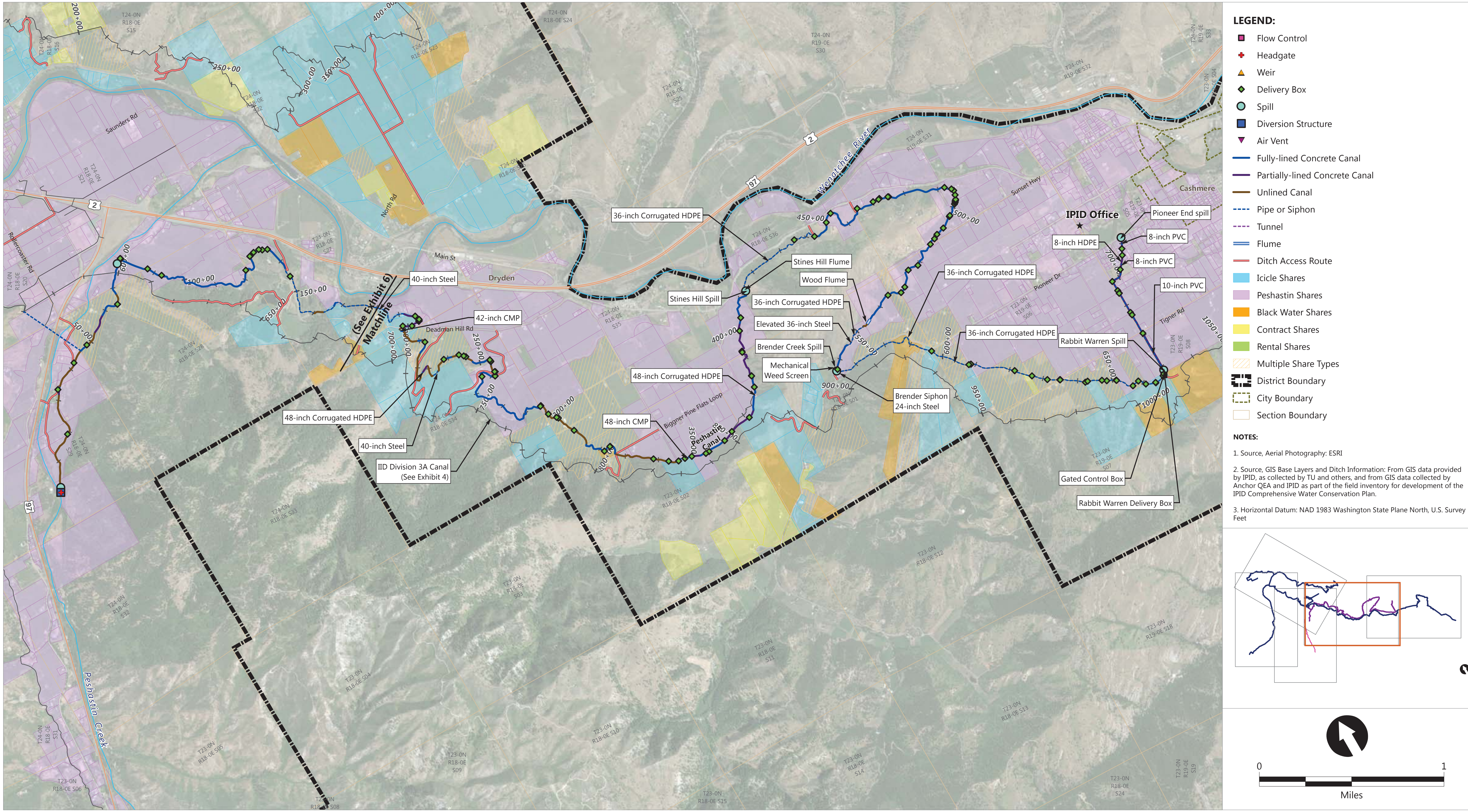

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Exhibit 7
Peshastin Canal
Comprehensive Water Conservation Plan
Icicle and Peshastin Irrigation Districts

Appendix B
Weir Stage-Discharge Ratings

IPID Comprehensive Water Conservation Plan
IPID Delivery Systems
Stage-Discharge Ratings

IID Leavenworth Bifurcation 6-foot Cipoletti Weir (To IID Division 4 and 5)		**IID Peshastin Bifurcation 6-foot Cipoletti Weir (To IID Division 3A)**		**IID Peshastin Bifurcation 6-foot Cipoletti Weir ("Spillway", to PID and Gibbs)**		**IID Peshastin Bifurcation 4-foot Cipoletti Weir (To Gibbs Ditch Pipeline)**		**IID Posey Weir 6-foot Cipoletti Weir (Upstream End of IID Division 4)**		**IID Posey Weir 7-foot Cipoletti Weir (Upstream End of IID Division 5)**	
Gage Reading (feet)	**Q (cfs)**	**Gage Reading (feet)**	**Q (cfs)**	**Gage Reading (feet)**	**Q (cfs)**	**Gage Reading (feet)**	**Q (cfs)**	**Gage Reading (feet)**	**Q (cfs)**	**Gage Reading (feet)**	**Q (cfs)**
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.1	0.6	0.1	0.6	0.1	0.6	0.1	0.4	0.1	0.6	0.1	0.7
0.2	1.8	0.2	1.8	0.2	1.8	0.2	1.2	0.2	1.8	0.2	2.1
0.3	3.3	0.3	3.3	0.3	3.3	0.3	2.2	0.3	3.3	0.3	3.9
0.4	5.1	0.4	5.1	0.4	5.1	0.4	3.4	0.4	5.1	0.4	6.0
0.5	7.1	0.5	7.1	0.5	7.1	0.5	4.8	0.5	7.1	0.5	8.3
0.6	9.4	0.6	9.4	0.6	9.4	0.6	6.3	0.6	9.4	0.6	11.0
0.7	11.8	0.7	11.8	0.7	11.8	0.7	7.9	0.7	11.8	0.7	13.8
0.8	14.5	0.8	14.5	0.8	14.5	0.8	9.6	0.8	14.5	0.8	16.9
0.9	17.2	0.9	17.2	0.9	17.2	0.9	11.5	0.9	17.2	0.9	20.1
1.0	20.2	1.0	20.2	1.0	20.2	1.0	13.5	1.0	20.2	1.0	23.6
1.1	23.3	1.1	23.3	1.1	23.3	1.1	15.5	1.1	23.3	1.1	27.2
1.2	26.6	1.2	26.6	1.2	26.6	1.2	17.7	1.2	26.6	1.2	31.0
1.3	29.9	1.3	29.9	1.3	29.9	1.3	20.0	1.3	29.9	1.3	34.9
		1.4	33.5	1.4	33.5	1.4	22.3	1.4	33.5	1.4	39.0
		1.5	37.1	1.5	37.1	1.5	24.7	1.5	37.1	1.5	43.3
		1.6	40.9	1.6	40.9	1.6	27.3	1.6	40.9	1.6	47.7
		1.7	44.8	1.7	44.8	1.7	29.9	1.7	44.8	1.7	52.2
		1.8	48.8	1.8	48.8	1.8	32.5	1.8	48.8	1.8	56.9
		1.9	52.9	1.9	52.9	1.9	35.3	1.9	52.9	1.9	61.7
		2.0	57.1	2.0	57.1	2.0	38.1	2.0	57.1	2.0	66.7
Source: Cipoletti Weir Equation Q = 3.367 L $H^{3/2}$, where: L = 6 feet (6-foot weir) H = Water Surface Above Weir Note: At H values greater than 1.3 feet, weir start to become submerged.		Source: Cipoletti Weir Equation Q = 3.367 L $H^{3/2}$, where: L = 6 feet (6-foot weir) H = Water Surface Above Weir		Source: Cipoletti Weir Equation Q = 3.367 L $H^{3/2}$, where: L = 6 feet (6-foot weir) H = Water Surface Above Weir		Source: Cipoletti Weir Equation Q = 3.367 L $H^{3/2}$, where: L = 6 feet (6-foot weir) H = Water Surface Above Weir		Source: Cipoletti Weir Equation Q = 3.367 L $H^{3/2}$, where: L = 6 feet (6-foot weir) H = Water Surface Above Weir		Source: Cipoletti Weir Equation Q = 3.367n L $H^{3/2}$, where: L = 6 feet (6-foot weir) H = Water Surface Above Weir n = Correction Factor (See Note) Note: Weir frequently becomes backwatered. Correction factor, n, applies when backwatered typically between 0.85 and 1.00	

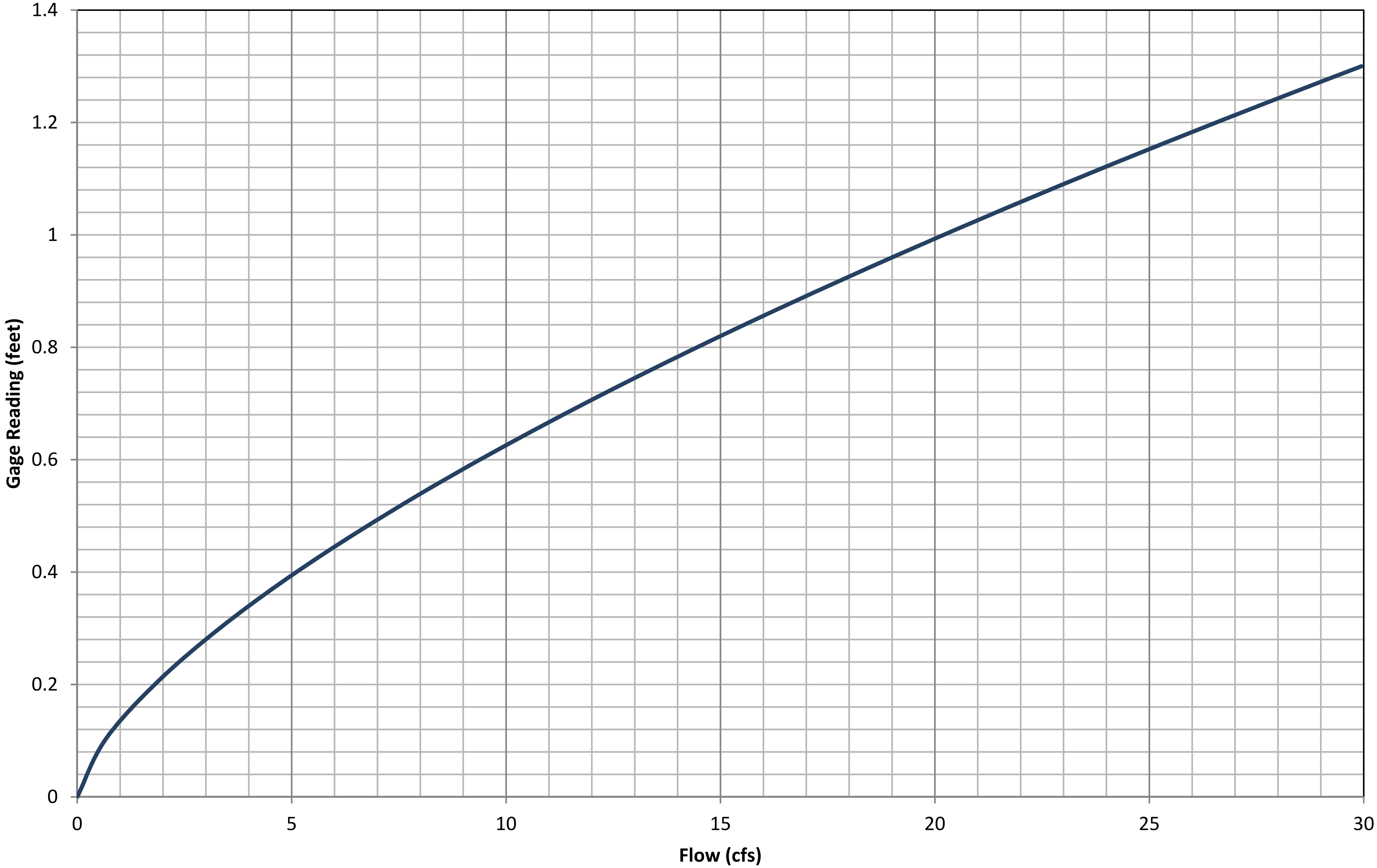


Figure B-1
Stage-Discharge Curve
Leavenworth Bifurcation Weir (To IID Divisions 4 and 5)
IPID Comprehensive Water Conservation Plan

ANCHOR QEA

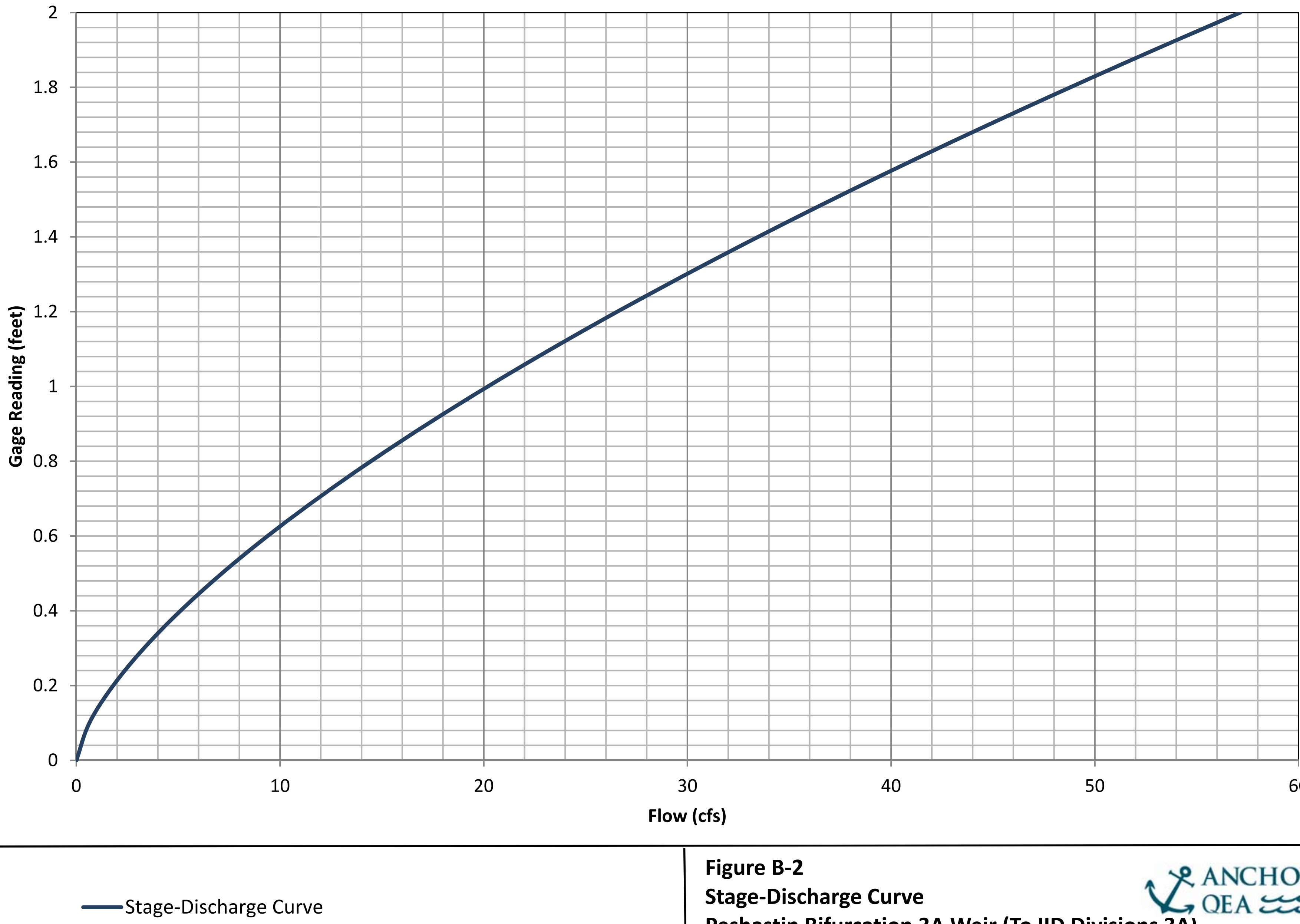
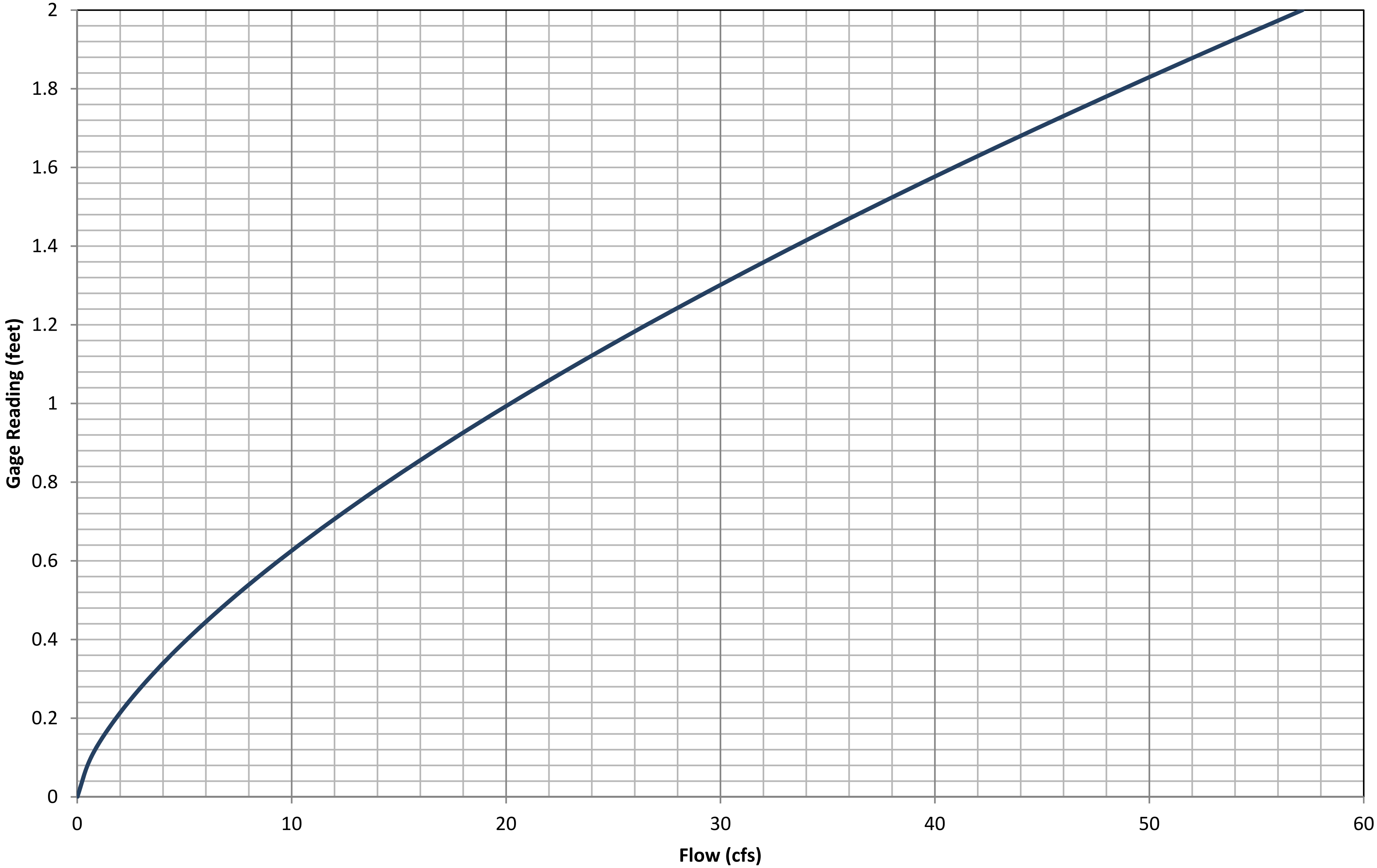


Figure B-2
Stage-Discharge Curve
Peshastin Bifurcation 3A Weir (To IID Divisions 3A)
IPID Comprehensive Water Conservation Plan



Stage-Discharge Curve

Figure B-3
Stage-Discharge Curve
Peshastin Bifurcation Spillway Weir (To PID and Gibbs)
IPID Comprehensive Water Conservation Plan

ANCHOR QEA

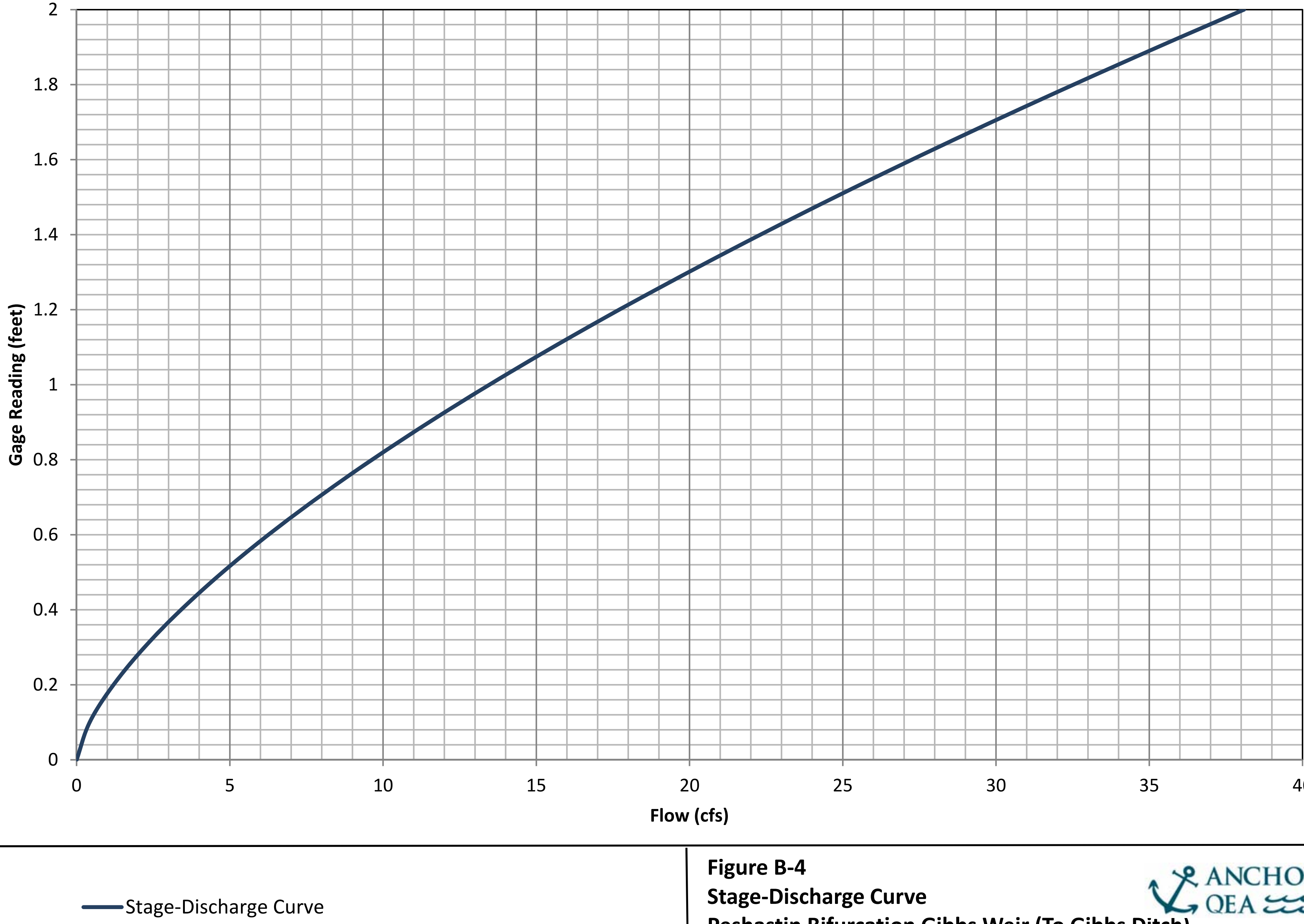


Figure B-4
Stage-Discharge Curve
Peshastin Bifurcation Gibbs Weir (To Gibbs Ditch)
IPID Comprehensive Water Conservation Plan

ANCHOR QEA

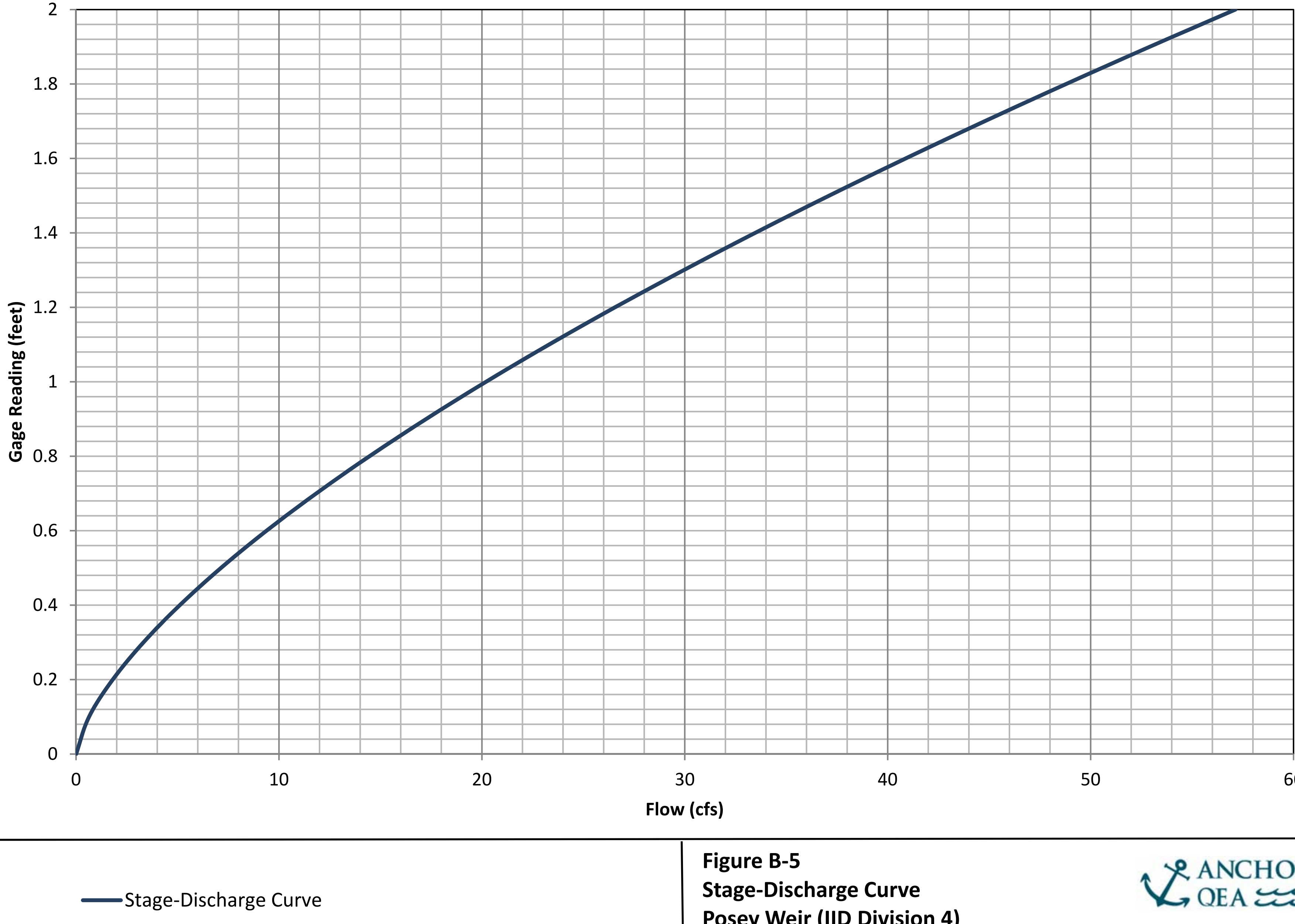
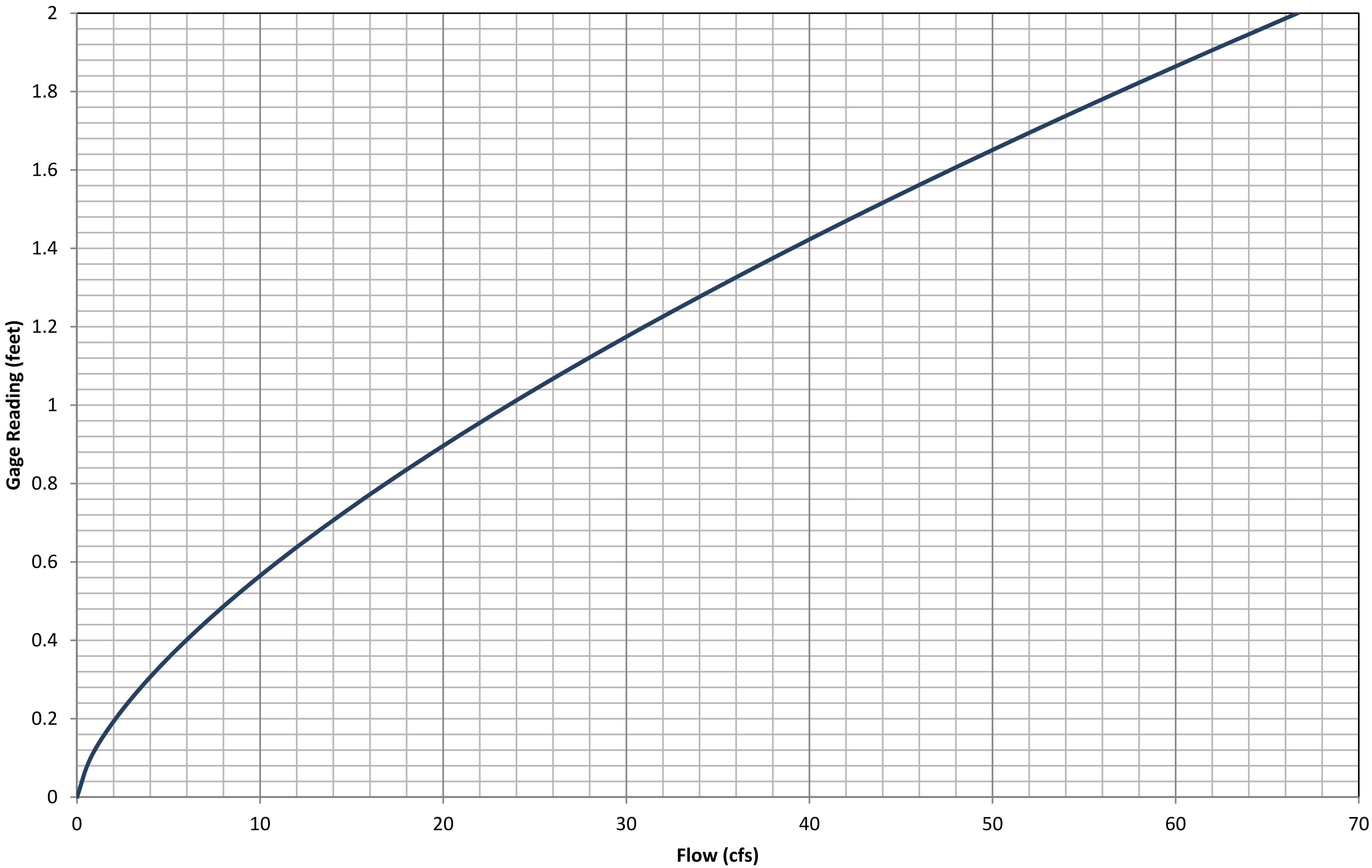


Figure B-5
Stage-Discharge Curve
Posey Weir (IID Division 4)
IPID Comprehensive Water Conservation Plan

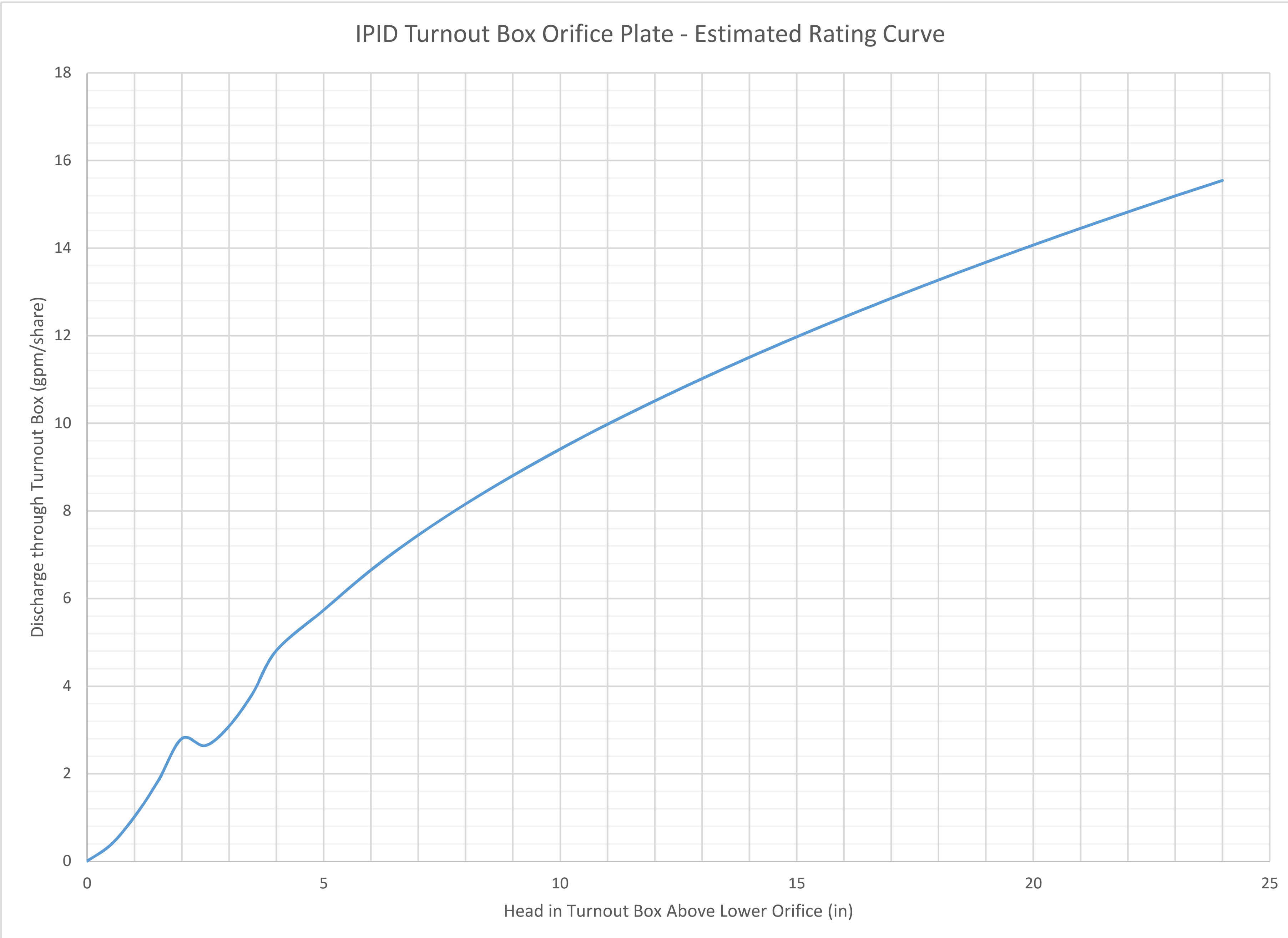
ANCHOR QEA



Note: Weir frequently becomes backwatered. Correction factor, n, applies when backwatered typically between 0.85 and 1.00.

Figure B-6
Stage-Discharge Curve
Parsons Weir (IID Division 5)
IPID Comprehensive Water Conservation Plan

ANCHOR QEA


IPID Turnout Box Orifice Plate - Estimated Rating Curve
Discharge through Turnout Box (gpm/share)
Head in Turnout Box Above Lower Orifice (in)
0
2
4
6
8
10
12
14
16
18
0
5
10
15
20
25

Appendix C
Flow Monitoring Results

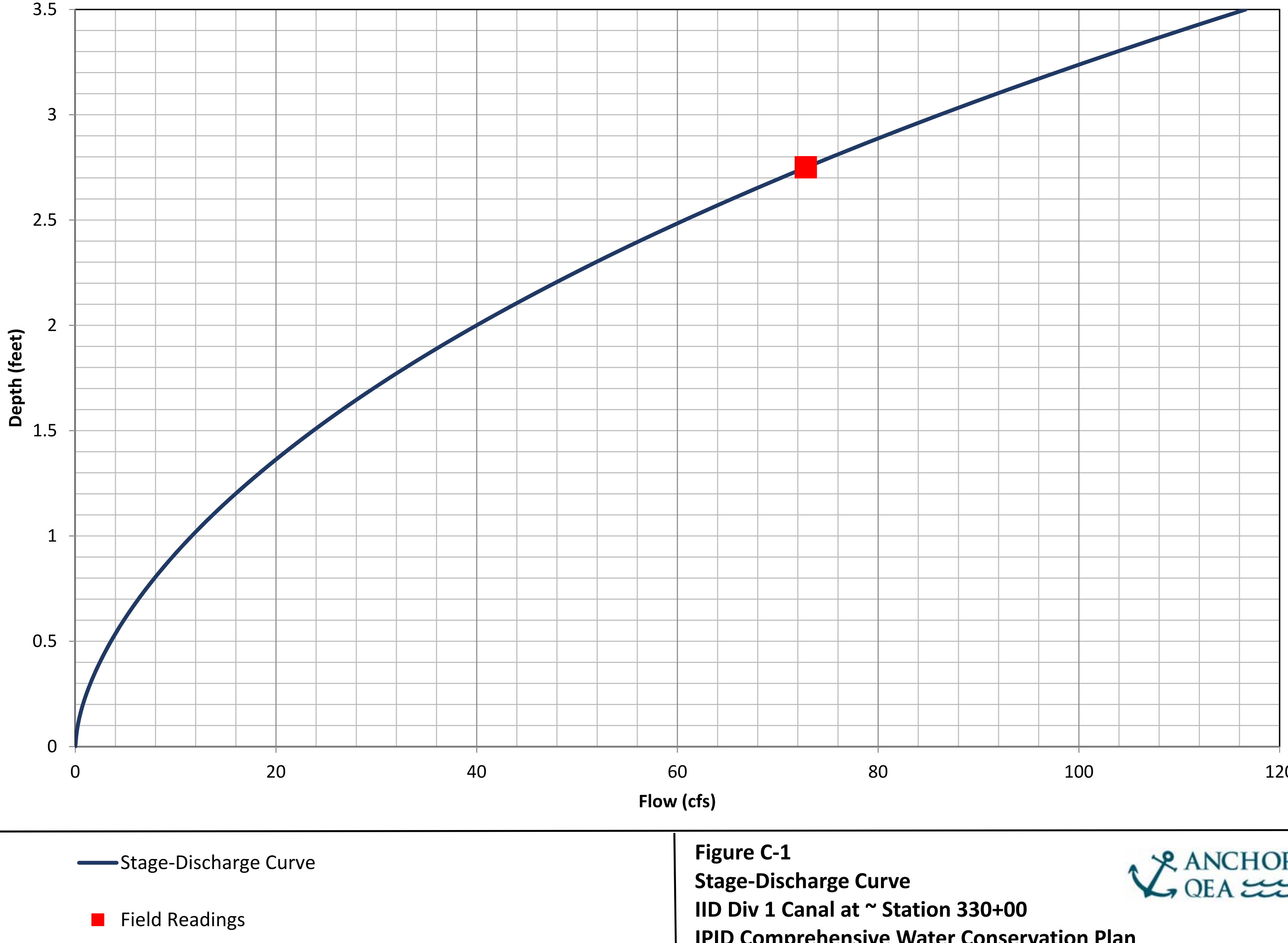
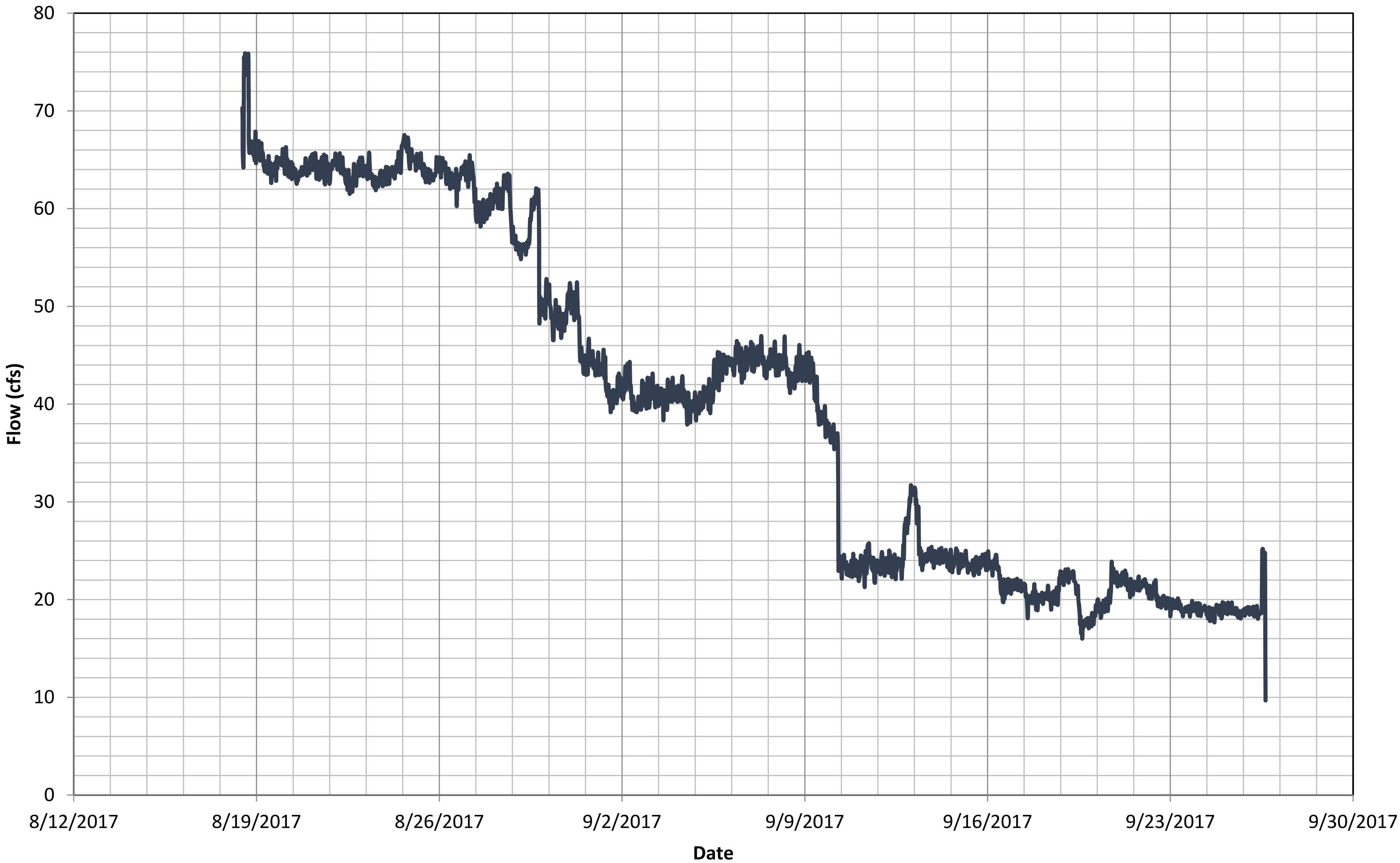


Figure C-1
Stage-Discharge Curve
IID Div 1 Canal at ~ Station 330+00
IPID Comprehensive Water Conservation Plan

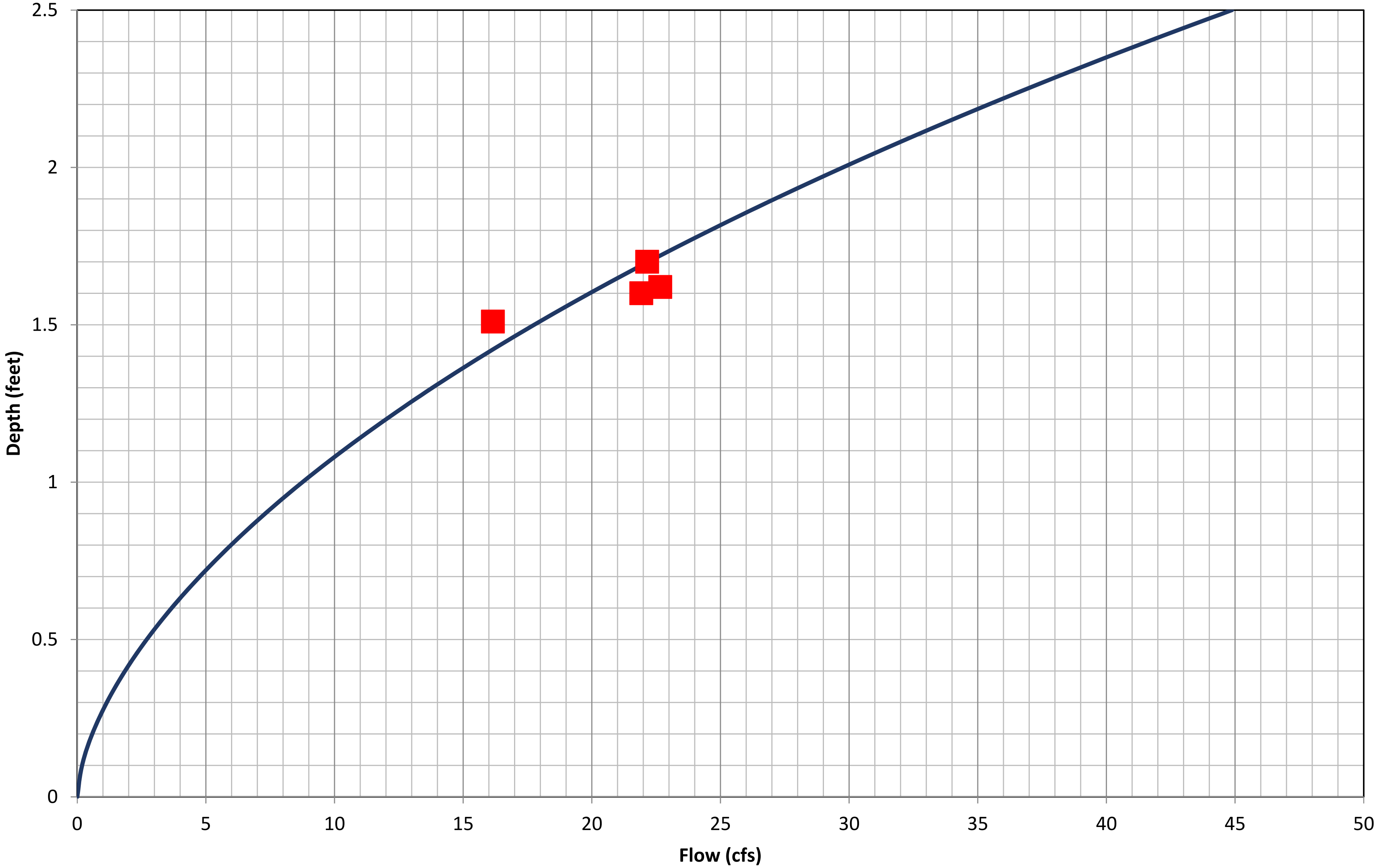
ANCHOR QEA



Estimated Flow from Sensor and Stage-Discharge Curve

Figure C-2
Measured and Estimated Flows
IID Div 1 Canal at ~ Station 330+00
IPID Comprehensive Water Conservation Plan

ANCHOR QEA



Stage-Discharge Curve

Field Readings

Figure C-3
Stage-Discharge Curve
IID Division 3A Canal at ~ Station 725+00
IPID Comprehensive Water Conservation Plan

ANCHOR QEA

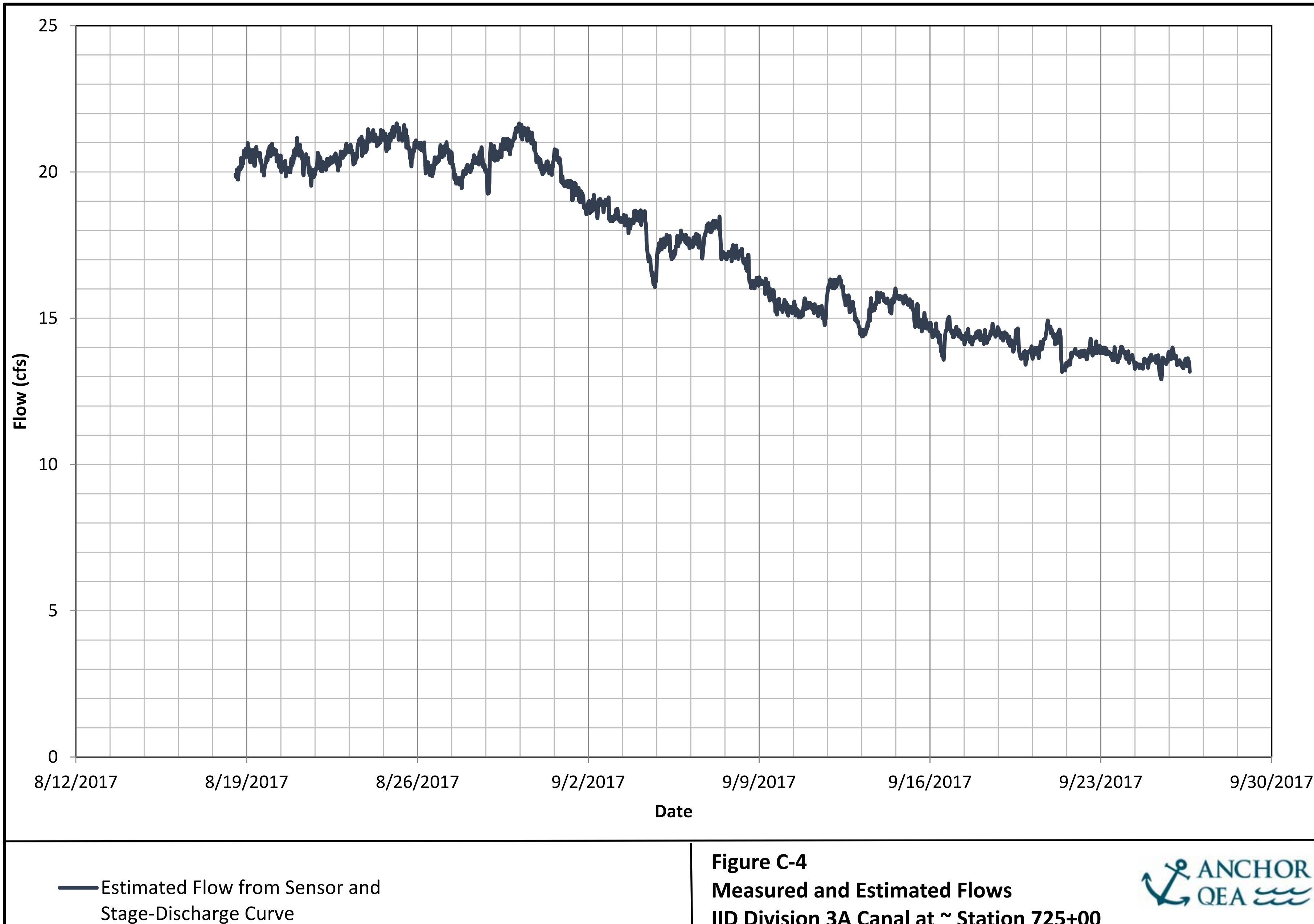


Figure C-4
Measured and Estimated Flows
IID Division 3A Canal at ~ Station 725+00
IPID Comprehensive Water Conservation Plan

ANCHOR QEA

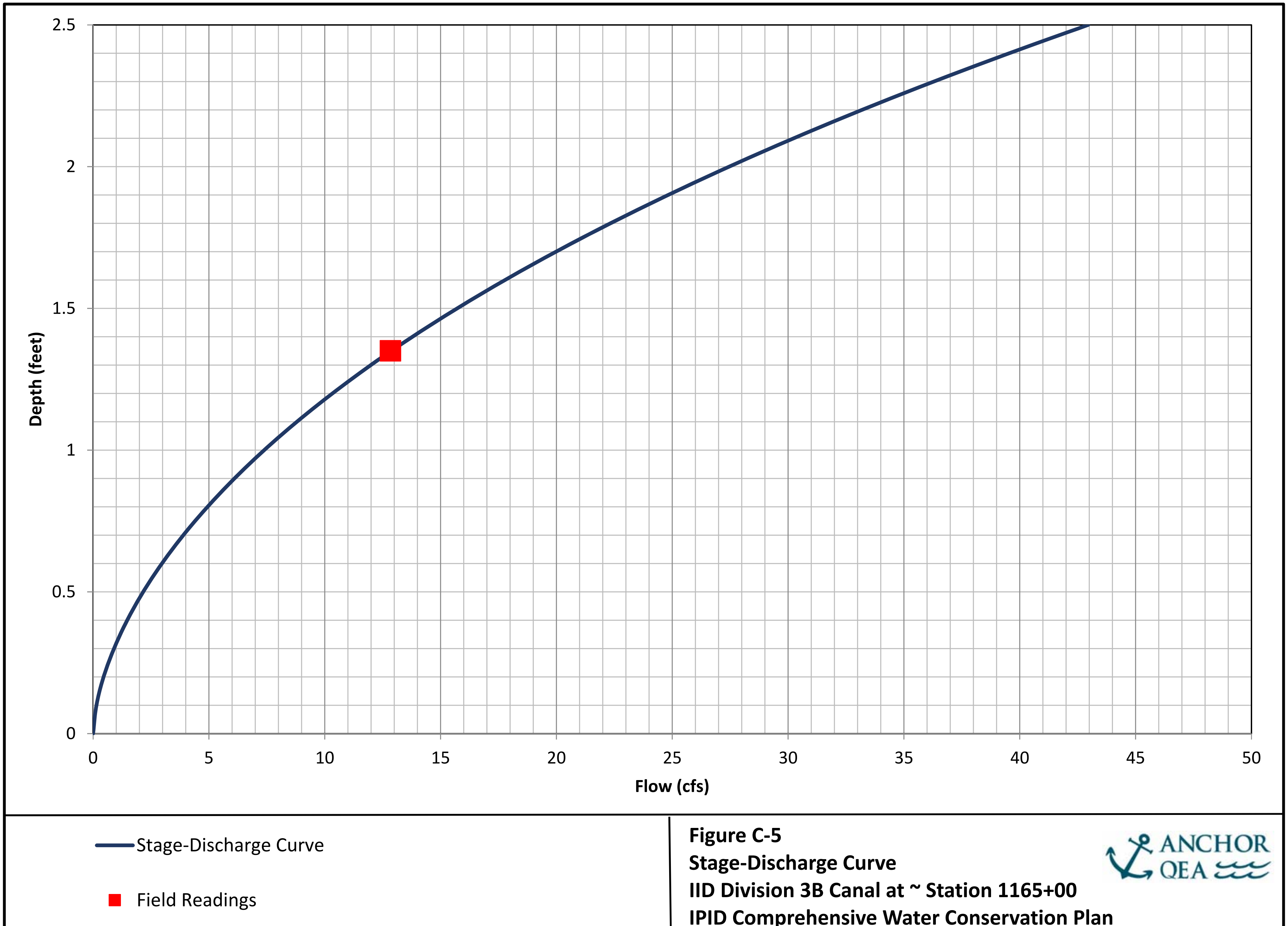
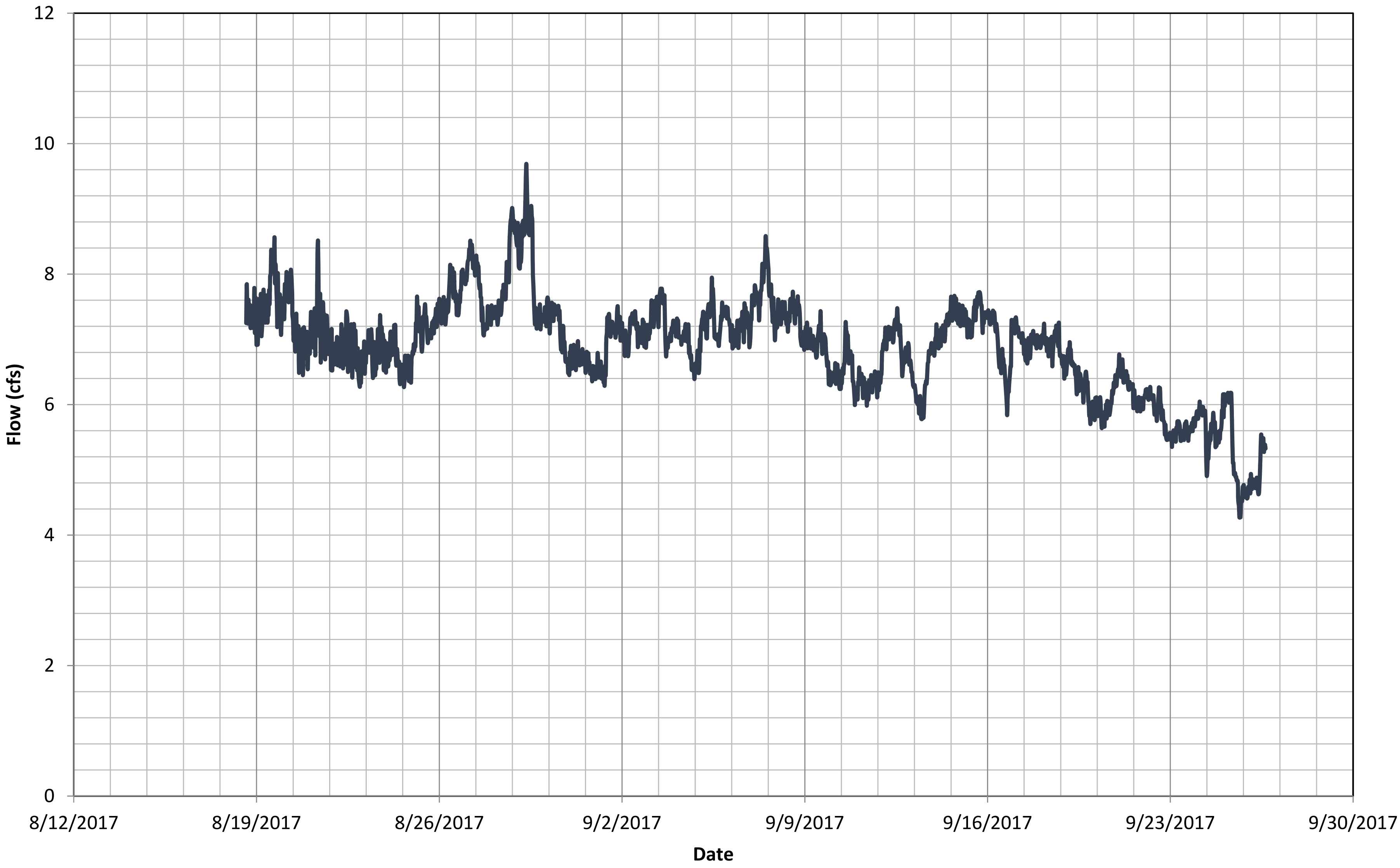


Figure C-5
Stage-Discharge Curve
IID Division 3B Canal at ~ Station 1165+00
IPID Comprehensive Water Conservation Plan



Estimated Flow from Sensor and Stage-Discharge Curve

Figure C-6
Measured and Estimated Flows
IID Division 3A Canal at ~ Station 725+00
IPID Comprehensive Water Conservation Plan

ANCHOR QEA

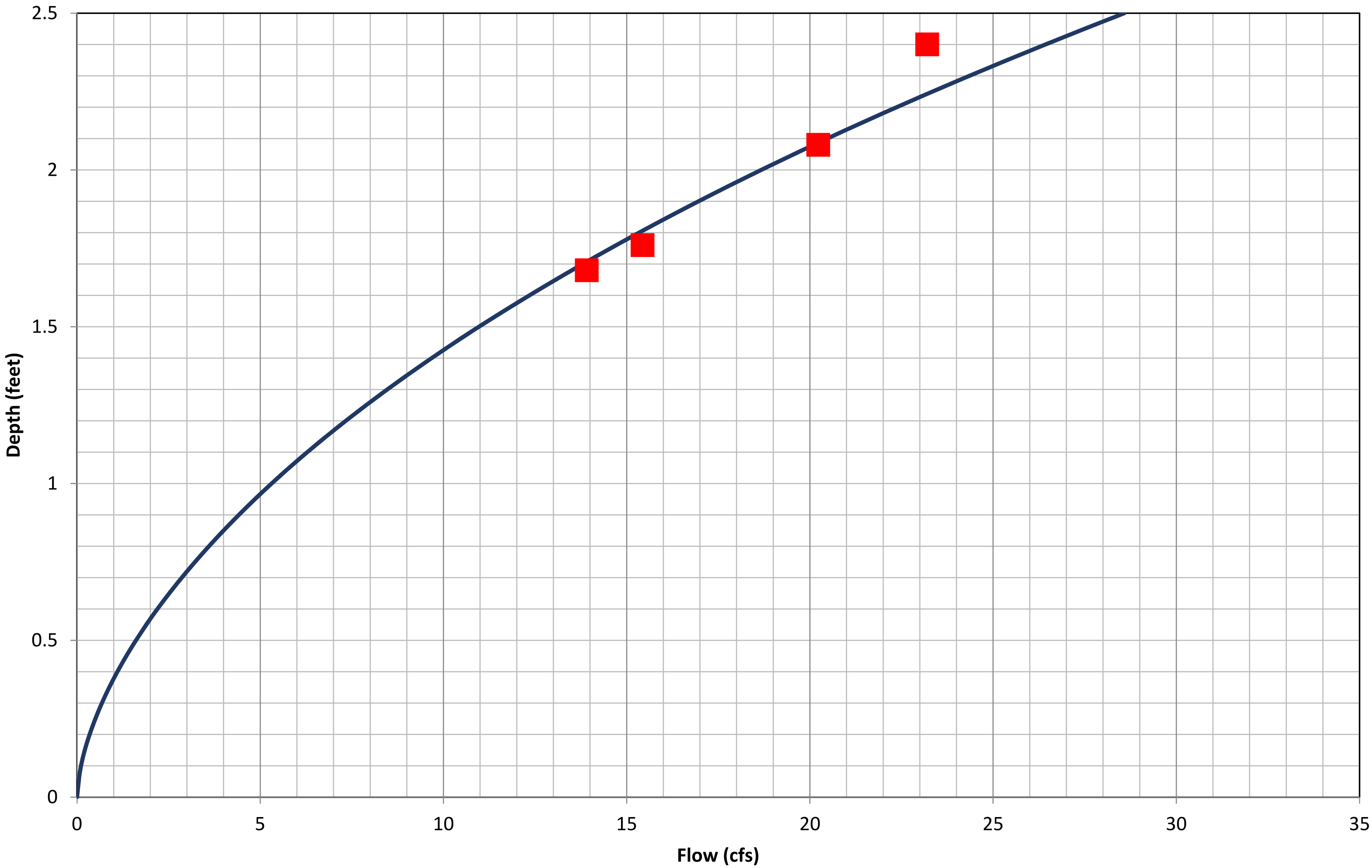


Figure C-7
Stage-Discharge Curve
PID Main Canal at ~ Station 200+00
IPID Comprehensive Water Conservation Plan

ANCHOR QEA

Estimated Flow from Sensor and Stage-Discharge Curve

Figure C-8
Measured and Estimated Flows
PID Main Canal at ~ Station 200+00
IPID Comprehensive Water Conservation Plan

ANCHOR QEA

Appendix D

Water Balance Model

IPID Water Conservation Plan
Water Balance
Summary of Shares and Estimated Water Deliveries

Input
Calculation
Output

VARIABLES:

Maximum Delivery =	6.75	gpm/share

GIS Reach	Station	Station Description	Peshastin Shares	Icicle Shares	Contract Shares	Balck Water Shares	Rental Shares	Total Shares Assigned to Reach	Cumulative Shares Assigned	Deliveries Served from Reach (gpm)	Deliveries Served from Reach (cfs)	Cumulative Downstream Deliveries (gpm)	Cumulative Downstream Deliveries (cfs)
IID Division 1 Canal:													
	+0	Intake											
100			0.00	0.00	0.00	0.00	0.00	0.00	5,148.86	0.00	0.00	34,754.78	77.43
	5+00	Head Gates, Main Spill											
100			0.00	0.00	0.00	0.00	0.00	0.00	5,148.86	0.00	0.00	34,754.78	77.43
	8+00	Fish Screen, Bypass, Spill											
150			0.00	0.00	0.00	0.00	0.00	0.00	5,148.86	0.00	0.00	34,754.78	77.43
	18+00	Snow Creek Spill											
200			0.00	0.00	0.00	0.00	0.00	0.00	5,148.86	0.00	0.00	34,754.78	77.43
	59+00	Rock Tunnel											
300			0.00	0.00	0.00	0.00	0.00	0.00	5,148.86	0.00	0.00	34,754.78	77.43
	111+00	Mountain Home Spill											
400			0.00	1.88	0.00	0.00	1.00	2.88	5,148.86	19.44	0.04	34,754.78	77.43
	187+00	First Turnout Box											
600			0.00	14.00	0.00	0.00	7.00	21.00	5,145.98	141.75	0.32	34,735.34	77.39
	270+00	Van Brocklin Spill											
650			0.00	116.86	4.00	5.70	3.00	129.56	5,124.98	874.56	1.95	34,593.59	77.07
	343+00	Leavenworth Bifurcation											
IID Division 2 Canal:													
700			28.17	74.20	3.00	45.00	1.00	151.37	2,990.02	1,021.75	2.28	20,182.62	44.96
	412+00	Rock Tunnel											
900			264.09	20.58	0.00	0.00	0.00	284.67	2,838.65	1,921.52	4.28	19,160.88	42.69
	473+00	End of Partial Lining											
950			133.62	5.00	0.00	0.00	0.00	138.62	2,553.98	935.69	2.08	17,239.35	38.41
	537+00	Parcel, Mid-Canal											
1000			66.50	0.00	0.00	0.00	0.00	66.50	2,415.36	448.90	1.00	16,303.67	36.32
	568+00	Peshastin Spill											
IID Division 3A Canal:													
1100			0.00	0.00	0.00	0.00	0.00	0.00	1,818.01	0.00	0.00	12,271.56	27.34
	601+00	Peshastin Siphon Outlet											
1100			0.00	24.00	0.00	0.00	0.00	24.00	1,818.01	162.00	0.36	12,271.56	27.34
	658+00	Carson's Pipeline Inlet											
1200			0.00	21.75	1.50	1.00	0.00	24.25	1,794.01	163.69	0.36	12,109.56	26.98
	670+00	Carson's Pipeline Outlet											
1200			0.00	21.75	1.50	1.00	0.00	24.25	1,769.76	163.69	0.36	11,945.87	26.61

IPID Water Conservation Plan
Water Balance
Summary of Shares and Estimated Water Deliveries

Input
Calculation
Output

VARIABLES:

Maximum Delivery =	6.75	gpm/share

GIS Reach	Station	Station Description	Peshastin Shares	Icicle Shares	Contract Shares	Balck Water Shares	Rental Shares	Total Shares Assigned to Reach	Cumulative Shares Assigned	Deliveries Served from Reach (gpm)	Deliveries Served from Reach (cfs)	Cumulative Downstream Deliveries (gpm)	Cumulative Downstream Deliveries (cfs)
	713+00	Maxwell Siphon Inlet											
1600			0.00	9.72	0.00	1.00	0.00	10.72	1,745.51	72.36	0.16	11,782.18	26.25
	722+00	Maxwell Siphon Outlet											
1600			0.00	38.88	0.00	4.00	0.00	42.88	1,734.79	289.44	0.64	11,709.82	26.09
	839+00	Pine Flats Flume											
1900			0.00	31.08	17.50	8.33	0.00	56.91	1,691.91	384.15	0.86	11,420.38	25.44
	862+00	Sandtone Tunnels Inlet											
1900			0.00	13.32	7.50	3.57	0.00	24.39	1,635.00	164.63	0.37	11,036.24	24.59
	873+00	Brender Spill 1											
2100			0.00	18.00	0.00	2.00	0.00	20.00	1,610.61	135.00	0.30	10,871.60	24.22
	900+00	Brender Spill 2											
2200			1.06	18.00	12.00	22.28	0.00	53.34	1,590.61	360.03	0.80	10,736.60	23.92
	970+00	US End Fully-lined Canal											
2400			0.00	32.62	0.00	21.00	0.00	53.62	1,537.27	361.94	0.81	10,376.57	23.12
	1078+00	Mission Spill											
IID Division 3B Canal:													
2500			0.00	0.00	0.00	0.00	0.00	0.00	1,483.65	0.00	0.00	10,014.64	22.31
	1117+00	DS End of Siphon											
2600			0.00	59.18	0.00	132.00	0.00	191.18	1,483.65	1,290.47	2.87	10,014.64	22.31
	1144+00	US End Partially-lined Canal											
2700			0.00	300.47	2.24	36.69	10.00	349.41	1,292.47	2,358.49	5.25	8,724.17	19.44
	1187+00	Pipeline Inlet											
2900			0.00	13.50	0.00	0.00	0.00	13.50	943.06	91.13	0.20	6,365.68	14.18
	1221+00	Weed Screen Spill											
3000			0.00	0.00	0.00	0.00	0.00	0.00	929.56	0.00	0.00	6,274.56	13.98
	1226+00	Spill											
3100			0.00	299.95	2.00	14.00	3.00	318.95	929.56	2,152.94	4.80	6,274.56	13.98
	1293+00	Siphon Inlet											
3600			0.00	367.94	2.50	7.00	0.00	377.44	610.61	2,547.72	5.68	4,121.62	9.18
	1342+00	Fairview Canyon Spill											
3650			0.00	201.17	6.00	25.00	1.00	233.17	233.17	1,573.90	3.51	1,573.90	3.51
	1368+00	End Spill											
IID Division 4 Canal:													
	+0	Posey Weir											
4900			0.00	131.13	0.00	12.00	3.00	146.13	1,432.53	986.38	2.20	9,669.59	21.54

IPID Water Conservation Plan
Water Balance
Summary of Shares and Estimated Water Deliveries

Input
Calculation
Output

VARIABLES:

Maximum Delivery =	6.75	gpm/share

GIS Reach	Station	Station Description	Peshastin Shares	Icicle Shares	Contract Shares	Balck Water Shares	Rental Shares	Total Shares Assigned to Reach	Cumulative Shares Assigned	Deliveries Served from Reach (gpm)	Deliveries Served from Reach (cfs)	Cumulative Downstream Deliveries (gpm)	Cumulative Downstream Deliveries (cfs)
	43+00	CMP											
5000			0.00	286.56	0.00	0.00	0.00	286.56	1,286.40	1,934.30	4.31	8,683.21	19.35
	89+00	Anderson Canyon Siphon											
5100			0.00	53.34	0.80	0.40	0.40	54.94	999.84	370.82	0.83	6,748.91	15.04
	104+00	Steel Flume											
5100			0.00	80.00	1.20	0.60	0.60	82.40	944.90	556.23	1.24	6,378.10	14.21
	130+00	DS End Partially-lined Canal											
5100			0.00	133.34	2.00	1.00	1.00	137.34	862.50	927.05	2.07	5,821.87	12.97
	187+00	Derby Canyon Spill											
5500			0.00	23.29	33.00	0.00	0.00	56.29	725.16	379.96	0.85	4,894.82	10.91
	255+00	Sand Trap Spills											
5550			0.00	49.63	9.00	17.74	0.00	76.37	668.87	515.49	1.15	4,514.87	10.06
	270+00	DS End of Pipeline											
5550			0.00	49.63	9.00	17.74	0.00	76.37	592.50	515.49	1.15	3,999.37	8.91
	364+00	Pipeline Inlet											
5700			0.00	415.62	41.51	59.00	0.00	516.13	516.13	3,483.88	7.76	3,483.88	7.76
	380+00	Williams Canyon Spill											
IID Division 5 Canal:													
	+0	Parsons Weir											
3700			0.00	154.40	0.00	4.44	0.00	158.84	572.86	1,072.14	2.39	3,866.82	8.61
	18+00	Moe Spill											
3900			0.00	37.06	0.00	28.00	10.00	75.06	414.03	506.66	1.13	2,794.68	6.23
	58+00	Fox Spill											
4100			0.00	32.13	0.00	7.20	0.00	39.33	338.97	265.46	0.59	2,288.02	5.10
	78+00	Chumstick Siphon											
4100			0.00	8.03	0.00	1.80	0.00	9.83	299.64	66.37	0.15	2,022.56	4.51
	94+00	Chumstick Spill											
4400			0.00	256.18	15.00	9.30	9.33	289.81	289.81	1,956.19	4.36	1,956.19	4.36
	140+00	End Spill											

PID Canal:													
	+0	Intake											
16600			102.50	0.00	0.00	0.00	0.00	102.50	2,541.33	691.88	1.54	17,153.96	38.22
	45+00	Inflow, Peshastin Crossover											
16650			46.50	0.00	2.00	4.00	0.00	52.50	2,438.83	354.38	0.79	16,462.09	36.68

IPID Water Conservation Plan
Water Balance
Summary of Shares and Estimated Water Deliveries

Input
Calculation
Output

VARIABLES:

Maximum Delivery =	6.75	gpm/share

GIS Reach	Station	Station Description	Peshastin Shares	Icicle Shares	Contract Shares	Balck Water Shares	Rental Shares	Total Shares Assigned to Reach	Cumulative Shares Assigned	Deliveries Served from Reach (gpm)	Deliveries Served from Reach (cfs)	Cumulative Downstream Deliveries (gpm)	Cumulative Downstream Deliveries (cfs)
	79+00	Fryburger Spill											
16660			116.10	0.00	0.00	0.00	0.00	116.10	2,386.33	783.69	1.75	16,107.71	35.89
	142+00	Pipe Inlet											
17000			103.13	0.00	0.00	0.00	0.00	103.13	2,270.23	696.13	1.55	15,324.03	34.14
	160+00	Break in Pipeline											
39100			109.10	0.00	0.00	0.00	0.00	109.10	2,167.10	736.43	1.64	14,627.90	32.59
	190+00	Deadman Hill Road											
39150			181.78	18.95	0.00	5.50	0.00	206.23	2,058.00	1,392.02	3.10	13,891.47	30.95
	258+00	DS End, Unlined Sections											
39150			181.78	18.95	0.00	5.50	0.00	206.23	1,851.77	1,392.02	3.10	12,499.45	27.85
	294+00	DS End, Fully-lined Canal											
39155			206.15	0.00	0.00	0.00	0.00	206.15	1,645.55	1,391.51	3.10	11,107.44	24.75
	349+00	DS End, Unlined Sections											
39160			14.00	0.00	0.00	0.00	0.00	14.00	1,439.40	94.50	0.21	9,715.92	21.65
	413+00	Stines Hill Spill											
64700			75.10	0.00	0.00	0.00	0.00	75.10	1,425.40	506.93	1.13	9,621.42	21.44
	442+00	Pipeline Outlet											
64750			354.53	0.00	0.00	2.40	0.00	356.93	1,350.30	2,409.27	5.37	9,114.50	20.31
	545+00	Wood Flume											
64750			88.63	0.00	0.00	0.60	0.00	89.23	993.37	602.32	1.34	6,705.23	14.94
	563+00	Brender Siphon											
64760			479.27	33.46	1.00	49.72	0.50	563.96	904.14	3,806.70	8.48	6,102.91	13.60
	667+00	Control Box, Rabbit Warren											
69200			338.18	2.00	0.00	0.00	0.00	340.18	340.18	2,296.21	5.12	2,296.21	5.12
	711+00	Pioneer End Spill											
Tandy Ditch													
1			230.73	0.00	0.00	0.00	0.00	230.73	230.73	1,557.43	3.47	1,557.43	3.47
Gibb Ditch													
2			530.85	0.00	0.00	0.00	0.00	530.85	530.85	3,583.21	7.98	3,583.21	7.98
Total for Entire IPID Systems													
Total			3,651.77	3,487.57	174.25	556.50	50.83	7,920.91	7,920.91	53,466.17	119.12	53,466.17	119.12

IPID Water Conservation Plan
Water Balance
Model - Peak Flow - With Improvements

Input
Calculation
Output

VARIABLES:

Scenario:	Peak flow
% of Peak Flow Delivered:	100%

Peshastin Crossover Flow	15	cfs
Snow Creek Pick-up Flow	0	cfs
Mountain Home Pick-up Flow	0	cfs

GIS Reach	Station	Station Description	Length	Reach Description	Outflows: Deliveries Served from Reach (cfs)	Outflows: Operational Spills (cfs)	Outflows: Estimated Loss from Reach (cfs)	Outflows: Estimated Loss Rate (cfs/mile)	Total Flow Required (cfs)
IID Division 1 Canal:									
	+0	Intake							114.44
100			500	Diversion Canal, Concrete	0.00	2.24	0.10	1.03	
	5+00	Head Gates, Main Spill							112.10
100			300	Flume, Concrete	0.00	2.20	0.00	0.06	
	8+00	Fish Screen, Bypass, Spill							109.90
150			1,000	Partially- and Fully-lined Canal	0.00	2.15	0.17	0.89	
	18+00	Snow Creek Spill							107.58
200			4,100	Fully-lined Canal, Flume	0.00		0.83	1.07	
	59+00	Rock Tunnel							106.75
300			5,200	Rock Tunnels, Fully-lined Canal, Flume	0.00	1.05	1.04	1.06	
	111+00	Mountain Home Spill							104.66
400			7,600	Partially-lined Canal	0.04		1.34	0.93	
	187+00	First Turnout Box							103.27
600			8,300	Partially-lined Canal	0.32	0.51	1.45	0.92	
	270+00	Van Brocklin Spill							101.00
650			7,300	Partially- and Fully-lined Canal, Flume	1.95	0.48	1.62	1.17	
	343+00	Leavenworth Bifurcation							96.95
IID Division 2 Canal:									
700			6,900	Partially- and Fully-lined Canal	2.28		0.76	0.58	
	412+00	Rock Tunnel							61.92
900			6,100	Tunnel, Partially- and Fully-lined Canal	4.28		0.11	0.09	
	473+00	End of Partial Lining							57.53
950			6,400	Fully-lined Canal	2.08		0.62	0.51	
	537+00	Parcel, Mid-Canal							54.82
1000			3,100	Fully-lined Canal	1.00	0.27	0.29	0.49	
	568+00	Peshastin Spill							53.27

IPID Water Conservation Plan
Water Balance
Model - Peak Flow - With Improvements

Input
Calculation
Output

VARIABLES:

Scenario:	Peak flow
% of Peak Flow Delivered:	100%

Peshastin Crossover Flow	15	cfs
Snow Creek Pick-up Flow	0	cfs
Mountain Home Pick-up Flow	0	cfs

GIS Reach	Station	Station Description	Length	Reach Description	Outflows: Deliveries Served from Reach (cfs)	Outflows: Operational Spills (cfs)	Outflows: Estimated Loss from Reach (cfs)	Outflows: Estimated Loss Rate (cfs/mile)	Total Flow Required (cfs)
IID Division 3A Canal:									
1100			3,300	Peshastin Siphon	0.00		0.01	0.02	
	601+00	Peshastin Siphon Outlet							30.27
1100			5,700	Fully-lined Canal	0.36		0.29	0.27	
	658+00	Carson's Pipeline Inlet							29.62
1200			1,200	Carson's Pipeline (Buckled, Leaks)	0.36		0.00	0.02	
	670+00	Carson's Pipeline Outlet							29.25
1200			4,300	Fully-lined Canal, Steel Pipeline	0.36		0.19	0.24	
	713+00	Maxwell Siphon Inlet							28.70
1600			900	Maxwell Siphon	0.16		0.00	0.02	
	722+00	Maxwell Siphon Outlet							28.53
1600			11,700	Fully-lined Canal	0.64		0.62	0.28	
	839+00	Pine Flats Flume							27.27
1900			2,300	Fully-lined Canal, Flume	0.86		0.01	0.01	
	862+00	Sandtone Tunnels Inlet							26.40
1900			1,100	Sandstone Tunnels, Fully-lined Canal	0.37		0.00	0.01	
	873+00	Brender Spill 1							26.03
2100			2,700	Brender Siphon, Fully-lined Canal	0.30	0.13	0.06	0.11	
	900+00	Brender Spill 2							25.55
2200			7,000	Partially- and Fully-lined Canal	0.80	0.00	0.30	0.23	
	970+00	US End Fully-lined Canal							24.44
2400			10,800	Fully-lined Canal	0.81	0.12	0.49	0.24	
	1078+00	Mission Spill							23.03
IID Division 3B Canal:									
2500			3,900	Mission Siphon	0.00		0.01	0.01	
	1117+00	DS End of Siphon							23.02
2600			2,700	Fully-lined Canal	2.87		0.12	0.23	
	1144+00	US End Partially-lined Canal							20.03

IPID Water Conservation Plan
Water Balance
Model - Peak Flow - With Improvements

Input
Calculation
Output

VARIABLES:

Scenario:	Peak flow
% of Peak Flow Delivered:	100%

Peshastin Crossover Flow	15	cfs
Snow Creek Pick-up Flow	0	cfs
Mountain Home Pick-up Flow	0	cfs

GIS Reach	Station	Station Description	Length	Reach Description	Outflows				Total Flow Required (cfs)
					Deliveries Served from Reach (cfs)	Operational Spills (cfs)	Estimated Loss from Reach (cfs)	Estimated Loss Rate (cfs/mile)	
2700			4,300	Partially- and Fully-lined Canal	5.25		0.17	0.21	
	1187+00	Pipeline Inlet							14.60
2900			3,400	Pipeline	0.20	0.07	0.00	0.01	
	1221+00	Weed Screen Spill							14.32
3000			500	Fully-lined Canal	0.00	0.07	0.01	0.14	
	1226+00	Spill							14.24
3100			6,700	Fully-lined Canal, Siphons	4.80		0.06	0.04	
	1293+00	Siphon Inlet							9.39
3600			4,900	Siphon, Pipeline	5.68	0.02	0.00	0.00	
	1342+00	Fairview Canyon Spill							3.69
3650			2,600	Siphon, Pipeline	3.51		0.00	0.00	
	1368+00	End Spill							0.18
IID Division 4 Canal:									
	+0	Posey Weir							22.71
4900			4,300	Fully-lined Canal	2.20		0.18	0.23	
	43+00	CMP							20.33
5000			4,600	Fully-lined Canal	4.31	0.08	0.18	0.20	
	89+00	Anderson Canyon Siphon							15.76
5100			1,500	Siphon, Fully-lined Canal	0.83		0.02	0.07	
	104+00	Steel Flume							14.92
5100			2,600	Flume, Partially-lined Canal	1.24		0.00	0.01	
	130+00	DS End Partially-lined Canal							13.68
5100			5,700	Fully-lined Canal	2.07	0.06	0.01	0.01	
	187+00	Derby Canyon Spill							11.55
5500			6,800	Pipeline	0.85	0.05	0.01	0.01	
	255+00	Sand Trap Spills							10.64
5550			1,500	Pipeline	1.15		0.00	0.01	
	270+00	DS End of Pipeline							9.49

IPID Water Conservation Plan
Water Balance
Model - Peak Flow - With Improvements

Input
Calculation
Output

VARIABLES:

Scenario:	Peak flow
% of Peak Flow Delivered:	100%

Peshastin Crossover Flow	15	cfs
Snow Creek Pick-up Flow	0	cfs
Mountain Home Pick-up Flow	0	cfs

GIS Reach	Station	Station Description	Length	Reach Description	Outflows: Deliveries Served from Reach (cfs)	Outflows: Operational Spills (cfs)	Outflows: Estimated Loss from Reach (cfs)	Outflows: Estimated Loss Rate (cfs/mile)	Total Flow Required (cfs)
5550			9,400	Fully-lined Canal	1.15		0.17	0.09	
	364+00	Williams Canyon Spill							8.17
5700			1,600	Pipeline	7.76		0.00	0.00	
	380+00	Williams Canyon Spill							0.41
IID Division 5 Canal:									
	+0	Parsons Weir							9.29
3700			1,800	Fully-lined Canal	2.39	0.03	0.15	0.43	
	18+00	Moe Spill							6.72
3900			4,000	Moe Siphon, Fully-lined Canal	1.13	0.03	0.19	0.25	
	58+00	Fox Spill							5.38
4100			2,000	Fox Siphon, Fully-lined Canal	0.59		0.01	0.03	
	78+00	Chumstick Siphon							4.78
4100			1,600	Chumstick Siphon	0.15	0.02	0.00	0.00	
	94+00	Chumstick Spill							4.61
4400			4,600	Pipeline, Fully-lined Canal	4.36		0.02	0.02	
	140+00	End Spill							0.23
PID Canal:									
	+0	Intake							26.54
16600			4,500	Unlined Canal	1.54		0.20	0.24	
	45+00	Inflow, Peshastin Crossover							24.80
16650			3,400	Unlined, Partially-lined Canal	0.79	0.57	0.72	1.11	
	79+00	Fryburger Spill							37.73
16660			6,300	Fully-lined Canal	1.75		0.45	0.37	
	142+00	Pipe Inlet							35.53
17000			1,800	Pipeline	1.55		0.01	0.02	
	160+00	Break in Pipeline							33.98
39100			3,000	Pipeline, Fully-lined Canal	1.64		0.05	0.08	

IPID Water Conservation Plan
Water Balance
Model - Peak Flow - With Improvements

Input
Calculation
Output

VARIABLES:

Scenario:	Peak flow
% of Peak Flow Delivered:	100%

Peshastin Crossover Flow	15	cfs
Snow Creek Pick-up Flow	0	cfs
Mountain Home Pick-up Flow	0	cfs

GIS Reach	Station	Station Description	Length	Reach Description	Outflows				Total Flow Required (cfs)
					Deliveries Served from Reach (cfs)	Operational Spills (cfs)	Estimated Loss from Reach (cfs)	Estimated Loss Rate (cfs/mile)	
	190+00	Deadman Hill Road							32.29
39150			6,800	Unlined Canal, some Fully-lined Canal	3.10		0.10	0.08	
	258+00	DS End, Unlined Sections							29.09
39150			3,600	Fully-lined Canal	3.10		0.20	0.29	
	294+00	DS End, Fully-lined Canal							25.79
39155			5,500	Unlined Canal, some Fully-lined Canal	3.10		0.04	0.04	
	349+00	DS End, Unlined Sections							22.65
39160			6,400	Partially- and Fully-lined Canal	0.21	0.11	0.23	0.19	
	413+00	Stines Hill Spill							22.09
64700			2,900	Pipeline	1.13		0.01	0.01	
	442+00	Pipeline Outlet							20.96
64750			10,300	Fully-lined Canal	5.37		0.02	0.01	
	545+00	Wood Flume							15.57
64750			1,800	Fully-lined Canal	1.34	0.07	0.25	0.73	
	563+00	Brender Siphon							13.91
64760			10,400	Pipeline	8.48	0.03	0.01	0.01	
	667+00	Control Box, Rabbit Warren							5.39
69200			4,400	Pressure Pipeline	5.12		0.00	0.00	
	711+00	Pioneer End Spill							0.27

IPID Water Conservation Plan
Water Balance
Model - Peak Flow

Input
Calculation
Output

VARIABLES:

Scenario:	Peak flow
% of Peak Flow Delivered:	100%

Peshastin Crossover Flow	15	cfs
Snow Creek Pick-up Flow	0	cfs
Mountain Home Pick-up Flow	0	cfs

GIS Reach	Station	Station Description	Length	Reach Description	Outflows: Deliveries Served from Reach (cfs)	Outflows: Operational Spills (cfs)	Outflows: Estimated Loss from Reach (cfs)	Outflows: Estimated Loss Rate (cfs/mile)	Total Flow Required (cfs)
IID Division 1 Canal:									
	+0	Intake							122.53
100			500	Diversion Canal, Concrete	0.00	2.40	0.12	1.23	
	5+00	Head Gates, Main Spill							120.01
100			300	Flume, Concrete	0.00	2.35	0.00	0.06	
	8+00	Fish Screen, Bypass, Spill							117.66
150			1,000	Partially- and Fully-lined Canal	0.00	2.30	0.18	0.96	
	18+00	Snow Creek Spill							115.17
200			4,100	Fully-lined Canal, Flume	0.00		0.89	1.15	
	59+00	Rock Tunnel							114.28
300			5,200	Rock Tunnels, Fully-lined Canal, Flume	0.00	1.12	1.12	1.14	
	111+00	Mountain Home Spill							112.04
400			7,600	Partially-lined Canal	0.04		2.09	1.45	
	187+00	First Turnout Box							109.91
600			8,300	Partially-lined Canal	0.32	0.53	2.23	1.42	
	270+00	Van Brocklin Spill							106.83
650			7,300	Partially- and Fully-lined Canal, Flume	1.95	0.51	1.71	1.24	
	343+00	Leavenworth Bifurcation							102.65
IID Division 2 Canal:									
700			6,900	Partially- and Fully-lined Canal	2.28		1.90	1.45	
	412+00	Rock Tunnel							66.08
900			6,100	Tunnel, Partially- and Fully-lined Canal	4.28		1.59	1.37	
	473+00	End of Partial Lining							60.21
950			6,400	Fully-lined Canal	2.08		2.03	1.67	
	537+00	Parcel, Mid-Canal							56.10
1000			3,100	Fully-lined Canal	1.00	0.27	0.93	1.59	
	568+00	Peshastin Spill							53.90

IPID Water Conservation Plan
Water Balance
Model - Peak Flow

Input
Calculation
Output

VARIABLES:

Scenario:	Peak flow
% of Peak Flow Delivered:	100%

Peshastin Crossover Flow	15	cfs
Snow Creek Pick-up Flow	0	cfs
Mountain Home Pick-up Flow	0	cfs

GIS Reach	Station	Station Description	Length	Reach Description	Outflows: Deliveries Served from Reach (cfs)	Outflows: Operational Spills (cfs)	Outflows: Estimated Loss from Reach (cfs)	Outflows: Estimated Loss Rate (cfs/mile)	Total Flow Required (cfs)
IID Division 3A Canal:									
1100			3,300	Peshastin Siphon	0.00		0.01	0.02	
	601+00	Peshastin Siphon Outlet							30.90
1100			5,700	Fully-lined Canal	0.36		0.33	0.31	
	658+00	Carson's Pipeline Inlet							30.21
1200			1,200	Carson's Pipeline (Buckled, Leaks)	0.36		0.32	1.42	
	670+00	Carson's Pipeline Outlet							29.52
1200			4,300	Fully-lined Canal, Steel Pipeline	0.36		0.19	0.24	
	713+00	Maxwell Siphon Inlet							28.97
1600			900	Maxwell Siphon	0.16		0.00	0.02	
	722+00	Maxwell Siphon Outlet							28.80
1600			11,700	Fully-lined Canal	0.64		0.63	0.28	
	839+00	Pine Flats Flume							27.53
1900			2,300	Fully-lined Canal, Flume	0.86		0.11	0.25	
	862+00	Sandtone Tunnels Inlet							26.57
1900			1,100	Sandstone Tunnels, Fully-lined Canal	0.37		0.06	0.27	
	873+00	Brender Spill 1							26.14
2100			2,700	Brender Siphon, Fully-lined Canal	0.30	0.13	0.06	0.11	
	900+00	Brender Spill 2							25.66
2200			7,000	Partially- and Fully-lined Canal	0.80	0.00	0.38	0.29	
	970+00	US End Fully-lined Canal							24.48
2400			10,800	Fully-lined Canal	0.81	0.12	0.49	0.24	
	1078+00	Mission Spill							23.06
IID Division 3B Canal:									
2500			3,900	Mission Siphon	0.00		0.01	0.01	
	1117+00	DS End of Siphon							23.05
2600			2,700	Fully-lined Canal	2.87		0.12	0.23	
	1144+00	US End Partially-lined Canal							20.06

IPID Water Conservation Plan
Water Balance
Model - Peak Flow

Input
Calculation
Output

VARIABLES:

Scenario:	Peak flow
% of Peak Flow Delivered:	100%

Peshastin Crossover Flow	15	cfs
Snow Creek Pick-up Flow	0	cfs
Mountain Home Pick-up Flow	0	cfs

GIS Reach	Station	Station Description	Length	Reach Description	Outflows				Total Flow Required (cfs)
					Deliveries Served from Reach (cfs)	Operational Spills (cfs)	Estimated Loss from Reach (cfs)	Estimated Loss Rate (cfs/mile)	
2700			4,300	Partially- and Fully-lined Canal	5.25		0.17	0.21	
	1187+00	Pipeline Inlet							14.63
2900			3,400	Pipeline	0.20	0.07	0.00	0.01	
	1221+00	Weed Screen Spill							14.35
3000			500	Fully-lined Canal	0.00	0.07	0.01	0.14	
	1226+00	Spill							14.27
3100			6,700	Fully-lined Canal, Siphons	4.80		0.09	0.07	
	1293+00	Siphon Inlet							9.39
3600			4,900	Siphon, Pipeline	5.68	0.02	0.00	0.00	
	1342+00	Fairview Canyon Spill							3.69
3650			2,600	Siphon, Pipeline	3.51		0.00	0.00	
	1368+00	End Spill							0.18
IID Division 4 Canal:									
	+0	Posey Weir							23.10
4900			4,300	Fully-lined Canal	2.20		0.19	0.23	
	43+00	CMP							20.72
5000			4,600	Fully-lined Canal	4.31	0.08	0.18	0.21	
	89+00	Anderson Canyon Siphon							16.15
5100			1,500	Siphon, Fully-lined Canal	0.83		0.02	0.07	
	104+00	Steel Flume							15.30
5100			2,600	Flume, Partially-lined Canal	1.24		0.25	0.50	
	130+00	DS End Partially-lined Canal							13.82
5100			5,700	Fully-lined Canal	2.07	0.06	0.15	0.14	
	187+00	Derby Canyon Spill							11.55
5500			6,800	Pipeline	0.85	0.05	0.01	0.01	
	255+00	Sand Trap Spills							10.64
5550			1,500	Pipeline	1.15		0.00	0.01	
	270+00	DS End of Pipeline							9.49

IPID Water Conservation Plan
Water Balance
Model - Peak Flow

Input
Calculation
Output

VARIABLES:

Scenario:	Peak flow
% of Peak Flow Delivered:	100%

Peshastin Crossover Flow	15	cfs
Snow Creek Pick-up Flow	0	cfs
Mountain Home Pick-up Flow	0	cfs

GIS Reach	Station	Station Description	Length	Reach Description	Outflows: Deliveries Served from Reach (cfs)	Outflows: Operational Spills (cfs)	Outflows: Estimated Loss from Reach (cfs)	Outflows: Estimated Loss Rate (cfs/mile)	Total Flow Required (cfs)
5550			9,400	Fully-lined Canal	1.15		0.17	0.09	
	364+00	Williams Canyon Spill							8.17
5700			1,600	Pipeline	7.76		0.00	0.00	
	380+00	Williams Canyon Spill							0.41
IID Division 5 Canal:									
	+0	Parsons Weir							9.29
3700			1,800	Fully-lined Canal	2.39	0.03	0.15	0.43	
	18+00	Moe Spill							6.72
3900			4,000	Moe Siphon, Fully-lined Canal	1.13	0.03	0.19	0.25	
	58+00	Fox Spill							5.38
4100			2,000	Fox Siphon, Fully-lined Canal	0.59		0.01	0.03	
	78+00	Chumstick Siphon							4.78
4100			1,600	Chumstick Siphon	0.15	0.02	0.00	0.00	
	94+00	Chumstick Spill							4.61
4400			4,600	Pipeline, Fully-lined Canal	4.36		0.02	0.02	
	140+00	End Spill							0.23

GIS Reach	Station	Station Description	Length	Reach Description	Deliveries Served from Reach (cfs)	Operational Spills (cfs)	Estimated Loss from Reach (cfs)	Estimated Loss Rate (cfs/mile)	Total Flow Required (cfs)
PID Canal:									
	+0	Intake							37.30
16600			4,500	Unlined Canal	1.54		2.79	3.28	
	45+00	Inflow, Peshastin Crossover							32.96
16650			3,400	Unlined, Partially-lined Canal	0.79	0.67	1.83	2.85	
	79+00	Fryburger Spill							44.67
16660			6,300	Fully-lined Canal	1.75		0.53	0.44	
	142+00	Pipe Inlet							42.39
17000			1,800	Pipeline	1.55		0.01	0.02	
	160+00	Break in Pipeline							40.84
39100			3,000	Pipeline, Fully-lined Canal	1.64		0.06	0.10	

IPID Water Conservation Plan
Water Balance
Model - Peak Flow

Legend
Input
Calculation
Output

VARIABLES:

Scenario:	Peak flow
% of Peak Flow Delivered:	100%

Peshastin Crossover Flow	15	cfs
Snow Creek Pick-up Flow	0	cfs
Mountain Home Pick-up Flow	0	cfs

GIS Reach	Station	Station Description	Length	Reach Description	Outflows: Deliveries Served from Reach (cfs)	Outflows: Operational Spills (cfs)	Outflows: Estimated Loss from Reach (cfs)	Outflows: Estimated Loss Rate (cfs/mile)	Total Flow Required (cfs)
	190+00	Deadman Hill Road							39.14
39150			6,800	Unlined Canal, some Fully-lined Canal	3.10		2.85	2.21	
	258+00	DS End, Unlined Sections							33.18
39150			3,600	Fully-lined Canal	3.10		0.23	0.33	
	294+00	DS End, Fully-lined Canal							29.86
39155			5,500	Unlined Canal, some Fully-lined Canal	3.10		1.78	1.71	
	349+00	DS End, Unlined Sections							24.97
39160			6,400	Partially- and Fully-lined Canal	0.21	0.12	0.63	0.52	
	413+00	Stines Hill Spill							24.01
64700			2,900	Pipeline	1.13		0.01	0.01	
	442+00	Pipeline Outlet							22.88
64750			10,300	Fully-lined Canal	5.37		1.94	0.99	
	545+00	Wood Flume							15.57
64750			1,800	Fully-lined Canal	1.34	0.07	0.25	0.73	
	563+00	Brender Siphon							13.91
64760			10,400	Pipeline	8.48	0.03	0.01	0.01	
	667+00	Control Box, Rabbit Warren							5.39
69200			4,400	Pressure Pipeline	5.12		0.00	0.00	
	711+00	Pioneer End Spill							0.27

IPID Water Conservation Plan
Water Balance
Model - Calibrate Against June 2017 Flow Measurements

Input
Calculation
Output

VARIABLES:

Scenario:	Calibration to June 28, 2017
% of Peak Flow Delivered:	75%

Peshastin Crossover Flow	0	cfs
Snow Creek Pick-up Flow	0	cfs
Mountain Home Pick-up Flow	0	cfs

GIS Reach	Station	Station Description	Length	Reach Description	Outflows: Deliveries Served from Reach (cfs)	Outflows: Operational Spills (cfs)	Outflows: Estimated Loss from Reach (cfs)	Outflows: Estimated Loss Rate (cfs/mile)	Total Flow Required (cfs)
IID Division 1 Canal:									
	+0	Intake							79.48
100			500	Diversion Canal, Concrete	0.00	1.56	0.08	0.80	
	5+00	Head Gates, Main Spill							77.85
100			300	Flume, Concrete	0.00	1.53	0.00	0.04	
	8+00	Fish Screen, Bypass, Spill							76.32
150			1,000	Partially- and Fully-lined Canal	0.00	1.13	0.12	0.62	
	18+00	Snow Creek Spill							75.07
200			4,100	Fully-lined Canal, Flume	0.00		0.58	0.75	
	59+00	Rock Tunnel							74.49
300			5,200	Rock Tunnels, Fully-lined Canal, Flume	0.00	0.73	0.73	0.74	
	111+00	Mountain Home Spill							73.03
400			7,600	Partially-lined Canal	0.03		1.36	0.95	
	187+00	First Turnout Box							71.64
600			8,300	Partially-lined Canal	0.24	0.35	1.46	0.93	
	270+00	Van Brocklin Spill							69.60
650			7,300	Partially- and Fully-lined Canal, Flume	1.46	0.33	1.11	0.81	
	343+00	Leavenworth Bifurcation							66.69
IID Division 2 Canal:									
700			6,900	Partially- and Fully-lined Canal	1.71		1.15	0.88	
	412+00	Rock Tunnel							39.54
900			6,100	Tunnel, Partially- and Fully-lined Canal	3.21		0.95	0.82	
	473+00	End of Partial Lining							35.38
950			6,400	Fully-lined Canal	1.56		1.19	0.98	
	537+00	Parcel, Mid-Canal							32.62
1000			3,100	Fully-lined Canal	0.75	0.16	0.54	0.92	
	568+00	Peshastin Spill							31.17

IPID Water Conservation Plan
Water Balance
Model - Calibrate Against June 2017 Flow Measurements

Input
Calculation
Output

VARIABLES:

Scenario:	Calibration to June 28, 2017
% of Peak Flow Delivered:	75%

Peshastin Crossover Flow	0	cfs
Snow Creek Pick-up Flow	0	cfs
Mountain Home Pick-up Flow	0	cfs

GIS Reach	Station	Station Description	Length	Reach Description	Outflows				Total Flow Required (cfs)
					Deliveries Served from Reach (cfs)	Operational Spills (cfs)	Estimated Loss from Reach (cfs)	Estimated Loss Rate (cfs/mile)	
IID Division 3A Canal:									
1100			3,300	Peshastin Siphon	0.00		0.01	0.01	
	601+00	Peshastin Siphon Outlet							23.18
1100			5,700	Fully-lined Canal	0.27		0.25	0.23	
	658+00	Carson's Pipeline Inlet							22.66
1200			1,200	Carson's Pipeline (Buckled, Leaks)	0.27		0.24	1.07	
	670+00	Carson's Pipeline Outlet							22.15
1200			4,300	Fully-lined Canal, Steel Pipeline	0.27		0.15	0.18	
	713+00	Maxwell Siphon Inlet							21.73
1600			900	Maxwell Siphon	0.12		0.00	0.01	
	722+00	Maxwell Siphon Outlet							21.61
1600			11,700	Fully-lined Canal	0.48		0.47	0.21	
	839+00	Pine Flats Flume							20.65
1900			2,300	Fully-lined Canal, Flume	0.64		0.08	0.19	
	862+00	Sandtone Tunnels Inlet							19.93
1900			1,100	Sandstone Tunnels, Fully-lined Canal	0.28		0.04	0.20	
	873+00	Brender Spill 1							19.61
2100			2,700	Brender Siphon, Fully-lined Canal	0.23	0.10	0.04	0.08	
	900+00	Brender Spill 2							19.25
2200			7,000	Partially- and Fully-lined Canal	0.60	0.00	0.28	0.21	
	970+00	US End Fully-lined Canal							18.36
2400			10,800	Fully-lined Canal	0.60	0.09	0.37	0.18	
	1078+00	Mission Spill							17.30
IID Division 3B Canal:									
2500			3,900	Mission Siphon	0.00		0.01	0.01	
	1117+00	DS End of Siphon							17.30
2600			2,700	Fully-lined Canal	2.16		0.09	0.17	
	1144+00	US End Partially-lined Canal							15.05

IPID Water Conservation Plan
Water Balance
Model - Calibrate Against June 2017 Flow Measurements

Input
Calculation
Output

VARIABLES:

Scenario:	Calibration to June 28, 2017
% of Peak Flow Delivered:	75%

Peshastin Crossover Flow	0	cfs
Snow Creek Pick-up Flow	0	cfs
Mountain Home Pick-up Flow	0	cfs

GIS Reach	Station	Station Description	Length	Reach Description	Outflows: Deliveries Served from Reach (cfs)	Outflows: Operational Spills (cfs)	Outflows: Estimated Loss from Reach (cfs)	Outflows: Estimated Loss Rate (cfs/mile)	Total Flow Required (cfs)
2700			4,300	Partially- and Fully-lined Canal	3.94		0.13	0.16	
	1187+00	Pipeline Inlet							10.98
2900			3,400	Pipeline	0.15	0.05	0.00	0.01	
	1221+00	Weed Screen Spill							10.77
3000			500	Fully-lined Canal	0.00	0.05	0.01	0.11	
	1226+00	Spill							10.71
3100			6,700	Fully-lined Canal, Siphons	3.60		0.06	0.05	
	1293+00	Siphon Inlet							7.04
3600			4,900	Siphon, Pipeline	4.26	0.01	0.00	0.00	
	1342+00	Fairview Canyon Spill							2.77
3650			2,600	Siphon, Pipeline	2.63		0.00	0.00	
	1368+00	End Spill							0.14
IID Division 4 Canal:									
	+0	Posey Weir							17.33
4900			4,300	Fully-lined Canal	1.65		0.14	0.17	
	43+00	CMP							15.54
5000			4,600	Fully-lined Canal	3.23	0.06	0.13	0.15	
	89+00	Anderson Canyon Siphon							12.11
5100			1,500	Siphon, Fully-lined Canal	0.62		0.01	0.05	
	104+00	Steel Flume							11.48
5100			2,600	Flume, Partially-lined Canal	0.93		0.19	0.38	
	130+00	DS End Partially-lined Canal							10.36
5100			5,700	Fully-lined Canal	1.55	0.04	0.11	0.10	
	187+00	Derby Canyon Spill							8.66
5500			6,800	Pipeline	0.63	0.04	0.01	0.00	
	255+00	Sand Trap Spills							7.98
5550			1,500	Pipeline	0.86		0.00	0.00	
	270+00	DS End of Pipeline							7.12

IPID Water Conservation Plan
Water Balance
Model - Calibrate Against June 2017 Flow Measurements

Input
Calculation
Output

VARIABLES:

Scenario:	Calibration to June 28, 2017
% of Peak Flow Delivered:	75%

Peshastin Crossover Flow	0	cfs
Snow Creek Pick-up Flow	0	cfs
Mountain Home Pick-up Flow	0	cfs

GIS Reach	Station	Station Description	Length	Reach Description	Outflows: Deliveries Served from Reach (cfs)	Outflows: Operational Spills (cfs)	Outflows: Estimated Loss from Reach (cfs)	Outflows: Estimated Loss Rate (cfs/mile)	Total Flow Required (cfs)
5550			9,400	Fully-lined Canal	0.86		0.12	0.07	
	364+00	Williams Canyon Spill							6.13
5700			1,600	Pipeline	5.82		0.00	0.00	
	380+00	Williams Canyon Spill							0.31
IID Division 5 Canal:									
	+0	Parsons Weir							6.97
3700			1,800	Fully-lined Canal	1.79	0.03	0.11	0.33	
	18+00	Moe Spill							5.04
3900			4,000	Moe Siphon, Fully-lined Canal	0.85	0.02	0.14	0.19	
	58+00	Fox Spill							4.03
4100			2,000	Fox Siphon, Fully-lined Canal	0.44		0.01	0.02	
	78+00	Chumstick Siphon							3.58
4100			1,600	Chumstick Siphon	0.11	0.02	0.00	0.00	
	94+00	Chumstick Spill							3.45
4400			4,600	Pipeline, Fully-lined Canal	3.27		0.01	0.01	
	140+00	End Spill							0.17
PID Canal:									
	+0	Intake							40.13
16600			4,500	Unlined Canal	1.16		3.01	3.53	
	45+00	Inflow, Peshastin Crossover							35.97
16650			3,400	Unlined, Partially-lined Canal	0.59	0.50	1.38	2.14	
	79+00	Fryburger Spill							33.50
16660			6,300	Fully-lined Canal	1.31		0.40	0.33	
	142+00	Pipe Inlet							31.79
17000			1,800	Pipeline	1.16		0.01	0.02	
	160+00	Break in Pipeline							30.62
39100			3,000	Pipeline, Fully-lined Canal	1.23		0.04	0.07	

IPID Water Conservation Plan
Water Balance
Model - Calibrate Against June 2017 Flow Measurements

Input
Calculation
Output

VARIABLES:

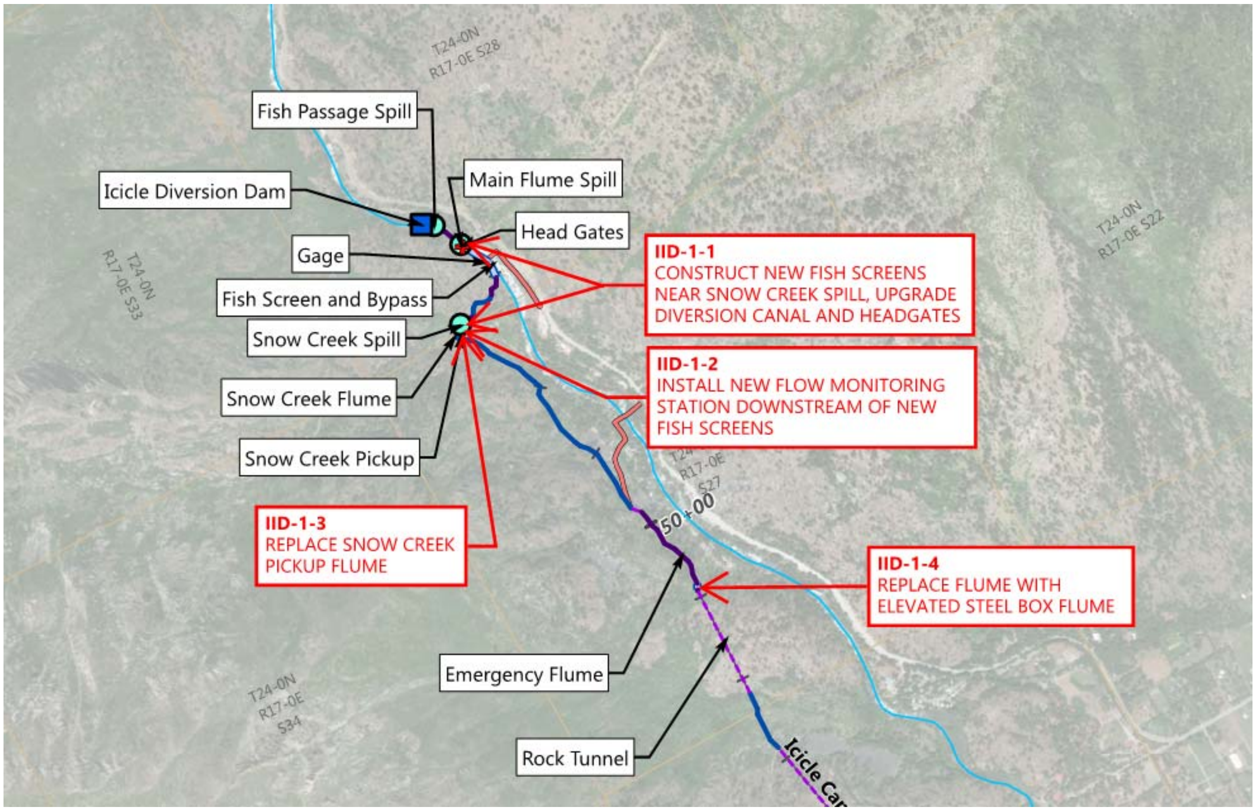
Scenario:	Calibration to June 28, 2017
% of Peak Flow Delivered:	75%

Peshastin Crossover Flow	0	cfs
Snow Creek Pick-up Flow	0	cfs
Mountain Home Pick-up Flow	0	cfs

GIS Reach	Station	Station Description	Length	Reach Description	Outflows: Deliveries Served from Reach (cfs)	Outflows: Operational Spills (cfs)	Outflows: Estimated Loss from Reach (cfs)	Outflows: Estimated Loss Rate (cfs/mile)	Total Flow Required (cfs)
	190+00	Deadman Hill Road							29.35
39150			6,800	Unlined Canal, some Fully-lined Canal	2.33		2.14	1.66	
	258+00	DS End, Unlined Sections							24.89
39150			3,600	Fully-lined Canal	2.33		0.17	0.25	
	294+00	DS End, Fully-lined Canal							22.39
39155			5,500	Unlined Canal, some Fully-lined Canal	2.33		1.34	1.28	
	349+00	DS End, Unlined Sections							18.73
39160			6,400	Partially- and Fully-lined Canal	0.16	0.09	0.47	0.39	
	413+00	Stines Hill Spill							18.01
64700			2,900	Pipeline	0.85		0.01	0.01	
	442+00	Pipeline Outlet							17.16
64750			10,300	Fully-lined Canal	4.03		1.46	0.75	
	545+00	Wood Flume							11.67
64750			1,800	Fully-lined Canal	1.01	0.05	0.19	0.55	
	563+00	Brender Siphon							10.43
64760			10,400	Pipeline	6.36	0.02	0.01	0.01	
	667+00	Control Box, Rabbit Warren							4.04
69200			4,400	Pressure Pipeline	3.84		0.00	0.00	
	711+00	Pioneer End Spill							0.20

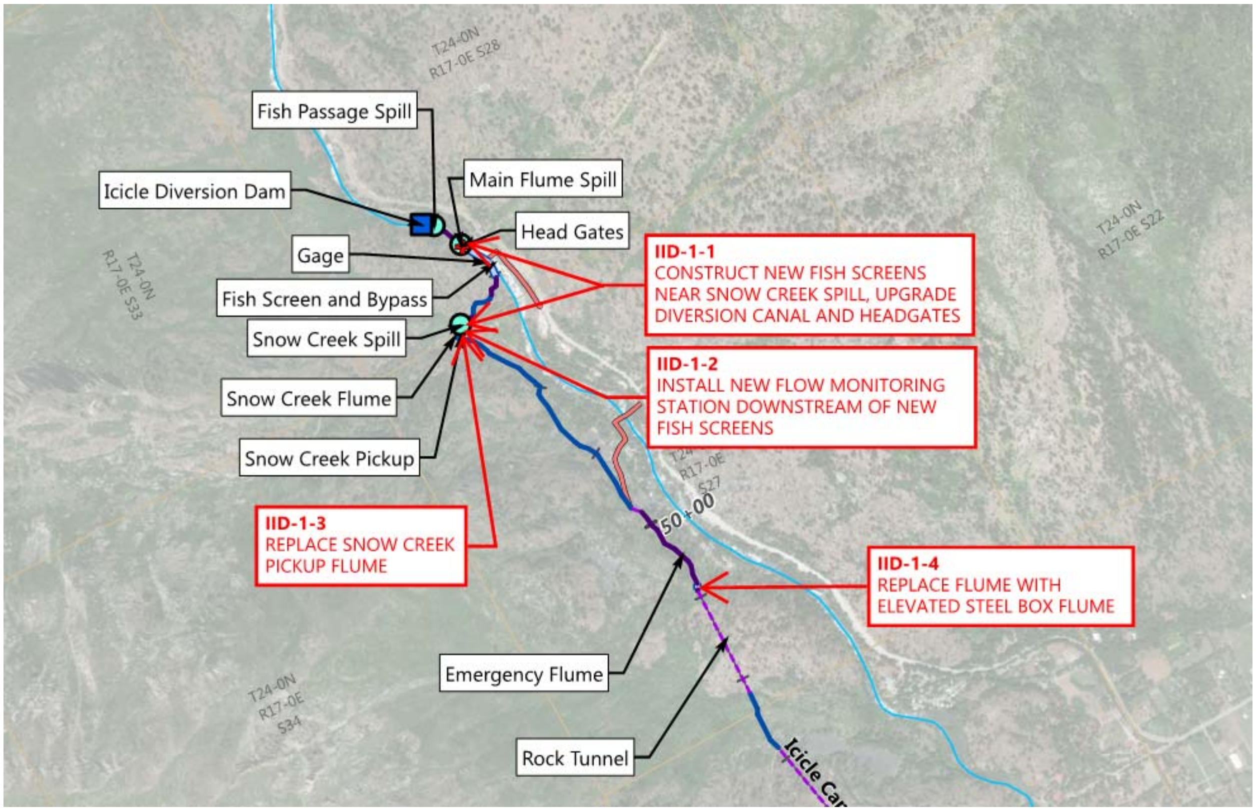
Appendix E
Summaries of Proposed Improvement Projects

Project: IID-1-1 – Replace Existing Fish Screens



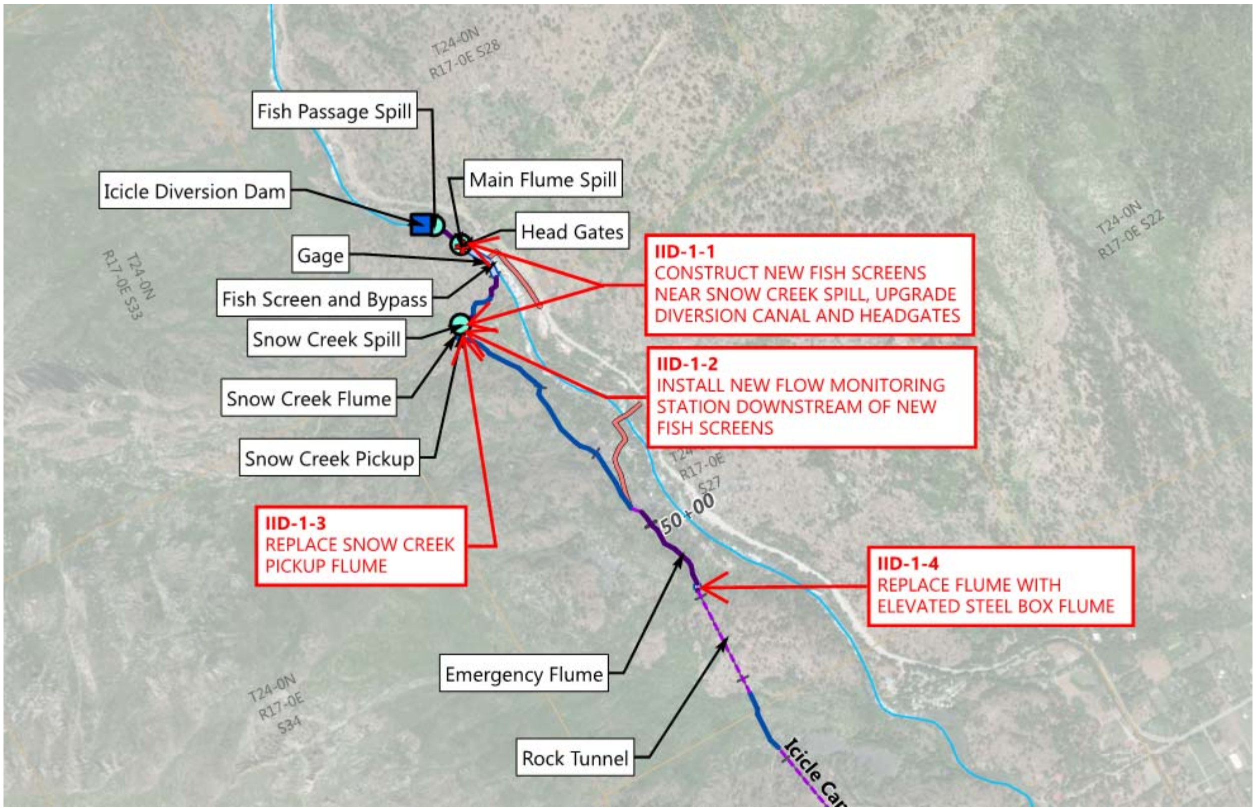
<table>
<tr><td>Location (Reach or Division):</td><td colspan="3">IID Division 1 (Station 5+00 to 18+00)</td></tr>
<tr><td>Projected Water Savings:</td><td colspan="3">0 cfs</td></tr>
<tr><td>Deficiency Addressed/Purpose:</td><td colspan="3">• Existing fish screens and bypass system do not meet current NMFS and WDFW guidelines
• Proposed upgrades to Boulder Field downstream of IPID Diversion will increase presence of ESA-listed anadromous fish</td></tr>
<tr><td>Project Description:</td><td colspan="3">Replace existing fish screens with new fish screens located near existing Snow Creek Spill. Upgrade head gates and diversion canal.</td></tr>
<tr><td rowspan="5">Estimated Implementation Cost:</td><td>Item</td><td>Low</td><td>High</td></tr>
<tr><td>Materials</td><td>$990,800</td><td>$1,120,000</td></tr>
<tr><td>Labor, Other</td><td>$424,600</td><td>$480,000</td></tr>
<tr><td>Construction Subtotal</td><td>$1,415,400</td><td>$1,600,000</td></tr>
<tr><td>Other Costs</td><td>$283,100</td><td>$320,000</td></tr>
<tr><td>Notes:</td><td colspan="3">Designs are being prepared by WDFW under a grant from the Bonneville Power Administration. Rough costs from WDFW.</td></tr>
<tr><td>Recommended Priority/Timeline:</td><td colspan="3">High priority. Design anticipated to be complete in 2018. Potential 2019 construction.</td></tr>
</table>

Project: IID-1-2 – Install New Flow Monitoring Station



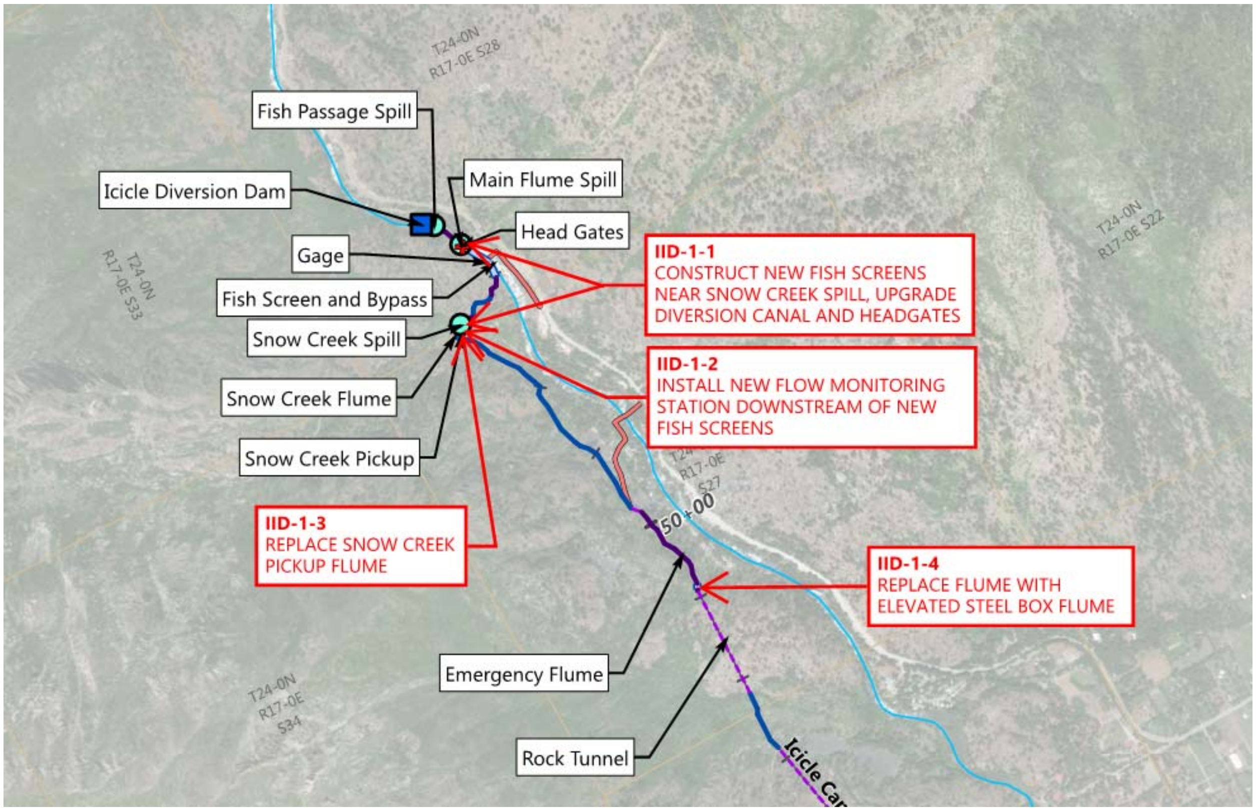
Location (Reach or Division):	IID Division 1 (Station 18+50)		
Projected Water Savings:	0 cfs		
Deficiency Addressed/Purpose:	• Existing flow monitoring has to be corrected to account for spills and Section has to be continuously rated.		
Project Description:	Install new flow monitoring equipment to measure and transmit flow data from canal just downstream of new screening facilities.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$3,500	$3,900
	Labor, Other	$1,500	$1,700
	Construction Subtotal	**$5,000**	**$5,600**
	Other Costs	$1,000	$1,100
Notes:	Could be incorporated into fish screen replacement project (See Project IID-1-1). Coordination with WDFW required.		
Recommended Priority/Timeline:	High priority (same as fish screens). Design anticipated to be complete in 2018. Potential 2019 construction.		

Project: IID-1-3 – Replace Snow Creek Flume



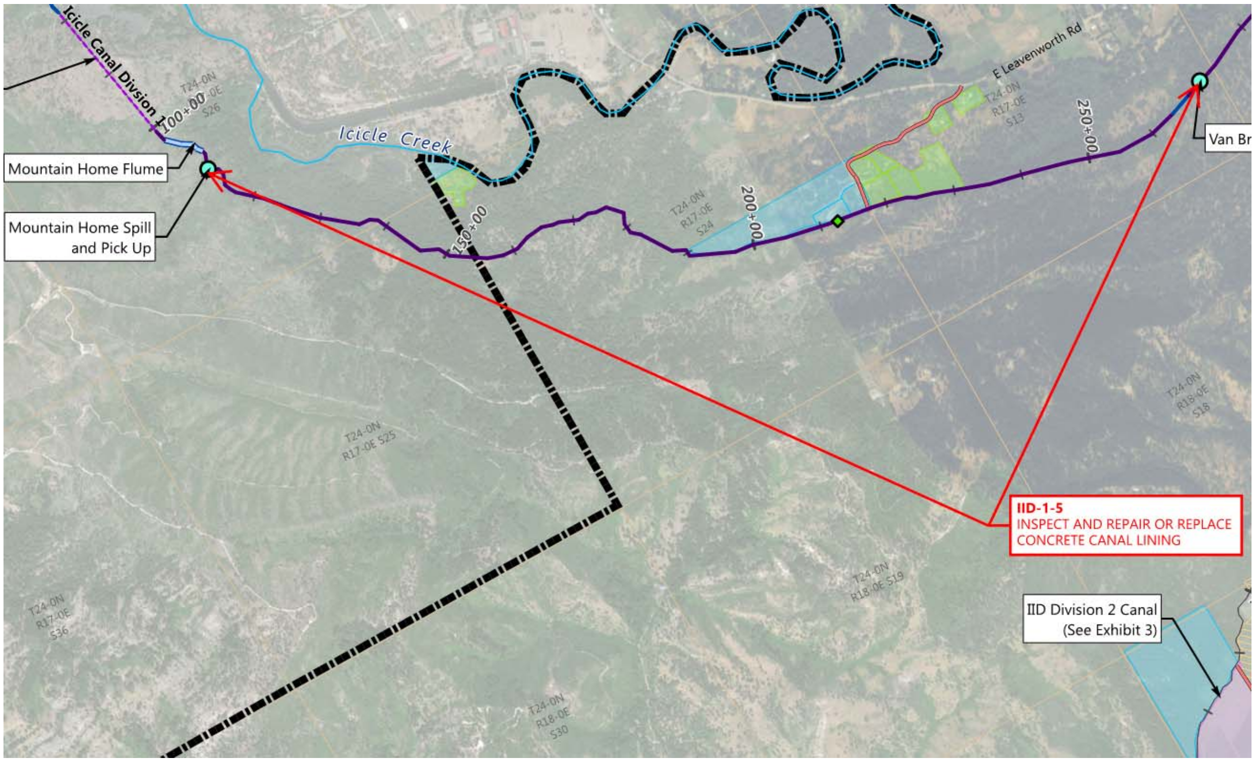
Location (Reach or Division):	IID Division 1 (Station 19+00)		
Projected Water Savings:	0 cfs		
Deficiency Addressed/Purpose:	• Existing flume is in poor condition (rusted, failing).		
Project Description:	Replace existing gate and flume that divert water from Snow Creek to the IID Division 1A Canal with a new gate and pipeline.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$17,300	$19,400
	Labor, Other	$7,500	$8,400
	Construction Subtotal	**$24,800**	**$27,800**
	Other Costs	$5,000	$5,600
Notes:	Snow Creek pickup facilities are typically only used during drought years, when Icicle Creek flows are extremely low.		
Recommended Priority/Timeline:	Medium priority. Target implementation within next 6 to 8 years.		

Project: IID-1-4 – Replace Existing Steel Flume



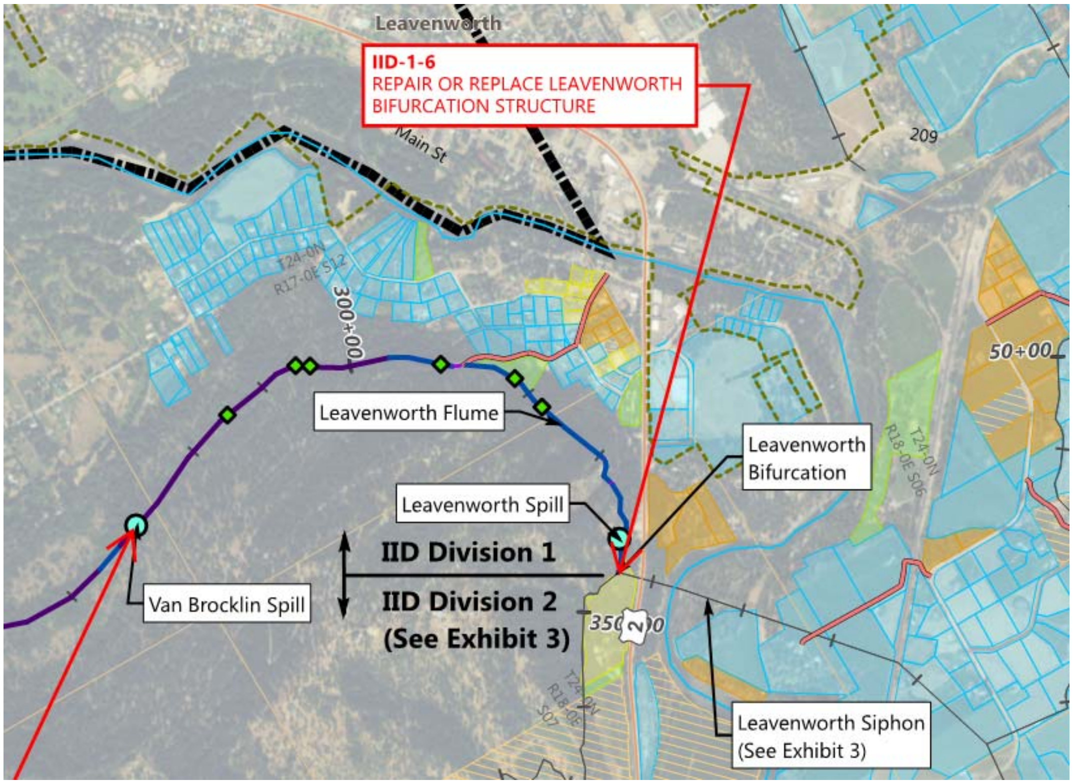
Location (Reach or Division):	IID Division 1 (Station 55+00)		
Projected Water Savings:	0 cfs		
Deficiency Addressed/Purpose:	• Flume is in poor condition (rusted, deformed, etc.). • Flume support structure is in poor condition).		
Project Description:	Install new elevated steel box flume to replace existing flume.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$30,300	$34,000
	Labor, Other	$13,000	$14,600
	Construction Subtotal	**$43,300**	**$48,600**
	Other Costs	$8,700	$9,700
Notes:	Remote locations, access will be challenging.		
Recommended Priority/Timeline:	Medium Priority. Target implementation next 6 to 8 years.		

Project: IID-1-5 –Repair or Replace Concrete Canal Lining



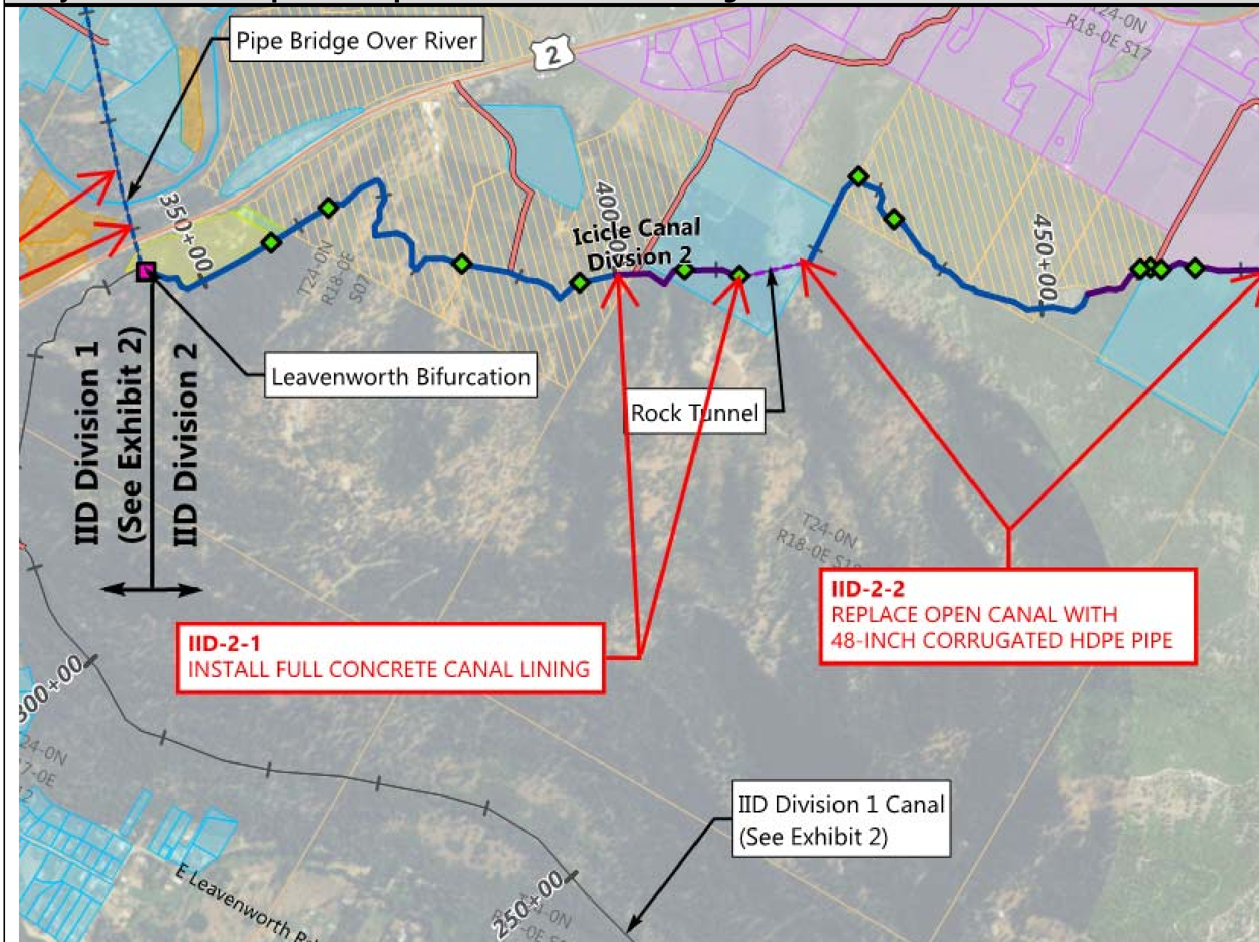
Location (Reach or Division):	IID Division 1 (Station 111+00 to 270+00)		
Projected Water Savings:	1.5 cfs		
Deficiency Addressed/Purpose:	• Existing lining is old, weathered, and cracking in places. • Sections of canal have failed due to seepage and erosion.		
Project Description:	Inspect and repair or replace concrete canal lining from Mountain Home Spill to Van Brocklin Spill.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$715,300	$817,500
	Labor, Other	$306,500	$357,600
	Construction Subtotal	**$1,021,800**	**$1,175,100**
	Other Costs	$204,400	$235,000
Notes:	Canal is either fully or partially (concrete poured up to bedrock hillside) lined, but lining is mostly old. Costs assume full replacement.		
Recommended Priority/Timeline:	Low to Medium Priority. Canal lining and repair will occur as needed. Target full implementation next 9 to 15 years.		

Project: IID-1-6 – Replace or Repair Leavenworth Bifurcation Structure



Location (Reach or Division):	IID Division 1 (Station 343+00)		
Projected Water Savings:	0 cfs		
Deficiency Addressed/Purpose:	• Existing structure is old, weathered, etc. • Gates are old and rusted, but in working condition.		
Project Description:	Repair or replace the existing Leavenworth Bifurcaton structure, cipoletti weir, and associated slide gates.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$21,600	$24,200
	Labor, Other	$9,300	$10,400
	Construction Subtotal	**$30,900**	**$34,600**
	Other Costs	$6,200	$6,900
Notes:	Costs assume full replacement.		
Recommended Priority/Timeline:	Low Priority. Target implementation next 16 to 25 years.		

Project: IID-2-1 – Repair or Replace Concrete Canal Lining

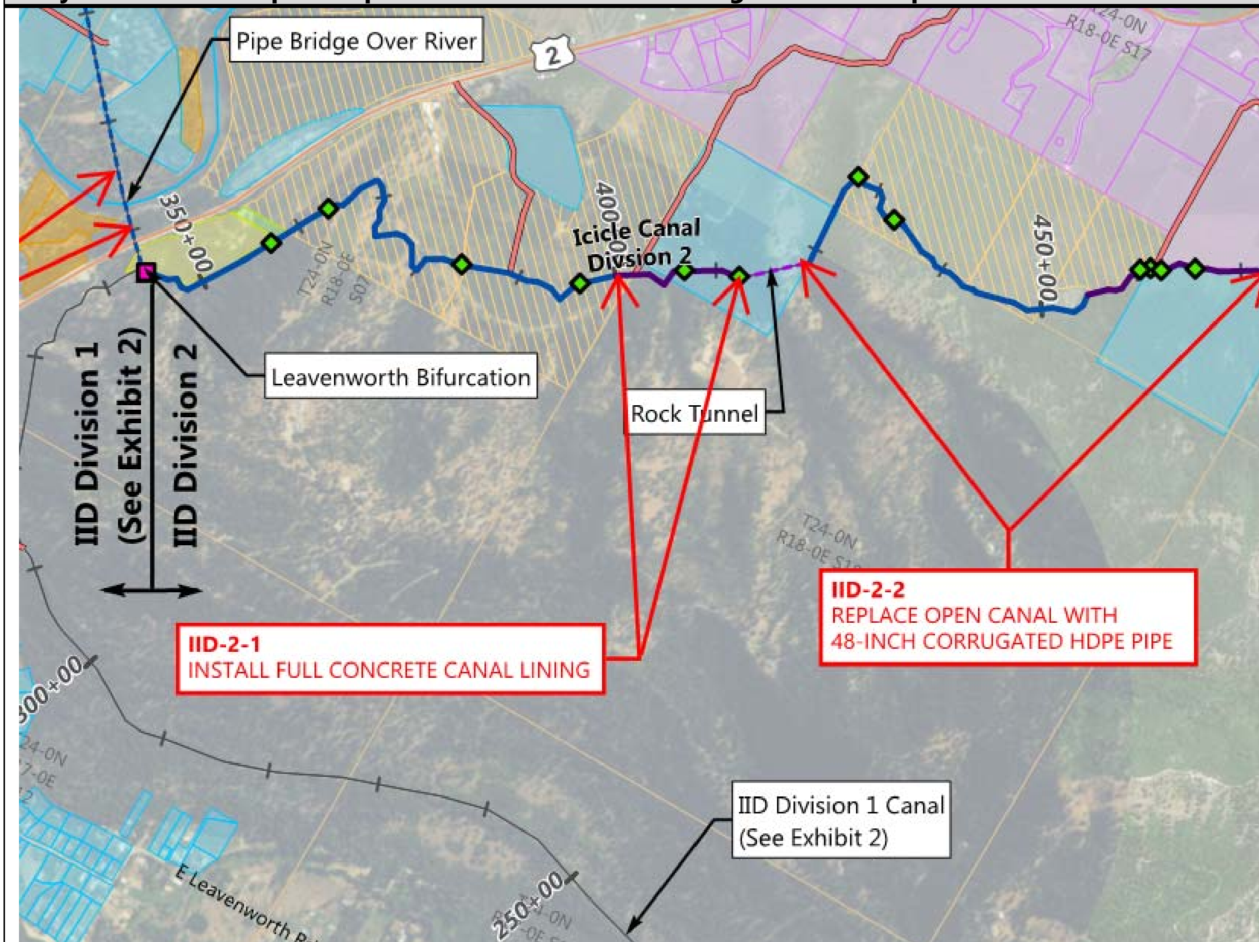


Location (Reach or Division):	IID Division 2 (Station 400+00 to 412+00)
Projected Water Savings:	1.1 cfs
Deficiency Addressed/Purpose:	• Existing lining is old, weathered, and cracked in places with vegetation growing in cracks. • Measurements indicate loss in this section.
Project Description:	Inspect and repair or replace concrete canal lining upstream of rock tunnel. Fully line partially-lined canal.
Estimated Implementation Cost:	see below
Notes:	Costs assume full replacement.
Recommended Priority/Timeline:	High Priority. IPID intends to implement next 3 years.

Estimated Implementation Cost:

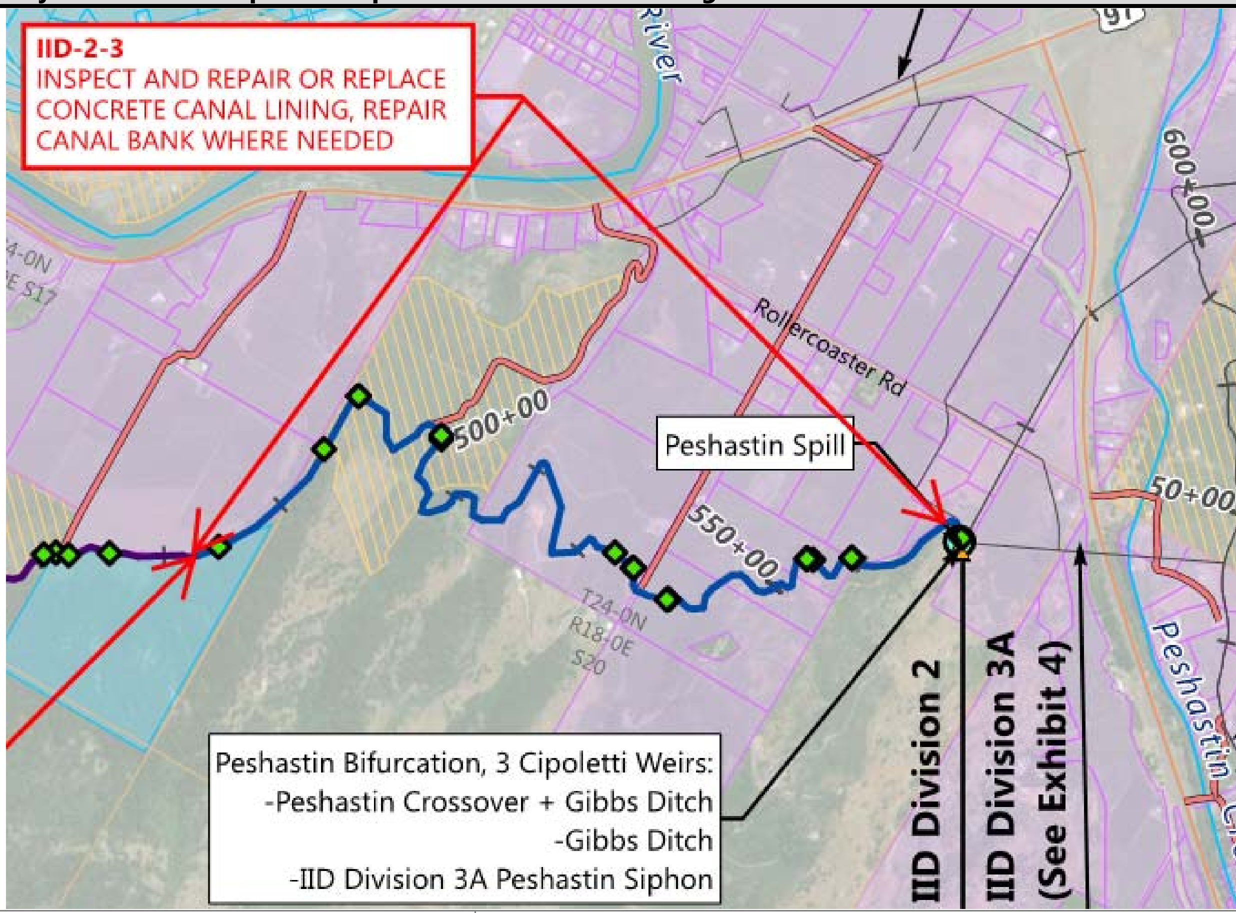
Item	Low	High
Materials	$52,300	$59,700
Labor, Other	$22,400	$26,100
Construction Subtotal	**$74,700**	**$85,800**
Other Costs	$14,900	$17,200

Project: IID-2-2 – Replace Open Canal with 54-inch Corrugated HDPE Pipe



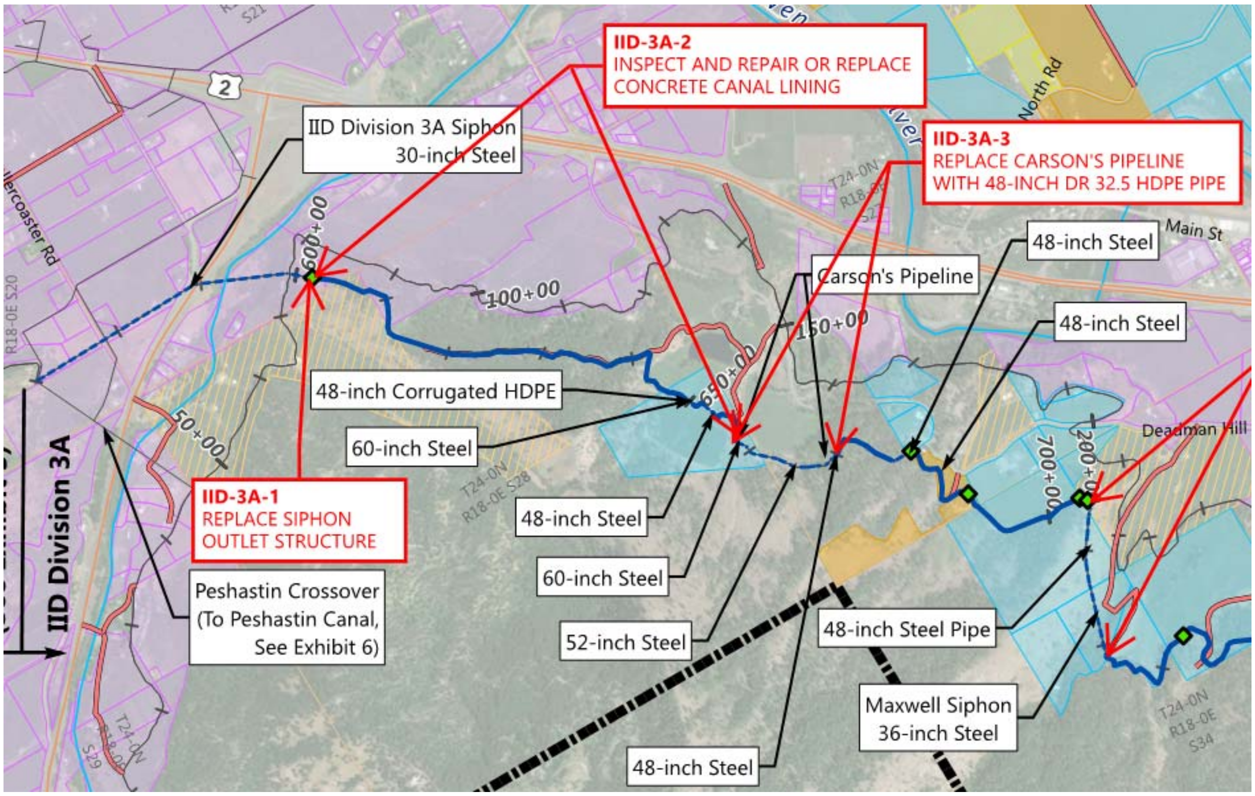
Location (Reach or Division):	IID Division 2 (Station 418+00 to 474+00)		
Projected Water Savings:	1.5 cfs		
Deficiency Addressed/Purpose:	• Existing lining is old, weather, and cracked in places with vegetation growing in cracks. • Measurements indicate loss in this section.		
Project Description:	Replace open canal with 54-inch corrugated HDPE pipe.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$1,680,000	$1,904,000
	Labor, Other	$616,000	$672,000
	Construction Subtotal	**$2,296,000**	**$2,576,000**
	Other Costs	$459,200	$515,200
Notes:	None.		
Recommended Priority/Timeline:	Medium Priority. Target implementation within next 6 to 8 years.		

Project: IID-2-3 – Repair or Replace Concrete Canal Lining



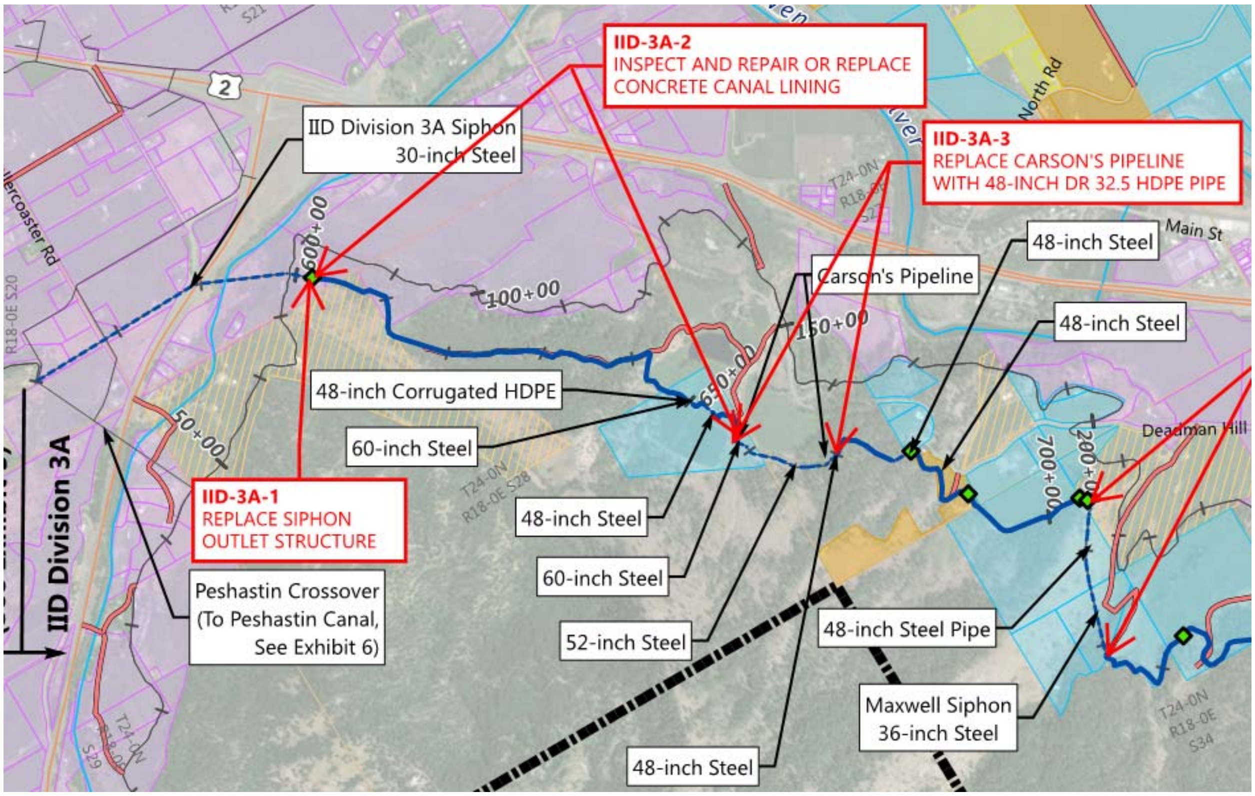
Location (Reach or Division):	IID Division 2 (Station 474+00 to 568+00)		
Projected Water Savings:	1.4 cfs		
Deficiency Addressed/Purpose:	• Existing lining is old, weathered, and cracked in places with vegetation growing in cracks. • Measurements indicate loss in this section.		
Project Description:	Inspect and repair or replace concrete canal lining upstream of rock tunnel.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$409,500	$468,000
	Labor, Other	$175,500	$204,700
	Construction Subtotal	**$585,000**	**$672,700**
	Other Costs	$117,000	$134,500
Notes:	Costs assume full replacement.		
Recommended Priority/Timeline:	Medium Priority. Target implementation within next 6 to 8 years.		

Project: IID-3A-1 – Repair or Replace Division 3A Siphon Outlet Structure



Location (Reach or Division):	IID Division 3A (Station 601+00)		
Projected Water Savings:	0 cfs		
Deficiency Addressed/Purpose:	• Existing siphon outlet is old, weathered, and in poor condition.		
Project Description:	Repair or replace concrete structure at IID Division 3A Siphon outlet.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$7,800	$8,700
	Labor, Other	$3,300	$3,700
	Construction Subtotal	**$11,100**	**$12,400**
	Other Costs	$2,200	$2,500
Notes:	Costs assume full replacement.		
Recommended Priority/Timeline:	Low to Medium Priority. Target full implementation next 9 to 15 years.		

Project: IID-3A-2 – Repair or Replace Concrete Canal Lining

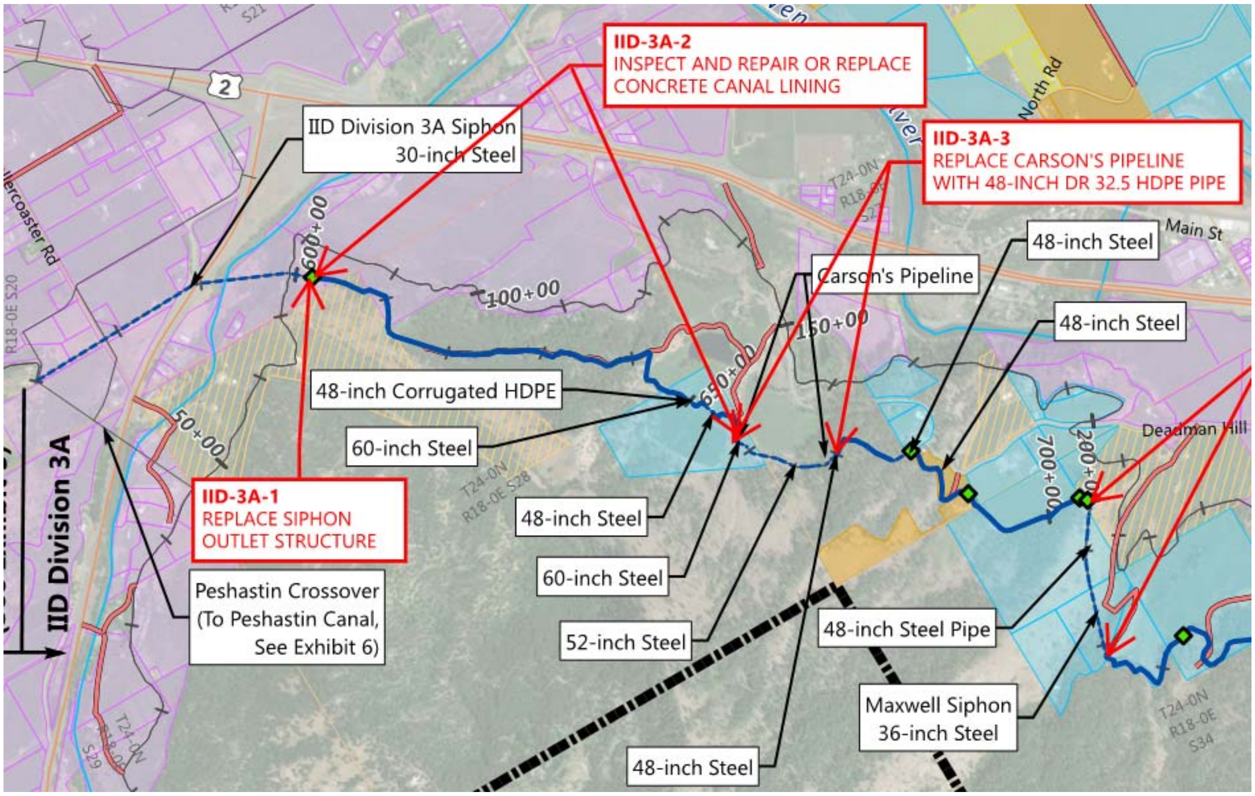


Location (Reach or Division):	IID Division 3A (Station 601+00 to 658+00)
Projected Water Savings:	0 cfs
Deficiency Addressed/Purpose:	• Existing lining is old, weathered, and cracked in places. • Measurements indicate loss in this section.
Project Description:	Inspect and repair or replace concrete canal lining from siphon outlet to Carson's Pipeline.
Estimated Implementation Cost:	
Notes:	Could be replaced with pipe, rather than lining. Costs assume full replacement of lining.
Recommended Priority/Timeline:	Medium Priority. Target implementation within next 6 to 8 years.

Estimated Implementation Cost:

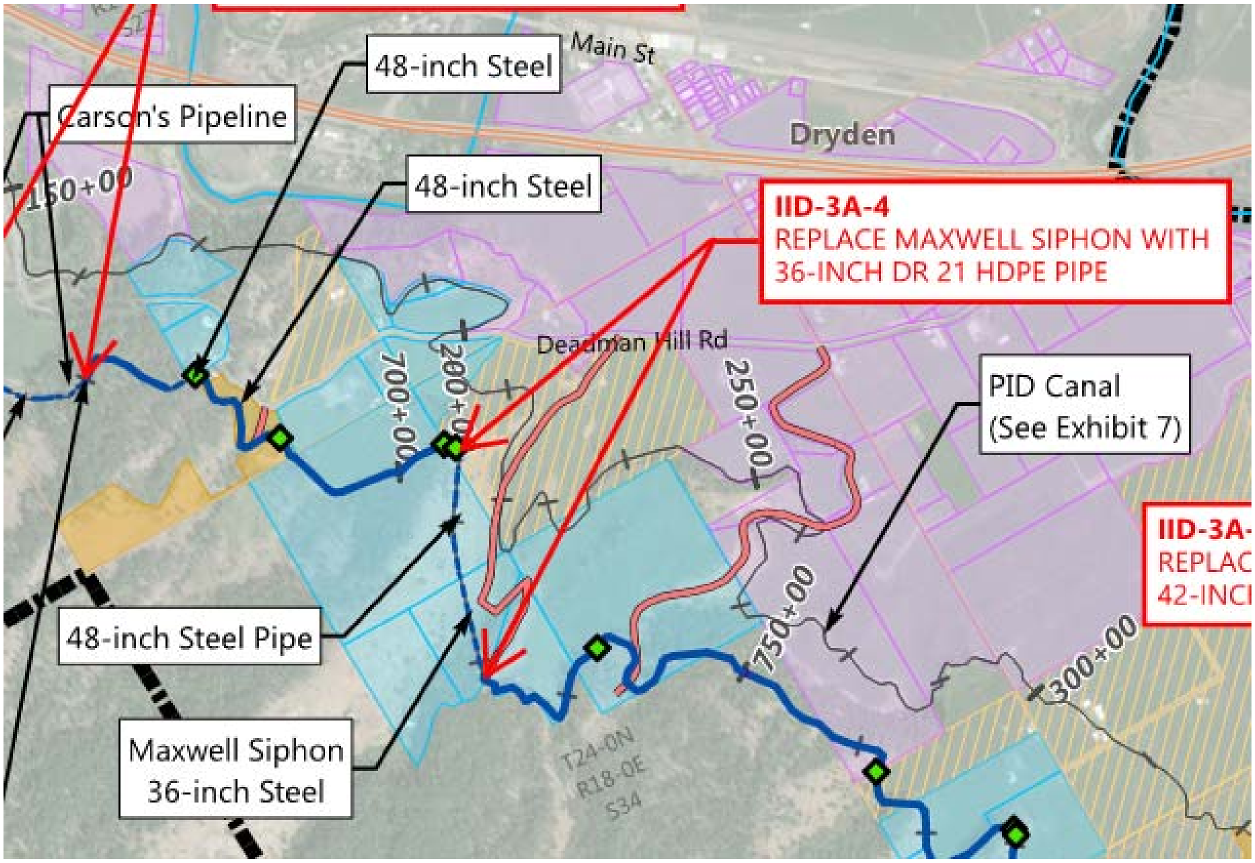
Item	Low	High
Materials	$234,100	$267,600
Labor, Other	$100,300	$117,100
Construction Subtotal	**$334,400**	**$384,700**
Other Costs	$66,900	$76,900

Project: IID-3A-3 – Replace Existing Steel Pipes with 48-inch DR 32.5 HDPE Pipe



Location (Reach or Division):	IID Division 3A (Station 658+00 to 690+00)		
Projected Water Savings:	0.3 cfs		
Deficiency Addressed/Purpose:	• Existing pipeline has buckled due to landslide and erosion. • Existing pipeline is rusted, pitted, and in poor condition.		
Project Description:	Replace existing steel pipes referred to as Carson's Pipeline with 48-inch DR 32.5 HDPE Pipe.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$736,000	$832,000
	Labor, Other	$288,000	$320,000
	Construction Subtotal	**$1,024,000**	**$1,152,000**
	Other Costs	$204,800	$230,400
Notes:	None.		
Recommended Priority/Timeline:	High Priority. Target implementation within next 5 years.		

Project: IID-3A-4 – Replace Maxwell Siphon with 36-inch DR 21 HDPE Pipe

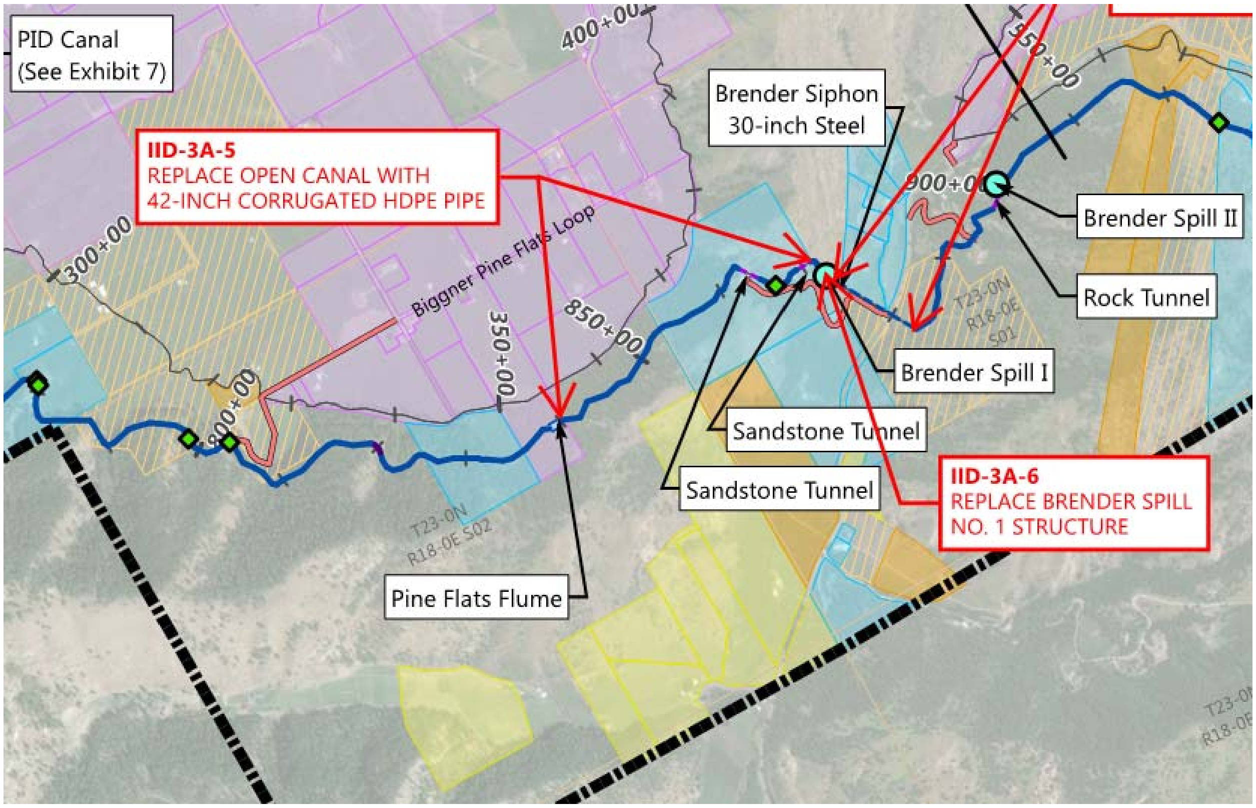


Location (Reach or Division):	IID Division 3A (Station 713+00 to 721+00)
Projected Water Savings:	0 cfs
Deficiency Addressed/Purpose:	• Existing siphon is steel pipe and is rusted, but in fair condition. • Pipe may be leaking in places.
Project Description:	Replace Maxwell Siphon with 36-inch DR 21 HDPE pipe.
Estimated Implementation Cost:	see below
Notes:	None.
Recommended Priority/Timeline:	Low to Medium Priority. Target implementation within next 9 to 15 years.

Estimated Implementation Cost:

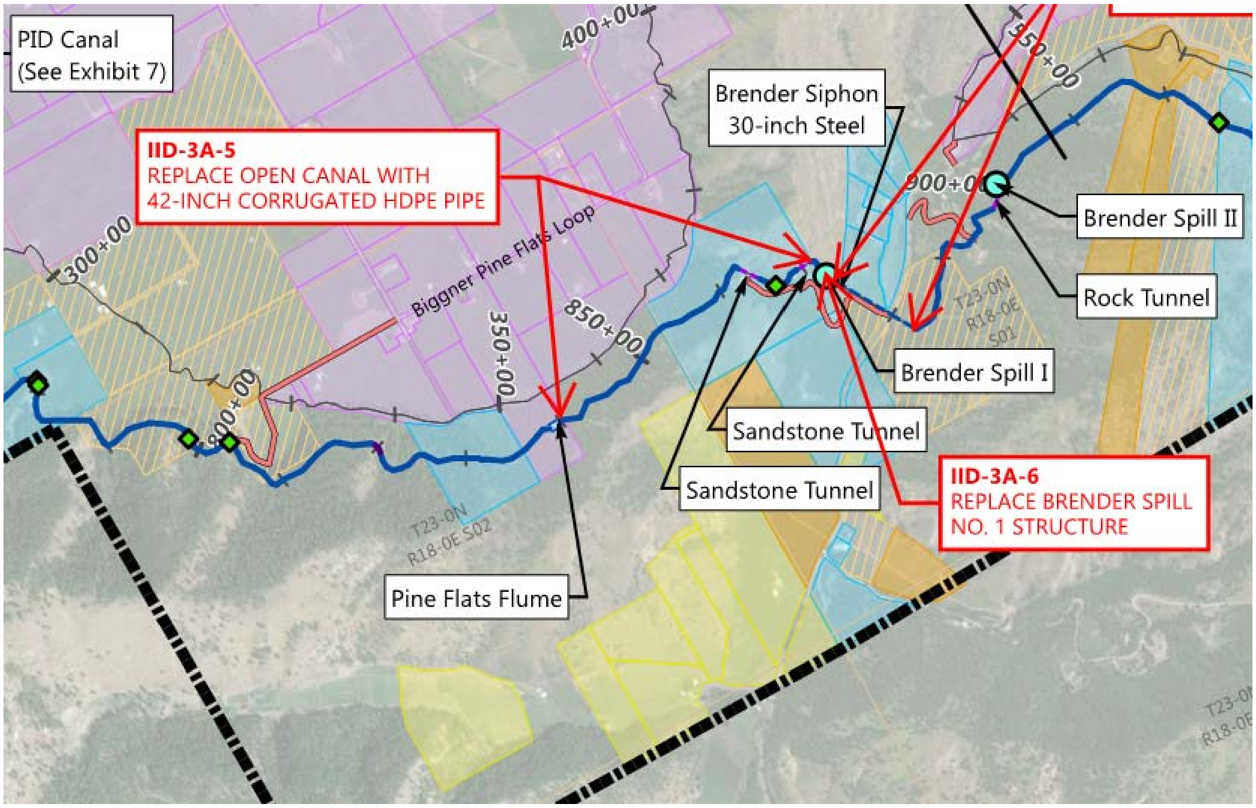
Item	Low	High
Materials	$240,000	$272,000
Labor, Other	$88,000	$96,000
Construction Subtotal	**$328,000**	**$368,000**
Other Costs	$65,600	$73,600

Project: IID-3A-5 – Replace Open Canal with 42-inch Corrugated HDPE Pipe



Location (Reach or Division):	IID Division 3A (Station 840+00 to 871+00)		
Projected Water Savings:	0.2 cfs		
Deficiency Addressed/Purpose:	• Existing lining is old, weathered, and cracked in places. • Measurements indicate loss in this section.		
Project Description:	Replace open canal with 42-inch Corrugated HDPE pipe and extend through sandstone tunnels.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$775,000	$868,000
	Labor, Other	$279,000	$310,000
	Construction Subtotal	**$1,054,000**	**$1,178,000**
	Other Costs	$210,800	$235,600
Notes:	None.		
Recommended Priority/Timeline:	High Priority. Target implementation next 5 years.		

Project: IID-3A-6 – Repair or Replace Brender Spill No. 1 Structure



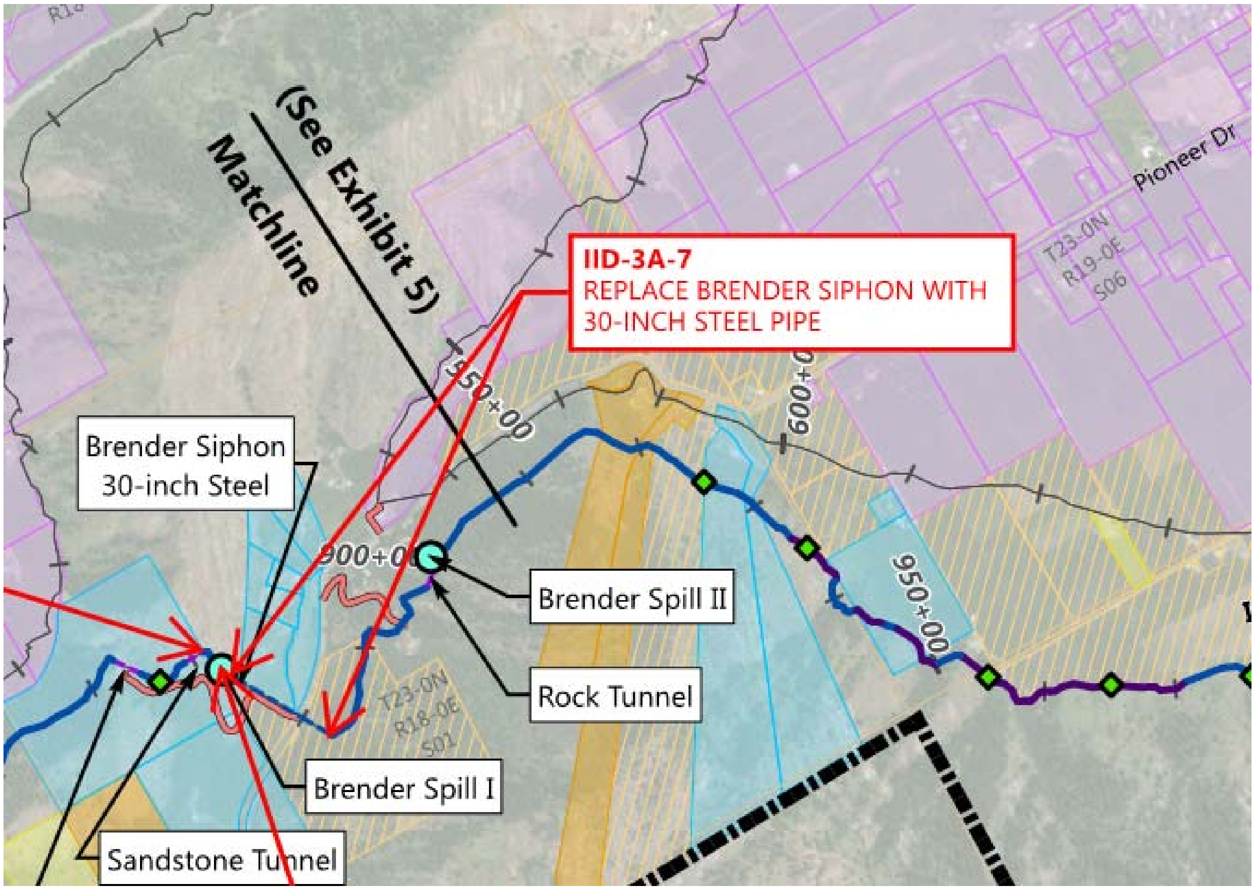
Location (Reach or Division):	IID Division 3A (Station 873+00)
Projected Water Savings:	0 cfs
Deficiency Addressed/Purpose:	• Existing spill structure is old and weathered. Concrete is cracking and in poor condition.
Project Description:	Repair or replace concrete spill structure.

Estimated Implementation Cost:

Item	Low	High
Materials	$13,000	$14,500
Labor, Other	$5,600	$6,200
Construction Subtotal	**$18,600**	**$20,700**
Other Costs	$3,700	$4,100

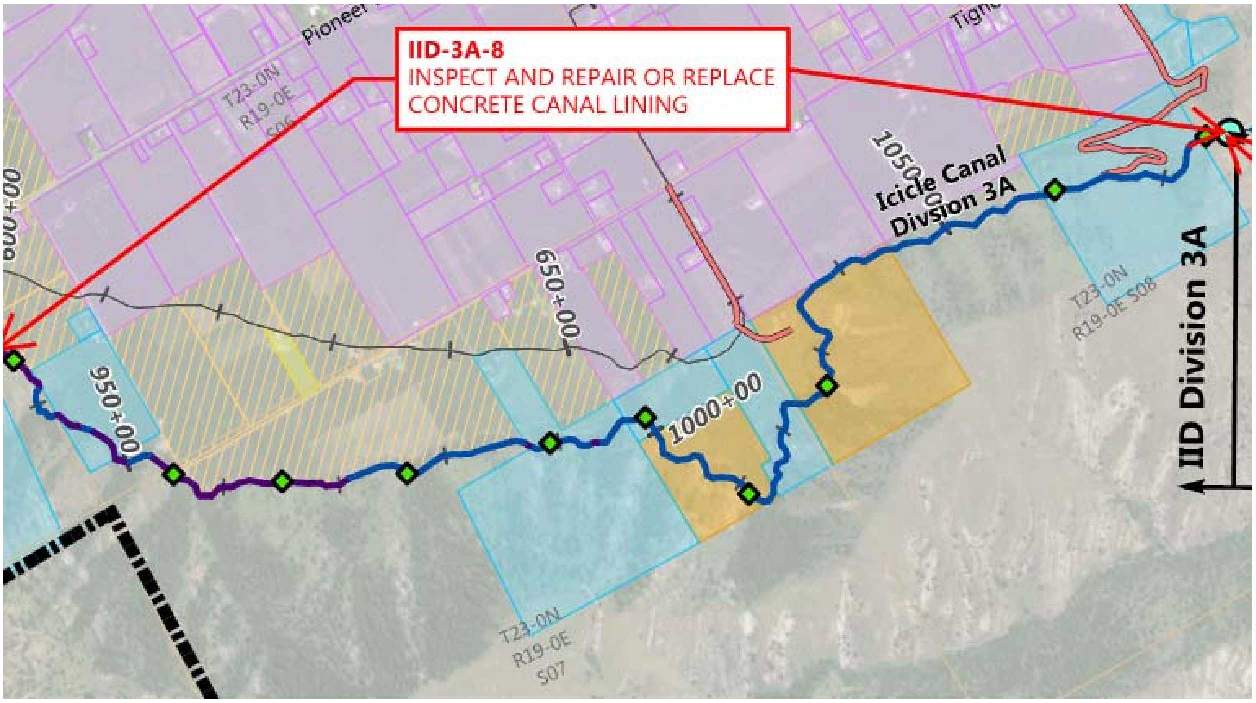
Notes:	Costs assume full replacement.
Recommended Priority/Timeline:	Low to Medium Priority. Target implementation within next 9 to 15 years. Replace when siphon is replaced (Project IID-3A-7).

Project: IID-3A-7 – Repair or Replace Brender Siphon with 30-inch Steel Pipe



Location (Reach or Division):	IID Division 3A (Station 873+00 to 883+00)		
Projected Water Savings:	0 cfs		
Deficiency Addressed/Purpose:	• Existing siphon is old and rusted, with holes in places. • Siphon may be leaking.		
Project Description:	Replace existing 30-inch steel siphon under Brender Creek and Brender Canyon Road with 30-inch steel pipe.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$190,000	$220,000
	Labor, Other	$70,000	$80,000
	Construction Subtotal	**$260,000**	**$300,000**
	Other Costs	$52,000	$60,000
Notes:	None.		
Recommended Priority/Timeline:	Low to Medium Priority. Target implementation within next 9 to 15 years. Replace when Brender Spill is replaced (Project IID-3A-6).		

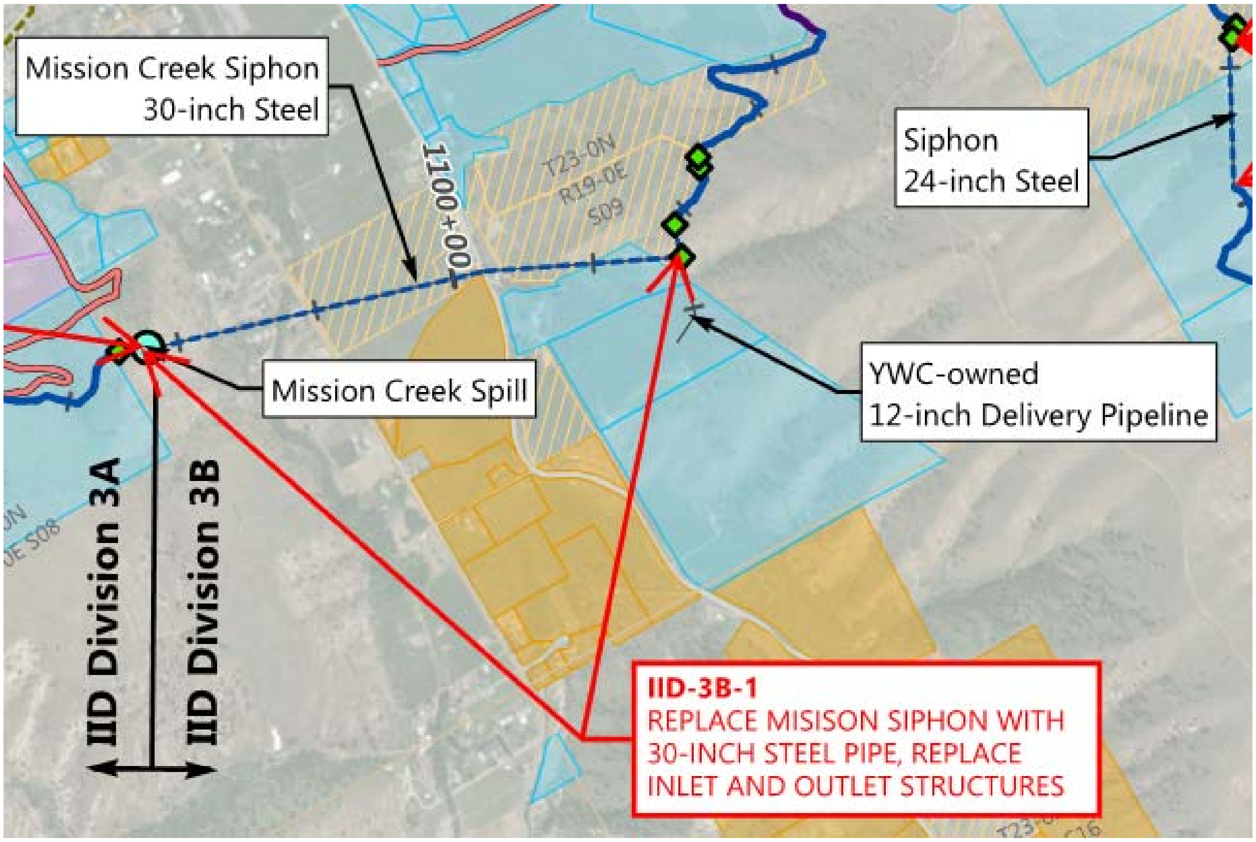
Project: IID-3A-8 – Repair or Replace Concrete Canal Lining



Location (Reach or Division):	IID Division 3A (Station 934+00 to 1078+00)
Projected Water Savings:	0.1 cfs
Deficiency Addressed/Purpose:	• Existing lining is old, weathered, and cracked in places.
Project Description:	Inspect and repair or replace concrete canal lining from south of the west end of Pioneer Drive to the Mission Siphon.
Estimated Implementation Cost:	
Notes:	Costs assume full replacement.
Recommended Priority/Timeline:	High Priority. Target implementation within next 5 years.

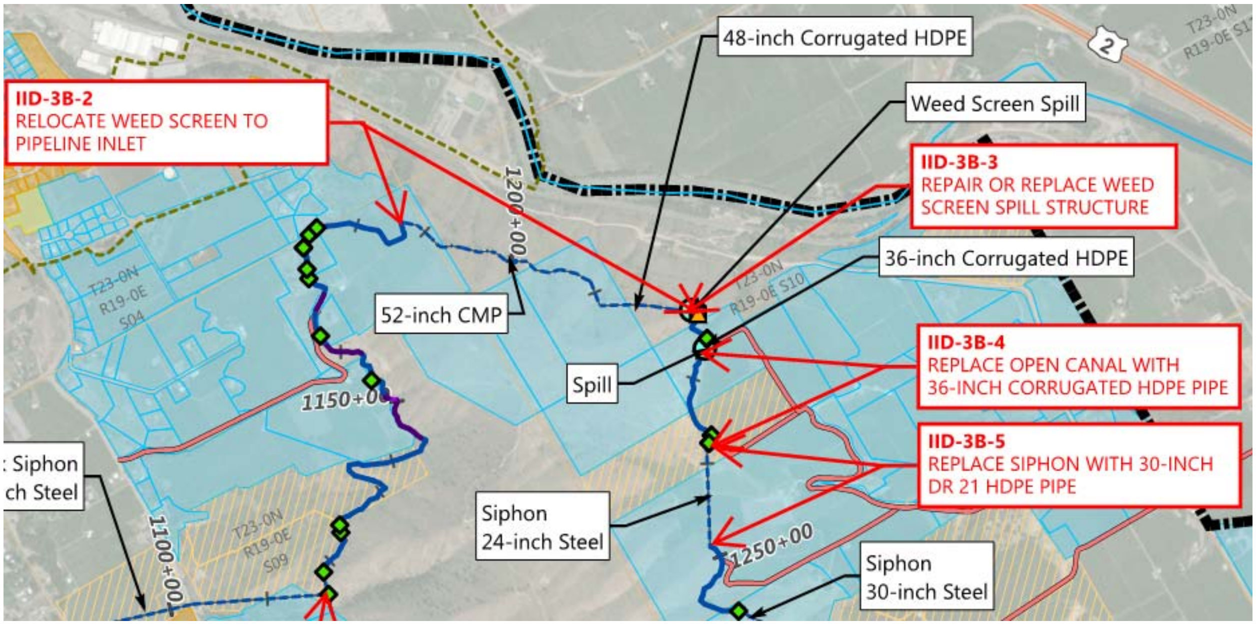
Item	**Low**	**High**
Materials	$591,400	$675,900
Labor, Other	$253,500	$295,700
Construction Subtotal	**$844,900**	**$971,600**
Other Costs	$169,000	$194,300

Project: IID-3B-1 – Replace Mission Siphon with 30-inch Steel Pipe



Location (Reach or Division):	IID Division 3B (Station 1078+00 to 1117+00)		
Projected Water Savings:	0 cfs		
Deficiency Addressed/Purpose:	• Existing siphon is old and rusted, but in fair condition. • Inlet and outlet structures are weathered, cracking.		
Project Description:	Replace existing steel Mission Siphon with 30-inch steel pipe. Replace inlet and outlet structures.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$819,000	$897,000
	Labor, Other	$312,000	$351,000
	Construction Subtotal	**$1,131,000**	**$1,248,000**
	Other Costs	$226,200	$249,600
Notes:	None.		
Recommended Priority/Timeline:	Low Priority. Target implementation within next 16 to 25 years.		

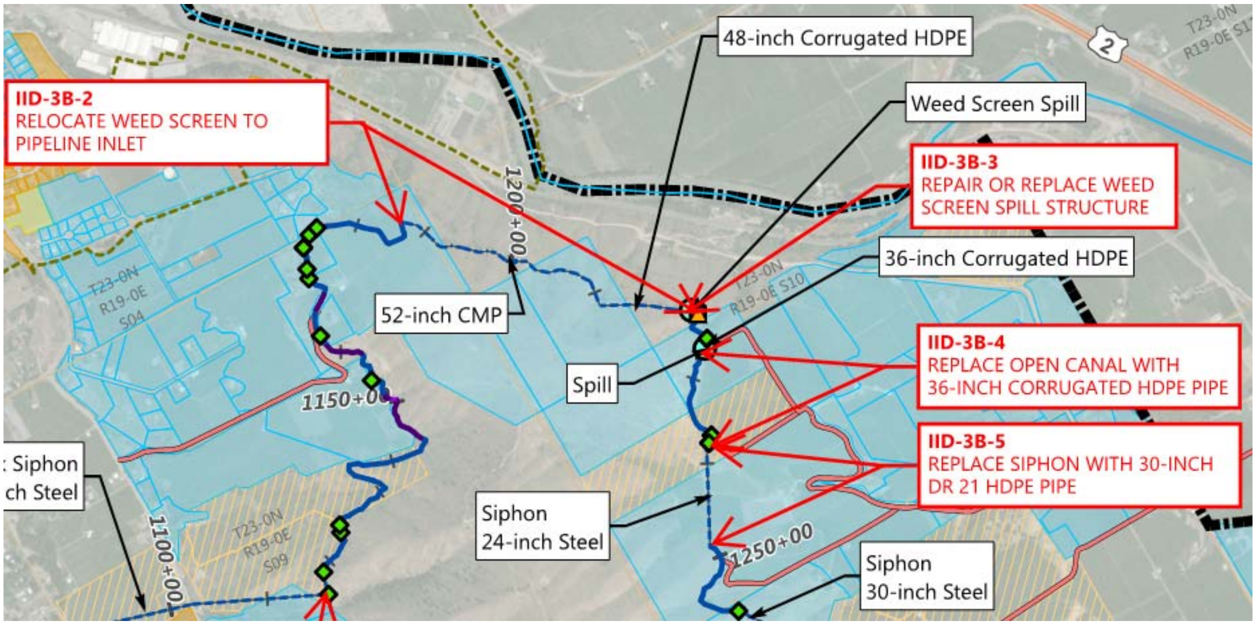
Project: IID-3B-2 – Relocate Weed Screen Upstream of 52-inch Pipeline Inlet



Location (Reach or Division):	IID Division 3B (Station 1187+00)
Projected Water Savings:	0 cfs
Deficiency Addressed/Purpose:	• Debris and algae need to be removed at pipeline inlet, instead of downstream of pipeline.
Project Description:	Relocate the existing weed screen to a new structure at the upstream end of the 52-inch pipeline that is currently upstream of the weed screen.
Estimated Implementation Cost:	
Notes:	None.
Recommended Priority/Timeline:	Low Priority. Target implementation within next 16 to 25 years.

Item	Low	High
Materials	$13,800	$15,500
Labor, Other	$5,900	$6,600
Construction Subtotal	**$19,700**	**$22,100**
Other Costs	$3,900	$4,400

Project: IID-3B-3 – Repair or Replace Weed Screen Spill Structure



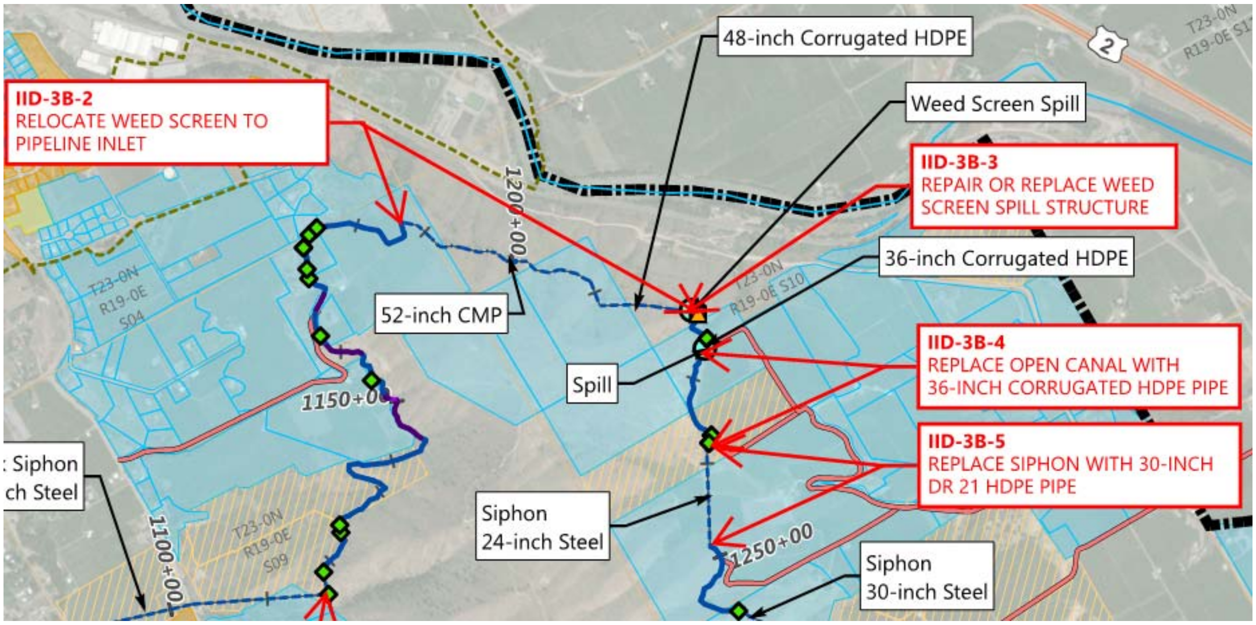
Location (Reach or Division):	IID Division 3B (Station 1221+00)
Projected Water Savings:	0 cfs
Deficiency Addressed/Purpose:	• Existing structure is old, weathered, and cracked in places. • Stop logs are leaky and slide gate is rusted.
Project Description:	Inspect and repair or replace Wee Screen Spill structure.

Estimated Implementation Cost:

Item	Low	High
Materials	$19,900	$22,300
Labor, Other	$8,500	$9,500
Construction Subtotal	**$28,400**	**$31,800**
Other Costs	$5,700	$6,400

Notes:	Costs assume full replacement.
Recommended Priority/Timeline:	Low Priority. Target implementation within next 16 to 25 years.

Project: IID-3B-4 – Replace Open Canal with 36-inch Corrugated HDPE Pipe

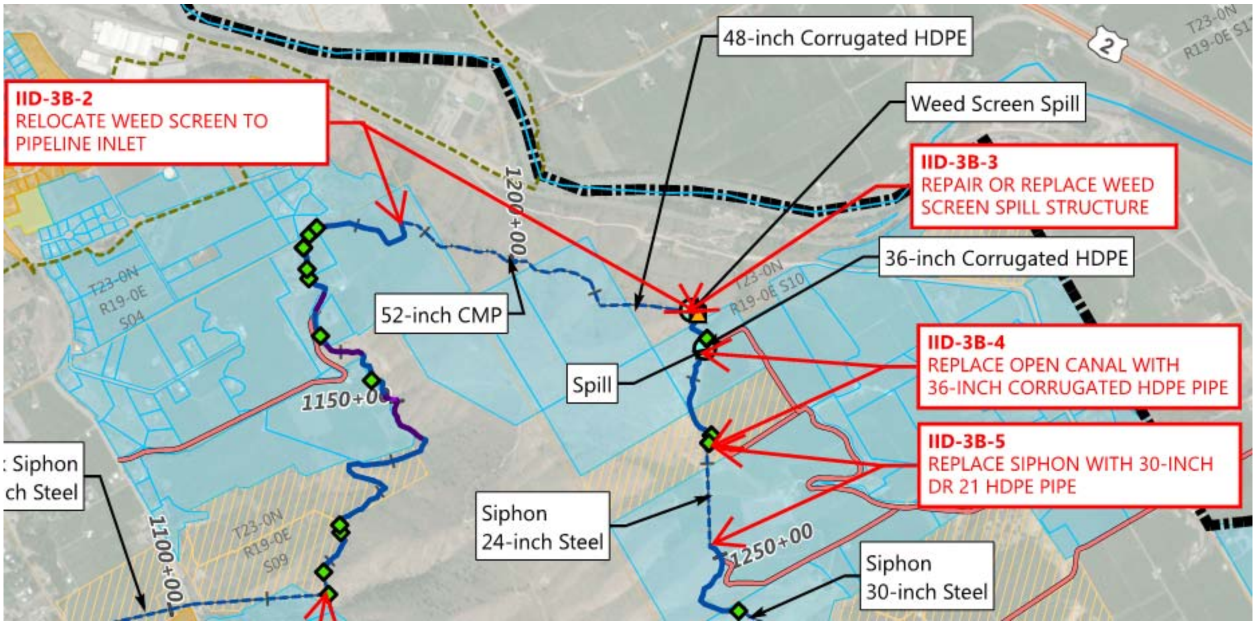


Location (Reach or Division):	IID Division 3B (Station 1225+00 to 1238+00)
Projected Water Savings:	0 cfs
Deficiency Addressed/Purpose:	• Existing lining is old, weathered, and cracked in places.
Project Description:	Inspect and repair or replace concrete canal lining from Weed Screen to siphon inlet structure.
Estimated Implementation Cost:	See table below
Notes:	None.
Recommended Priority/Timeline:	High Priority. Target implementation within next 5 years.

Estimated Implementation Cost:

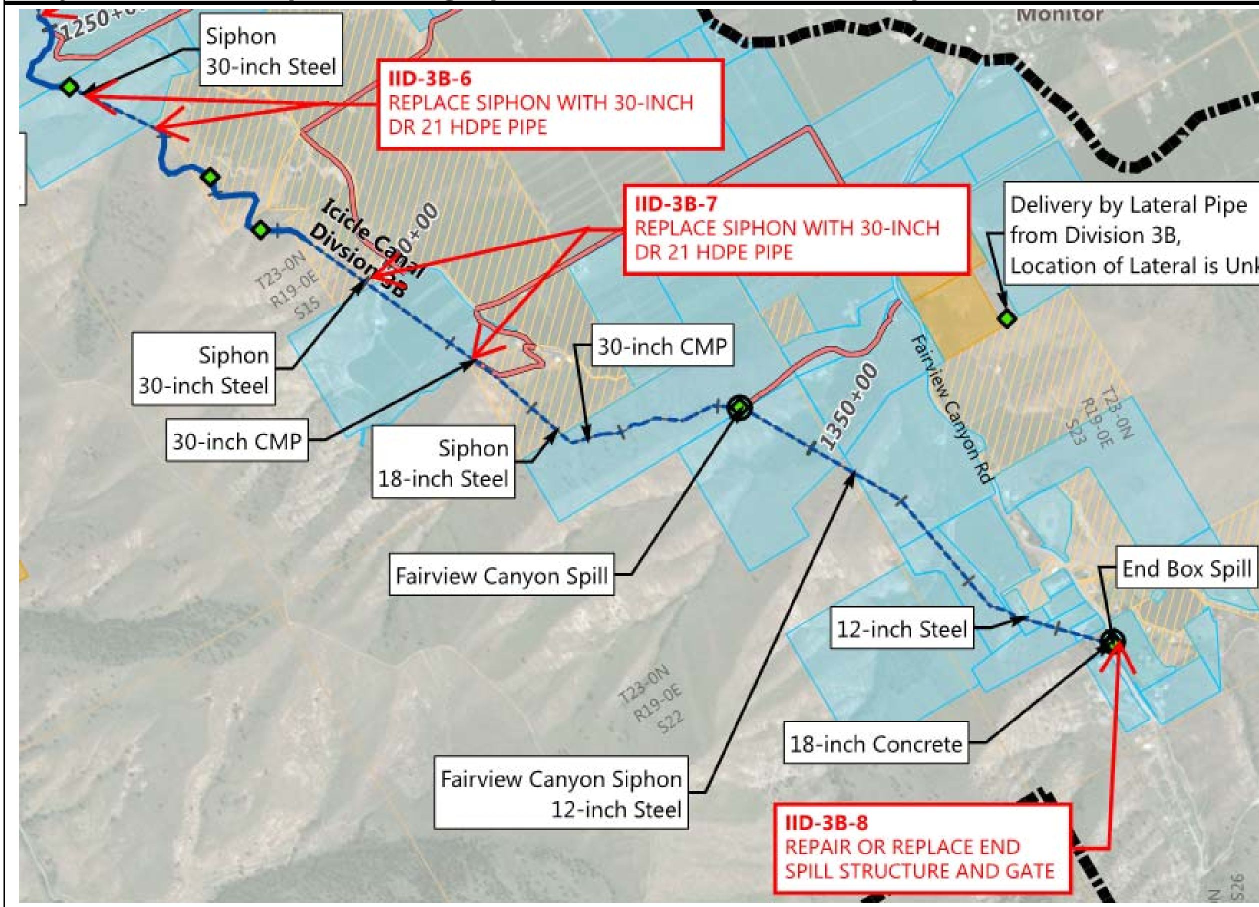
Item	Low	High
Materials	$208,000	$234,000
Labor, Other	$78,000	$91,000
Construction Subtotal	**$286,000**	**$325,000**
Other Costs	$57,200	$65,000

Project: IID-3B-5 – Replace Existing Siphon with 30-inch DR 21 HDPE Pipe



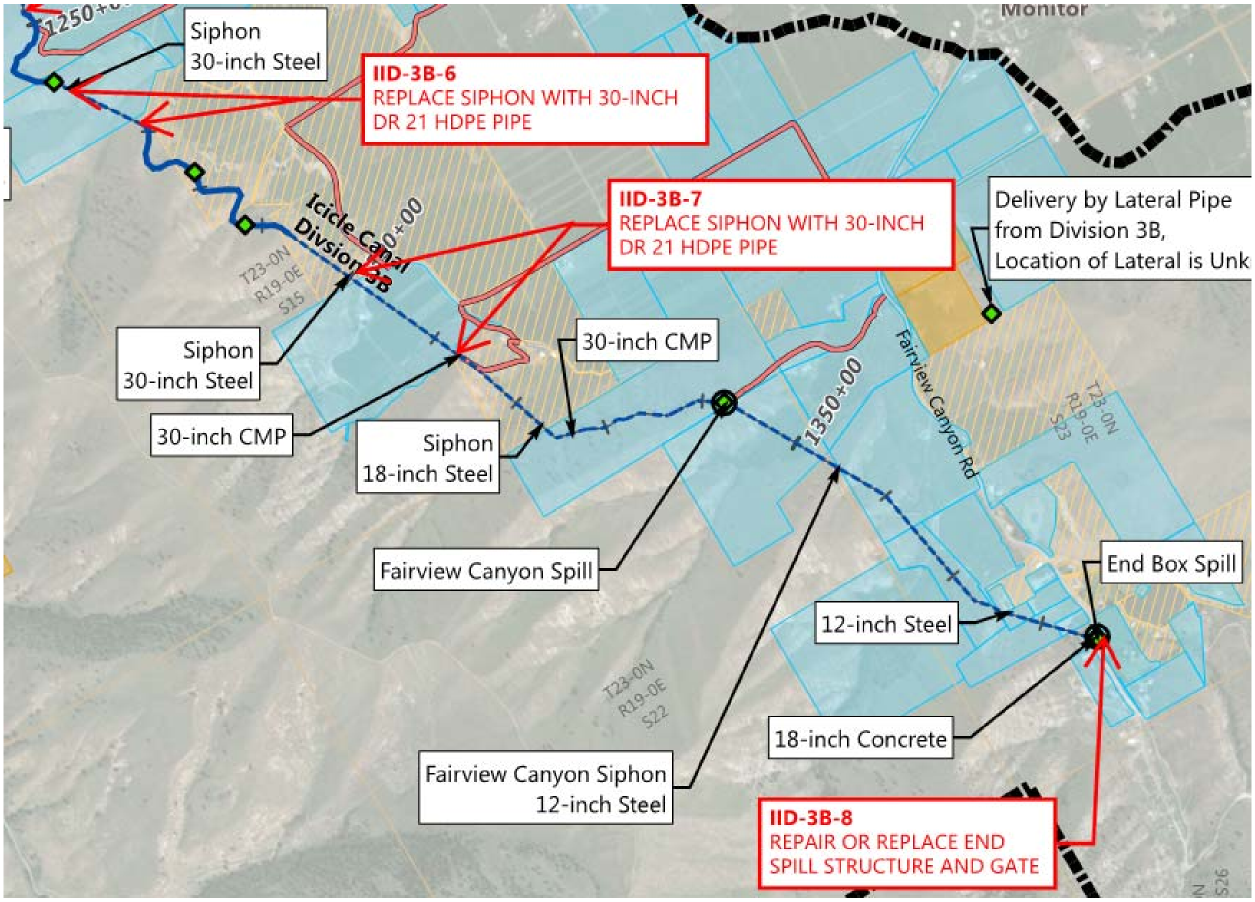
Location (Reach or Division):	IID Division 3B (Station 1238+00 to 1248+00)		
Projected Water Savings:	0 cfs		
Deficiency Addressed/Purpose:	• Existing siphon is old, rusted, and leaking. • Drain valve rusted and failed recently. Had to be replaced. • Siphon has limited capacity (is a bottleneck).		
Project Description:	Replace existing 24-inch steel siphon with 30-inch DR 21 HDPE pipe.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$210,000	$230,000
	Labor, Other	$80,000	$80,000
	Construction Subtotal	**$290,000**	**$310,000**
	Other Costs	$58,000	$62,000
Notes:	None.		
Recommended Priority/Timeline:	High Priority. Target implementation within next 5 years.		

Project: IID-3B-6 – Replace Existing Siphon with 30-inch DR 21 HDPE Pipe



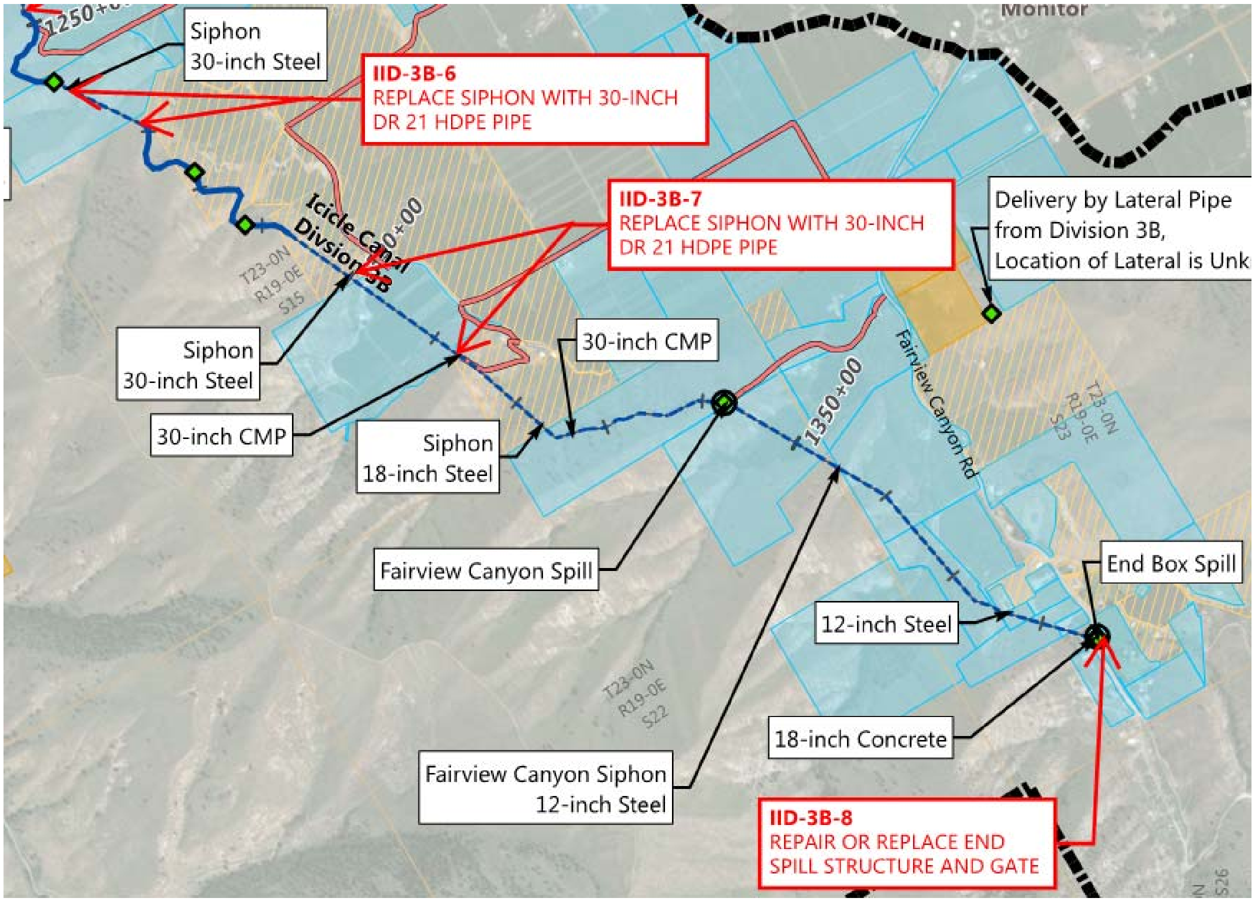
Location (Reach or Division):	IID Division 3B (Station 1260+00 to 1269+00)		
Projected Water Savings:	0 cfs		
Deficiency Addressed/Purpose:	• Existing siphon is old, rusted, and leaking.		
Project Description:	Replace existing 30-inch steel siphon with 30-inch DR 21 HDPE pipe.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$189,000	$207,000
	Labor, Other	$72,000	$72,000
	Construction Subtotal	**$261,000**	**$279,000**
	Other Costs	$52,200	$55,800
Notes:	None.		
Recommended Priority/Timeline:	Medium Priority. Target implementation within next 6 to 8 years.		

Project: IID-3B-7 – Replace Existing Siphon with 30-inch DR 21 HDPE Pipe	



Location (Reach or Division):	IID Division 3B (Station 1293+00 to 1314+00)		
Projected Water Savings:	0 cfs		
Deficiency Addressed/Purpose:	• Existing siphon is old, rusted, and leaking.		
Project Description:	Replace existing 30-inch steel siphon with 30-inch DR 21 HDPE pipe.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$441,000	$483,000
	Labor, Other	$168,000	$168,000
	Construction Subtotal	**$609,000**	**$651,000**
	Other Costs	$121,800	$130,200
Notes:	None.		
Recommended Priority/Timeline:	Medium Priority. Target implementation within next 6 to 8 years.		

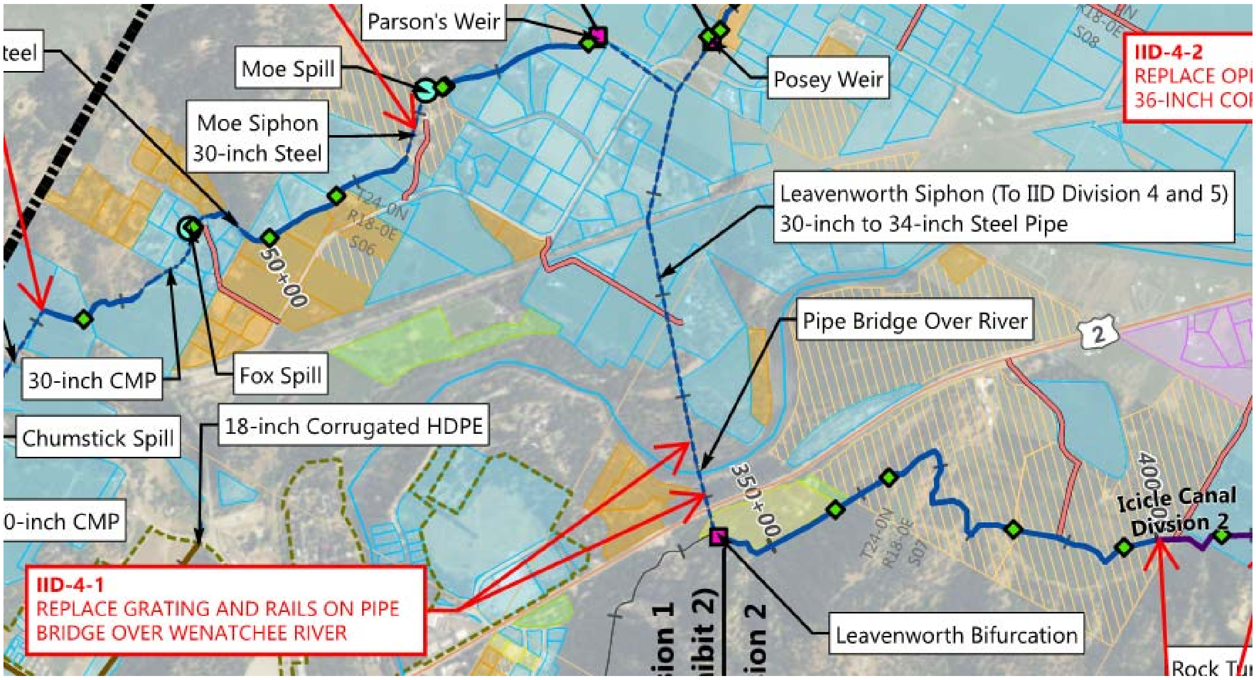
Project: IID-3B-8 – Repair or Replace End Spill Structure



Location (Reach or Division):	IID Division 3B (Station 1363+00)
Projected Water Savings:	0 cfs
Deficiency Addressed/Purpose:	• Existing spill structure is old, weathered, and cracked in places.
Project Description:	Repair or replace existing spill structure and gate.
Estimated Implementation Cost:	see table below
Notes:	Costs assume full replacement.
Recommended Priority/Timeline:	Medium Priority. Target implementation within next 6 to 8 years.

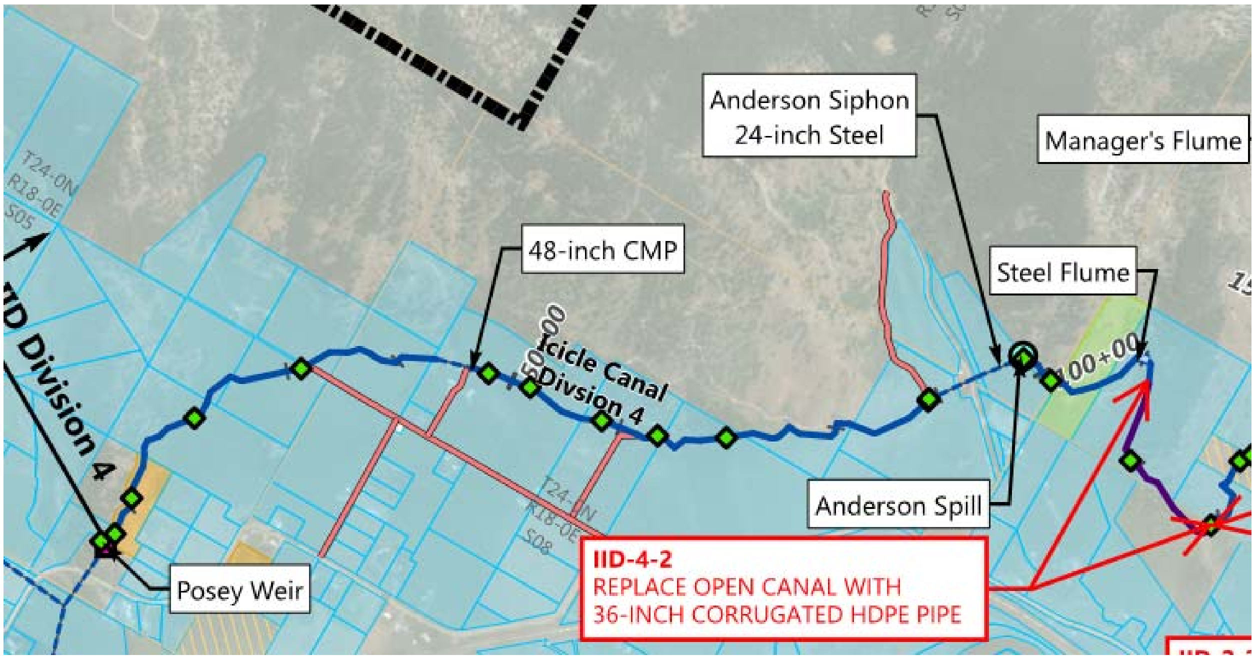
Item	**Low**	**High**
Materials	$25,900	$29,100
Labor, Other	$11,100	$12,500
Construction Subtotal	**$37,000**	**$41,600**
Other Costs	$7,400	$8,300

Project: IID-4-1 – Replace Grating and Rails on Pipe Bridge Crossing Over Wenatchee River



Location (Reach or Division):	Leavenworth Siphon to IID Division 4/5		
Projected Water Savings:	0 cfs		
Deficiency Addressed/Purpose:	• Existing grating is rusted, with holes in places. • Existing railing is rusted.		
Project Description:	Replace grating and rails on pipe bridge crossing over Wenatchee River near Leavenworth.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$37,100	$41,700
	Labor, Other	$15,900	$17,900
	Construction Subtotal	**$53,000**	**$59,600**
	Other Costs	$10,600	$11,900
Notes:	None.		
Recommended Priority/Timeline:	High Priority. Target implementation within next 5 years.		

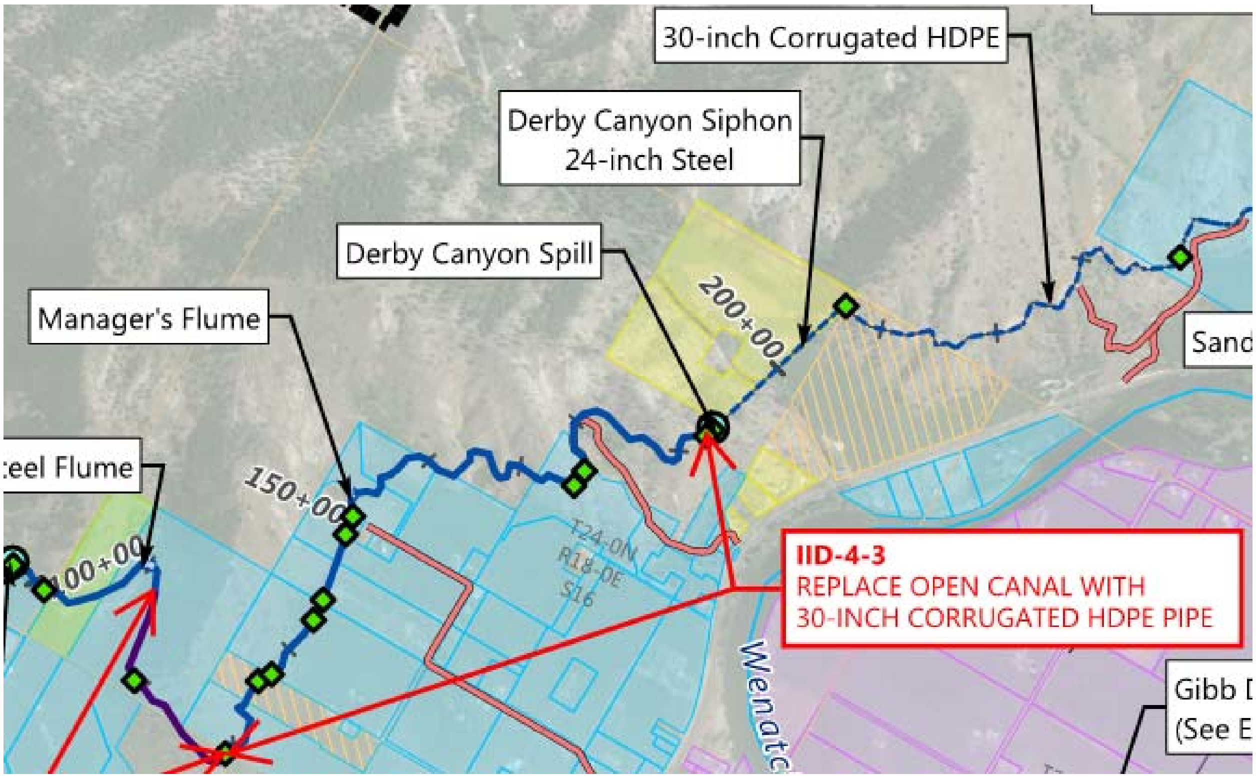
Project: IID-4-2 – Replace Open Canal with 36-inch Corrugated HDPE Pipe



Location (Reach or Division):	IID Division 4 (Station 112+00 to 130+00)
Projected Water Savings:	0.2 cfs
Deficiency Addressed/Purpose:	• Existing lining is only partially-lined. Lining is old, weathered. • Measurements indicate loss in this section of canal.
Project Description:	Replace open canal through partially-lined section downstream of new steel flume with 36-inch corrugated HDPE pipe.
Estimated Implementation Cost:	See cost table below
Notes:	None.
Recommended Priority/Timeline:	Low Priority. Target implementation within next 16 to 25 years.

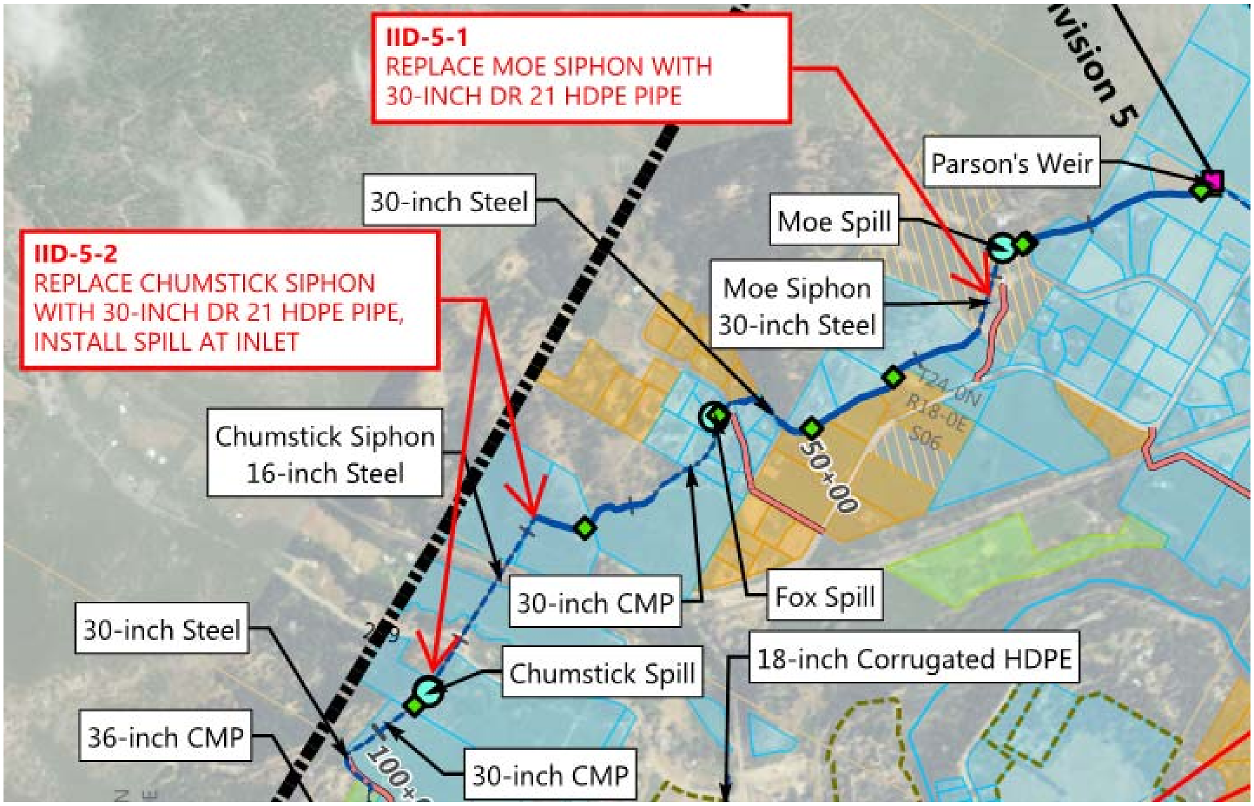
Item	Low	High
Materials	$288,000	$324,000
Labor, Other	$108,000	$126,000
Construction Subtotal	**$396,000**	**$450,000**
Other Costs	$79,200	$90,000

Project: IID-4-3 – Replace Open Canal with 30-inch Corrugated HDPE Pipe



<table>
<tr><td>Location (Reach or Division):</td><td colspan="3">IID Division 4 (Station 130+00 to 187+00)</td></tr>
<tr><td>Projected Water Savings:</td><td colspan="3">0.1 cfs</td></tr>
<tr><td>Deficiency Addressed/Purpose:</td><td colspan="3">• Existing lining is old, weathered, and cracked in places.
• Measurements indicate loss in this section of canal.</td></tr>
<tr><td>Project Description:</td><td colspan="3">Replace open canal through downstream to Derby Canyon siphon and spill with 30-inch corrugated HDPE pipe.</td></tr>
<tr><td rowspan="5">Estimated Implementation Cost:</td><td>Item</td><td>Low</td><td>High</td></tr>
<tr><td>Materials</td><td>$741,000</td><td>$855,000</td></tr>
<tr><td>Labor, Other</td><td>$285,000</td><td>$342,000</td></tr>
<tr><td>Construction Subtotal</td><td>$1,026,000</td><td>$1,197,000</td></tr>
<tr><td>Other Costs</td><td>$205,200</td><td>$239,400</td></tr>
<tr><td>Notes:</td><td colspan="3">None.</td></tr>
<tr><td>Recommended Priority/Timeline:</td><td colspan="3">Low Priority. Target implementation within next 16 to 25 years.</td></tr>
</table>

Project: IID-5-1 – Replace Moe Siphon with 24-inch DR 21 HDPE Pipe

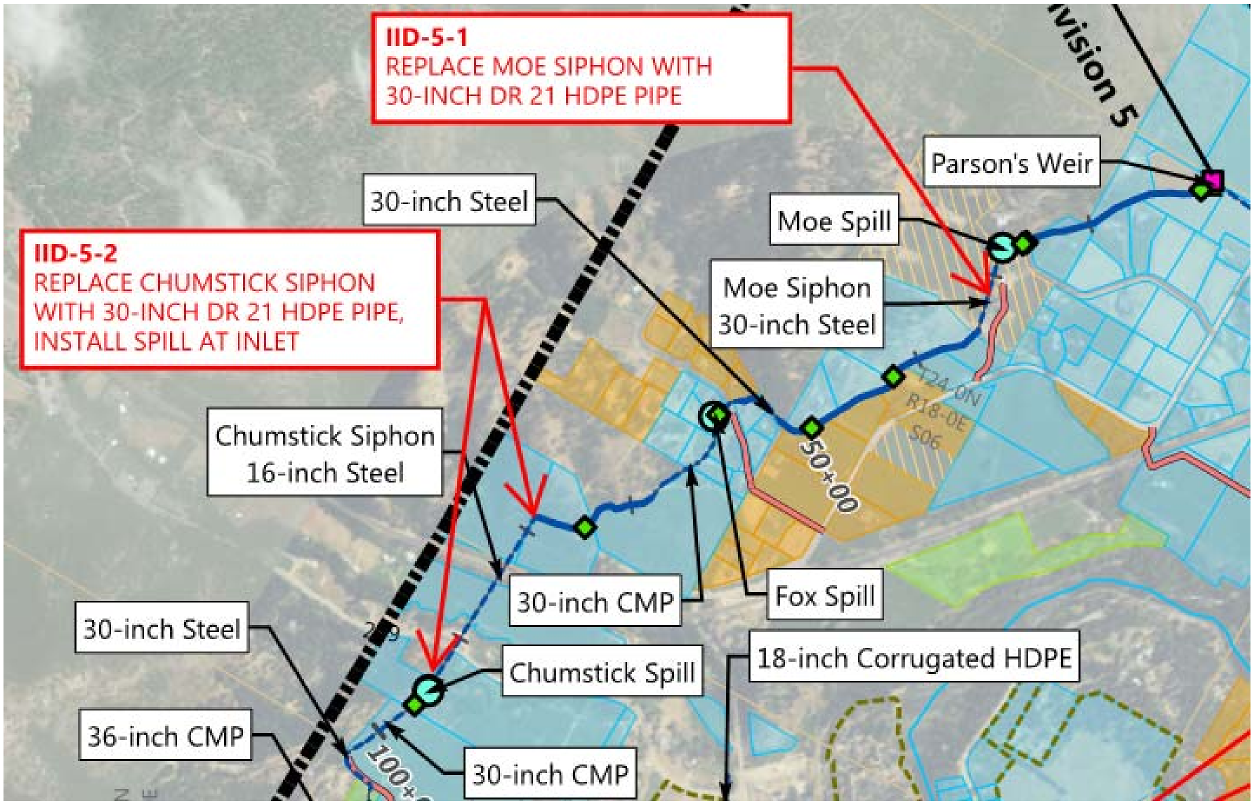


Location (Reach or Division):	IID Division 5 (Station 28+00 to 35+00)
Projected Water Savings:	0 cfs
Deficiency Addressed/Purpose:	• Existing steel siphon is old, rusty, and leaking.
Project Description:	Replace existing 24-inch steel Moe Siphon with 30-inch DR 21 HDPE pipe.
Estimated Implementation Cost:	see below
Notes:	None.
Recommended Priority/Timeline:	Low to Medium Priority. Target implementation within next 9 to 15 years.

Estimated Implementation Cost:

Item	**Low**	**High**
Materials	$147,000	$161,000
Labor, Other	$56,000	$56,000
Construction Subtotal	**$203,000**	**$217,000**
Other Costs	$40,600	$43,400

Project: IID-5-2 – Replace Chumstick Siphon with 24-inch DR 21 HDPE Pipe

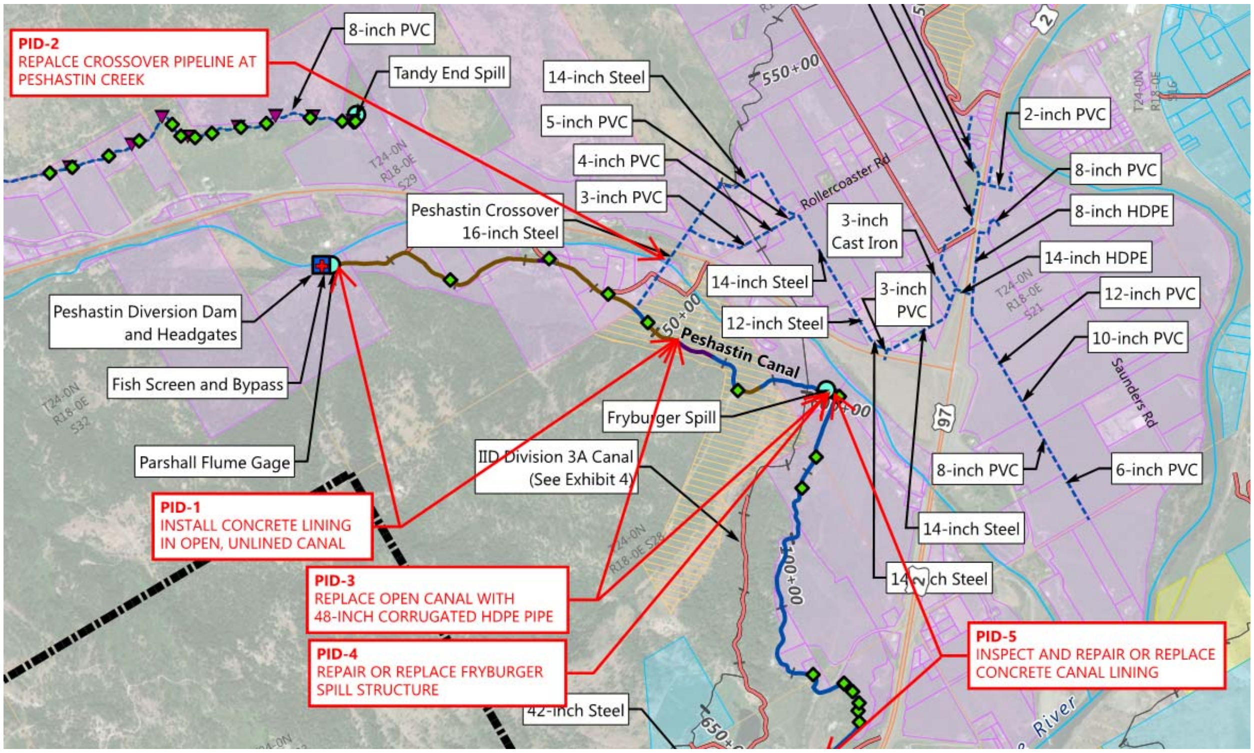


Location (Reach or Division):	IID Division 5 (Station 79+00 to 95+00)
Projected Water Savings:	0 cfs
Deficiency Addressed/Purpose:	• Existing steel siphon is old, rusty, and leaking. • Existing spill can't be used effectively because it is on the downstream side of the siphon and discharge has caused previous slope failure.
Project Description:	Replace existing 24-inch steel Chumstick Siphon with 30-inch DR 21 HDPE pipe. Install a spill at the siphon inlet.
Estimated Implementation Cost:	
Notes:	Spill will need to be routed through private property and under a railroad to Chumistick Creek. Additional evaluation needed to more fully understand constraints and costs.
Recommended Priority/Timeline:	Low to Medium Priority. Target implementation within next 9 to 15 years.

Estimated Implementation Cost:

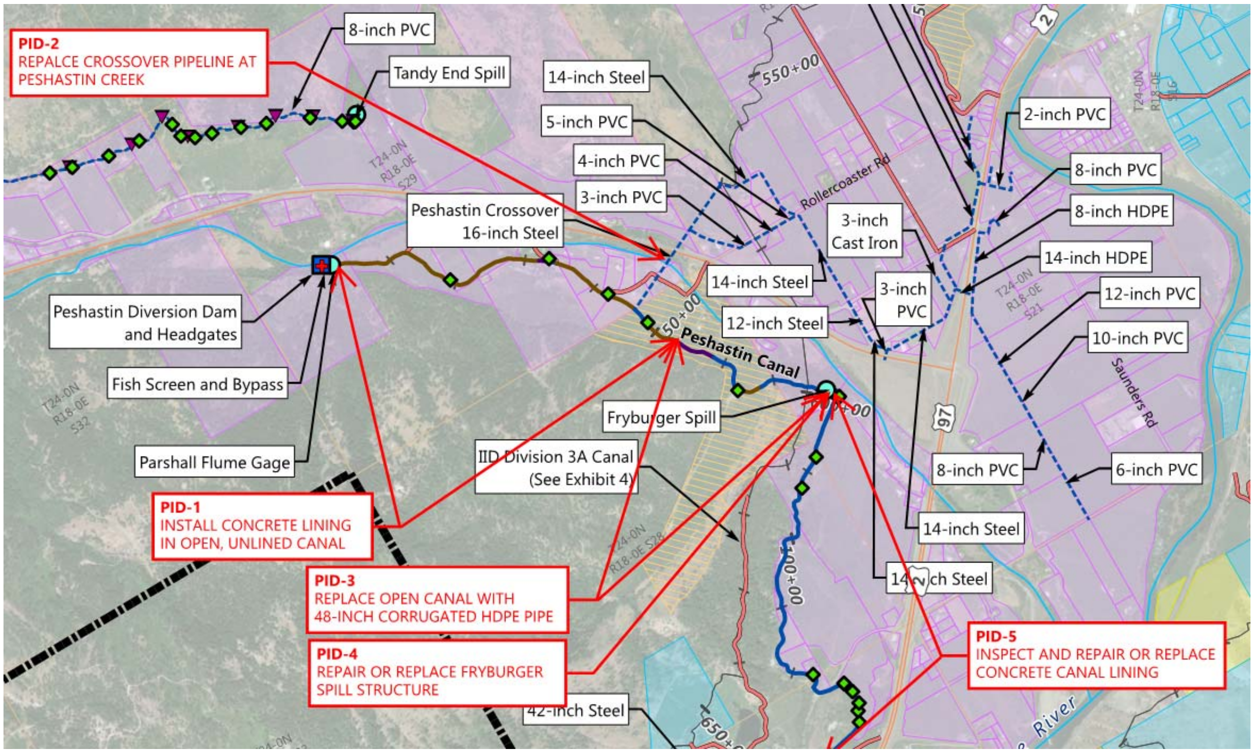
Item	**Low**	**High**
Materials	$368,000	$416,000
Labor, Other	$128,000	$144,000
Construction Subtotal	**$496,000**	**$560,000**
Other Costs	$99,200	$112,000

Project: PID-1 – Install Concrete Canal Lining in Unlined and Partially-lined Canal



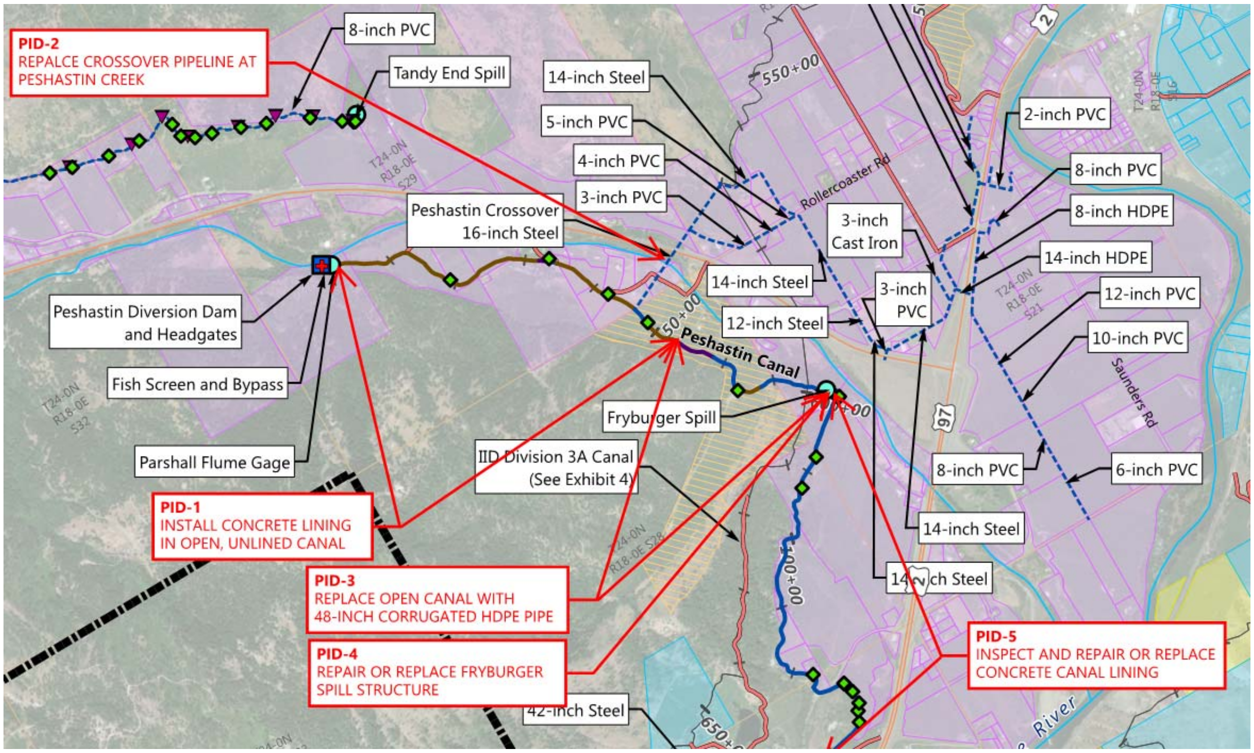
Location (Reach or Division):	PID Main Canal (Station 2+50 to 58+00)		
Projected Water Savings:	2.6 cfs		
Deficiency Addressed/Purpose:	• Existing canal is mostly unlined. • Significant loss measured in this section of canal.		
Project Description:	Install full concrete lining through segments of open, un-lined and partially-lined canal.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$193,400	$221,000
	Labor, Other	$82,900	$96,700
	Construction Subtotal	**$276,300**	**$317,700**
	Other Costs	$55,300	$63,500
Notes:	None.		
Recommended Priority/Timeline:	High Priority. Target implementation within next 5 years.		

Project: PID-2 – Replace Peshastin Crossover Pipeline at Peshastin Creek



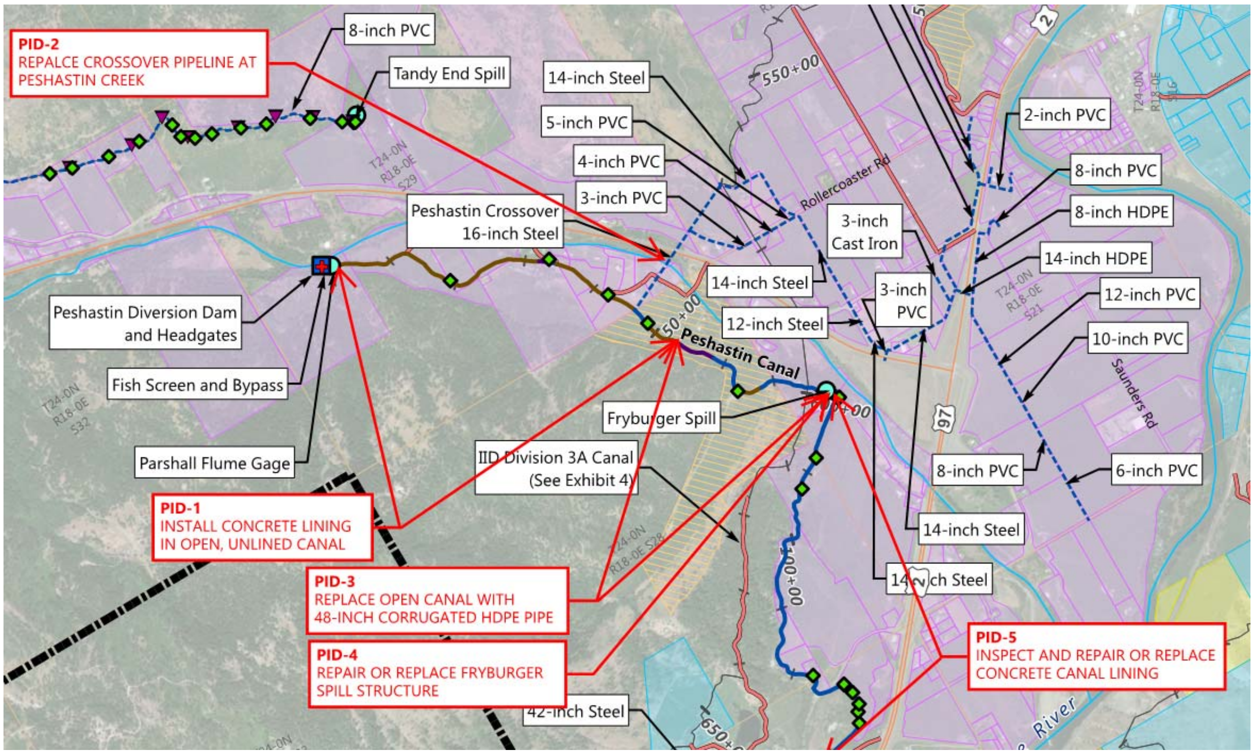
Location (Reach or Division):	PID Main Canal (Station 45+00)		
Projected Water Savings:	0 cfs		
Deficiency Addressed/Purpose:	• Crossover pipeline is exposed in creek. • Relief or spill valve is exposed in creek and subject to damage.		
Project Description:	Replace segment of Peshastin Crossover pipeline where it crosses Peshastin Creek with 16-inch steel pipe. Bury pipe with minimum of 4 feet of cover under creek. Replace the existing valve.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$15,500	$17,400
	Labor, Other	$6,700	$7,500
	Construction Subtotal	**$22,200**	**$24,900**
	Other Costs	$4,400	$5,000
Notes:	Valve will require conveyance for flushing back to creek.		
Recommended Priority/Timeline:	High Priority. Target implementation within next 5 years.		

Project: PID-3 – Repair or Replace Fryburger Spill Structure



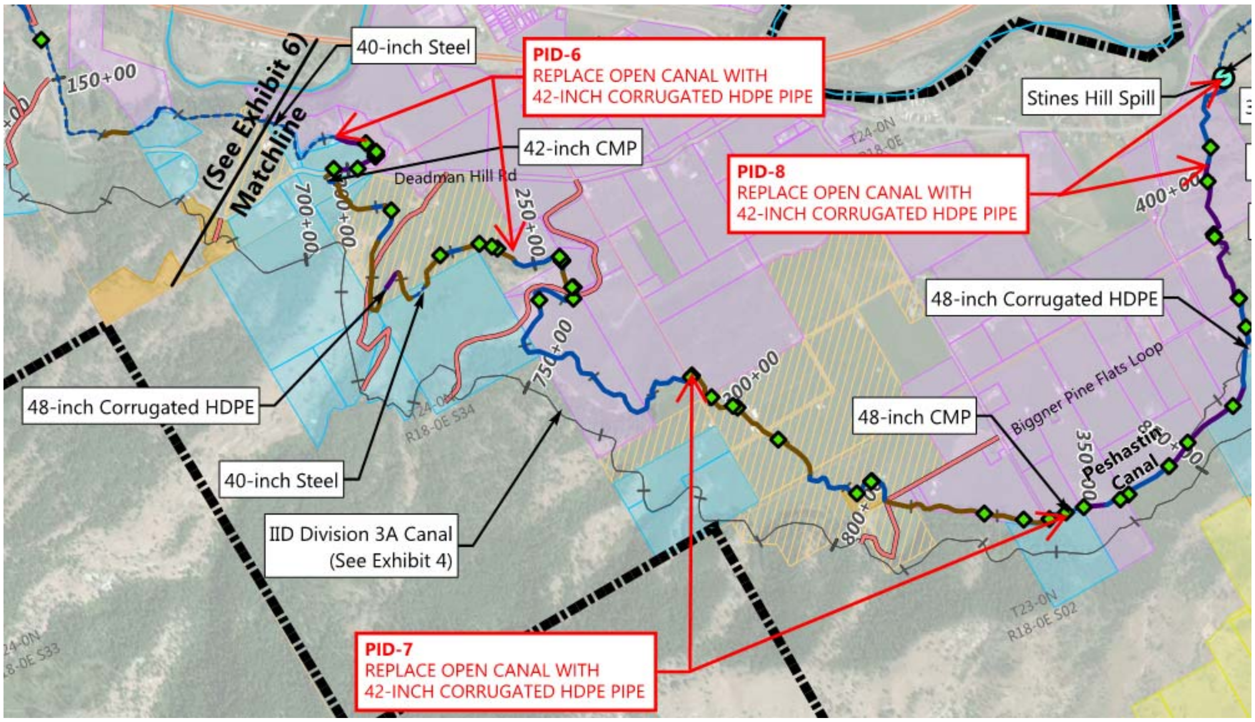
Location (Reach or Division):	PID Main Canal (Station 79+00)		
Projected Water Savings:	0 cfs		
Deficiency Addressed/Purpose:	• Concrete structure is old and weather, but in fair condition. • Gate in canal is rusted and in poor condition.		
Project Description:	Repair or replace existing Fryburger Spill structure.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$13,000	$14,500
	Labor, Other	$5,600	$6,200
	Construction Subtotal	**$18,600**	**$20,700**
	Other Costs	$3,700	$4,100
Notes:	Costs assume full replacement.		
Recommended Priority/Timeline:	High Priority. Target implementation within next 5 years.		

Project: PID-4 – Repair or Replace Concrete Canal Lining



Location (Reach or Division):	PID Main Canal (Station 79+00 to 142+00)		
Projected Water Savings:	0.1 cfs		
Deficiency Addressed/Purpose:	• Existing lining is old, weathered, and cracked in places.		
Project Description:	Inspect and repair or replace concrete canal lining from Fryburger Spill to pipeline inlet downstream of Deadman Hill Road.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$160,800	$183,700
	Labor, Other	$68,900	$80,400
	Construction Subtotal	**$229,700**	**$264,100**
	Other Costs	$45,900	$52,800
Notes:	Costs assume full replacement.		
Recommended Priority/Timeline:	Medium Priority. Target implementation within next 6 to 8 years.		

Project: PID-5 – Replace Open Canal with 42-inch Corrugated HDPE Pipe

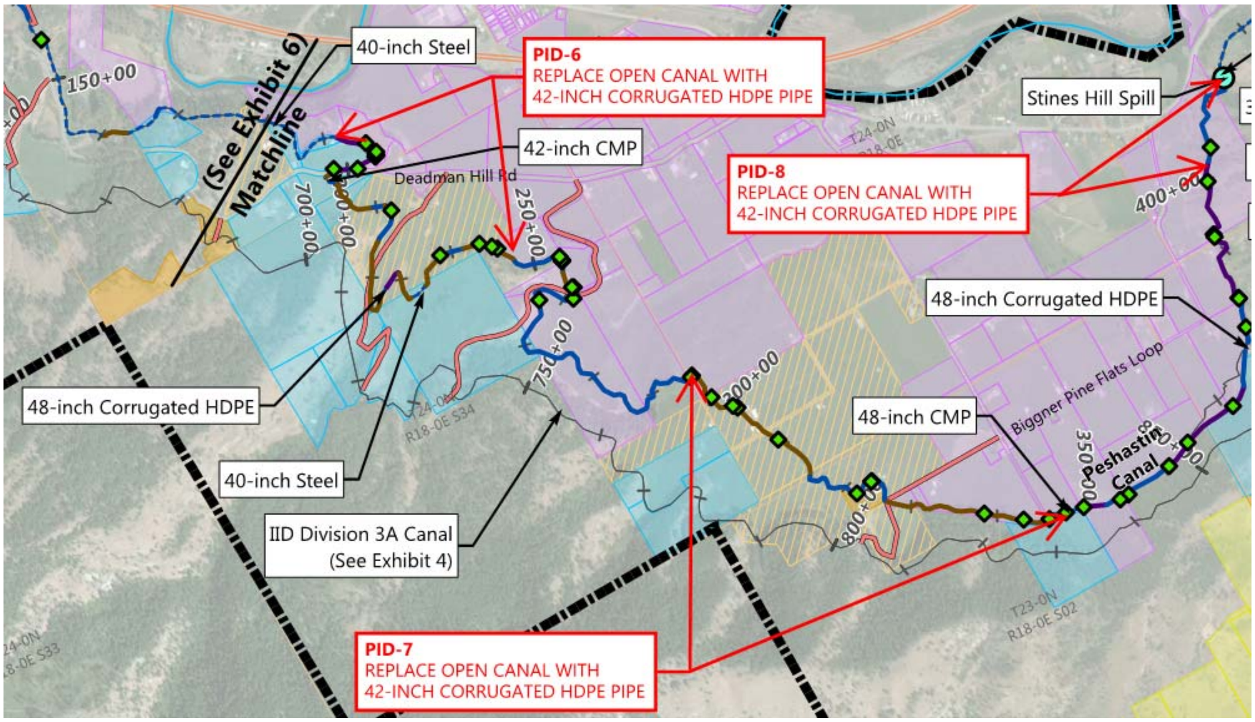


Location (Reach or Division):	PID Main Canal (Station 192+00 to 247+00)
Projected Water Savings:	2.8 cfs
Deficiency Addressed/Purpose:	• Existing canal is mostly unlined. • Loss measured in this section of canal.
Project Description:	Replace existing open canal with 42-inch corrugated HDPE pipe.
Estimated Implementation Cost:	See table below
Notes:	None.
Recommended Priority/Timeline:	Medium Priority. Target implementation within next 6 to 8 years.

Estimated Implementation Cost:

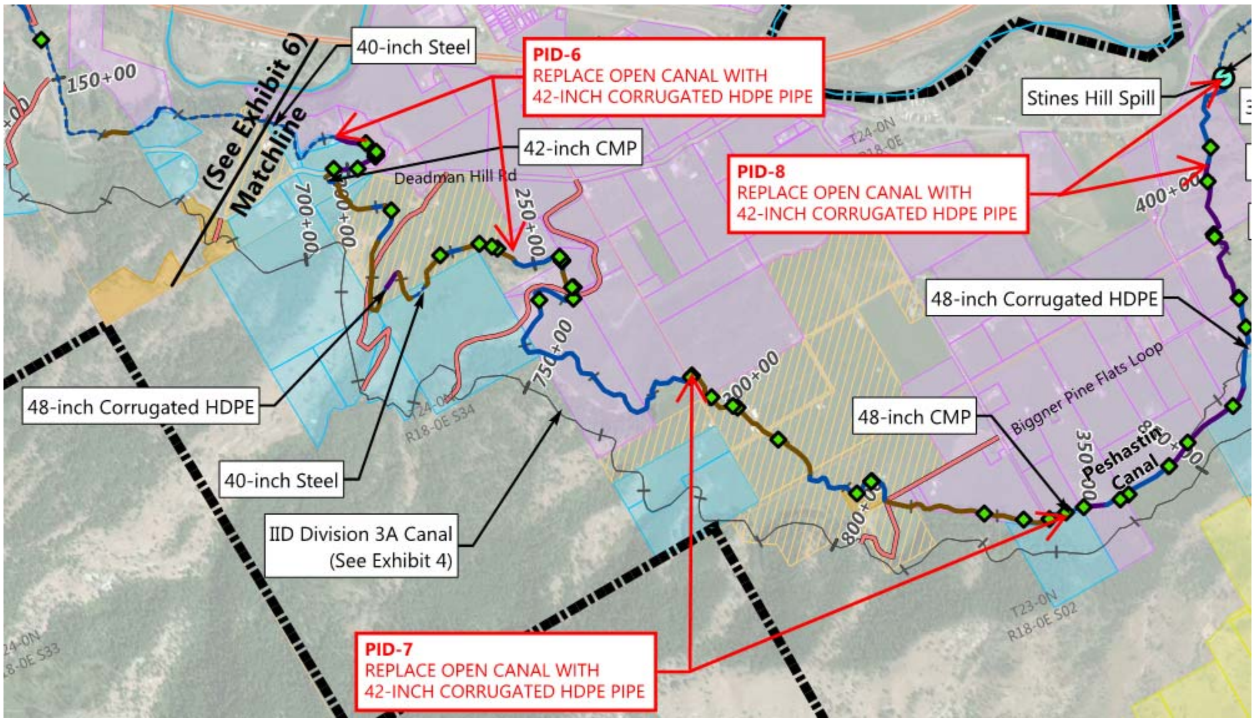
Item	Low	High
Materials	$1,375,000	$1,540,000
Labor, Other	$495,000	$550,000
Construction Subtotal	**$1,870,000**	**$2,090,000**
Other Costs	$374,000	$418,000

Project: PID-6 – Replace Open Canal with 42-inch Corrugated HDPE Pipe



Location (Reach or Division):	PID Main Canal (Station 297+00 to 345+00)		
Projected Water Savings:	1.7 cfs		
Deficiency Addressed/Purpose:	• Existing canal is mostly unlined. • Loss measured in this section of canal.		
Project Description:	Replace existing open canal with 42-inch corrugated HDPE pipe.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$1,200,000	$1,344,000
	Labor, Other	$432,000	$480,000
	Construction Subtotal	**$1,632,000**	**$1,824,000**
	Other Costs	$326,400	$364,800
Notes:	None.		
Recommended Priority/Timeline:	Medium Priority. Target implementation within next 6 to 8 years.		

Project: PID-7 – Replace Open Canal with 42-inch Corrugated HDPE Pipe

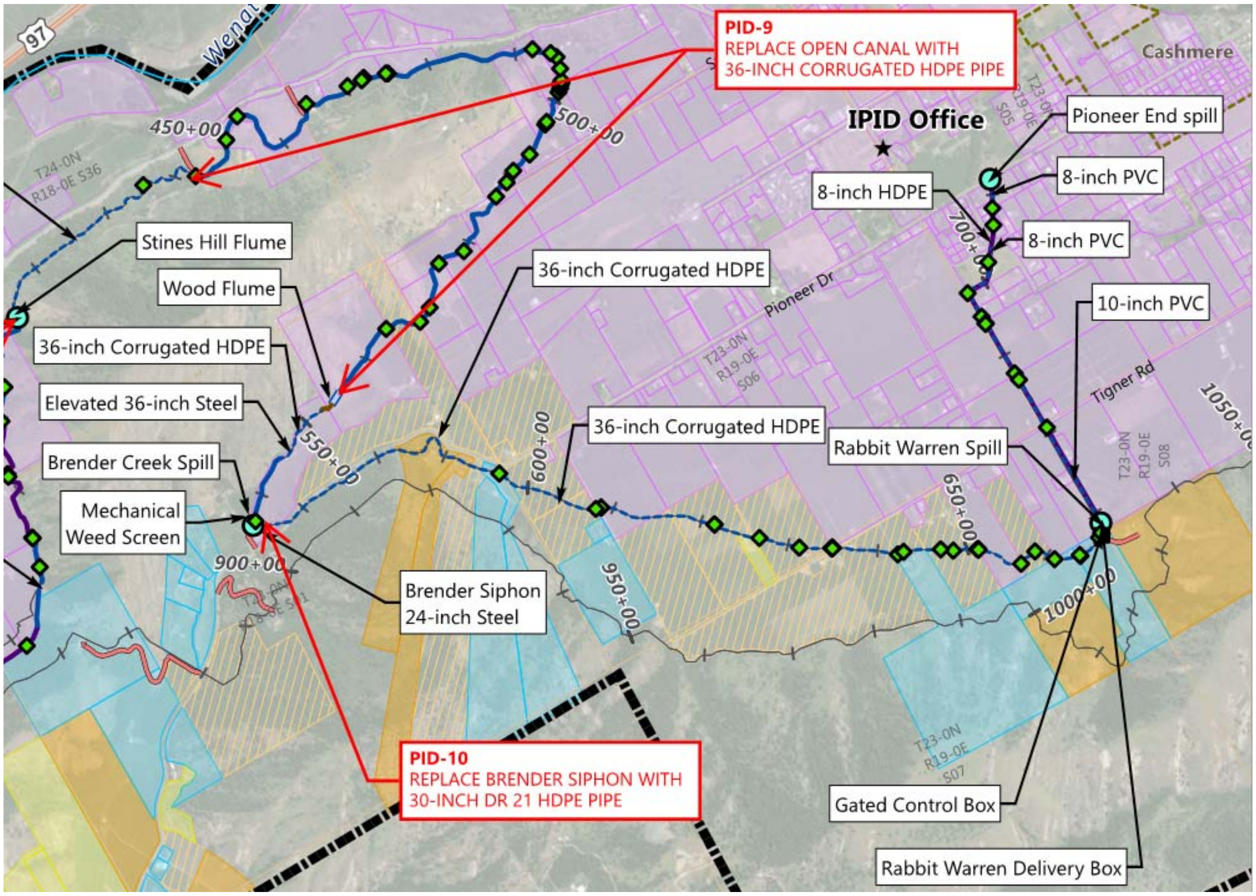


Location (Reach or Division):	PID Main Canal (Station 403+00 to 413+00)
Projected Water Savings:	0.4 cfs
Deficiency Addressed/Purpose:	• Existing lining is old, weathered, and cracked in places.
Project Description:	Replace existing open canal with 42-inch corrugated HDPE pipe, upstream of Stines Hill Spill for 1,000 feet.
Estimated Implementation Cost:	see below
Notes:	None.
Recommended Priority/Timeline:	Medium Priority. Target implementation within next 6 to 8 years.

Estimated Implementation Cost:

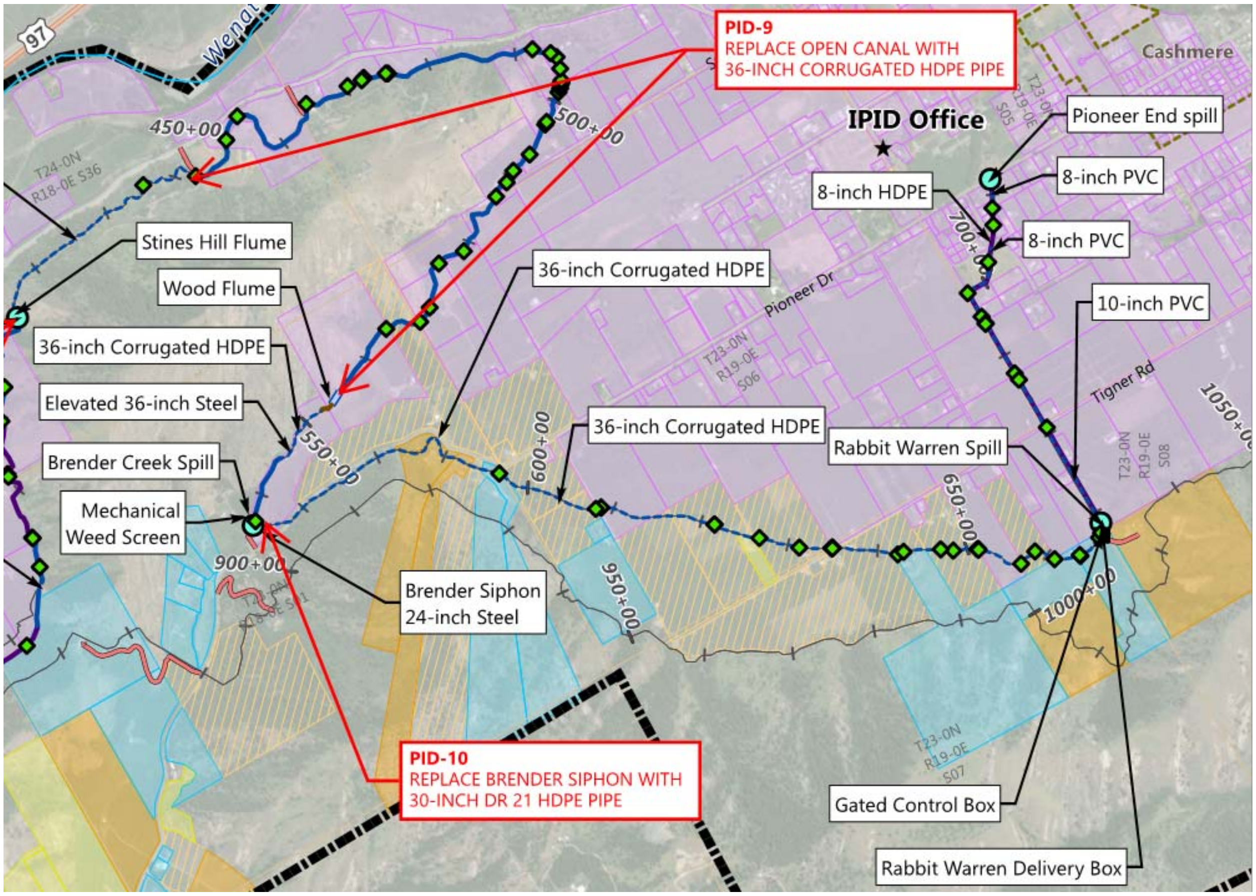
Item	Low	High
Materials	$1,200,000	$1,344,000
Labor, Other	$432,000	$480,000
Construction Subtotal	**$1,632,000**	**$1,824,000**
Other Costs	$326,400	$364,800

Project: PID-8 – Replace Open Canal with 36-inch Corrugated HDPE Pipe



Location (Reach or Division):	PID Main Canal (Station 443+00 to 545+00)		
Projected Water Savings:	1.9 cfs		
Deficiency Addressed/Purpose:	• Existing lining is old, weathered, and cracked in places.		
Project Description:	Replace existing open canal with 36-inch corrugated HDPE pipe, north and east sides of Stines Hill from existing pipe to wood flume.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$1,632,000	$1,836,000
	Labor, Other	$612,000	$714,000
	Construction Subtotal	**$2,244,000**	**$2,550,000**
	Other Costs	$448,800	$510,000
Notes:	None.		
Recommended Priority/Timeline:	Low to Medium Priority. Target implementation within next 9 to 15 years.		

Project: PID-9 – Repair or Replace Brender Siphon with 24-inch DR 21 HDPE Pipe



Location (Reach or Division):	PID Main Canal (Station 565+00 to 568+00)		
Projected Water Savings:	0 cfs		
Deficiency Addressed/Purpose:	• Steel pipe is rusting and failing. Holes have been observed in top of pipe.		
Project Description:	Replace existing 24-inch steel Brender siphon with 30-inch DR21 HDPE pipe.		
Estimated Implementation Cost:	**Item**	**Low**	**High**
	Materials	$63,000	$69,000
	Labor, Other	$24,000	$24,000
	Construction Subtotal	**$87,000**	**$93,000**
	Other Costs	$17,400	$18,600
Notes:	None.		
Recommended Priority/Timeline:	Low to Medium Priority. Target implementation within next 9 to 15 years.		

Appendix F
Opinions of Probable Project Costs

IPID Comprehensive Water Conservation Plan
Proposed Structural Improvements
Opinion of Probable Costs

Assumed Values:

Sales Tax	8.4%	Include in Materials and Labor/Other Unit Cost
Contingency - Low	15.0%	Include in Materials and Labor/Other Unit Cost
Contingency - High	30.0%	Include in Materials and Labor/Other Unit Cost
Engineering, Permitting, Adminstrative	20.0%	Include in Other Project Costs

									Opinion of Cost - Low Contingency						
Project	Division	Station	Facility Description	Description of Improvement	Priority	Estimated Water Savings (cfs)	Quantity	Unit	Materials Unit Cost[1,3]	Materials Subtotal[1,5]	Labor/Other Unit Cost[2,3]	Labor/Other Subtotal[2,5]	Subtotal - Construction Costs	Other Project Costs[6]	Total Project Costs
GEN-1	All	Various	Turnouts	Upgrade Turnouts	1	N/A	N/A	N/A							
GEN-2	All	N/A	Non-Structural	Merge Icicle and Peshastin Irrigation Districts	1	N/A	N/A	N/A							
GEN-3	All	N/A	Non-Structural	Encourage On-farm Conservation	2	N/A	N/A	N/A						$17,600	$17,600
GEN-4	All	N/A	Non-Structural	Continue to Refine District Mapping	1	N/A	N/A	N/A							
GEN-5	All	N/A	Non-Structural	Improve Automation, Flow Monitoring, Control	2	N/A	N/A	N/A							
IID-1-5	1	111+00 to 270+00	Head Gates and Fish Screens	Replace Fish Screens, Head Gates	1	0.0	1	LS	$990,800	$990,800	$424,600	$424,600	$1,415,400	$283,100	$1,698,500
IID-1-2	1	18+50	New Flow Monitoring Station	Install New Flow Monitoring	1	0.0	1	LS	$3,500	$3,500	$1,500	$1,500	$5,000	$1,000	$6,000
IID-1-3	1	19+00	Snow Creek Pickup	Replace Snow Creek Pickup Flume, Gates	2	0.0	1	LS	$17,300	$17,300	$7,500	$7,500	$24,800	$5,000	$29,800
IID-1-4	1	55+00	Steel Flume	Replace with an Elevated Steel Box Flume	2	0.0	1	LS	$30,300	$30,300	$13,000	$13,000	$43,300	$8,700	$52,000
IID-1-5	1	111+00 to 270+00	Open Canal	Replace Canal Lining	3	1.5	25,546	SY	$28	$715,300	$12	$306,500	$1,021,800	$204,400	$1,226,200
IID-1-6	1	343+00	Leavenworth Bifurcation	Replace Leavenworth Bifurcation	4	0.0	1	LS	$21,600	$21,600	$9,300	$9,300	$30,900	$6,200	$37,100
IID-2-1	2	400+00 to 412+00	Open Canal	Install Full Concrete Canal Lining	1	1.1	1,867	SY	$28	$52,300	$12	$22,400	$74,700	$14,900	$89,600
IID-2-2	2	418+00 to 474+00	Open Canal	Install 54-inch Corrugated HDPE Pipe	2	1.5	5,600	LF	$300	$1,680,000	$110	$616,000	$2,296,000	$459,200	$2,755,200
IID-2-3	2	474+00 to 568+00	Open Canal	Replace Canal Lining, Repair Ditch Bank	2	1.4	14,624	SY	$28	$409,500	$12	$175,500	$585,000	$117,000	$702,000
IID-3A-1	3A	601+00	Division 3A Siphon Outlet	Replace Division 3A Siphon Outlet	3	0.0	1	LS	$7,800	$7,800	$3,300	$3,300	$11,100	$2,200	$13,300
IID-3A-2	3A	601+00 to 658+00	Open Canal	Replace Canal Lining, Repair Ditch Bank	2	0.0	8,361	SY	$28	$234,100	$12	$100,300	$334,400	$66,900	$401,300
IID-3A-3	3A	658+00 to 690+00	Carson's Pipeline	Replace with 48-inch DR 32.5 HDPE Pipe	1	0.3	3,200	LF	$230	$736,000	$90	$288,000	$1,024,000	$204,800	$1,228,800
IID-3A-4	3A	713+00 to 721+00	Maxwell Siphon	Replace with 36-inch DR 21 HDPE Pipe	3	0.0	800	LF	$300	$240,000	$110	$88,000	$328,000	$65,600	$393,600
IID-3A-5	3A	840+00 to 871+00	Open Canal, Sandstone Tunnels	Install 42-inch Corrugated HDPE Pipe	1	0.2	3,100	LF	$250	$775,000	$90	$279,000	$1,054,000	$210,800	$1,264,800
IID-3A-6	3A	873+00	Brender No. 1 Spill	Replace Brender Spill Structure	3	0.0	1	LS	$13,000	$13,000	$5,600	$5,600	$18,600	$3,700	$22,300
IID-3A-7	3A	873+00 to 883+00	Brender Siphon	Replace with 30-inch Steel Pipe	3	0.0	1,000	LF	$190	$190,000	$70	$70,000	$260,000	$52,000	$312,000
IID-3A-8	3A	934+00 to 1078+00	Open Canal	Replace, Install Full Concrete Canal Lining	1	0.1	21,122	SY	$28	$591,400	$12	$253,500	$844,900	$169,000	$1,013,900
IID-3B-1	3B	1078+00 to 1117+00	Mission Siphon	Replace with 30-inch Steel Pipe	4	0.0	3,900	LF	$210	$819,000	$80	$312,000	$1,131,000	$226,200	$1,357,200
IID-3B-2	3B	1187+00	Weed Screen	Relocate Weed Screen	4	0.0	1	LS	$13,800	$13,800	$5,900	$5,900	$19,700	$3,900	$23,600
IID-3B-3	3B	1221+00	Weed Screen Spill	Replace Weed Screen Spill Structure	4	0.0	1	LS	$19,900	$19,900	$8,500	$8,500	$28,400	$5,700	$34,100
IID-3B-4	3B	1225+00 to 1238+00	Open Canal	Install 36-inch Corrugated HDPE Pipe	1	0.0	1,300	LF	$160	$208,000	$60	$78,000	$286,000	$57,200	$343,200
IID-3B-5	3B	1238+00 to 1248+00	Siphon	Replace with 30-inch DR 21 HDPE Pipe	1	0.0	1,000	LF	$210	$210,000	$80	$80,000	$290,000	$58,000	$348,000
IID-3B-6	3B	1260+00 to 1269+00	Siphon	Replace with 30-inch DR 21 HDPE Pipe	2	0.0	900	LF	$210	$189,000	$80	$72,000	$261,000	$52,200	$313,200
IID-3B-7	3B	1293+00 to 1314+00	Siphon	Replace with 30-inch DR 21 HDPE Pipe	2	0.0	2,100	LF	$210	$441,000	$80	$168,000	$609,000	$121,800	$730,800
IID-3B-8	3B	1363+00	End Spill	Repair or Replace Structure, Replace Gate	2	0.0	1	LS	$25,900	$25,900	$11,100	$11,100	$37,000	$7,400	$44,400
IID-4-1	4/5	N/A	Leavenworth Siphon	Replace Grating and Guard Rails on Bridge	1	0.0	1	LS	$37,100	$37,100	$15,900	$15,900	$53,000	$10,600	$63,600
IID-4-2	4	112+00 to 130+00	Open Canal	Install 36-inch Corrugated HDPE Pipe	4	0.2	1,800	LF	$160	$288,000	$60	$108,000	$396,000	$79,200	$475,200
IID-4-3	4	130+00 to 187+00	Open Canal	Install 30-inch Corrugated HDPE Pipe	4	0.1	5,700	LF	$130	$741,000	$50	$285,000	$1,026,000	$205,200	$1,231,200
IID-5-1	5	28+00 to 35+00	Moe Siphon	Replace with 30-inch DR 21 HDPE Pipe	3	0.0	700	LF	$210	$147,000	$80	$56,000	$203,000	$40,600	$243,600
IID-5-2	5	79+00 to 95+00	Chumstick Siphon	Replace with 30-inch DR 21 HDPE Pipe	3	0.0	1,600	LF	$230	$368,000	$80	$128,000	$496,000	$99,200	$595,200
PID-1	Peshastin	2+50 to 58+00	Open Canal	Install Full Concrete Canal Lining	1	2.6	6,908	SY	$28	$193,400	$12	$82,900	$276,300	$55,300	$331,600
PID-2	Peshastin	45+00	Peshastin Crossover	Replace with 16-inch Steel Pipe	1	0.0	1	LS	$15,500	$15,500	$6,700	$6,700	$22,200	$4,400	$26,600
PID-3	Peshastin	79+00	Fryburger Spill	Replace Fryburger Spill Structure	1	0.0	1	LS	$13,000	$13,000	$5,600	$5,600	$18,600	$3,700	$22,300
PID-4	Peshastin	79+00 to 142+00	Open Canal	Replace Concrete Canal Lining	2	0.1	5,741	SY	$28	$160,800	$12	$68,900	$229,700	$45,900	$275,600
PID-5	Peshastin	192+00 to 247+00	Open Canal	Install 42-inch Corrugated HDPE Pipe	2	2.8	5,500	LF	$250	$1,375,000	$90	$495,000	$1,870,000	$374,000	$2,244,000
PID-6	Peshastin	297+00 to 345+00	Open Canal	Install 42-inch Corrugated HDPE Pipe	2	1.7	4,800	LF	$250	$1,200,000	$90	$432,000	$1,632,000	$326,400	$1,958,400
PID-7	Peshastin	403+00 to 413+00	Open Canal	Install 42-inch Corrugated HDPE Pipe	2	0.4	4,800	LF	$250	$1,200,000	$90	$432,000	$1,632,000	$326,400	$1,958,400
PID-8	Peshastin	443+00 to 545+00	Open Canal	Install 36-inch Corrugated HDPE Pipe	3	1.9	10,200	LF	$160	$1,632,000	$60	$612,000	$2,244,000	$448,800	$2,692,800
PID-9	Peshastin	565+00 to 568+00	Brender Siphon	Replace with 30-inch DR 21 HDPE Pipe	3	0.0	300	LF	$210	$63,000	$80	$24,000	$87,000	$17,400	$104,400

IPID Comprehensive Water Conservation Plan
Proposed Structural Improvements
Opinion of Probable Costs

Assumed Values:

Sales Tax	8.4%	Include in Materials and Labor/Other Unit Cost
Contingency - Low	15.0%	Include in Materials and Labor/Other Unit Cost
Contingency - High	30.0%	Include in Materials and Labor/Other Unit Cost
Engineering, Permitting, Adminstrative	20.0%	Include in Other Project Costs

Summary by Division/Reach:										
IID Division 1 Subtotal	1.8				$1,778,800		$762,400	$2,541,200	$508,400	$3,049,600
IID Division 2 Subtotal	4.7				$2,141,800		$813,900	$2,955,700	$591,100	$3,546,800
IID Division 3A Subtotal	0.6				$2,787,300		$1,087,700	$3,875,000	$775,000	$4,650,000
IID Division 3B Subtotal	0.0				$1,926,600		$735,500	$2,662,100	$532,400	$3,194,500
IID Division 4 Subtotal	0.4				$1,066,100		$408,900	$1,475,000	$295,000	$1,770,000
IID Division 5 Subtotal	0.0				$515,000		$184,000	$699,000	$139,800	$838,800
PID Subtotal	10.6				$5,852,700		$2,159,100	$8,011,800	$1,602,300	$9,614,100
Total - All Canals	**18.1**				**$16,068,300**		**$6,151,500**	**$22,219,800**	**$4,444,000**	**$26,663,800**
Summary by Priority - All Canals:										
High Priority (1, Next 5 Years)					$3,826,000		$1,538,100	$5,364,100	$1,072,800	$6,436,900
Medium Priority (2, Next 6 to 8 Years)					$6,962,900		$2,591,300	$9,554,200	$1,928,500	$11,482,700
Low to Medium Priority (3, Next 9 to 15 Years)					$3,376,100		$1,293,400	$4,669,500	$933,900	$5,603,400
Low Priority (4, Next 16 to 25 Years)					$1,903,300		$728,700	$2,632,000	$526,400	$3,158,400
Summary by Priority - IID Canals:										
High Priority (1, Next 5 Years)					$3,604,100		$1,442,900	$5,047,000	$1,009,400	$6,056,400
Medium Priority (2, Next 6 to 8 Years)					$3,027,100		$1,163,400	$4,190,500	$847,000	$5,037,500
Low to Medium Priority (3, Next 9 to 15 Years)					$1,681,100		$657,400	$2,338,500	$467,700	$2,806,200
Low Priority (4, Next 16 to 25 Years)					$1,903,300		$728,700	$2,632,000	$526,400	$3,158,400
IID Subtotal					**$10,215,600**		**$3,992,400**	**$14,208,000**	**$2,850,500**	**$17,058,500**
Summary by Priority - PID Canal:										
High Priority (1, Next 5 Years)					$221,900		$95,200	$317,100	$63,400	$380,500
Medium Priority (2, Next 6 to 8 Years)					$3,935,800		$1,427,900	$5,363,700	$1,081,500	$6,445,200
Low to Medium Priority (3, Next 9 to 15 Years)					$1,695,000		$636,000	$2,331,000	$466,200	$2,797,200
Low Priority (4, Next 16 to 25 Years)					$0		$0	$0	$0	$0
PID Subtotal					**$5,852,700**		**$2,159,100**	**$8,011,800**	**$1,611,100**	**$9,622,900**

Notes:
1) Materials include new materials that would have to be procured and imported to complete the project, including pipe, structural materials, concrete, gates, pipe bedding, structural fill, etc.
2) Labor/Other includes all costs associated with constructing the project beyond importing materials. This includes labor, equipment, contractor mark-up, excavation, backfill with native materials, etc.
3) The unit cost includes the unit cost of the materials, plus sales tax and the low contingency.
4) The unit cost includes the unit cost of the materials, plus sales tax and the high contingency.
5) The subtotal is the quantity times the unit cost, rounded to the nearest $100.
6) Other project costs include non-construction costs, such as engineering, permitting, and administraiton. An allowance of 20% of the construction subtotal was included for other project costs.
7) All costs are in 2017 dollars. The cost at the time of implementation will vary based on inflation, material prices, and labor costs.
8) The construction subtotal and total project costs reflect the cost that would result from having the project bid and constructed by a contractor. IPID constructs many improvements without an outside contractor. If IPID performs the work, project costs would be closer to the materials subtotal.

IPID Comprehensive Water Conservation Plan
Proposed Structural Improvements
Opinion of Probable Costs

Assumed Values:

Sales Tax	8.4%	Include in Materials and Labor/Other Unit Cost
Contingency - Low	15.0%	Include in Materials and Labor/Other Unit Cost
Contingency - High	30.0%	Include in Materials and Labor/Other Unit Cost
Engineering, Permitting, Adminstrative	20.0%	Include in Other Project Costs

									Opinion of Cost - High Contingency						
Project	**Division**	**Station**	**Facility Description**	**Description of Improvement**	**Priority**	**Estimated Water Savings (cfs)**	**Quantity**	**Unit**	**Materials Unit Cost[1,4]**	**Materials Subtotal[1,5]**	**Labor/Other Unit Cost[2,4]**	**Labor/Other Subtotal[2,5]**	**Subtotal - Construction Costs**	**Other Project Costs[6]**	**Total Project Costs**
GEN-1	All	Various	Turnouts	Upgrade Turnouts	1	N/A	N/A	N/A							
GEN-2	All	N/A	Non-Structural	Merge Icicle and Peshastin Irrigation Districts	1	N/A	N/A	N/A							
GEN-3	All	N/A	Non-Structural	Encourage On-farm Conservation	2	N/A	N/A	N/A						$20,000	$20,000
GEN-4	All	N/A	Non-Structural	Continue to Refine District Mapping	1	N/A	N/A	N/A							
GEN-5	All	N/A	Non-Structural	Improve Automation, Flow Monitoring, Control	2	N/A	N/A	N/A							
IID-1-5	1	111+00 to 270+00	Head Gates and Fish Screens	Replace Fish Screens, Head Gates	1	0.0	1	LS	$1,120,000	$1,120,000	$480,000	$480,000	$1,600,000	$320,000	$1,920,000
IID-1-2	1	18+50	New Flow Monitoring Station	Install New Flow Monitoring	1	0.0	1	LS	$3,900	$3,900	$1,700	$1,700	$5,600	$1,100	$6,700
IID-1-3	1	19+00	Snow Creek Pickup	Replace Snow Creek Pickup Flume, Gates	2	0.0	1	LS	$19,400	$19,400	$8,400	$8,400	$27,800	$5,600	$33,400
IID-1-4	1	55+00	Steel Flume	Replace with an Elevated Steel Box Flume	2	0.0	1	LS	$34,000	$34,000	$14,600	$14,600	$48,600	$9,700	$58,300
IID-1-5	1	111+00 to 270+00	Open Canal	Replace Canal Lining	3	1.5	25,546	SY	$32	$817,500	$14	$357,600	$1,175,100	$235,000	$1,410,100
IID-1-6	1	343+00	Leavenworth Bifurcation	Replace Leavenworth Bifurcation	4	0.0	1	LS	$24,200	$24,200	$10,400	$10,400	$34,600	$6,900	$41,500
IID-2-1	2	400+00 to 412+00	Open Canal	Install Full Concrete Canal Lining	1	1.1	1,867	SY	$32	$59,700	$14	$26,100	$85,800	$17,200	$103,000
IID-2-2	2	418+00 to 474+00	Open Canal	Install 54-inch Corrugated HDPE Pipe	2	1.5	5,600	LF	$340	$1,904,000	$120	$672,000	$2,576,000	$515,200	$3,091,200
IID-2-3	2	474+00 to 568+00	Open Canal	Replace Canal Lining, Repair Ditch Bank	2	1.4	14,624	SY	$32	$468,000	$14	$204,700	$672,700	$134,500	$807,200
IID-3A-1	3A	601+00	Division 3A Siphon Outlet	Replace Division 3A Siphon Outlet	3	0.0	1	LS	$8,700	$8,700	$3,700	$3,700	$12,400	$2,500	$14,900
IID-3A-2	3A	601+00 to 658+00	Open Canal	Replace Canal Lining, Repair Ditch Bank	2	0.0	8,361	SY	$32	$267,600	$14	$117,100	$384,700	$76,900	$461,600
IID-3A-3	3A	658+00 to 690+00	Carson's Pipeline	Replace with 48-inch DR 32.5 HDPE Pipe	1	0.3	3,200	LF	$260	$832,000	$100	$320,000	$1,152,000	$230,400	$1,382,400
IID-3A-4	3A	713+00 to 721+00	Maxwell Siphon	Replace with 36-inch DR 21 HDPE Pipe	3	0.0	800	LF	$340	$272,000	$120	$96,000	$368,000	$73,600	$441,600
IID-3A-5	3A	840+00 to 871+00	Open Canal, Sandstone Tunnels	Install 42-inch Corrugated HDPE Pipe	1	0.2	3,100	LF	$280	$868,000	$100	$310,000	$1,178,000	$235,600	$1,413,600
IID-3A-6	3A	873+00	Brender No. 1 Spill	Replace Brender Spill Structure	3	0.0	1	LS	$14,500	$14,500	$6,200	$6,200	$20,700	$4,100	$24,800
IID-3A-7	3A	873+00 to 883+00	Brender Siphon	Replace with 30-inch Steel Pipe	3	0.0	1,000	LF	$220	$220,000	$80	$80,000	$300,000	$60,000	$360,000
IID-3A-8	3A	934+00 to 1078+00	Open Canal	Replace, Install Full Concrete Canal Lining	1	0.1	21,122	SY	$32	$675,900	$14	$295,700	$971,600	$194,300	$1,165,900
IID-3B-1	3B	1078+00 to 1117+00	Mission Siphon	Replace with 30-inch Steel Pipe	4	0.0	3,900	LF	$230	$897,000	$90	$351,000	$1,248,000	$249,600	$1,497,600
IID-3B-2	3B	1187+00	Weed Screen	Relocate Weed Screen	4	0.0	1	LS	$15,500	$15,500	$6,600	$6,600	$22,100	$4,400	$26,500
IID-3B-3	3B	1221+00	Weed Screen Spill	Replace Weed Screen Spill Structure	4	0.0	1	LS	$22,300	$22,300	$9,500	$9,500	$31,800	$6,400	$38,200
IID-3B-4	3B	1225+00 to 1238+00	Open Canal	Install 36-inch Corrugated HDPE Pipe	1	0.0	1,300	LF	$180	$234,000	$70	$91,000	$325,000	$65,000	$390,000
IID-3B-5	3B	1238+00 to 1248+00	Siphon	Replace with 30-inch DR 21 HDPE Pipe	1	0.0	1,000	LF	$230	$230,000	$80	$80,000	$310,000	$62,000	$372,000
IID-3B-6	3B	1260+00 to 1269+00	Siphon	Replace with 30-inch DR 21 HDPE Pipe	2	0.0	900	LF	$230	$207,000	$80	$72,000	$279,000	$55,800	$334,800
IID-3B-7	3B	1293+00 to 1314+00	Siphon	Replace with 30-inch DR 21 HDPE Pipe	2	0.0	2,100	LF	$230	$483,000	$80	$168,000	$651,000	$130,200	$781,200
IID-3B-8	3B	1363+00	End Spill	Repair or Replace Structure, Replace Gate	2	0.0	1	LS	$29,100	$29,100	$12,500	$12,500	$41,600	$8,300	$49,900
IID-4-1	4/5	N/A	Leavenworth Siphon	Replace Grating and Guard Rails on Bridge	1	0.0	1	LS	$41,700	$41,700	$17,900	$17,900	$59,600	$11,900	$71,500
IID-4-2	4	112+00 to 130+00	Open Canal	Install 36-inch Corrugated HDPE Pipe	4	0.2	1,800	LF	$180	$324,000	$70	$126,000	$450,000	$90,000	$540,000
IID-4-3	4	130+00 to 187+00	Open Canal	Install 30-inch Corrugated HDPE Pipe	4	0.1	5,700	LF	$150	$855,000	$60	$342,000	$1,197,000	$239,400	$1,436,400
IID-5-1	5	28+00 to 35+00	Moe Siphon	Replace with 30-inch DR 21 HDPE Pipe	3	0.0	700	LF	$230	$161,000	$80	$56,000	$217,000	$43,400	$260,400
IID-5-2	5	79+00 to 95+00	Chumstick Siphon	Replace with 30-inch DR 21 HDPE Pipe	3	0.0	1,600	LF	$260	$416,000	$90	$144,000	$560,000	$112,000	$672,000
PID-1	Peshastin	2+50 to 58+00	Open Canal	Install Full Concrete Canal Lining	1	2.6	6,908	SY	$32	$221,000	$14	$96,700	$317,700	$63,500	$381,200
PID-2	Peshastin	45+00	Peshastin Crossover	Replace with 16-inch Steel Pipe	1	0.0	1	LS	$17,400	$17,400	$7,500	$7,500	$24,900	$5,000	$29,900
PID-3	Peshastin	79+00	Fryburger Spill	Replace Fryburger Spill Structure	1	0.0	1	LS	$14,500	$14,500	$6,200	$6,200	$20,700	$4,100	$24,800
PID-4	Peshastin	79+00 to 142+00	Open Canal	Replace Concrete Canal Lining	2	0.1	5,741	SY	$32	$183,700	$14	$80,400	$264,100	$52,800	$316,900
PID-5	Peshastin	192+00 to 247+00	Open Canal	Install 42-inch Corrugated HDPE Pipe	2	2.8	5,500	LF	$280	$1,540,000	$100	$550,000	$2,090,000	$418,000	$2,508,000
PID-6	Peshastin	297+00 to 345+00	Open Canal	Install 42-inch Corrugated HDPE Pipe	2	1.7	4,800	LF	$280	$1,344,000	$100	$480,000	$1,824,000	$364,800	$2,188,800
PID-7	Peshastin	403+00 to 413+00	Open Canal	Install 42-inch Corrugated HDPE Pipe	2	0.4	4,800	LF	$280	$1,344,000	$100	$480,000	$1,824,000	$364,800	$2,188,800
PID-8	Peshastin	443+00 to 545+00	Open Canal	Install 36-inch Corrugated HDPE Pipe	3	1.9	10,200	LF	$180	$1,836,000	$70	$714,000	$2,550,000	$510,000	$3,060,000
PID-9	Peshastin	565+00 to 568+00	Brender Siphon	Replace with 30-inch DR 21 HDPE Pipe	3	0.0	300	LF	$230	$69,000	$80	$24,000	$93,000	$18,600	$111,600

IPID Comprehensive Water Conservation Plan
Proposed Structural Improvements
Opinion of Probable Costs

Assumed Values:

Sales Tax	8.4%	Include in Materials and Labor/Other Unit Cost
Contingency - Low	15.0%	Include in Materials and Labor/Other Unit Cost
Contingency - High	30.0%	Include in Materials and Labor/Other Unit Cost
Engineering, Permitting, Adminstrative	20.0%	Include in Other Project Costs

Summary by Division/Reach:										
IID Division 1 Subtotal	1.8				$2,019,000		$872,700	$2,891,700	$578,300	$3,470,000
IID Division 2 Subtotal	4.7				$2,431,700		$902,800	$3,334,500	$666,900	$4,001,400
IID Division 3A Subtotal	0.6				$3,158,700		$1,228,700	$4,387,400	$877,400	$5,264,800
IID Division 3B Subtotal	0.0				$2,117,900		$790,600	$2,908,500	$581,700	$3,490,200
IID Division 4 Subtotal	0.4				$1,220,700		$485,900	$1,706,600	$341,300	$2,047,900
IID Division 5 Subtotal	0.0				$577,000		$200,000	$777,000	$155,400	$932,400
PID Subtotal	10.6				$6,569,600		$2,438,800	$9,008,400	$1,801,600	$10,810,000
Total - All Canals	**18.1**				**$18,094,600**		**$6,919,500**	**$25,014,100**	**$5,002,600**	**$30,016,700**
Summary by Priority - All Canals:										
High Priority (1, Next 5 Years)					$4,318,100		$1,732,800	$6,050,900	$1,210,100	$7,261,000
Medium Priority (2, Next 6 to 8 Years)					$7,823,800		$2,859,700	$10,683,500	$2,156,600	$12,840,100
Low to Medium Priority (3, Next 9 to 15 Years)					$3,814,700		$1,481,500	$5,296,200	$1,059,200	$6,355,400
Low Priority (4, Next 16 to 25 Years)					$2,138,000		$845,500	$2,983,500	$596,700	$3,580,200
Summary by Priority - IID Canals:										
High Priority (1, Next 5 Years)					$4,065,200		$1,622,400	$5,687,600	$1,137,500	$6,825,100
Medium Priority (2, Next 6 to 8 Years)					$3,412,100		$1,269,300	$4,681,400	$946,200	$5,627,600
Low to Medium Priority (3, Next 9 to 15 Years)					$1,909,700		$743,500	$2,653,200	$530,600	$3,183,800
Low Priority (4, Next 16 to 25 Years)					$2,138,000		$845,500	$2,983,500	$596,700	$3,580,200
IID Subtotal					**$11,525,000**		**$4,480,700**	**$16,005,700**	**$3,211,000**	**$19,216,700**
Summary by Priority - PID Canal:										
High Priority (1, Next 5 Years)					$252,900		$110,400	$363,300	$72,600	$435,900
Medium Priority (2, Next 6 to 8 Years)					$4,411,700		$1,590,400	$6,002,100	$1,210,400	$7,212,500
Low to Medium Priority (3, Next 9 to 15 Years)					$1,905,000		$738,000	$2,643,000	$528,600	$3,171,600
Low Priority (4, Next 16 to 25 Years)					$0		$0	$0	$0	$0
PID Subtotal					**$6,569,600**		**$2,438,800**	**$9,008,400**	**$1,811,600**	**$10,820,000**

Notes:

1) Materials include new materials that would have to be procured and imported to complete the project, including pipe, structural materials, concrete, gates, pipe bedding, structural fill, etc.
2) Labor/Other includes all costs associated with constructing the project beyond importing materials. This includes labor, equipment, contractor mark-up, excavation, backfill with native mat
3) The unit cost includes the unit cost of the materials, plus sales tax and the low contingency.
4) The unit cost includes the unit cost of the materials, plus sales tax and the high contingency.
5) The subtotal is the quantity times the unit cost, rounded to the nearest $100.
6) Other project costs include non-construction costs, such as engineering, permitting, and administraiton. An allowance of 20% of the construction subtotal was included for other project cos
7) All costs are in 2017 dollars. The cost at the time of implementation will vary based on inflation, material prices, and labor costs.
8) The construction subtotal and total project costs reflect the cost that would result from having the project bid and constructed by a contractor. IPID constructs many improvements without

Appendix G
Full Piping Option Memorandum

720 Olive Way, Suite 1900
Seattle, Washington 98101
206.287.9130

Memorandum

January 24, 2018

To: Tony Jantzer, Manager – Icicle and Peshastin Irrigation Districts

From: David Rice, P.E. – Anchor QEA

cc: Dan Jaspers – Trout Unlimited

Mike Cushman – Cascadia Conservation District

Levi Jantzer – Icicle and Peshastin Irrigation Districts

Re: IPID Conservation Plan – Full Piping Improvement Option

Icicle and Peshastin Irrigation Districts (IPID) deliver water for irrigation to approximately 8,000 acres in the Wenatchee River Valley from the City of Leavenworth to the Community of Monitor. Irrigation water is critical to agriculture, which is the primary industry in the Wenatchee River Valley and a key piece of its culture, history, and identity. The IPID delivery systems consist primarily of open canals, flumes, tunnels, and pipelines that are supplied through surface water diversions on Icicle Creek and Peshastin Creek, two of the principal tributaries to the Wenatchee River. This memorandum was prepared to summarize the evaluation of an improvement concept that would include replacement of the existing IPID irrigation delivery systems entirely with pressurized pipelines supplied through pump stations on the Wenatchee River. The project would shift diversions from Icicle Creek and Peshastin Creek to the Wenatchee River. Icicle Creek and Peshastin Creek provide critical habitat for anadromous fish and other wildlife. The proposed improvement concept would increase flows and benefit fish passage and habitat conditions in the lowest 5.7 miles of Icicle Creek and the lowest 2.4 miles of Peshastin Creek. The proposed improvement concept would not eliminate the need for or reduce reliance on storage operated by IPID in the Alpine Lakes Wilderness Area in the Icicle Creek Basin to maintain water supply availability in the late summer and early fall.

This evaluation was prepared in parallel with the update of the *Icicle and Peshastin Irrigation Districts Comprehensive Water Conservation Plan* (Anchor QEA forthcoming). The evaluation has been summarized in a stand-alone memorandum because of the magnitude of the project described herein. In addition, if this project were pursued further as the preferred option for future improvement of IPID, it would replace the need for other potential conservation and improvement projects identified in the *Icicle and Peshastin Irrigation Districts Comprehensive Water Conservation Plan*. Funding has also already been committed or is being pursued to complete some large improvement projects, such as upgrading IPID's surface water diversion on Icicle Creek. Those projects may not need to be completed if this project, referred to herein as the "full piping option," were pursued as the preferred option for future improvement of IPID.

Prior to development of the current conservation planning process, the idea of fully piping the IPID system and shifting surface water diversions to the Wenatchee River had been discussed, but had not been evaluated in detail and was generally not considered a feasible option by IPID due to the magnitude of the project and the costs associated with implementation and operation. However, as part of the conservation planning process, IPID agreed that a very high-level review of this option would be worthwhile to better understand the overall scope and order-of-magnitude costs.

Purpose

The purpose of this memorandum is to identify the major components of the improvement concept in just enough detail to develop an order-of-magnitude opinion of the probable costs associated with implementation and operation of the concept. This memorandum is intended to describe the concept and costs to help IPID, potential project funders, and other decision makers determine whether further consideration and study of the concept, or some variation of it, is warranted.

The memorandum evaluates one configuration of the proposed improvement concept that would shift IPID's diversions to the Wenatchee River and replace the IPID delivery systems with pressurized pipe. There are other potential configurations that would provide the same benefit in terms of flow benefit to Icicle Creek and Peshastin Creek and improved delivery efficiency. For example, this configuration assumes that pipelines would generally be constructed in existing canal alignments, but there may be efficiency in constructing pipelines within public road right-of-way rather than in the existing canal alignments. There may be other configurations or variations on the project that could potentially reduce cost; however, study of additional alternatives, configurations, or variations is beyond the scope of this memorandum.

Background

Icicle Irrigation District (IID) is located in Chelan County, Washington. IID delivers water for irrigation to approximately 4,300 acres, on both sides of the Wenatchee River Valley from Leavenworth to the town of Monitor. IID irrigation deliveries support primarily pear and apple orchards. Irrigation water is delivered through approximately 37 miles of canals, pipelines, flumes, and tunnels. The primary water supply for IID is a diversion on the right bank of Icicle Creek approximately 5.7 miles upstream of its confluence with the Wenatchee River.

Peshastin Irrigation District (PID) is also located in Chelan County, Washington. PID delivers water for irrigation to approximately 3,700 acres between Peshastin Creek and Cashmere on the south side of the Wenatchee River Valley. PID also includes areas served by the Tandy and Gibbs Ditch Companies. PID irrigation deliveries also support primarily pear and apple orchards. Irrigation water is delivered through approximately 13 miles of canals, pipelines, flumes, and tunnels. The primary water supply for PID is a diversion on the right bank of Peshastin Creek approximately 2.4 miles upstream of its confluence with the Wenatchee River. During the late summer, when flow in Peshastin Creek is insufficient to supply water needs to PID water users, water supply is supplemented through a pipeline that conveys water from a bifurcation structure at the downstream end of the IID Division 2 Canal to the PID Canal. IID and PID jointly own and operate the diversion on Icicle Creek and the IID Division 1 and 2 Canals, which convey water from the diversion on Icicle Creek to a bifurcation structure near the junction of Highway 97 and Highway 2 in Peshastin.

IID and PID share a manager, operations personnel, and operating expenses. Due to the overlap in management, operations, and infrastructure, IID and PID are in the process of consolidating into one district, referred to herein as IPID. The proposed improvement concept would shift water supplies for both districts and replace both delivery systems with pressurized pipe.

The idea of shifting at least a portion of the IID and PID diversions to the Wenatchee River has been discussed in a variety of stakeholder meetings. Late summer low flows in Peshastin Creek and Icicle Creek limit passage and impact habitat conditions for Endangered Species Act (ESA)-listed anadromous fish species. Reducing irrigation diversions or shifting diversions to the Wenatchee River have been discussed as potential ways to improve those conditions. Some variation of late summer pumping from the Wenatchee River to the IID and PID systems has been studied in the documents listed in Table 1.

Table 1
Prior Studies and Related Documents

Date	Study and Relevance	Author
January 2007[1]	*Peshastin Subbasin Needs and Alternatives Study* This report evaluated the primary summertime water needs within the Peshastin Creek Subbasin. Several alternatives were identified for improving water management, including the potential for late summer pumping from the Wenatchee River to improve flows in Peshastin Creek.	Anchor Environmental, LLC
December 2012[2]	*PID Pump Exchange Project Appraisal Study* This report provided an appraisal-level assessment of a project that would provide an additional source of supply for PID by pumping from the Wenatchee River near Dryden. The study outlined the project concept, evaluated five alternatives, and provided an appraisal-level opinion of probable project implementation and long-term operating costs.	Anchor QEA, LLC
February 2013[3]	*IID Pump Exchange Project – Initial Project Assessment* This report provided a concept-level review of a potential project that would provide an additional source of supply to IID through a pump station on the Wenatchee River near the Leavenworth Siphon.	Anchor QEA, LLC
July 2014[4]	*Draft IID Instream Flow Improvement Options Analysis Study* This study, prepared under the direction of Trout Unlimited, included an evaluation of potential alternatives for an additional source of supply for IID by pumping from the Wenatchee River. Several alternatives were identified and opinions of probable project implementation and long-term operating costs were provided.	Forsgren Associates, Inc.

Date	Study and Relevance	Author
March 2015[5]	*IPID Pump Exchange, Summary of Additional Analysis* This study, prepared under the direction of Chelan County, provided a summary of the various pump exchange options that had been evaluated and attempted to adjust the opinions of cost so that consistent assumptions were used regarding operations, maintenance, pumping, and other long-term costs. The intent was to compare the various options.	Anchor QEA, LLC

Notes:

1. Anchor Environmental 2007
2. Anchor QEA 2012
3. Anchor QEA 2013
4. Forsgren Associates 2014
5. Anchor QEA 2015

Various pumping concepts and other projects related to IPID's water supplies have been recently discussed and evaluated by the Icicle Work Group (IWG). The IWG is a group of stakeholders working together to identify and evaluate solutions to water supply, habitat, and fish passage issues in the Icicle Creek Basin. As the largest water user in the Icicle Creek Basin, IPID is a key participant in the IWG. The IWG has established a set of common goals, referred to as Guiding Principles. The potential project evaluated in this memorandum would meet multiple prongs of the IWG Guiding Principles, including the following:

- Improved streamflow in Icicle Creek that would result from shifting the diversion to the Wenatchee River
- Improved agricultural reliability that would result from more efficient use of water and replacement of delivery infrastructure and water supply facilities

The IWG has set a specific target of maintaining flows in lower Icicle Creek of at least 100 cubic feet per second (cfs) during normal and wet years and at least 60 cfs during drought years. Some stakeholders have suggested that a shift in IPID's diversion could alone achieve those goals, since IPID diverts up to 117 cfs from Icicle Creek in the late summer and early fall. It should be noted that, during the late summer low flow period, IPID's diversions are made possible by releases from IPID's storage facilities in the Alpine Lakes Wilderness Area. A shift in diversion locations to the Wenatchee River would not eliminate the need for those releases. If storage releases were eliminated, there would not be enough water in Icicle Creek and in the Wenatchee River in the late summer and early fall to supply IPID's diversions, maintain instream flows, and supply other water rights. Continued operation of IPID's storage facilities in the Alpine Lakes will be needed to ensure reliable water supply, no matter where IPID diverts water.

Description of Proposed Improvements

The proposed full piping option is illustrated in Figure 1. The project would eliminate the surface water diversions on Icicle Creek and Peshastin Creek, construct three surface water intake and pumping facilities on the Wenatchee River, and construct three pressurized pipe delivery systems that would replace the existing IPID delivery systems. These systems are summarized in Table 2.

It should be noted that the configuration and summary represented in Figure 1 and Table 2 represents just one potential configuration of the improvement concept. There are other variations on this configuration that could be evaluated and may reduce the overall cost. Evaluation of alternative configurations is beyond the scope of the memorandum; however, a couple iterations of refinement of the concept were completed in an effort to optimize pipe sizes and pumping. Other examples of alternative configurations that may warrant additional study could include:

- **Piping in Right-of-Way** - The systems evaluated in this memorandum assume that pipe will mostly be installed within existing canal alignments. There may likely be some efficiency that could be achieved and opportunities for improving operations and maintenance by rebuilding the system within existing road right-of-way.
- **Smaller Systems** – The systems evaluated in this memorandum include several long, dead-end irrigation pipelines. One potential way to serve the shareholders that are furthest from intake and pumping facilities on the Wenatchee River may be to serve them through separate smaller, discrete systems served by smaller, local intake and pumping facilities or groundwater wells, if the area served is relatively small. This approach could reduce the size of pumping facilities and delivery pipelines required. For example, customers currently served by the Icicle Division 1 Canal under the configuration evaluated in this memorandum will require a relatively long, dead-end main. Most of the shareholders served by the Division 1 Canal are smaller, non-agricultural users. Creation of a small system supplied by groundwater wells might be a more efficient way to serve these shareholders and could potentially reduce pumping costs, length of pipe installed, and overall cost.
- **Demand Management Strategies** – There may be opportunities to reduce peak irrigation demand through implementation of demand management strategies, such as irrigation scheduling and automation of delivery facilities. Reducing peak irrigation demand could reduce the size and cost of pumping facilities and delivery pipelines.

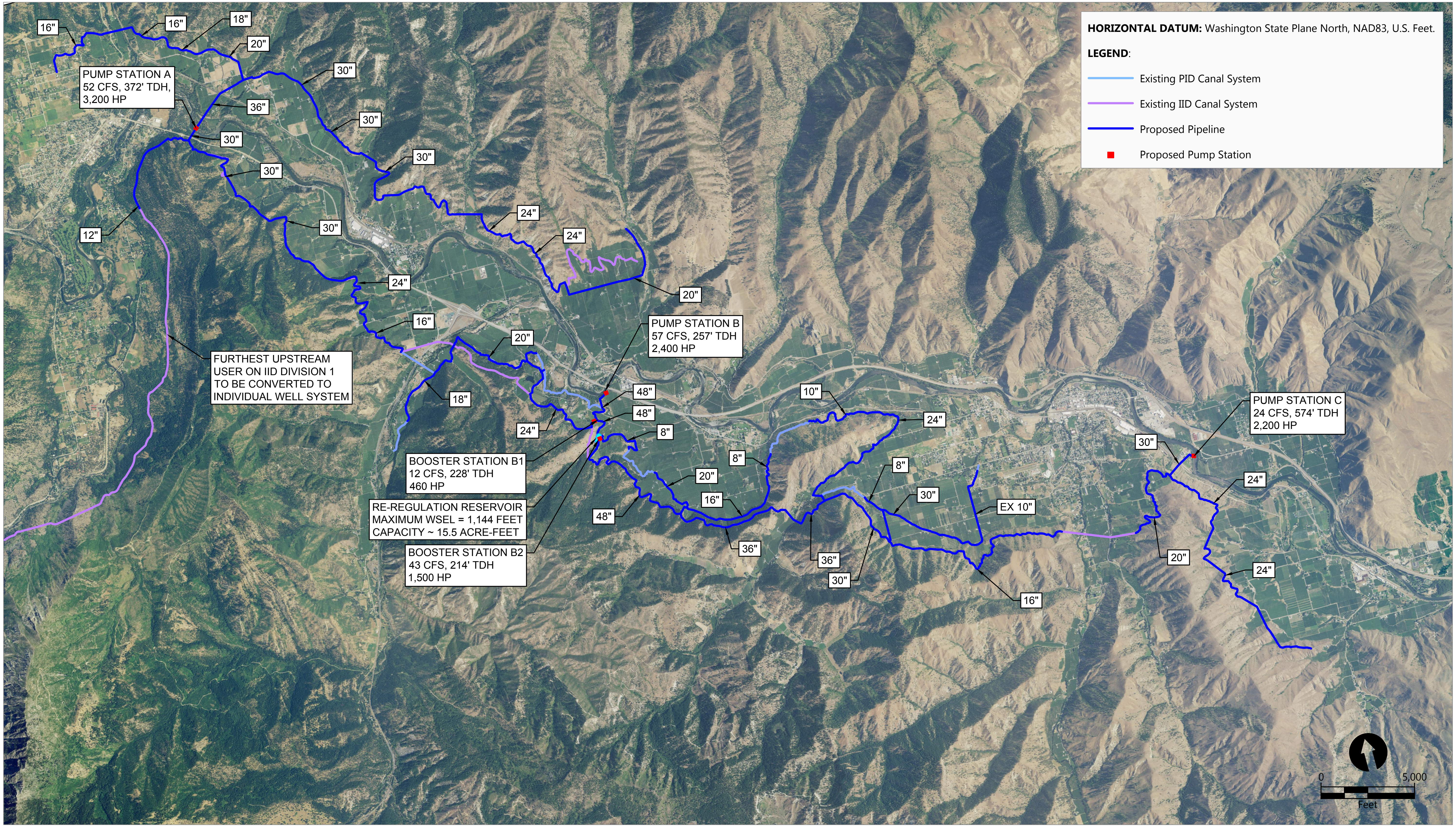
Table 2
Summary of Improvement Concept Evaluated in this Memorandum

Characteristic	System A	System B	System C
Existing Infrastructure Replaced by System	IID Division 1, 2, 4, and 5 Canals, Gibbs Ditch	IID Division 3A Canal and PID Canal	IID Division 3B Canal
Intake, Pump Station Location	PS A - Wenatchee River, Near Leavenworth Siphon	PS B – Wenatchee River, Upstream of Dryden Dam	PS C – Wenatchee River, Near Cashmere WWTP
Capacity[1]	52 cfs	57 cfs	24 cfs
Pumping Head	372 feet	257 feet	574 feet
Pumping Power	3,200 horsepower	2,400 horsepower	2,200 horsepower
Booster Station	N/A	BPS B-1	N/A
Capacity	N/A	12 cfs	N/A
Pumping Head	N/A	228 feet	N/A
Pumping Power	N/A	460 horsepower	N/A
Booster Station	N/A	BPS B-2	N/A
Capacity	N/A	43 cfs	N/A
Pumping Head	N/A	214 feet	N/A
Pumping Power	N/A	1,500 horsepower	N/A
Re-regulating Pond Location	N/A	In Bend in PID Main Canal, near Dryden	N/A
Re-regulating Pond Size	N/A	15.5 Acre-feet	N/A
Re-regulating Pond WSEL	N/A	1,144 feet	N/A
Pipe Sizing	12-inch to 36-inch	8-inch to 48-inch	20-inch to 30-inch
Delivery Pressures	Just enough to provide positive pressure at highest or most remote customer turnout	Just enough to provide positive pressure at highest or most remote customer turnout	Just enough to provide positive pressure at highest or most remote customer turnout

Notes:

1. The capacity was determined by estimating the number of shares served by each system and multiplying by 6.75 gpm per share, which is the maximum amount IPID delivers to its customers at each customer turnout. A 5 percent allowance was added on to the calculated flow rate to allow for leakage and loss in the distribution system.

BPS: Booster Pump Station
cfs: cubic feet per second
IID: Icicle Irrigation District
PID: Peshastin Irrigation District
PS: Pump Station
WSEL: Water Surface Elevation
WWTP: Wastewater Treatment Plant



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Filepath: L:\Projects\Trout_Unlimited\IPID_Conservation_Plan_Update_(171070-01.01)\CAD\0170-RP-002-Full Piping Alternative-Figure 1.dwg Figure 1

ANCHOR QEA

Figure 1
IPID - Full Piping Improvement Alternative

Comprehensive Water Conservation Plan
Icicle and Peshastin Irrigation Districts

Hydraulic Analysis

Each system shown in Figure 1 would consist of a surface water intake and pump station that would deliver water through a network for pressurized delivery pipelines to water users. System B would pump water into a re-regulating pond at the elevation of the existing PID Canal and two booster pump stations would be constructed to lift the water to the elevation of the IID Canal. It was assumed that pipelines would generally be installed in existing canal easements. A spreadsheet analysis was performed to estimate pump and pipeline sizes based on flow rates needed to serve downstream irrigation shares. IPID delivers up to 6.75 gpm per share to existing customer turnouts. That number was applied to downstream irrigation shares served by each facility and a 5% allowance was added to the total to account for potential leaks or losses in the distribution system. Pumps and pipelines were sized to deliver just enough pressure to maintain positive pressure at the highest, most remote customer turnout in the system. The results of the hydraulic analysis are included as Attachment A.

Overall, the project would require a total of approximately 9,760-horsepower of pumping. Pumps would likely be vertical turbine pumps designed to draw water from a wet well filled through intake facilities constructed at the river bank.

A total of more than 39 miles of pressurized pipeline would be required, ranging in size from 8-inch diameter to 48-inch diameter. Pipelines would extend only to the furthest water user in each canal that is being replaced, so the length of pipe required would be less than the length of existing canals. The analysis assumes that one customer furthest upstream on the IID Division 1 Canal would be converted to an individual well system because it would take a long length of dead-end pipe to reach that customer. Pipelines would be butt-fused high-density polyethylene (HDPE) pipe, where HDPE pipe is available in the size and pressure-rating required. Discharge pipelines from pump stations and other high-pressure pipelines would likely need to be welded-steel. Most of the pipes installed at the elevation of the IID Canals would operate at low pressures and would accommodate pipe with a thinner wall and lower pressure-rating. Pipes in the PID Canals would generally operate at higher pressures and would require pipe with higher pressure ratings.

Cost Analysis

A concept-level opinion of probable costs for the proposed project was developed. The costs include both project implementation costs and long-term operating costs. A detailed breakdown of those costs is included as Attachment B.

Project Implementation Costs

Table 3 summarizes the opinion of probable implementation costs for the project. Pipe costs were estimated based on unit prices that include pipe, related materials, installation, trenching, bedding, backfill, surface repair, and completion of all appurtenances and related equipment. The opinion of probable implementation costs includes the following assumptions and allowances:

- A 10% allowance was included for mobilization/demobilization.
- Costs are provided as a range.
  - For the low end of the range, a 15% contingency was included.
  - For the high end of the range, a 30% contingency was included.
  - For the low end of the range, a 10.0% allowance was included for engineering, permitting, and construction administration.
  - For the high end of the range, a 12.5% allowance was included for engineering, permitting, and construction administration.
- The total project cost includes 8.2% sales tax.
- An allowance of $500,000 was included for land acquisition for pump station and pipeline easements.

The total opinion of probable construction costs ranges from $65.4 million to $74.0 million. Of that, $8.5 million to $17.1 million has been included as a contingency to account for project elements that are not understood or have not been defined at this concept stage. The contingency would be narrowed down as the planning and design progresses. The total opinion of probable project implementation costs, including the non-construction related costs listed above, ranges from $72.5 million to $83.7 million.

Table 3
Opinion of Probable Project Implementation Costs

Item	Cost
Site Work	$ 1,970,000
Pressurized Pipe Distribution System	$ 28,383,000
PS/Intake Facility A (52 cfs, 3,200 hp)	$ 4,800,000
PS/Intake Facility B (57 cfs, 2,400 hp), BPS B-1 (12 cfs, 460 hp), BPS B-2 (43 cfs, 1,500 hp)	$ 8,300,000
Re-regulation Pond, System B (15.5 Acre-feet)	$ 600,000
PS/Intake Facility C (24 cfs, 2,200 hp)	$ 4,000,000
Construction Subtotal	**$ 48,053,000**
Mobilization/Demobilization (10%)	$ 4,805,000
Sales Tax (8.4%)	$ 4,037,000
Subtotal – Construction Contract	**$ 56,895,000**
Contingency - Low (15%)	$ 8,534,000
Contingency - High (30%)	$ 17,069,000
Total Construction Cost - Low	**$ 65,429,000**
Total Construction Cost - High	**$ 73,964,000**
Engineering, Permitting, Administration - Low (10.0%)	$ 6,544,000
Engineering, Permitting, Administration - High (12.5%)	$ 9,246,000
Allowance for Land Acquisition and Easements	$ 500,000
Subtotal – Non-construction Cost – Low	**$ 7,043,000**
Subtotal – Non-construction Cost – High	**$ 9,746,000**
Total Project Implementation Cost – Low	**$ 72,472,000**
Total Project Implementation Cost – High	**$ 83,710,000**

Notes:
1. All numbers are rounded to the nearest $1,000.
2. All numbers are in 2017 dollars.

BPS: Booster Pump Station
cfs: cubic feet per second
hp: horsepower
PS: Pump Station

Long-Term Operating Costs

Opinions of long-term annual operating costs were also developed for each alternative. These were developed based on the following assumptions:

- An allowance for annual operations and maintenance was estimated as 0.8% of the pump station implementation costs plus 0.2% of the pipeline implementation costs. This is consistent with the operations and maintenance assumptions presented in the *IPID Pump Exchange, Summary of Additional Analysis* (Anchor QEA 2015) memorandum, which was developed to compare several pump exchange alternatives.

- Pumping power costs are based on Chelan Public Utility District Rate Schedule 5, for irrigation service.
- Power costs are also based on the estimated horsepower required to deliver the peak design flow rate.
- The energy charge portion of the power cost was estimated based on delivering an annual volume of approximately 24,250 acre-feet, which would allow for delivery of 2.43 feet per acre annually to nearly 8,000 acres with an assumed average on-farm efficiency of 80%.
- The power costs assume that the monthly basic charge and demand charge would only apply during the irrigation season. It is assumed that the power service would be shut down during the off season.

Table 4 provides summary of the opinion of long-term operating costs for the pump exchange project at Dryden. Additional detail is included in Attachment B.

Table 4
Opinion of Probable Long-term Operating Costs

Item	Cost
Annual Operations and Maintenance Costs - Low[1]	$ 299,700
Annual Operations and Maintenance Costs - High[1]	$ 346,200
Annual Pumping Power Costs[2]	$ 475,286
Total Annual Operating Costs - Low[3]	**$ 775,000**
Total Annual Operating Costs - High[3]	**$ 821,000**

Notes:

1. Annual Operations and Maintenance Costs is assumed equal to 0.8% of pump station project costs + 0.2% of pipeline costs.
2. Pumping power costs are based on Chelan Public Utilities District Electrical Rate Schedule 5 (Irrigation Service).
3. Total is rounded to the nearest $1,000.
4. Numbers are in 2017 dollars. Operating costs would increase with inflation and increases in power rates.

Life Cycle Replacement Costs

Replacement costs were evaluated to determine the annual deposit that would need to be made to an account to fund replacement of the facilities at the end of the assumed life cycle for the project. It is likely that some components of the project will have longer or shorter design life cycles; however, to simplify the analysis, an overall design life cycle of 50 years was assumed. It is also unlikely that all of the facilities would need to be completely replaced during the assumed life cycle. For this reason, the analysis was performed for three levels of replacement: 25%, 50%, and 100%. The life cycle replacement cost analysis is also included in Attachment B.

Two methods of annual deposit to a replacement fund were evaluated. The first would be a constant annual deposit through the life of the project. The second would be an increasing annual deposit, escalated at the assumed annual inflation rate of 3%. Table 5 summarizes the total estimated annual replacement fund costs at project years 1, 25, and 50.

Table 5
Summary of Probable Annual Replacement Fund Costs

Year	Level of Replacement	Annual Deposit Required
Assumes Constant Annual Deposit Through Life of Project:		
1-50	25%	$ 824,174
	50%	$ 1,648,348
	100%	$ 3,296,696
Assumes Annual Deposit Increases at the Assumed Rate of Inflation:		
1	25%	$ 436,840
	50%	$ 873,679
	100%	$ 1,747,358
25	25%	$ 888,005
	50%	$ 1,776,010
	100%	$ 3,552,020
50	25%	$ 1,859,285
	50%	$ 3,718,570
	100%	$ 7,437,140

Summary

The memorandum evaluated a potential project that would shift IPID's diversions from Icicle Creek and Peshastin Creek to intake and pumping facilities on the Wenatchee River and would replace IPID's existing canal system with pressurized pipe delivery systems. Overall, the project would include three pump stations with intake facilities on the Wenatchee River, two booster pump stations, a re-regulating pond, approximately 9,760 horsepower of pumping, and more than 39 miles of delivery pipelines ranging in size from 8-inch to 48-inch diameter. The concept-level opinion of the probable cost to implement the project ranges from $72.4 million to $83.7 million, in 2017 dollars. Annual operating costs range from $775,000 to $821,000, in 2017 dollars, including $475,286 of annual pumping power costs. These costs are intended to be order-of-magnitude costs. Additional refinement of the concept and opinions of cost will be needed if IPID and other stakeholders find that additional study of this project is a worthwhile pursuit.

The scope of this memorandum was limited to evaluation and costing of a single configuration for a full piping option. There are likely other alternative configurations or variations on the configuration identified in this memorandum that would reduce project implementation costs and/or long-term operating costs. Such configurations might include piping within public road right-of-way, or smaller more discrete systems, where some existing shareholders are served through individual or small surface water- or groundwater well-supplied systems.

Recommended Next Step

It is anticipated that IPID will use this information as a basis for discussion with potential funding partners to determine whether a full piping option could be funded and is worth further consideration. Evaluation of additional alternatives and potential cost savings is recommended as a next step if IPID and other stakeholders determine that a full piping option warrants further study. A more detailed alternatives analysis could be completed where 5 or 6 potential alternative system configurations are identified and evaluated in enough detail to compare the costs and benefits of each. Those alternatives would be evaluated and compared based on key criteria or considerations identified by IPID and other stakeholders. Concept plans and a refined opinion of probable implementation costs and long-term operating costs would be developed for each alternative configuration for comparison. The goal of the study would be to provide enough information for IPID and other stakeholders to select a preferred (or multiple preferred) project alternative(s).

References

Anchor Environmental, 2007. *Peshastin Subbasin Needs and Alternatives Study*. Prepared for Chelan County Natural Resources Department. January 2007.

Anchor QEA, 2012. *Peshastin Irrigation District Pump Exchange Project Appraisal Study*. Prepared for Chelan County Natural Resources Department and the Washington State Department of Ecology. December 2012.

Anchor QEA, 2013. *Icicle Irrigation District Pump Exchange Project – Initial Project Assessment*. Technical memorandum prepared for Chelan County Natural Resources Department and Icicle Irrigation District. February 2013.

Anchor QEA, 2015. *Icicle and Peshastin Irrigation Districts Pump Exchange, Summary of Additional Analysis*. Technical memorandum prepared for Chelan County Natural Resources Department and Icicle and Peshastin Irrigation Districts. March 2015.

Anchor QEA, forthcoming. *Icicle and Peshastin Irrigation Districts Comprehensive Water Conservation Plan*. Prepared concurrently with this memorandum for Trout Unlimited and Icicle and Peshastin Irrigation Districts. Forthcoming.

Forsgren Associates, 2014. *Draft Icicle Irrigation District Instream Flow Improvement Options Analysis Study*. Prepared for Trout Unlimited. July 2014.

Attachment A
Hydraulic Analysis

PIPELINE SIZING CALCULATION
PROJECT: IPID FULLY PIPED CONCEPT
PUMP STATION A

BY: JTS
DATE: 12/22/2017

HYDRAULIC PROFILE - MAX DISCHARGE PRESSURE

ASSUMES:			
	-Plastic Pipe, C =	140	
	-Elevation at High Point =	1,385.00	feet
	-HGL at High Point =	1,399.00	feet
	-Pressure at High Point =	6.1	psi

Legend
Input
Calculation
Output
Check

Reach	Upstream End	Upstream Elevation (Feet)	Downstream End	Downstream Elevation (Feet)	Reach Length (Feet)	Pipe I.D. (Inches)	Flow (gpm)	Flow (cfs)	Velocity (fps)	Headloss Gradient (feet/ 1,000 feet)	Headloss (feet)	Est. Minor Loss (feet)	Upstream HGL (feet)	Upstream Pressure (psi)	Downstream HGL (feet)	Downstream Pressure (psi)
SOUTHWEST BRANCH																
			River P.S. Tee	1,065											1,411.67	150.2
P.S. A South	River P.S. Tee	1,065	Tee to 20/30	1,380	520	28.00	9,085	20.2	4.7	2.1	1.1	0.1	1,411.67	150.2	1,411.67	13.7
30	Tee to 20/30	1,380	40	1,355	6,850	28.01	8,164	18.2	4.3	1.8	12.0	1.2	1,411.67	13.7	1,398.47	18.8
40	30	1,355	50	1,354	6,030	28.01	7,088	15.8	3.7	1.3	8.1	0.8	1,398.47	18.8	1,389.53	15.4
50	40	1,354	60	1,352	5,850	22.41	5,066	11.3	4.1	2.1	12.5	1.3	1,389.53	15.4	1,375.73	10.3
60	50	1,352	End	1,350	3,050	14.94	2,518	5.6	4.6	4.2	12.9	1.3	1,375.73	10.3	1,361.54	5.0
NORTHWEST BRANCH																
20	Tee to 20/30	1,380	End	1,385	5,800	11.91	921	2.1	2.7	2.0	11.5	1.2	1,411.67	13.7	1,399.00	6.1
SOUTHEAST BRANCH																
			River P.S. Tee	1,065											1,411.67	150.2
P.S. A North	River P.S. Tee	1,065	Tee to 300/400	1,340	3,950	34.00	14,130	31.5	5.0	1.9	7.4	0.7	1,411.67	150.2	1,403.49	27.5
400	Tee to 300/400	1,340	410	1,340	4,260	28.01	10,050	22.4	5.2	2.6	11.0	1.1	1,403.49	27.5	1,391.43	22.3
410	400	1,340	420	1,335	4,400	28.01	9,012	20.1	4.7	2.1	9.2	0.9	1,391.43	22.3	1,381.26	20.0
420	410	1,335	430	1,330	9,980	28.01	6,976	15.5	3.6	1.3	13.1	1.3	1,381.26	20.0	1,366.89	16.0
430	420	1,330	440	1,325	4,520	22.41	5,024	11.2	4.1	2.1	9.5	1.0	1,366.89	16.0	1,356.39	13.6
440	430	1,325	450	1,315	5,330	22.41	4,624	10.3	3.8	1.8	9.7	1.0	1,356.39	13.6	1,345.77	13.3
450	440	1,315	End	1,300	10,700	18.68	4,079	9.1	4.8	3.5	37.3	3.7	1,345.77	13.3	1,304.71	2.0
NORTHEAST BRANCH																
300	Tee to 300/400	1,340	310	1,340	2,700	18.68	4,079	9.1	4.8	3.5	9.4	0.9	1,403.49	27.5	1,393.13	23.0
310	300	1,340	320	1,330	2,970	16.81	2,951	6.6	4.3	3.2	9.5	0.9	1,393.13	23.0	1,382.68	22.8
320	310	1,330	330	1,320	3,580	14.94	2,417	5.4	4.4	3.9	14.0	1.4	1,382.68	22.8	1,367.23	20.5
330	320	1,320	End	1,300	4,000	14.94	2,068	4.6	3.8	2.9	11.8	1.2	1,367.23	20.5	1,354.29	23.5

PIPELINE SIZING CALCULATION
PROJECT: IPID FULLY PIPED CONCEPT
PUMP STATION B

BY: JTS
DATE: 12/22/2017

HYDRAULIC PROFILE - MAX DISCHARGE PRESSURE

ASSUMES:	-Plastic Pipe, C =	140	
	-Elevation at High Point =	1,150.00	feet
	-HGL at High Point =	1,154.62	feet
	-Pressure at High Point =	2.0	psi

Legend
Input
Calculation
Output
Check

Reach	Upstream End	Upstream Elevation (Feet)	Downstream End	Downstream Elevation (Feet)	Reach Length (Feet)	Pipe I.D. (Inches)	Flow (gpm)	Flow (cfs)	Velocity (fps)	Headloss Gradient (feet/ 1,000 feet)	Headloss (feet)	Est. Minor Loss (feet)	Upstream HGL (feet)	Upstream Pressure (psi)	Downstream HGL (feet)	Downstream Pressure (psi)
MAIN LINE																
			P.S. B	927											1,159.07	100.6
100	P.S. B	927	B.P.S. B1	1,150	2,250	46.0	25,498	56.8	4.9	1.3	2.9	0.3	1,159.07	100.6	1,155.88	2.5
120	B.P.S. B1	1,150	RE-REG POND	1,150	1,250	44.8	19,807	44.1	4.0	0.9	1.1	0.1	1,155.88	2.5	1,154.62	2.0
BRANCH																
125	RE-REG POND	1,150	End	1,140	3,600	8.1	274	0.6	1.7	1.4	5.1	0.5	1,154.62	2.0	1,149.01	3.9

HYDRAULIC PROFILE - BOOSTER PUMP STATION - B1

ASSUMES:	-Plastic Pipe, C =	140	
	-Elevation at High Point =	1,315.00	feet
	-HGL at High Point =	1,319.62	feet
	-Pressure at High Point =	2.0	psi

Legend
Input
Calculation
Output
Check

Reach	Upstream End	Upstream Elevation (Feet)	Downstream End	Downstream Elevation (Feet)	Reach Length (Feet)	Pipe I.D. (Inches)	Flow (gpm)	Flow (cfs)	Velocity (fps)	Headloss Gradient (feet/ 1,000 feet)	Headloss (feet)	Est. Minor Loss (feet)	Upstream HGL (feet)	Upstream Pressure (psi)	Downstream HGL (feet)	Downstream Pressure (psi)
WEST BRANCH																
			B.P.S B1	1,150											1,342.76	83.5
110	B.P.S B1	1,150	80	1,315	5,100	20.3	5,574	12.4	5.5	4.1	21.0	2.1	1,342.76	83.5	1,319.62	2.0
80	110	1,315	70	1,180	8,100	18.0	3,729	8.3	4.7	3.6	28.8	2.9	1,319.62	2.0	1,287.97	46.8
70	90	1,180	End	1,190	6,000	16.2	2,904	6.5	4.5	3.7	22.4	2.2	1,287.97	46.8	1,263.32	31.8

HYDRAULIC PROFILE - BOOSTER PUMP STATION - B2

ASSUMES:
- -Plastic Pipe, C = 140
- -Elevation at High Point = 1,315.00 feet
- -HGL at High Point = 1,338.70 feet
- -Pressure at High Point = 10.3 psi

Input
Calculation
Output
Check

Reach	Upstream End	Upstream Elevation (Feet)	Downstream End	Downstream Elevation (Feet)	Reach Length (Feet)	Pipe I.D. (Inches)	Flow (gpm)	Flow (cfs)	Velocity (fps)	Headloss Gradient (feet/ 1,000 feet)	Headloss (feet)	Est. Minor Loss (feet)	Upstream HGL (feet)	Upstream Pressure (psi)	Downstream HGL (feet)	Downstream Pressure (psi)
MAIN																
			B.P.S B2	1,315											1,338.70	10.3
130	B.P.S B2	1,315	150	1,310	6,160	44.8	19,140	42.6	3.9	0.9	5.3	0.5	1,338.70	10.3	1,332.87	9.9
150	130	1,310	190	1,305	6,070	33.6	13,385	29.8	4.8	1.8	10.9	1.1	1,332.87	9.9	1,320.85	6.9
190	150	1,305	200	1,300	3,570	33.6	12,655	28.2	4.6	1.6	5.8	0.6	1,320.85	6.9	1,314.48	6.3
200	190	1,300	240	1,290	5,070	28.0	8,583	19.1	4.5	1.9	9.7	1.0	1,314.48	6.3	1,303.77	6.0
240	200	1,290	End	1,280	9,750	14.9	1,414	3.2	2.6	1.5	14.2	1.4	1,303.77	6.0	1,288.17	3.5
LATERAL 1																
140	Tee 140/155	1,145	End	1,140	2,990	16.9	3,068	6.8	4.4	3.3	9.9	1.0	1,332.87	81.4	1,321.95	78.8
155	130	1,145	160	1,130	5,270	13.5	1,564	3.5	3.5	2.8	14.9	1.5	1,332.87	81.4	1,316.48	80.8
160	155	1,130	End	1,120	2,200	7.3	99	0.2	0.8	0.3	0.8	0.1	1,316.48	80.8	1,315.64	84.8
LATERAL 2																
180	Tee to 180	1,300	170	1,100	9,510	20.3	3,930	8.8	3.9	2.2	20.6	2.1	1,314.48	6.3	1,291.87	83.1
170	180	1,100	End	1,110	4,020	9.1	760	1.7	3.8	5.2	20.7	2.1	1,291.87	83.1	1,269.08	68.9
LATERAL 3																
210	Tee to 210	1,290	End	1,090	7,800	25.4	6,431	14.3	4.1	1.8	14.2	1.4	1,303.77	6.0	1,288.20	85.9
220	210	1,090	230	1,100	1,000	7.3	401	0.9	3.1	4.6	4.6	0.5	1,303.77	92.6	1,298.71	86.1
230	220	1,100	End	890	4,000	9.6	2,424	5.4	10.8	34.4	137.8	13.8	1,288.20	81.5	1,136.64	106.9

PIPELINE SIZING CALCULATION
PROJECT: IPID FULLY PIPED CONCEPT
PUMP STATION C

BY: JTS
DATE: 12/22/2017

HYDRAULIC PROFILE - MAX DISCHARGE PRESSURE

ASSUMES:
-Plastic Pipe, C = 140
-Elevation at High Point = 1,265.00 feet
-HGL at High Point = 1,269.62 feet
-Pressure at High Point = 2.0 psi

Input
Calculation
Output
Check

Reach	Upstream End	Upstream Elevation (Feet)	Downstream End	Downstream Elevation (Feet)	Reach Length (Feet)	Pipe I.D. (Inches)	Flow (gpm)	Flow (cfs)	Velocity (fps)	Headloss Gradient (feet/ 1,000 feet)	Headloss (feet)	Est. Minor Loss (feet)	Upstream HGL (feet)	Upstream Pressure (psi)	Downstream HGL (feet)	Downstream Pressure (psi)
MAIN LINE																
			P.S. C	750											1,298.96	237.9
245	P.S. C	750	TEE to 250/260	1,260	1,750	28.0	10,606	23.6	5.5	2.8	5.0	0.5	1,298.96	237.9	1,293.48	14.5
260	TEE to 250/260	1,260	270	1,240	7,315	22.4	6,701	14.9	5.5	3.6	26.3	2.6	1,293.48	14.5	1,264.53	10.6
270	270	1,240	END	1,220	8,150	22.4	6,605	14.7	5.4	3.5	28.6	2.9	1,264.53	10.6	1,233.12	5.7
LATERAL 1																
250	TEE to 250/260	1,260	END	1,265	6,740	18.7	3,906	8.7	4.6	3.2	21.7	2.2	1,293.48	14.5	1,269.62	2.0

PUMP SIZING CALCULATION
PROJECT: IPID FULLY PIPED CONCEPT

PUMP STATION A

Description	Flow (cfs)	Flow (gpm)	Elevation (feet)	Min Suction HGL (feet)	Max Suction HGL (feet)	Min Discharge HGL (feet)	Max Discharge HGL (feet)	PS Loss (feet)	Min TDH (feet)	Max TDH (feet)	Design TDH (feet)	Efficiency	Horsepower
PUMP STATION A w/o BPS	51.7	23,214	1,065	1,045	1,055	1,412	1,412	10	367	377	372	70%	3,120

PUMP STATION B

Description	Flow (cfs)	Flow (gpm)	Elevation (feet)	Min Suction HGL (feet)	Max Suction HGL (feet)	Min Discharge HGL (feet)	Max Discharge HGL (feet)	PS Loss (feet)	Min TDH (feet)	Max TDH (feet)	Design TDH (feet)	Efficiency	Horsepower
PUMP STATION B	56.8	25,498	927	907	917	1,159	1,159	10	252	262	257	70%	2,370
BPS B1	12.4	5,574	1,140	1,120	1,130	1,343	1,343	10	223	233	228	70%	460
BPS B2	43.3	19,415	1,150	1,130	1,140	1,339	1,339	10	209	219	214	70%	1,500

PUMP STATION C

Description	Flow (cfs)	Flow (gpm)	Elevation (feet)	Min Suction HGL (feet)	Max Suction HGL (feet)	Min Discharge HGL (feet)	Max Discharge HGL (feet)	PS Loss (feet)	Min TDH (feet)	Max TDH (feet)	Design TDH (feet)	Efficiency	Horsepower
PUMP STATION C w/o BPS	23.6	10,606	750	730	740	1,299	1,299	10	569	579	574	70%	2,200

Attachment B

Opinion of Probable Costs

IPID Comprehensive Water Conservation Plan 22-Dec-17
Full Piping Improvement Option
Opinion of Probable Costs

ITEM	UNIT	UNIT COST	QTY	COST
Site Work				
Diversion and Care of Water	LS	VARIES	1	$480,000
Temporary and Permanent Access	LS	VARIES	1	$480,000
Temporary Erosion and Sediment Control	LS	VARIES	1	$720,000
Construction Surveying	LS	VARIES	1	$150,000
Clearing and Grubbing	AC	$2,500	56	$140,000
Subtotal - Site Work				**$1,970,000**
Pressurized Distribution Pipe System [1]				
48-inch Welded Steel Pipe	LF	$450	2,250	$1,012,500
36-inch Welded Steel Pipe	LF	$350	3,950	$1,382,500
30-inch Welded Steel Pipe	LF	$300	2,270	$681,000
48-inch HDPE DR 32.5 (63-psi) Butt-fused Pipe	LF	$295	7,410	$2,185,950
36-inch HDPE DR 32.5 (63-psi) Butt-fused Pipe	LF	$220	9,640	$2,120,800
30-inch HDPE DR 32.5 (63-psi) Butt-fused Pipe	LF	$165	36,590	$6,037,350
24-inch HDPE DR 32.5 (63-psi) Butt-fused Pipe	LF	$110	31,680	$3,484,800
20-inch HDPE DR 32.5 (63-psi) Butt-fused Pipe	LF	$85	22,940	$1,949,900
18-inch HDPE DR 32.5 (63-psi) Butt-fused Pipe	LF	$72	2,970	$213,840
16-inch HDPE DR 32.5 (63-psi) Butt-fused Pipe	LF	$60	22,480	$1,348,800
12-inch HDPE DR 32.5 (63-psi) Butt-fused Pipe	LF	$42	5,800	$243,600
8-inch HDPE DR 32.5 (63-psi) Butt-fused Pipe	LF	$28	3,600	$100,800
24-inch HDPE DR 21 (100-psi) Butt-fused Pipe	LF	$135	8,100	$1,093,500
20-inch HDPE DR 21 (100-psi) Butt-fused Pipe	LF	$100	6,000	$600,000
30-inch HDPE DR 13.5 (160-psi) Butt-fused Pipe	LF	$270	7,800	$2,106,000
24-inch HDPE DR 13.5 (160-psi) Butt-fused Pipe	LF	$180	14,610	$2,629,800
20-inch HDPE DR 13.5 (160-psi) Butt-fused Pipe	LF	$130	2,990	$388,700
16-inch HDPE DR 13.5 (160-psi) Butt-fused Pipe	LF	$90	5,270	$474,300
10-inch HDPE DR 13.5 (160-psi) Butt-fused Pipe	LF	$50	4,020	$201,000
8-inch HDPE DR 13.5 (160-psi) Butt-fused Pipe	LF	$40	3,200	$128,000
Subtotal - Pressurized Distribution Pipe				**$28,383,000**
Pump Station and Intake Facility A (52-cfs)				
Pump Station and Intake Facility A (52-cfs, 3,200 HP)	LS	$4,800,000	1	$4,800,000
Subtotal - Pump Station and Intake Facility A				**$4,800,000**
Pump Station and Intake Facility B (57-cfs)				
Pump Station and Intake Facility B (57-cfs, 2,400 HP)	LS	$3,900,000	1	$3,900,000
Booster Pump Station B-1 (12-cfs, 460 HP)	LS	$1,400,000	1	$1,400,000
Booster Pump Station B-2 (43-cfs, 1,500 HP)	LS	$3,000,000	1	$3,000,000
Subtotal - Pump Station and Intake Facility B				**$8,300,000**
Re-regulation Reservoir - System B (15.5 Acre-feet)				
Re-regulation Reservoir - System B (15.5 Acre-feet)	LS	$600,000	1	$600,000
Subtotal - Re-regulation Reservoir - System B (15.5 Acre-feet)				**$600,000**
Pump Station and Intake Facility C (24-cfs)				
Pump Station and Intake Facility B (24-cfs, 2,200 HP)	LS	$4,000,000	1	$4,000,000
Subtotal - Pump Station and Intake Facility C				**$4,000,000**
Construction Subtotal				**$48,053,000**
Mobilization / Demobilization	10.0%			$4,805,300
Sales Tax	8.4%			$4,036,452
Subtotal - Construction Contract				**$56,895,000**
Contingency - Low	15.0%			$8,534,250
Contingency - High	30.0%			$17,068,500
Total Construction Cost - Low				**$65,429,000**
Total Construction Cost - High				**$73,964,000**
Non-consturction Costs				
Engineering, Permitting, and Adminstration - Low	10.0%			$6,542,900
Engineering, Permitting, and Adminstration - High	12.5%			$9,245,500
Allowance for Land Acquisition and Easements	LS	VARIES	1	$500,000
Total - Non-construction Costs - Low				**$7,043,000**
Total - Non-construction Costs - High				**$9,746,000**
Total Project Cost - Low				**$72,472,000**
Total Project Cost - High				**$83,710,000**

Notes:
1) Pipe unit costs include trenching; furnishing and installing pipe, fittings, and appurtenances including turnout connections for water users; backfilling; compaction of backfill; and surface repair.
2) Subtotals and totals are rounded to the nearest $1,000.
3) Costs are in 2017 dollars.

Full Piping Improvement Option
Long-term Operating Costs (Operations and Maintenance, Pumping Power, and Replacement Fund Costs)

ITEM		UNIT	UNIT COST	QTY	COST
Annual Operations and Maintenance Cost - Low[1,3]					**$299,700**
Annual Operations and Maintenance Cost - High[1,3]					**$346,200**
Pumping Power Costs[2]					
Monthly Basic Charge (3-Phase Power)		/EA/MO	$14.50	5	$72.50
Seasonal Energy Charge					
	APR	/kWh	$0.0165	1,310,573	$21,624.45
	MAY	/kWh	$0.0165	1,625,110	$26,814.32
	JUN	/kWh	$0.0165	2,621,146	$43,248.90
	JUL	/kWh	$0.0165	3,791,924	$62,566.75
	AUG	/kWh	$0.0165	3,791,924	$62,566.75
	SEP	/kWh	$0.0165	3,145,375	$51,898.68
Monthly Demand Charge		/HP/MO	$3.52	9,760	$34,355
Total Annual Pumping Costs					**$475,286**
Total Annual Operating Costs - Low[3]					**$775,000**
Total Annual Operating Costs - High[3]					**$821,000**

Notes:
1) Annual Operations and Maintenance Costs assumed equal to 0.8% of pump station project costs + 0.2% of pipeline costs.
2) Pumping power costs are based on Chelan PUD Electrical Rate Schedule 5 (Irrigation Service), in 2017 dollars.
3) Rounded to nearest $1,000.

Icicle and Peshastin Irrigation District (IPID) Comprehensive Water Conservation Plan
Full Piping Improvement Option
Life Cycle Cost Analysis

Input Cells - Assumed or Given Values

ASSUMPTIONS:		
Estimated Capital Cost:	$83,710,000	Total Capital Cost
Interest on Replacement Fund:	3.00%	
Rate of Inflation:	3.00%	
Project Design Life:	50	Years

SUMMARY REPLACEMENT COSTS:	CURRENT COST[2]	FUTURE COST[3]
Estimated Project Replacement Cost:		
To Replace 25% After Life of Project		$91,744,193
To Replace 50% After Life of Project		$183,488,386
To Replace 100% After Life of Project	$83,710,000	$366,976,773
Disposal and Removal Cost:		
To Replace 25% After Life of Project		$1,220,063
To Replace 50% After Life of Project		$2,440,126
To Replace 100% After Life of Project	$1,113,220	$4,880,252
Total Replacement Cost:		
To Replace 25% After Life of Project		**$92,964,256**
To Replace 50% After Life of Project		**$185,928,512**
To Replace 100% After Life of Project	**$84,823,220**	**$371,857,025**

REPLACEMENT FUND SUMMARY	
Annual Deposit Required (Assume Equal Deposit Made Each Year):	
To Replace 25% After Life of Project	$824,174
To Replace 50% After Life of Project	$1,648,348
To Replace 100% After Life of Project	$3,296,696
Deposit Required at Year 1 (Assume Deposits Increase at the Rate of Inflation):	
To Replace 25% After Life of Project	$436,840
To Replace 50% After Life of Project	$873,679
To Replace 100% After Life of Project	$1,747,358
Deposit Required at Year 25 (Assume Deposits Increase at the Rate of Inflation):	
To Replace 25% After Life of Project	$888,005
To Replace 50% After Life of Project	$1,776,010
To Replace 100% After Life of Project	$3,552,020
Deposit Required at Year 50 (Assume Deposits Increase at the Rate of Inflation):	
To Replace 25% After Life of Project	$1,859,285
To Replace 50% After Life of Project	$3,718,570
To Replace 100% After Life of Project	$7,437,140

TOTAL LONG-TERM COST SUMMARY: (PRESENT VALUE OF LONG-TERM COSTS THROUGH 50-YEAR LIFE CYCLE)	**Replacment Fund**	**O &M**	**Power**	**TOTAL**
Assuming the Pumping Power Costs for a 153-Day Annual Operating Duration:				
25% Replacement	$21,205,805	$14,985,000	$23,764,302	**$59,955,107**
50% Replacement	$42,411,610	$14,985,000	$23,764,302	**$81,160,912**
100% Replacement	$84,823,220	$14,985,000	$23,764,302	**$123,572,522**

LIFE CYCLE COSTS:

Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
Capital Expenses:	$83,710,000																							
Replacement Fund (For Funding Replacement of 25% of System):																								
Deposits		$436,840	$449,945	$463,443	$477,346	$491,667	$506,417	$521,609	$537,258	$553,375	$569,977	$587,076	$604,688	$622,829	$641,514	$660,759	$680,582	$700,999	$722,029	$743,690	$766,001	$788,981	$812,650	$837,030
Interest		$0	$13,105	$26,997	$41,710	$57,282	$73,750	$91,155	$109,538	$128,942	$149,411	$170,993	$193,735	$217,688	$242,903	$269,436	$297,342	$326,679	$357,510	$389,896	$423,903	$459,601	$497,058	$536,349
End of Year Balance		**$436,840**	**$899,890**	**$1,390,329**	**$1,909,386**	**$2,458,334**	**$3,038,501**	**$3,651,265**	**$4,298,061**	**$4,980,378**	**$5,699,766**	**$6,457,835**	**$7,256,258**	**$8,096,774**	**$8,981,191**	**$9,911,386**	**$10,889,309**	**$11,916,988**	**$12,996,527**	**$14,130,113**	**$15,320,017**	**$16,568,598**	**$17,878,307**	**$19,251,686**
Replacement Fund (For Funding Replacement of 50% of System):																								
Deposits		$873,679	$899,890	$926,886	$954,693	$983,334	$1,012,834	$1,043,219	$1,074,515	$1,106,751	$1,139,953	$1,174,152	$1,209,376	$1,245,658	$1,283,027	$1,321,518	$1,361,164	$1,401,999	$1,444,059	$1,487,380	$1,532,002	$1,577,962	$1,625,301	$1,674,060
Interest		$0	$26,210	$53,993	$83,420	$114,563	$147,500	$182,310	$219,076	$257,884	$298,823	$341,986	$387,470	$435,375	$485,806	$538,871	$594,683	$653,359	$715,019	$779,792	$847,807	$919,201	$994,116	$1,072,698
End of Year Balance		**$873,679**	**$1,799,779**	**$2,780,659**	**$3,818,771**	**$4,916,668**	**$6,077,002**	**$7,302,530**	**$8,596,121**	**$9,960,756**	**$11,399,531**	**$12,915,669**	**$14,512,516**	**$16,193,549**	**$17,962,382**	**$19,822,772**	**$21,778,619**	**$23,833,976**	**$25,993,054**	**$28,260,226**	**$30,640,034**	**$33,137,197**	**$35,756,613**	**$38,503,371**
Replacement Fund (For Funding Replacement of 100% of System):																								
Deposits		$1,747,358	$1,799,779	$1,853,772	$1,909,386	$1,966,667	$2,025,667	$2,086,437	$2,149,030	$2,213,501	$2,279,906	$2,348,303	$2,418,753	$2,491,315	$2,566,055	$2,643,036	$2,722,327	$2,803,997	$2,888,117	$2,974,761	$3,064,003	$3,155,924	$3,250,601	$3,348,119
Interest		$0	$52,421	$107,987	$166,840	$229,126	$295,000	$364,620	$438,152	$515,767	$597,645	$683,972	$774,940	$870,751	$971,613	$1,077,743	$1,189,366	$1,306,717	$1,430,039	$1,559,583	$1,695,614	$1,838,402	$1,988,232	$2,145,397
End of Year Balance		**$1,747,358**	**$3,599,558**	**$5,561,317**	**$7,637,543**	**$9,833,336**	**$12,154,003**	**$14,605,061**	**$17,192,243**	**$19,921,511**	**$22,799,063**	**$25,831,338**	**$29,025,031**	**$32,387,097**	**$35,924,765**	**$39,645,544**	**$43,557,238**	**$47,667,952**	**$51,986,107**	**$56,520,451**	**$61,280,068**	**$66,274,394**	**$71,513,227**	**$77,006,743**
Operations and Maintenance Expenses:		**$299,700**	**$308,691**	**$317,952**	**$327,490**	**$337,315**	**$347,434**	**$357,857**	**$368,593**	**$379,651**	**$391,041**	**$402,772**	**$414,855**	**$427,301**	**$440,120**	**$453,323**	**$466,923**	**$480,931**	**$495,358**	**$510,219**	**$525,526**	**$541,292**	**$557,530**	**$574,256**
Pumping Power Costs:		**$475,286**	**$489,545**	**$504,231**	**$519,358**	**$534,939**	**$550,987**	**$567,516**	**$584,542**	**$602,078**	**$620,140**	**$638,745**	**$657,907**	**$677,644**	**$697,974**	**$718,913**	**$740,480**	**$762,695**	**$785,575**	**$809,143**	**$833,417**	**$858,419**	**$884,172**	**$910,697**
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**

NOTES:
1) Total Field Cost is from Engineer's Opinion of Probable Costs, includes construction costs and contingency.
2) Current Cost is equal to the Engineer's opinion of the probable cost of the project at beginning of project life (2012 dollars) plus the current estimated cost of disposal and removal.
3) Future cost is value or the project cost at end of life cycle of the project, or the current cost inflated at the rate shown through the life cycle of the project.
4) Salaries assumes salary for 1/12 full-time equivalent (FTE) to help manage/operate the pump station, or one person for about 8 hours per week during irrigation season.
5) Benefits assumes benefits = salaries X 40%.
6) Allowance for trips to and from pump station.
7) Estimated in the first year as 0.3% of the capacital cost of the pump station, rounded to the nearest $100.
8) Assumes pumping power costs, or power rates, increase at the assumed rate of inflation.

Icicle and Peshastin Irrigation District (IPID) Comprehensive Water Conservation Plan
Full Piping Improvement Option
Life Cycle Cost Analysis

24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
$862,141	$888,005	$914,645	$942,084	$970,347	$999,457	$1,029,441	$1,060,324	$1,092,134	$1,124,898	$1,158,645	$1,193,404	$1,229,207	$1,266,083	$1,304,065	$1,343,187	$1,383,483	$1,424,987	$1,467,737	$1,511,769	$1,557,122	$1,603,836	$1,651,951	$1,701,509	$1,752,555	$1,805,131	$1,859,285
$577,551	$620,741	$666,004	$713,423	$763,088	$815,091	$869,528	$926,497	$986,102	$1,048,449	$1,113,649	$1,181,818	$1,253,075	$1,327,543	$1,405,352	$1,486,634	$1,571,529	$1,660,179	$1,752,734	$1,849,348	$1,950,182	$2,055,401	$2,165,178	$2,279,692	$2,399,128	$2,523,679	$2,653,543
$20,691,377	**$22,200,123**	**$23,780,772**	**$25,436,280**	**$27,169,715**	**$28,984,264**	**$30,883,233**	**$32,870,054**	**$34,948,290**	**$37,121,637**	**$39,393,931**	**$41,769,153**	**$44,251,434**	**$46,845,060**	**$49,554,477**	**$52,384,298**	**$55,339,310**	**$58,424,476**	**$61,644,948**	**$65,006,065**	**$68,513,369**	**$72,172,606**	**$75,989,735**	**$79,970,936**	**$84,122,618**	**$88,451,428**	**$92,964,256**
$1,724,281	$1,776,010	$1,829,290	$1,884,169	$1,940,694	$1,998,915	$2,058,882	$2,120,649	$2,184,268	$2,249,796	$2,317,290	$2,386,809	$2,458,413	$2,532,165	$2,608,130	$2,686,374	$2,766,965	$2,849,974	$2,935,474	$3,023,538	$3,114,244	$3,207,671	$3,303,902	$3,403,019	$3,505,109	$3,610,262	$3,718,570
$1,155,101	$1,241,483	$1,332,007	$1,426,846	$1,526,177	$1,630,183	$1,739,056	$1,852,994	$1,972,203	$2,096,897	$2,227,298	$2,363,636	$2,506,149	$2,655,086	$2,810,704	$2,973,269	$3,143,058	$3,320,359	$3,505,469	$3,698,697	$3,900,364	$4,110,802	$4,330,356	$4,559,384	$4,798,256	$5,047,357	$5,307,086
$41,382,754	**$44,400,246**	**$47,561,544**	**$50,872,559**	**$54,339,430**	**$57,968,528**	**$61,766,466**	**$65,740,108**	**$69,896,580**	**$74,243,273**	**$78,787,861**	**$83,538,306**	**$88,502,868**	**$93,690,120**	**$99,108,953**	**$104,768,596**	**$110,678,620**	**$116,848,953**	**$123,289,895**	**$130,012,130**	**$137,026,738**	**$144,345,211**	**$151,979,469**	**$159,941,872**	**$168,245,237**	**$176,902,856**	**$185,928,512**
$3,448,563	$3,552,020	$3,658,580	$3,768,338	$3,881,388	$3,997,829	$4,117,764	$4,241,297	$4,368,536	$4,499,592	$4,634,580	$4,773,617	$4,916,826	$5,064,331	$5,216,261	$5,372,749	$5,533,931	$5,699,949	$5,870,947	$6,047,076	$6,228,488	$6,415,343	$6,607,803	$6,806,037	$7,010,218	$7,220,525	$7,437,140
$2,310,202	$2,482,965	$2,664,015	$2,853,693	$3,052,354	$3,260,366	$3,478,112	$3,705,988	$3,944,406	$4,193,795	$4,454,596	$4,727,272	$5,012,298	$5,310,172	$5,621,407	$5,946,537	$6,286,116	$6,640,717	$7,010,937	$7,397,394	$7,800,728	$8,221,604	$8,660,713	$9,118,768	$9,596,512	$10,094,714	$10,614,171
$82,765,508	**$88,800,493**	**$95,123,088**	**$101,745,118**	**$108,678,860**	**$115,937,055**	**$123,532,931**	**$131,480,216**	**$139,793,159**	**$148,486,546**	**$157,575,723**	**$167,076,612**	**$177,005,736**	**$187,380,239**	**$198,217,907**	**$209,537,193**	**$221,357,239**	**$233,697,906**	**$246,579,790**	**$260,024,260**	**$274,053,475**	**$288,690,422**	**$303,958,938**	**$319,883,743**	**$336,490,474**	**$353,805,713**	**$371,857,025**
$591,484	**$609,228**	**$627,505**	**$646,330**	**$665,720**	**$685,692**	**$706,263**	**$727,451**	**$749,274**	**$771,752**	**$794,905**	**$818,752**	**$843,315**	**$868,614**	**$894,672**	**$921,513**	**$949,158**	**$977,633**	**$1,006,962**	**$1,037,171**	**$1,068,286**	**$1,100,334**	**$1,133,344**	**$1,167,345**	**$1,202,365**	**$1,238,436**	**$1,275,589**
$938,018	**$966,159**	**$995,143**	**$1,024,998**	**$1,055,748**	**$1,087,420**	**$1,120,043**	**$1,153,644**	**$1,188,253**	**$1,223,901**	**$1,260,618**	**$1,298,436**	**$1,337,390**	**$1,377,511**	**$1,418,837**	**$1,461,402**	**$1,505,244**	**$1,550,401**	**$1,596,913**	**$1,644,820**	**$1,694,165**	**$1,744,990**	**$1,797,340**	**$1,851,260**	**$1,906,798**	**$1,964,002**	**$2,022,922**
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50