DECISION MATRIX
CASCADE ORCHARDS IRRIGATION DISTRICT
ICICLE CREEK FLOW RESTORATION PROJECT
PIPE MATERIAL

Pipe Material	Durability	Operations and Maintenance Requirements	Operating Cost[2]	Constructability	Capital Cost (12-inch Pipe, Installed)[1]	Ease of Permitting[3]
PVC	• Relatively durable • Some PVC pipe has been installed without repair for more than 50 years.	• Easy to repair • Repair couplings, saddles are very common • Flushing (2 to 3 times per season) • Periodic leak repair	• Similar, all pipe materials	• Lightweight, easy to install • Bell/spigot joints • Commonly used for municipal water mains • Not flexible, requires fittings at bends	$50/LF	• Similar, all pipe materials
HDPE	• Very durable • Pipe is relatively new (has become common in last 20 years or so)	• Easy to repair • Requires couplings, saddles specific to HDPE pipe • Flushing (2 to 3 times per season) • Infrequent leak repair	• Similar, all pipe materials	• Lightweight, relatively easy to install • Fused joints, requires a certified fusion machine operator • More commonly used last 20 years • Reactive to sunlight • Flexible, only requires bends at tight corners	$65/LF	• Similar, all pipe materials
DI	• Very durable • Some municipalities will only allow DI pipe because of durability • Installations have lasted 60+ years	• Easy to repair • Repair couplings, saddles are very common • Flushing (2 to 3 times per season) • Infrequent leak repair	• Similar, all pipe materials	• Heavier, more involved installation • Bell/spigot, flanged, or mechanical joints • Commonly used for municipal water mains • Not flexible, requires fittings at bends	$190/LF	• Similar, all pipe materials
Steel	• Very durable • Installations have lasted 60+ years	• Repair can require welding, but repairs are infrequent • Repair couplings, saddles are very common • Flushing (2 to 3 times per season) • Infrequent leak repair	• Similar, all pipe materials	• Heavier, more involved installation • Welded or flanged joints • Commonly used, especially for mechanical or high-pressure piping • Not flexible, requires fittings at bends	$210/LF	• Similar, all pipe materials

ENGINEER'S RECOMMENDATION:

- Main Line – Use HDPE if funding will support the increased capital cost over PVC. HDPE is flexible and will be easier to install in the existing ditch alignment.
- Laterals – Use HDPE if funding will support the increased capital cost over PVC. It would be better for long-term maintenance to use the same pipe materials throughout the project. Using the same material will also simplify procurement and construction.
- Mechanical Piping Manifolds (Pump Station) – Use steel with flanged or welded joints.

Notes:
1. Capital cost is total approximate per linear foot of 12-inch pipe installed with fittings, appurtenances, trenching, backfill, and surface repair included.
2. Operating cost for pipelines is likely to be a relatively small percentage of the overall operating budget of the system, no matter which pipe material is selected.
3. The selection of pipe material is not anticipated to affect the ease or difficulty of permitting the overall project.

DI: ductile iron
HDPE: high-density polyethylene
LF: linear foot
PVC: polyvinyl chloride

DECISION MATRIX
CASCADE ORCHARDS IRRIGATION DISTRICT
ICICLE CREEK FLOW RESTORATION PROJECT
SYSTEM OPERATING PRESSURE

Description	Minimum Delivery Pressure	Maximum Delivery Pressure	Total Pumping Required	Impact to Capital Cost	Impact to Pumping Power Cost	Challenges and Benefits
Design system to just barely maintain positive pressure at highest, most remote shareholder turnout connection	• 1 to 2 psi, at highest most remote shareholder turnout connection	• 25 psi, at highest most remote shareholder turnout connection • 53 psi at pump station discharge	160 horsepower	• Lowest cost of pumps • Lowest pressure rating and cost of piping • Probably a reduction of 5% to 10% over cost of project targeting a 25-psi minimum pressure	• ~$9,900 Annual Power Cost	• Would provide very little benefit to highest and most remote customers • Would be difficult to maintain low, but positive pressures throughout system
Design system to maintain 25 psi at highest, most remote shareholder turnout connection; while minimizing shareholder turnout connections that experience pressures in excess of 65 psi	• 25 psi, at highest most remote shareholder turnout connection	• 48 psi, at highest most remote shareholder turnout connection • 76 psi at pump station discharge • Shareholders that would experience pressures in excess of 70 psi would have a pressure reducing valve on their turnout connection	240 horsepower	• Moderate cost of pumps • Moderate pressure rating and cost of piping	• ~$14,600 Annual Power Cost	• Would provide moderately positive pressure to all customers • Would require that some customers use pressure reducing valves to protect on-site irrigation systems
Design system to maintain 55 psi at highest, most remote shareholder turnout connection; realizing that a greater number of turnout connections will experience pressures in excess of 65 psi	• 55 psi, at highest most remote shareholder turnout connection	• 78 psi, at highest most remote shareholder turnout connection • 106 psi at pump station discharge • All shareholders would experience pressures in excess of 70 psi and would have a pressure reducing valves on their turnout connection	340 horsepower	• Higher cost of pumps • Higher pressure rating and cost of piping • Probably an increase of 15% over cost of project targeting a 25-psi minimum pressure	• ~$20,500 Annual Power Cost	• Would provide enough pressure for all shareholders to eliminate pumping • Would require that all customers have pressure reducing valves to protect against excessive pressures when demand is low.
ENGINEER'S RECOMMENDATION: • Design system to maintain at least 25 psi at the highest, most remote customer (Icicle Creek RV Resort). Provide pressure-reducing valves for customers that will experiences pressures in excess of 70 psi under static conditions.						

Notes:
psi: pounds per square inch

DECISION MATRIX
CASCADE ORCHARDS IRRIGATION DISTRICT
ICICLE CREEK FLOW RESTORATION PROJECT
SCREEN TYPE

Screen Type	Cleaning Mechanism	Durability	Operations and Maintenance Requirements	Operating Cost[2]	Constructability	Capital Cost[1] (8-cfs Screen)	Sit Suitability, Ease of Permitting[2]
Inclined Flat Panel	• Air Burst or Mechanical Brush	• Exposed at river bank (not retractable) • Would need to be protected from debris and ice during winter or high flows with steel plate or similar • Screen would be stainless steel to minimize corrosion	• Inspection, maintenance of mechanical and electrical systems • Perioding supplemental cleaning of screen • Installation of protection during off season from debris and ice in river	• Minor power cost for air burst or mechanical brush • Periodic replacement of mechanical and electrical components • Periodic supplemental cleaning of screen	• Screen installation is straightforward • Would require structure at river bank, with cofferedam during construction • Would require significant grading at bank • Installation of mechanical blower, plumbing for air-burst system is complicated	$110,000 to $140,000 (Includes Screen, Steel Supports, Steel Plate for Protection, Air-Burst System for Self-Cleaning)	• Screening at river preferred to off-channel screening • Shoreline impacts • Would not impact recreational uses as much as other options • May require in-river work to maintain constant submergence • Would need to match angle of bank to be acceptable to WDFW, which may not be steep enough
Retractable Cylinder Screen	• External and Internal Brushes	• Relatively durable • Retractable, so that it would not be exposed to debris and ice during off-season • Would need to be submerged to be protected from floating debris during late spring high flows • Screen would be stainless steel to minimize corrosion • Frame and other parts could be subject to rust, corrosion	• Inspection, maintenance of mechanical and hydraulic systems • Screen removal and cleaning at end of season • Screen placement at beginning of season • Supplemental cleaning during season, as needed	• Minor power cost for hoisting equipment to allow removal • Periodic replacement of mechanical and electrical components • Seasonal removal, placement, and cleaning	• Screen installation is straightforward • Would require structure at river bank, with cofferdam, during construction • Installation of hoist system may be more complicated • Would require significant grading at bank to provide support for constant sloping frame and rails for screen retraction	$120,000 to $150,000 (Includes Screen, Cleaning System, Hoist System, Connection)	• Screening at river preferred to off-channel screening • Shoreline impacts • Could be an obstacle or attraction to rafters, recreational users • Likely acceptable to WDFW
Cone Screen	• External Brushes	• Relatively durable • Could be retractable, but typically designed to remain in place year-round • Would need to be submerged to be protected from ice and floating debris • Screen would be stainless steel to minimize corrosion • Frame and other parts could be subject to rust, corrosion • Data on durability and operation is favorable	• Inspection, maintenance of mechanical and hydraulic systems • Perioding supplemental cleaning of screen • Could require removal and repair if damaged or if inspection is needed	• Minor power cost for hoisting equipment to allow removal • Periodic replacement of mechanical and electrical components • Periodic supplemental cleaning of screen	• Screen installation is straightforward • Would require trenching and installation through river bank, pipe connection to settling basin • Difficult configuration, deep excavation with high bank	$40,000 to $60,000 (Includes Screen, Cleaning System, Connection)	• Screening at river preferred to off-channel screening • Shoreline impacts • Could be an obstacle or attraction to rafters, recreational users, but would be submerged 2 to 3 feet at low flows • Likely acceptable to WDFW

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ICICLE CREEK FLOW RESTORATION PROJECT
SCREEN TYPE

Screen Type	Cleaning Mechanism	Durability	Operations and Maintenance Requirements	Operating Cost[2]	Constructability	Capital Cost[1] (8-cfs Screen)	Sit Suitability, Ease of Permitting[2]
End-of-Pipe Suction Screen	• Internal Spray Bar or Air Burst	• Relatively durable • Could be retractable, likely with a hoist, excavator, or other mechanical equipment • Would need to be submerged to be protected from ice and floating debris • Screen could be stainless steel to minimize corrosion • Metal parts could be subject to rust, corrosion • Data on consistency of self-cleaning varies from location to location	• Likely screen removal and cleaning at end of season • Screen placement at beginning of season. • Inspection, maintenance of moving spray bar • Supplemental cleaning during season, as needed	• Periodic replacement of mechanical components • Seasonal removal, placement, and cleaning	• Screen installation is straightforward • Could be designed to minimize construction at river bank • Installation of hoist system may be more complicated	$25,000 to $40,000 (Includes Screen with Internal Spray Bars, Hoist System, Connection)	• Would work better off-channel or as a pump suction screen. • Could be an obstacle or attraction to rafters, recreational users • Likely acceptable to WDFW
Traveling Water Screen	• External Brush	• Better for screening off-channel • Less durable for screening at river without protection • Plastic screen material, does not corrode	• Debris removal from back of screen • Debris management, and removal (either flushing or sweeping) • Moving parts in water are mostly plastic, would not require as much maintenance • Inspection, maintenance of self-cleaning mechanism and moving parts • Supplemental cleaning during season, as needed	• Periodic replacement of mechanical and electrical components • Periodic supplemental cleaning of screen	• Screen installation is straightforward • Would require mounting on a structure • Better for off-channel construction or placement behind a debris rack or other protection	$45,000 to $65,000 (Includes Screen, Frame, Debris Removal Sluice)	• Would work better off-channel • This application will likely require screening at the river, which make it less ideal than other options • Shoreline impacts
ENGINEER'S RECOMMENDATION: • Based on depth of pool and angle of left bank at proposed intake site on Icicle Creek, anticipated cost, and review with WDFW, we recommend installation of a stainless-steel cone screen with an exterior hydraulically driven mechanical brush. We recommend that the screen be designed to remain in place throughout the year, but with ability to remove and inspect the screen, as needed, to keep screen clean and operating efficiently.							

Notes:
1. Capital cost includes screen, appurtenances, self-cleaning mechanism, connection to on-bank structure or piping, and installation.
2. Anchor QEA and Washington Water Trust met with WDFW to discuss these screen options. WDFW and other permitting agencies will ultimately need to review these options to determine whether they apply with applicable guidelines for permit approval.
WDFW: Washington Department of Fish and Wildlife

ANCHOR QEA

DECISION MATRIX
CASCADE ORCHARDS IRRIGATION DISTRICT
ICICLE CREEK FLOW RESTORATION PROJECT
SEDIMENT AND DEBRIS CONTROL

Control Facility	Durability	Operations and Maintenance Requirements	Operating Cost[2]	Constructability	Capital Cost[1]	Ease of Permitting
Reinforced Concrete Settling Basin, Upstream of Pump Station Wet Well	• Durable • May experience some cracking with temperature, but would be designed to be water tight	• Daily inspection to monitor sediment accumulation • Structure would be 20+ feet deep with removable grating • Periodic removal of sediment from basin with vactor truck or excavator • Frequency of sediment removal will not be known until project is in operation	• Sediment removal cost • Periodic repair of gate to control flow through basin • Seasonal dewatering with a trash pump to remove water after irrigation season is over and system has been flushed	• Would require deep excavation • Would require consistent dewatering for concrete placement and construction	$70,000 to $90,000	• Additional land disturbance, excavation required near left bank of Icicle Creek • Likely would not impact ease or difficulty of permitting
Hydraulic Screen Filter (Manual)	• Durable steel or stainless-steel construction, pressure-rated • Flanged or grooved connections available	• Regular inspection and manual operation of purge port and valve • Periodic cleaning • Removal of sediment flushed from filter	• Sediment removal cost • High headloss in hydraulic filter means higher pumping costs	• Relatively easy to install on pump discharge line • Requires space in pump station, which could complicate design and construction of pump station	$25,000 to $35,000	• Likely would not impact ease of permitting • Could be restrictions on removal and disposal of sediment from filter
Centrifugal Sand Separator (Automatic)	• Durable, steel construction, pressure-rated • Flanged connections available	• Regular inspection of purge port and valve • Periodic cleaning • Removal of sediment flushed from separator	• Sediment removal cost • High headloss in sand separator means higher pumping costs	• Relatively easy to install on pump discharge line • Requires space in pump station, which could complicate design and construction of pump station	$15,000 to $20,000	• Likely would not impact ease of permitting • Could be restrictions on removal and disposal of sediment from sand separator

ENGINEER'S RECOMMENDATION:

- To facilitate sediment removal prior to pumping and limit the frequency and complication of operating the system and managing sediment removed from the water, we recommend installing a reinforced concrete settling basin on the left bank of Icicle Creek with a weir and a baffle designed to catch sediment and reduce suspended solids in water prior to pumping.

Notes:
1. Capital cost includes sediment control facility and all related excavation, backfill, and installation work required.

DECISION MATRIX
CASCADE ORCHARDS IRRIGATION DISTRICT
ICICLE CREEK FLOW RESTORATION PROJECT
INTAKE AND PUMP STATION CONFIGURATION

Intake and Pump Station Configuration	Challenges/Benefits	Operations and Maintenance Requirements	Constructability	Ease of Permitting
• Screening in Icicle Creek • Flow into deep (20+ feet deep) settling basin at left bank • Pipe conveyance to nearby pump station and wet well • Flow into deep (20+ feet deep) wet well below pump station • Pump station above wet well in small building • Four to five vertical turbine pumps operate on demand to maintain flow to system, controlled by discharge pressure	• Would simplify pumping and system control because pumping would only occur in one place • Would require settling basin and connecting pipes to extend below low water surface in river (20+ feet deep) • Would provide more straightforward hydraulic connection from river to pump station wet well	• Daily inspection to monitor sediment accumulation, monitor pumps, ensure system is working, etc. • Structure would be 20+ feet deep with removable grating • Periodic removal of sediment from basin with vactor truck or excavator • Frequency of sediment removal will not be known until project is in operation	• Would require much deeper and more extensive excavations for the settling basin, wet well, and connecting pipe • Would require shoring and constant dewatering for these facilities • Would require less electrical, controls, and simplify pump startup and testing	• Would require more upland disturbance and excavation, which could add some level of complication for permitting
• Screening in Icicle Creek • Flow into deep wet well at left bank • Pumping from wet well using two to three submersible pumps that operate to keep adjacent settling basin full, controlled by floats in the settling basin • Water pumped into relatively shallow (4 to 5 feet deep) settling basin • Pipe conveyance to nearby pump station and wet well • Flow into deep (20+ feet deep) wet well below pump station • Pump station above wet well in small building • Four to five vertical turbine pumps operate on demand to maintain flow to system, controlled by discharge pressure	• Would add a level of complication to pumping and system control • Would allow for a shallower settling basin, piping, and wet well, which would make construction and sediment removal easier	• Daily inspection to monitor sediment accumulation, monitor pumps, ensure system is working, etc. • Would include two to three additional pumps and associated electrical and controls to operate and maintain • Structure would be 4 to 5 feet deep with removable grating • Periodic removal of sediment from basin with vactor truck or excavator, or smaller equipment, with potential to flush sediment basin back to creek • Frequency of sediment removal will not be known until project is in operation	• Would allow for shallower excavations for the settling basin, pump station wet well, and connecting pipe • Would reduce the requirements for shoring and dewatering for the setting basin, pump station wet well, and connecting pipe • Would require installation of more electrical connections, controls equipment, and require more pump startup and testing work	• Would reduce upland disturbance and excavation, which could reduce level of complication for permitting
ENGINEER'S RECOMMENDATION: • To simplify pumping and provide fewer pumps, controls, and electrical equipment to operate and maintain, design system with single set of four to five vertical turbine pumps that would draw water from a deeper wet well supplied through a screen at Icicle Creek and a deep settling basin.				