WOODS CREEK HYDRO

renewable • reliable • environmentally responsible

TAKE A TOUR OF THE WOODS CREEK HYDROELECTRIC PROJECT AT SNOPUD.COM/CCL

Questions to Consider During Your Tour

INTAKE

What is the purpose of the trash rack?

The trash rack keeps larger debris from: 1) impacting the fish screens, and 2) getting into the hydropower project where it could damage to the facilities.

What is the purpose of the fish screens? What considerations go into sizing the screens?

The fish screens prevent fish (juvenile and adults) from entering the hydropower facilities and getting injured. Fish have a certain swimming capability, and too much force (velocity) of water pushing into the screen can make a fish get stuck. The screens are carefully designed and sized to distribute the flow of water over a wide enough area so the fish do not get stuck ("impinged") on the screens. Some considerations into the screen area and opening size are the: 1) quantity of water that is being diverted, 2) depth of the water, 3) lifestage (age and length) of the fish, and 4) species of the fish. Biologists identify what species and lifestages are in the area –they then can use literature to identify what the swimming capabilities are for those fish. Engineers then use the data to calculate the appropriate size (length, height, size openings) of the screens. Generally the National Marine Fishery Service protocols calls for a velocity of water along the screens to be not greater than 0.4 feet per second to prevent impingement of fish on the screens.

What would happen to the facility if too much sediment or debris entered the system?

The facility could suffer a reduction in efficiency and output of the system due to a build-up of sediment and debris. This build-up can cause parts to wear out or break, costing more money for maintenance and repair. Debris can also clog the system completely or severely damage the system, causing catastrophic failure of the system.

WEIR

What is the difference between a weir and a dam?

A weir is a barrier across a waterway used to impound water, but it can be overtopped (have the water run over the top of the weir once the impoundment reaches the height of the weir). A dam is also a barrier across a waterway used to impound water, but it typically is not overtopped. Water passes the dam through a tunnel, pipe, or spillway built into the dam. Both structures can be used to prevent flooding, measure discharge, make the waterway navigable, store water for domestic or industrial use, create recreational opportunities, and generate power.

The Woods Creek Hydro Project has a weir because it is overtopped during high flows. Its sole purpose is for power generation.

What are some potential negative effects that could occur from having a weir in a stream? How are these potential effects avoided or mitigated at this project?

A weir could block fish passage (upstream and/or downstream passage), disrupt the transport and distribution of gravel, change the fish community, alter the water course, or create an impoundment that chokes out vegetation.

The weir at Woods Creek Project is low and has a sluice gate, allowing water, fish, sediment, and gravel to go downstream past the barrier. Its low profile also keeps the water behind the weir within the ordinary high water mark so any impoundment rise does not affect the vegetation more than Mother Nature normally would.

What does it mean when a hydropower project is "run-of-the-river"? How is this different than a project that uses a reservoir?

A run-of-the-river hydroelectric project is a hydropower project that operates based on the current flow of the river without use of any upstream reservoir or water storage. There may be a small impoundment (or pondage) developed to help divert a portion of the water to the intake but basically has no storage capability. The Woods Creek Project is a run-of-the-river hydropower project. Whereas conventional hydropower projects use a reservoir to store water for dispatchable power. The reservoir could also serve multiple purposes beyond power generation; the reservoir could also be for flood control, drinking or industrial water supply, and/or recreational activities such as boating, fishing, etc.

Why isn't all the water routed through the intake?

If all the water was routed to the generator, then the area between the weir and the point of generation discharge (that section called the "bypass reach") would be dried up; water is needed in that bypass reach for the fish and aquatic resources that use that area. A "minimum flow" is provided in the bypass reach to protect these natural resources. This "minimum flow" is the least amount of water that has to be provided by the utility, but more water can also be provided in the reach by a reduction in generation or from rainfall. All water in excess of the plant capacity travels through the bypass reach.

PENSTOCK

What is the benefit of the buried penstock?

There are several benefits. The buried penstock:

- allows free movement along the ground for driving of vehicles
- does not impede migration or grazing of wildlife
- provide safety to the pipe from rockfall, tree falls, or other potentially damaging situations that could occur above ground
- hides the facility and makes the surrounding area look more natural or aesthetically appealing

Why isn't the whole penstock buried?

Burying a facility during construction is more expensive than leaving it above ground. Sometimes the ground conditions (like being in solid bedrock) would be too expensive to blast and remove the rock in order to bury the penstock.

What considerations are made for selecting the type of penstock?

There are multiple types of materials that have been and can be used for penstocks, e.g. steel, wood stave, fiberglass, plastic, concrete. Each material has its own strength, longevity, friction co-efficient, tolerance for hydraulics and stress, cost, weight, flexibility, and complexity of installation. Considerations include:

- How much of the penstock is low pressure and how much of the penstock is high pressure?
- Is the penstock above ground or buried?
- What quantity of water will flow through the penstock?
- What soil materials will the penstock be sitting on or be buried in?

The selection of the type of penstock is project specific. Engineers weigh these and other factors, advantages and disadvantages when selecting the material of penstock.

POWERHOUSE

What factors help determine how much power can be generated?

There are two main factors – 1) quantity of water, and 2) amount of "head" – the difference in height between the impoundment elevation and the turbine. There are other factors that can have an impact on the amount of generation including: 1) friction loss due to the type of penstock material, 2) energy dissipation due to the number and types of curves within the penstock, and 3) efficiency of the turbine.

Why are there two different sized turbines (200kW and 450kW) instead of just one (650kW)?

Having two turbines allows the project to operate in the most efficient manner at a larger band of water flows. Turbines are often less efficient when they are not running at their optimum flow level. As spring waters decrease and head into the summer low flow scenarios or as summer transitions into the fall, the flows in the creek are less than normal. So having two turbines allows one turbine to run at maximum efficiency when there isn't the full amount of water to support maximum efficiency of a larger 650 kW turbine.

Why is the powerhouse partially buried?

There are two main reasons – 1) a semi-buried powerhouse has a lower visual profile which makes it less distracting, and 2) it allows the turbines to be closer to the ground where the water will re-enter the creek, and maintains a higher "head" for the project.
Name a few reasons why the powerhouse would not be operating throughout the year.

- Shut down for maintenance
- Water flow is too low to operate
- Provide additional flow for fish and aquatic habitat
- No additional energy is needed by the users at that time
- Shut down due to integration with wind or solar, high output from solar during the day or wind at night so no additional need for energy from hydro

What is SCADA?

SCADA stands for "Supervisory Control and Data Acquisition". It is a control system that allows, in this case, the hydropower project to be remotely controlled, operated, and monitored using computers, networks, and coded signals over communication channels.

What are the benefits of having the project remotely operated?

- Save money from not having to drive to the site, or have separate staff at site to operate
- Easier operation because it is integrated with operations of other facilities or power resources
- Easy to see how project is operating (via computers, cameras, etc.)

TAILRACE

Why are fish screens needed at the tailrace?

Fish are attracted to flowing water. Since there is extra water flowing out of the tailrace the fish are attracted that direction. The screens prevent the fish from swimming towards the tailrace outlet and trying to enter the facility.

Is the water that comes out of the hydropower system at the tailrace different than when it went into the system at the intake (either in quantity or quality)?

No. The same amount/quantity of water that enters the facility is returned to the creek.

Water quality can be defined by temperature, dissolved oxygen levels and chemical composition. There is no change to the water quality at this project because of the short penstock (there is no heating of the water) and no contaminates are added along its route. The same level of water quality enters and exits the system.

TRANSMISSION

How does the power get out of the project and into the homes?

The power is transmitted out of the generator to the distribution lines. (Typically in larger projects, the power would be transmitted to a switchyard where the power would be stepped-up to a higher voltage and sent to a substation, where it is then sent to the distribution system and then to homes. Transmitting at higher voltage reduces line loses.)

What devices are used to protect raptors and eagles from injury associated with the lines?

The lines are placed in areas where there is not a typical migratory bird flight path. Conversely, in areas where there is a flight path, bird deterrent devices are installed on the lines to signal the bird away from that flight path. The surrounding trees help shield it from being a flight path. The spacing between the lines does not allow for the birds to touch two lines at the same time causing electrocution.

OTHER

What are the inputs and outputs of this hydropower system?

Inputs – water and potential energy. Output – water and electrical energy.

At what points of the system is there: 1) potential energy, 2) kinetic energy, 3) mechanical energy, and 4) electrical energy?

- potential energy – water at the impoundment (it is at a higher elevation than the turbine)
- kinetic energy – water moving through the penstock

- mechanical energy – the rotation of the turbine
- electrical energy – the electrons on the distribution line

Why is this project considered renewable?

It is a carbon free resource. The system inputs/outputs are not changed. It is part of the water cycle. The water can be used again in the water cycle.

Is power from this facility considered an "eligible renewable resource" under Washington's Energy Independence Act (EIA, I-937)?

Yes, the portion of energy produced from the system upgrades that increased efficiency of this hydropower project is considered and I-937 "eligible renewable resource."

At what point in the water cycle does hydropower take place?

Hydropower at this facility takes place during the surface water stage of the water cycle.

What environmental protections are incorporated into the design, operation and maintenance of the project?

Mentioned in video:

- Trash racks
- Fish screens
- Instream flows
- Buried penstock
- Raptor protection on power lines
- Requirements of Federal Energy Regulatory Commission, Department of Ecology, Department of Fish and Wildlife, Snohomish County

Also, the PUD does the following at this project:

- Removed un-necessary structures on site to re-establish habitat for wildlife
- Manages noxious/invasive weed species so native species can flourish
- Leaves snags (standing dead trees) and coarse woody debris (on the ground dead trees) in place for wildlife habitat
- Monitors flow to make sure meeting minimum flow requirements for fish and aquatic habitat
- A sluice gate at the weir is raised to prevent sediment and gravels from building up behind the weir and allowed to pass the weir for fish and aquatic habitat needs

What conditions at this site make it an ideal location for hydropower?

There are many conditions at this site that make it an ideal location for hydropower, including:

- The natural barrier (the tall waterfall) to fish (anadromous and resident) as to not impede their migration to spawning habitat. Fish cannot jump above this waterfall.
- The height difference between the intake and turbines provides for ~75 feet of "head".
- The short distance between the intake and the powerhouse keeps the footprint of impacted lands very small.
- The solid bedrock surfaces make it a safe and stable area.
- The close proximity to existing distribution lines and roads, so no new roads and lines needed to be built.
- The rainy conditions of the area where approximately 80 inches of rain falls each year – that's a lot of "free fuel from the sky."

How does this project help combat climate change?

It is a carbon free resource that off-sets the need for carbon based resources that contribute to climate change. The Woods Creek Hydro Project provides clean, renewable, and reliable energy while not depleting natural resources, or raising the temperature of water or the air.

SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT NO. 1

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