Columbia Basin Hydropower

REQUEST FOR PROPOSAL NO. PD-01-20

SMALL HYDROPOWER DEVELOPMENT AT FACILTIES LOCATED ON THE COLUMBIA BASIN IRRIGATION PROJECT

107 D Street NW
Ephrata, Washington 98823

REQUEST FOR PROPOSALS
SMALL HYDROPOWER DEVELOPMENT AT
FACILITIES LOCATED ON THE COLUMBIA BASIN IRRIGATION PROJECT

Contents

SECTION 1 – REQUEST FOR PROPOSALS

REQUEST FOR PROPOSALS
SMALL HYDROPOWER DEVELOPMENT AT
FACILITIES LOCATED ON THE COLUMBIA BASIN IRRIGATION PROJECT

Respondents are invited to submit sealed proposals for the development of one or multiple small hydropower facilities at one or multiple facilities on the Columbia Basin Irrigation Project that are identified in this Request for Proposals (RFP). Columbia Basin Hydropower (CBHP) will evaluate the proposals and may or may not select any proposals for further discussions and eventual development of projects. The decision whether to entertain or enter into any development arrangements will be made by the CBHP Board in its sole discretion. The five facilities in the Columbia Basin Irrigation Project that are being made available for potential hydropower development are:

1. Mesa Check
2. PE16.4 Wasteway
3. PE46A Wasteway
4. Scooteney Inlet
5. Scooteney Outlet

CBHP was called Grand Coulee Project Hydroelectric Authority (GCPHA) during the development of the reports and drawings included in the appendices of the reports in Section 3 – Reference Information. Therefore the name GCPHA is used throughout these reports and drawings to refer to CBHP.

Proposals shall include detailed descriptions of the proposed hydropower developments including physical configuration, proposed agreement with CBHP (and the Columbia Basin Irrigation Districts), financial information, and other details required by this RFP. CBHP is interested in proposals for a range of development concepts and energy outputs that focus on eliminating impact on the irrigation facilities.

Once proposals are received, CBHP will screen the proposals and select the most favorable proposals from the most qualified respondents for a more thorough due diligence evaluation. This process may require further interaction with respondents and requests for additional information.

Proposals selected for further evaluation will be placed on a short list for further discussion with the respondent(s). Such discussions may lead to negotiations of the terms and conditions of definitive agreements.

CBHP has no obligation to select any proposal for further evaluation or to enter into definitive agreements with any respondents to this RFP. CBHP may terminate or modify the RFP at any time without liability or obligation to any respondent.

Questions regarding the RFP are due by July 30, 2020. CBHP will receive sealed proposals until 11:00 AM local time on September 14, 2020 at the CBHP office, 107 D Street NW, Ephrata, Washington 98823. Proposals will be publicly opened, and the Final Proposal Figures described in Section 2, paragraph 1.6, shall be read aloud. Proposals received after the time of announced opening will not be accepted and will be returned unopened.

Respondents are required to visit each site that they propose to develop if they have not already visited the site(s). Site visits will be by appointment only. To arrange a site visit, respondents should contact Darvin Fales by phone at 509-754-2227, or email at dfales@cbhydropower.org. CBHP intends to select a short list and notify respondents by September 28, 2020. The notification date is subject to adjustment based on the review and evaluation process time requirements. Respondents will be informed of any change in the short list notification date.

Contact the CBHP office (509-754-2227) for an electronic copy of the detailed proposal package.

CBHP reserves the right to waive any irregularities as informalities and to reject any and all proposals in its sole discretion.

1. OVERVIEW OF COLUMBIA BASIN HYDROPOWER

CBHP is the agent and representative of the three Columbia Basin Irrigation Districts and on their behalf operates, maintains, and performs administrative functions for hydropower projects owned by the Districts. Generation from the five power developments currently owned by the Districts (Main Canal Headworks, Summer Falls, Russell D. Smith, Eltopia Branch Canal (E.B.C) 4.6, and Potholes East Canal (P.E.C.) 66.0) is purchased by the City of Seattle and the City of Tacoma under forty-year power purchase agreements from the dates of commercial operation.

CBHP provides Federal Energy Regulatory Commission (FERC) liaison support and administrative functions for two additional hydropower projects owned by the Districts, e.g., Quincy Chute and P.E.C. Headworks. The Quincy Chute and P.E.C. Headworks facilities are operated and maintained by Grant County Public Utility District under forty-year power purchase agreements from the dates of commercial operation.

2. PURPOSE OF REQUEST FOR PROPOSAL

CBHP is interested in partnering with third party developers to develop hydropower facilities at up to five sites in the Columbia Basin Irrigation Project canal system. The purpose of this RFP is to allow CBHP to evaluate proposals from multiple respondents interested in developing hydropower facilities at these sites to determine what development would most closely align to CBHP's goals and objectives.

CBHP's goals and objectives include:

- Development of small hydropower projects that produce power in a reliable and cost-effective manner
- No interruption to the supply of irrigation water through the canal system

- Minimize risk for damaging the existing canal system (an example would be failsafe mechanisms to bypass water around or through the hydropower project in the case of a unit trip to avoid canal overtopping)
- Minimize financial risk to the Colombia Basin Irrigation Districts.
- Maximize economic benefits to the Columbia Basin Irrigation Districts.

3. SITE DESCRIPTIONS AND LOCATIONS

The five facilities available for potential hydropower development are:

1. Mesa Check
2. PE16.4 Wasteway
3. PE46A Wasteway
4. Scooteney Inlet
5. Scooteney Outlet

Detailed descriptions and locations of each site are given in Section Three - Reference Information.

4. SCOPE OF RFP

The scope of the RFP includes the development of one or multiple small hydro facilities at the identified Columbia Basin Irrigation Districts' facilities and all required associated work. The successful respondent or respondents will be responsible for all financing, development, construction, commissioning, and other activities required by the proposed hydropower project. Additionally, the successful respondent will have a responsibility to negotiate, execute and comply with definitive agreements with CBHP governing the financial, ownership and operational requirements of the project.

5. SCHEDULE

5.1 CBHP will receive sealed proposals until 11:00 AM local time on September 14, 2020 at the CBHP office, 107 D Street NW, Ephrata, Washington 98823. Proposals will be publicly opened and the final proposal figures in each of the proposals shall be read aloud. Proposals received after the time of announced opening will not be accepted and will be returned unopened.

5.2 Visits to all five sites will be by appointment and will be hosted by CBHP staff.

5.3 A notice of inclusion on the short list will be issued on or about September 28, 2020. This date may shift based on the number and complexity of proposals received.

5.4 A possible negotiated definitive agreement shall be completed within approximately 6 months of notice of being short listed.

5.5 The date that the project(s) will be completed and in operation will be negotiated.

6. POTENTIAL DEVELOPMENT STRUCTURES

The following development structures will be considered by CBHP for the proposed projects. CBHP may be open to other arrangements that meet their goals and objectives. CBHP must have an ownership stake for the entire life of the project and reserves the right to control project operations to prioritize irrigation deliveries for the life of the project's construction and operation. CBHP will be the leasee for the United States Bureau of Reclamation's Lease of Power Privilege process. The exact arrangement for obtaining the Lease of Power Privilege will be negotiated as part of the development agreement.

6.1 Develop / Transfer

CBHP will consider a development structure where a respondent plans, designs, builds, and commissions the project and then transfers ownership of the project to CBHP for an agreed price.

6.2 Long-Term Site Lease

CBHP will consider a development structure where a respondent constructs, owns and operates the project under a long-term lease of the hydropower site from CBHP. This lease should be no longer than 20 years and should have a negotiated escalating annual cost. This cost may be fixed or variable depending on annual generation. At the end of the lease term, ownership of the project would be transferred to CBHP at no cost.

6.3 Private Public Partnership

CBHP would consider partnering with a developer in a joint ownership structure if there were significant enough benefits to support the additional complexity of this type of arrangement.

7. PROPOSAL PROCESS INFORMATION

7.1 Point of Contact for Questions:

Darvin Fales
Manager
Columbia Basin Hydropower
Office: (509) 754-2227
107 D Street NW
Ephrata, WA 98823

7.2 Request for Proposal Documents

Complete sets of the RFP documents may be obtained from CBHP.

Complete sets of RFP documents shall be used in preparing proposals. CBHP assumes no responsibility for errors or misinterpretations resulting from the use of incomplete sets of RFP documents.

CBHP, in making copies of RFP documents available on the above terms, does so only for obtaining proposals on the work and does not confer a license or grant for any other use.

It is the responsibility of each respondent before submitting a proposal, to (a) examine the RFP documents thoroughly; (b) consider federal, state and local laws, ordinances, rules and regulations that may affect cost, progress, or performance of the work; (c) study and correlate respondent's observations with the RFP documents; and (d) notify CBHP of all conflicts, errors, ambiguities or discrepancies which respondent has discovered in the RFP documents.

7.3 Addenda

CBHP may release additional information or clarifications in Addenda to this RFP.

8. OVERVIEW OF SELECTION PROCESS

CBHP staff will review the proposals, create a summary and develop a recommended short list of respondents for the development of each site. From this short list CBHP staff will make a summary and recommendation for selecting entities for further negotiation. This summary and recommendation will be presented to the CBHP Board at the December 22, 2020 Board meeting for consideration. The recommendation may also be sent to each individual Columbia Basin Irrigation District Board for review. Based on the CBHP Boards' decision, short list respondents will be notified. At this point, a thorough due diligence process will begin. The CBHP Board may require additional information before short list respondents are selected and notified. It is possible one respondent may be preferred for multiple sites.

8.1 Selection Criteria

CBHP has two primary criteria that must be met for any proposed development:

- No interruption to the supply of irrigation water through the canal system
- Minimize risk for damaging the existing canal system (an example would be failsafe mechanisms to bypass water around or through the hydropower project in the case of a unit trip to avoid canal overtopping)

Additionally, proposals will be scored on the following criteria:

- Proven experience of the respondent in the development of small hydropower facilities
- Financial stability of the respondent
- Risk reduction measures for development and operation of the facility
- Economic benefits to CBHP through lease payments or other arrangements
- CBHP may consider proposals that generate smaller amounts of energy with minimal impact on the irrigation facilities
    - For proposals involving ownership by CBHP:
        - Cost of project development verses projected generation
        - Projected cost of operation and maintenance
        - Availability of parts and service

8.2 Debrief

CBHP may, at CBHP's discretion, meet in person or over the phone with unsuccessful respondents to discuss the proposal and the reason(s) it was not selected.

9. CONTRACT PROCESS

Because each respondent is expected to offer a unique approach to hydropower development at the CBHP facilities, a customized contract may be developed after the evaluation of short list respondent's proposals and any additional information. Following the selection of a successful respondent(s), CBHP will develop a contract for negotiation with the successful respondent(s). CBHP anticipates the development of this contract would take approximately 6 months.

SECTION 2 – PROPOSAL REQUIREMENTS

1. REQUIRED CONTENT OF PROPOSALS

Proposals will be prepared in the proposer's own format and should contain the information required by CBHP staff to fully understand the proposed hydropower project from the development process through construction, operation, and the respondent's potential continuation of involvement in the project.

1.1 Proven Technology Preferred

CBHP will put a significant weight on proven turbine technologies that have a significant operating history at sites of similar head and output. Please describe similar installations including the size, date installed, and unit(s) availability during its operation.

1.2 Type of Development Approach Considered

The respondent shall describe the type of development process they are proposing and how each of the following major steps will be completed. Providing detailed examples of how similar steps have been successfully accomplished in past projects will aid in CBHP staff's evaluation.

- Permitting and licensing
- Design
- Financing
- Power sales
- Construction
- Operation
- Maintenance
- Project turnover

1.3 Conceptual Design of Development

The respondent shall describe in writing and with drawings the proposed design of the hydropower development. All of the following shall be included on conceptual level plan view and section drawings for the proposal to be considered by CBHP staff. Required information includes:

- Hydraulic capacity
- Type and number of turbines
- Generating capacity and voltage
- Size and position of water conveyance features
- Size and position of flow bypass
- Size and position of powerhouse
- Generator step-up transformer size and position

- Interconnect location and required power lines

1.4 Development Financials

The respondent shall provide complete financial projections that describe the project's cost and financial performance over the period of the respondent's involvement in the project. A projected net present value of the project shall be calculated along with the net present value of all projected revenues shall be included in the proposal.

1.5 Respondent Qualifications and Experience

The respondents shall include a table in their proposals that provides the following information about similar projects that have been developed by the respondent:

- Project Name
- Location
- Brief project description
- Capacity (kW)
- Annual power output (MWh)
- Cost to construct
- Time to construct
- Who currently owns the project
- Reference with the current owner if not the developer

1.6 Respondent Financial Information

The respondent shall submit the past 5 years of financial statements showing the health of the respondent's organization.

1.7 Final Proposal Figures to be Read Aloud

The respondent shall give the following numbers for each proposed project in a section labeled "final proposal figures": Project Capacity (kW), Project Cost ($), Project Cost per Installed Capacity ($/kW)

2. <u>SUBMISSION REQUIREMENTS</u>

2.1 Proposals shall include all information required by CBHP.

Proposals by corporations must be executed in the corporate name by the president or vice president (or other corporate officer accompanied by evidence of authority to sign) and the corporate seal must be affixed and attested by the secretary or an assistant secretary.

2.2 Proposals by partnerships must be executed in the partnership name and signed by a general partner of the partnership, whose title must appear under the signature.

2.3 All names must be typed or printed below the signature.

2.4 The contact person's email address and phone number for directing communications regarding the proposal must be shown.

2.5 Proposals shall be submitted at the time and place indicated in the Invitation to Propose and shall be included in an opaque sealed envelope, marked with the project title and the name and address of the Respondent or via email. If the proposal is sent through the mail or other delivery system, the sealed envelope shall be enclosed in a separate envelope with the notation "PROPOSAL ENCLOSED" on the face thereof. It is the Respondent's sole responsibility to see that its proposal is received at 107 D Street NW, Ephrata, Washington in proper time. Proposals received after the time of announced opening will not be accepted and will be returned unopened.

3. OPENING OF PROPOSALS

3.1 Proposals will be opened and read aloud in part publicly (only the final proposal figures to be read aloud). As stated above, proposals received after the time of announced opening will not be accepted and will be returned unopened.

3.2 As a public agency, CBHP is required to disclose a summary of proposals. This requirement does not extend to data identified by a respondent as confidential or proprietary data which has been provided in a proposal. Any data identified as confidential or proprietary may be subject to disclosure under Washington State law and will be released after 10 days' notice to respondent unless respondent obtains a court order preventing such release.

4. PROPOSALS TO REMAIN OPEN

All proposals will remain subject to acceptance for 120 days after the day of the proposal opening.

5. REJECTING OF PROPOSALS

CBHP reserves the right to reject any and all proposals for any reason, including without limitation the right to reject any or all nonconforming, non-responsive, unbalanced or conditional proposals and to reject the proposal of any respondents who have previously failed to perform properly or to complete on time contracts of any nature. CBHP also reserves the right to waive any irregularities as informalities.

6. INDEMNIFICATION AND HOLD HARMLESS

6.1 Respondent agrees to protect, defend, indemnify, and hold harmless CBHP, its constituent members, elected officials, directors, officers, employees, agents, and volunteers from any and all claims, demands, losses, liens, liabilities, penalties, fines, lawsuits, and other proceedings and all judgments, awards, costs and expenses (including reasonable attorneys' fees and disbursements) incurred by CBHP resulting from or arising out of respondent's response to this RFP or any proposal submitted by respondent.

6.2 Nothing contained in this section, the RPF or any proposal submitted by respondent shall be construed to create a liability or a right of indemnification in any third party.

7. PATENTS, TRADEMARKS AND COPYRIGHTS

The respondent warrants that the items to be furnished do not infringe upon any patent, registered trademark or copyright, and agrees to hold CBHP harmless in the event of any infringement or claim therefore.

8. CONFIDENTIALITY

8.1 Respondent and CBHP may each provide the other party with Confidential Information in connection with this RFP. Confidential Information means information that is designated in writing as confidential or proprietary. The respondent and CBHP agree to use the Confidential Information only in connection with the RFP, subject to the conditions in paragraph 8.2, below.

8.2 Respondent hereby acknowledges that CBHP is a governmental entity and as such is subject to the requirements of the Washington Public Records Act, RCW 42.56 et seq. Accordingly, respondent understands that to the extent a proper request is made, CBHP may be required by virtue of that Act to disclose any records actually in its possession or deemed by judicial determination to be in its possession, which may include records provided to CBHP by respondent that respondent might regard as confidential or proprietary. To the extent that respondent provides any records to CBHP that it regards as confidential or proprietary, it agrees to conspicuously mark the records as such. Respondent also hereby waives any and all claims or causes of action for any injury it may suffer by virtue of CBHP's release of records pursuant to the Public Records Act. CBHP agrees to take all reasonable steps to notify respondent in a timely fashion of any request made under the Public Records Act which may require disclosure of any records marked by respondent as confidential or proprietary, so that respondent may seek a judicial order of protection. CBHP shall have no obligation to defend against disclosure of such records in response to a request under the Public Records Act.

SECTION 3 – REFERENCE INFORMATION

MESA CHECK

SCREENING LEVEL FEASIBILITY REPORT

PEC 1973 MESA CHECK

FERC NO. P-14316

Prepared for:

Grand Coulee Project Hydroelectric Authority
Ephrata, Washington

Prepared by:

Kleinschmidt

Gresham, Oregon
www.KleinschmidtGroup.com

February 2015

SCREENING LEVEL FEASIBILITY REPORT

PEC 1973 MESA CHECK

FERC NO. P-14316

Prepared for:

Grand Coulee Project Hydroelectric Authority
Ephrata, Washington

Prepared by:

Kleinschmidt

Gresham, Oregon
www.KleinschmidtGroup.com

February 2015

SCREENING LEVEL FEASIBILITY REPORT

PEC 1973 MESA CHECK
FERC No. P-14316

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

J:\1823\003\Docs\Project Sites _SharePoint\Final Deliverables\02 Mesa Check\001 Mesa Check 3-3-15.docx

EXECUTIVE SUMMARY

The proposed Potholes East Canal (PEC) 1973 Mesa Check Hydroelectric Project (Project) would utilize irrigation water conveyed by the Potholes East Canal. The Project is located adjacent to the Mesa Check drop structure which regulates water elevations in the canal. Kleinschmidt Associates (Kleinschmidt) developed the Project concept through existing site information such as flow data, topography, site visits, discussions with Grand Coulee Project Hydroelectric Authority (GCPHA), and information from equipment vendors.

The proposed Project infrastructure includes a new concrete intake, a 220-foot long concrete water power canal, Langemann® Gates, a single 1,800 kilowatt (kW) horizontal Kaplan Pit turbine, a powerstation with a concrete substructure and superstructure, and a concrete and riprap tailrace (Appendix A). The project would produce approximately 6,860 MWh of energy annually using the conventional technology approach (Scenarios One and Two) and 5,500 MWh annually with alternative technology (Scenario Three).

Kleinschmidt has evaluated the proposed Project development in three scenarios. The first two scenarios consider conventional equipment described in the previous paragraph, and the third scenario considers new lower cost emerging technology equipment. Scenario One was evaluated as a plant that would have all the features of a larger facility and with operation and maintenance (O&M) costs prorated from existing GCPHA small hydro sites. Scenario Two was studied to determine if a lesser cost development is viable using the same conventional technology as Scenario One. For this Scenario, Kleinschmidt assumed the design would focus on cost-effective features while meeting requirements for safe and reliable operation, lower construction contingencies, purchase of lower cost turbine generator equipment manufactured in China, and that O&M efficiencies can be made by using existing staff resources to operate and maintain the Project. Scenario Three assumes the use of lower cost emerging technology for low head hydro equipment. For example, Natel Energy is currently installing a similar project in Oregon. The development costs for Scenario Three were pro-rated from a current development being built in central Oregon. Table 1 summarizes the results of each of the three scenarios.

TABLE 1 SUMMARY OF STUDY RESULTS – PEC 1973 MESA CHECK

	SCENARIO ONE	SCENARIO TWO	SCENARIO THREE
Total Development Cost Analysis	$10,230,000	$8,010,000	$4,490,000
20 Year Net Present Value	-$6,540,000	-$2,130,000	-$110,000

The results from this study indicate that under Scenario One and Two the Project is not financially viable. However, Scenario Three shows that the project has a small negative net present value (NPV) indicating that the Project is near breakeven and may warrant further study.

1.0 PROJECT DESCRIPTION

1.1 EXISTING CONDITIONS

The Potholes East Canal (PEC) 1973 Mesa Check is located in Franklin County, Washington, in the South Columbia Basin Irrigation District (SCBID), east of the Columbia River, and north of Pasco (Figure 1).

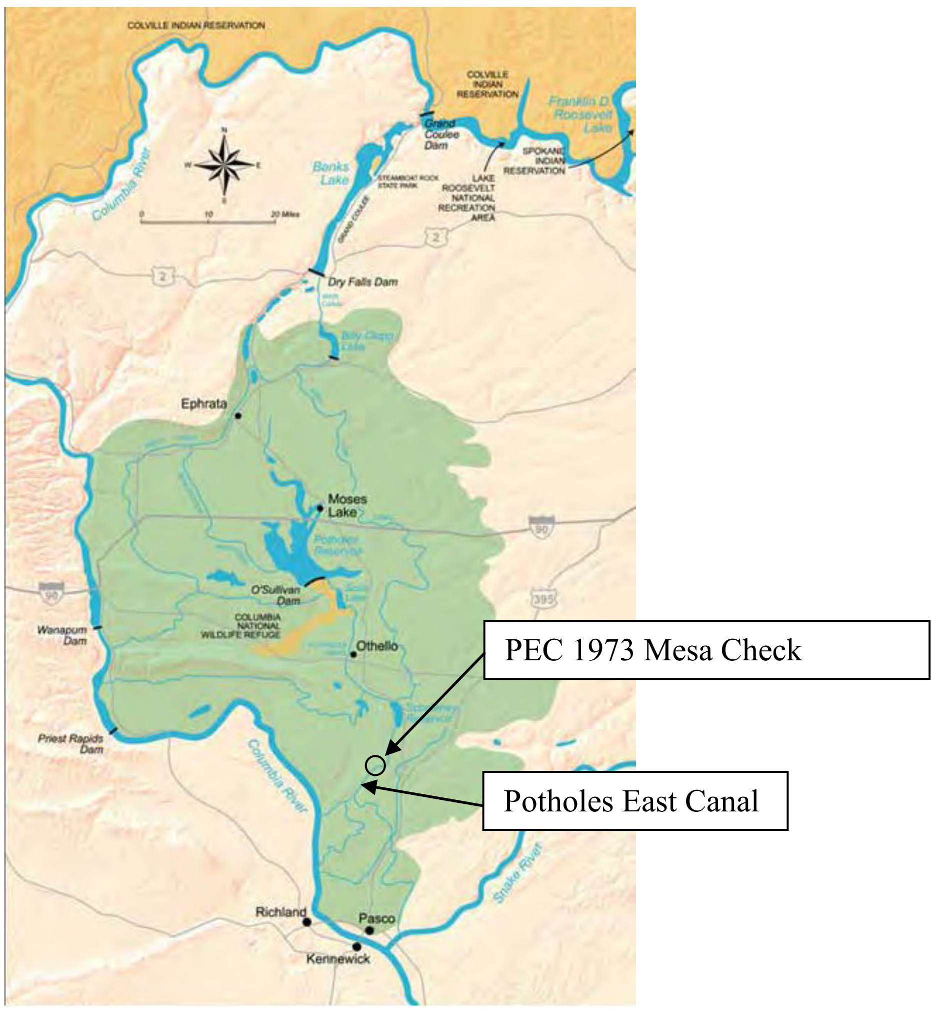


FIGURE 1 COLUMBIA BASIN PROJECT IRRIGATION AREA (BUREAU OF RECLAMATION MAP)

SCBID is part of the Columbia Basin Project which is owned by the United States Bureau of Reclamation (BOR). The PEC is a Transferred Works Project, which means that it is owned by BOR but its O&M have been transferred to SCBID. The PEC conveys irrigation water from Potholes Reservoir throughout SCBID. The Mesa Check drop structure and stilling pool is located closely downstream from Scooteney Reservoir and is used to maintain water surface elevations in the PEC to enable dependable irrigation water deliveries. More details on the canal elevations, drop structure, and water elevations are provided on existing canal drawings in Appendix C. The following site information was used to develop the Project concept and was provided by GCPHA, existing drawings, and data collected from site visits.

Water Elevations:

- Headpond: 908.9 feet
- Tailwater: 892.4 feet

Upstream Freeboard: 1 foot from the normal water level to top of canal wall core

Site Hydraulics: The PEC and Mesa Check see irrigation delivery flows during the irrigation season of late March through October and little flow from runoff and drainage during the non-irrigation season from November through March. The annual flow duration curve provided in Figure 2 is based on site flow data from Scooteney Outlet, which is only a short distance upstream with no intermediate significant inflows.

- Annual Flow Pattern: Flow only during irrigation season
Runoff and drainage flow during the off season
- Emergency Flow Capacity: 1,800 cubic feet per second (cfs)

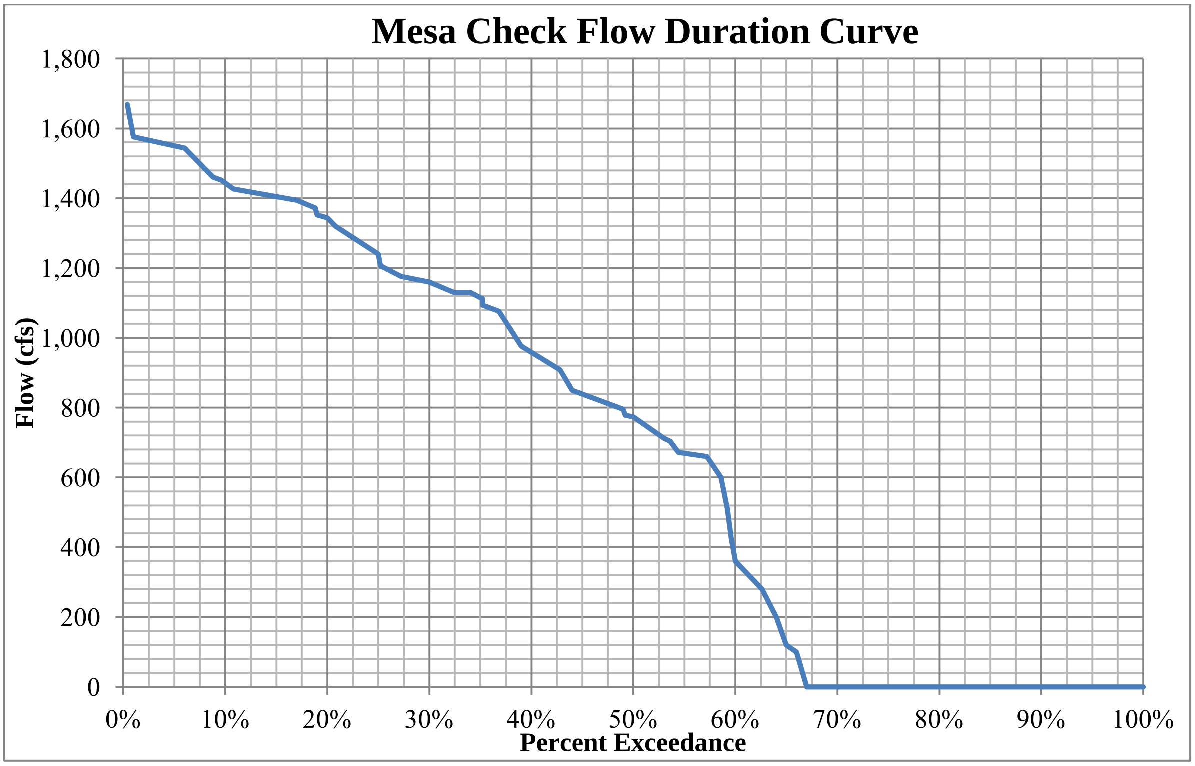


FIGURE 2 FLOW DURATION CURVE

Geotechnical Considerations: The site soil characteristics in the proposed locations of the intake, water channel, and powerhouse are assumed to be primarily sand and gravel with no rock. This assumption is based on a visual site assessment and existing drawings. Further geotechnical investigation, such as site borings and test pits, would reduce the risk of encountering unexpected geotechnical conditions such as foundation material with unacceptably lower bearing pressures.

1.2 PROPOSED DEVELOPMENT

The Project concept layout is shown in Appendix A. This Project concept is located north of the PEC and adjacent to the existing canal structure. Site photos of the proposed Project location are provided in Appendix B. The Project has the following basic features:

- Capacity: 1,800 kilowatts (kW)
- Turbine Type: Horizontal Axial Flow Kaplan Pit Turbine
- Turbine Design Flow: 1,600 cfs
- Gross Head: 16.5 feet
- Transmission Line Length: 1,100 feet

Water Control & Bypass: Water elevations are tightly maintained during the irrigation season to provide accurate water deliveries upstream and downstream of Mesa Check. Any project layout will need to reliably pass irrigation flows under all operating scenarios. Therefore, Kleinschmidt is proposing a three method approach to pass flow in the event of a sudden unit trip in order to maintain water elevations.

1. The turbine will be specified to operate for an extended period of time in over speed. Over speed is when the unit is no longer electrically connected to the grid and loses rotational resistance from the generator and increases speed until it reaches an internal equilibrium. At over speed the turbine will pass nearly all the water that it did at normal operation; however the increased speed will put more stress on the runner, shaft, and bearings. Therefore, these components must be designed to withstand these additional stresses for an extended period time. This arrangement does not require the operation of any other gates and is a reliable way to pass flows, but induces additional wear on the unit.
2. To limit unit over speed two new Langemann® Gates, which GCPHA has reported to have had good reliability performance, are proposed on the intake side chutes of the Mesa Check drop structure. Modifications to the existing drop structure will be required to accommodate the increased capacity of the side chutes with two new gates.
3. Finally, upgrades to the existing drop structure gate operator are proposed to increase reliability.

Intake: A new concrete intake structure would be built just upstream of the existing check structure inlet. The intake includes a headwall and gate structure leading to the water power canal, a new concrete canal wall and apron, steel trashracks, and repairs to the concrete canal wall. The trashracks at this site require a trash rake since aquatic weeds in the canal can be a significant issue at certain times during the year.

Power Canal: An open flume concrete power canal will convey water from the intake to the powerhouse. An open canal is possible for this Project due to the low available head and high flow. The concrete canal is less expensive to construct than a large diameter steel penstock due to low procurement and installation costs of concrete compared to spiral wound steel and approximately equal excavation and backfill requirements for both options. The concrete canal was sized to deliver the maximum design flow and head to the unit while also providing 1 foot of free board from the normal water elevation to the top of the canal wall. Details of the canal are as follows:

- Length: 220 feet
- Canal Opening: 12 feet deep, 13.5 feet wide
- Material: Concrete

Powerhouse: The powerhouse consists of a reinforced concrete substructure and superstructure. The powerhouse is founded on bedrock assuming that bedrock is present at or above the bottom elevation of the powerstation. Due to the size of the unit, the powerhouse footprint dimensions are approximately 45 feet long by 30 feet wide with a 20-foot long draft tube. A roof hatch will be installed for access to the unit and a small monorail chain hoist will be installed for basic operation and maintenance. The powerhouse will have a small separate electrical room with climate control to extend the life of the control, protective relaying, and switchgear equipment. The powerhouse will be unmanned, automated, and monitored remotely.

Generating Unit: Kleinschmidt selected a horizontal Kaplan Pit turbine for the conventional development of this Project as it generates energy over nearly the entire range of flow shown in Figure 2 and can have a higher setting that reduces excavation depth. Details on the turbine are as follows:

- Type: Horizontal Kaplan Pit Turbine
- Operational Range: 400-1,600 cfs
- Setting: 6 feet below tailwater
- Number: 1

Access and Constructability: Access to the intake, penstock, and powerhouse areas will be achieved by the existing access road off of Road 170 and approximately 2.5 miles off of Route 17. The canal is not fed from Scooteney Reservoir in the winter but will have some surface water and drainage flow that will need to be controlled during construction.

To reduce costs, Kleinschmidt assumed that the construction of the upstream water retaining portion of the intake and the excavation of the downstream tailrace tie-in with the canal would occur during the low to no flow period between November and March and only require minor water diversion and no cofferdams.

Substation and Transmission Interconnection: A generator step-up transformer (GSU) is needed to match the voltage from the unit generator to the 13.2 kilovolt (kV) transmission line. Approximately 1,100 feet of three-phase transmission line and poles are needed to connect the Project's GSU to the overhead distribution line owned by Big Bend Electric Cooperative (BBEC). Disconnect switches, metering, and protection equipment are assumed to be required by BBEC to interconnect to their system and are included in the cost estimate. System studies are required to finalize the design, equipment requirements, and potential system upgrades. The cost of these studies is included in the cost analysis for the Project. If BBEC's wheeling charges are too high, the Project may connect directly into the Franklin Public Utility District's (PUD) system. Such connection would require construction of additional 13.2 kV facilities in order to reach the nearest Franklin PUD line.

1.3 SCENARIO THREE – NEW EMERGING TECHNOLOGY DEVELOPMENT

The two primary costs for the initial conventional development with a pit turbine are the water-to-wire equipment and powerhouse costs (see Section 2.0). Because this conventional development approach is financially unfeasible, Kleinschmidt also looked at utilizing new unconventional low head hydroelectric technologies. These technologies have either lower equipment costs, such as the Natel Energy's turbine and Andritz's EcoBulb, or do not require a powerhouse, such as Voith's StreamDiver matrix turbine. Appendix E provides more information on these technologies. Although these technologies typically have disadvantages of lower efficiencies and limited operational histories, the intent of conceptually reviewing these options was to determine if they warrant further consideration.

For Scenario Three, Kleinschmidt selected three low head Natel Energy units similar to one in a project currently being developed nearby in Oregon, so that actual costs of an on-going project could be considered. New infrastructure to support these units includes a combined intake/powerhouse that is integrated into the existing drop structure. Kleinschmidt did not complete a conceptual layout and a detailed cost analysis for this scenario. The development cost used in this report was determined by pro-rating actual costs from the project being developed in central Oregon, featuring one Natel unit. Kleinschmidt estimated the rating of each Natel unit at Mesa Check to be 400 kW for a total capacity of 1,200 kW and the annual energy generation to be 5,500 MWh.

The advantage of this scenario is the anticipated lower costs of development. The disadvantage is that this technology is new which means the design life of these units are not yet proven, energy production will be lower, and operation and maintenance costs are unknown. However, Natel has offered the option of providing Project funding or a development partnership that would allow them to carry the technology risk.

2.0 COST ANALYSIS

2.1 CONSTRUCTION COST ANALYSIS

For Scenario One, an analysis of construction cost is provided in Table 2. This table includes total construction costs including: temporary construction features, permanent civil work, purchase and installation of the turbine/generator equipment, mechanical equipment, electrical equipment, substation and interconnection, and other related Project costs.

TABLE 2 CONSTRUCTION COST FOR SCENARIO ONE – PEC 1973 MESA CHECK

ITEM	DESCRIPTION	CONTINGENCY	CONSTRUCTION COST ANALYSIS[1]	NOTES
1	Mobilization and Demobilization	0%	$550,000	Site set up, soil erosion measures, site restoration
2	Cofferdams and Dewatering	25%	$130,000	Small cofferdam upstream
3	Spillway Work	25%	$420,000	Two new Langemann® Gates and chute modifications
4	Intake	20%	$690,000	Intake structure concrete, trashracks, walkways, trashrake, headgate, and stoplogs
5	Power Canal	20%	$610,000	Open flume concrete power canal, 220' long
6	Powerhouse and Tailrace	20%	$1,390,000	Concrete substructure and superstructure.
7	Turbine/Generator Supply and Install	10%	$4,400,000	Kaplan Pit Turbine, 8'-4" ID runner. Water-to-wire package including controls, switchgear, etc.
8	Balance of Plant	20%	$90,000	Bifurcation valve, HPU, HVAC, P&ID, etc.
9	Substation and Interconnection	25%	$370,000	GSU, transmission line, primary metering, protection, and interconnection study
10	Other	5%	$240,000	Insurance and bonding
	Weighted Average Contingency	14%		
	CONSTRUCTION COST ANALYSIS TOTAL		**$8,890,000**	

[1] These numbers are based on 2014 costs.

The major cost item, which is nearly half of the development cost, is for the water-to-wire package which includes supply and installation of an 8-foot 4-inch diameter Kaplan turbine unit, the generator, PLC, switchgear, etc. The second largest cost is construction of the powerhouse which is primarily made of concrete. The large size of the turbine results in a powerhouse footprint of approximately 65 feet long, including the draft tube, and 30 feet wide. Also, the average depth of the substructure below tailwater is approximately 12 feet due to the runner setting below tailwater.

The civil/site costs such as temporary structures, excavation, concrete, etc. were developed based on quantities taken from the proposed concept layout and existing drawings of the canal combined with unit costs. The unit costs were prorated from the averages of actual costs from hydroelectric projects constructed in the northern United States within the last two years. In addition JR Merit, a Washington state contractor, provided input on regionally appropriate line item costs and construction considerations.

Turbine/generator equipment costs were based on vendor budgetary quotes Kleinschmidt solicited for the Project from established North American turbine suppliers. These water-to-wire equipment budgetary bids also include the unit switchgear, controls, and hydraulic power unit. Balance of plant costs include valves, pumps, HVAC, piping, and instrumentation. Balance of plant equipment costs were derived from recent experience with prices from similar projects.

The estimated substation and interconnection capital cost includes the overhead transmission line, primary metering, special substation relay/protection equipment, system studies, a GSU, and GSU containment pad.

Kleinschmidt included contingencies for each area of work which are provided in Table **2**. Any work that will occur near a body of water or that will require deeper excavation or pile driving, such as the spillway work, cofferdams, etc. were given a contingency of 25% due to unknowns with site geology. The water conveyance work was assigned a contingency of 20% due to the possibility of unknown subsurface conditions. Balance of plant and interconnection costs were given a contingency of 20% due to more unknowns as opposed to the 10% contingency used for turbine/generator equipment where budgetary quotes were provided by vendors.

Scenario Two incorporates features required for safe and reliable operation. The costs were reduced for this scenario by considering the following factors:

- Shared risk of construction costs with a qualified and reliable construction company. This could be done in several ways such as engaging a contractor to prepare an independent cost estimate or entering into various alternatives to traditional Design-Bid-Build such as Construction Management or Design-Build contract delivery methods.
- Purchase of turbine/generator (T/G) equipment directly from Chinese manufacturers. North American turbine suppliers have been purchasing more Chinese fabricated equipment over the last 10 years in order to be more cost competitive. These suppliers have quality control and assurance programs in place to assure the foreign products meet specification standards. It is important that these standards are understood and properly specified. When purchasing equipment directly from Chinese manufacturers, owners often choose to hire a third party quality assurance company near the manufacturing facility. Kleinschmidt's experience with this method of T/G procurement results in savings compared to going through a North American supply company. Similar to Japanese supplied equipment, the Chinese manufactures do not have maintenance and rebuild crews in the United States; however, GCPHA operates Japanese T/G equipment without the benefit of domestic maintenance and rebuild crews. To date, GCPHA has experienced no resulting adverse reliability effects.
- Construction cost-focused design. The powerhouse footprint and other civil infrastructure such as the intake would be optimized to achieve safe and reliable operation conditions but may sacrifice maintenance space. Also, instead of a trash rake, a less expensive air blast system could be installed on the trashracks that would essentially blow debris off the trashracks to sluice trash.

Table 3 shows the breakdown of each factor that could combine to create the overall savings of up to 25%. The 25% reduction shown in Table 3 was selected to be near the middle of the 10% and 37% range assuming that much but not all of the cost savings listed will be achieved under favorable conditions.

TABLE 3 CONTRIBUTING FACTORS FOR REDUCED CONSTRUCTION COST IN SCENARIO TWO – PEC 1973 MESA CHECK

ITEM	DESCRIPTION	POSSIBLE COST REDUCTION	NOTES
1	Reduced Contingency	0-17%	Possibility for site conditions or pricing to be more favorable than predicted
2	Economy Focused Design and Delivery	5-10%	Minimized civil works, minimized powerhouse footprint
3	Chinese Turbine Supply	5-10%	
	Overall Cost Reduction	25%	
	CONSTRUCTION COST ANALYSIS TOTAL WITH 25% REDUCTION	**$6,670,000**	

Kleinschmidt assumed the Scenario Three construction costs would scale from a current development in central Oregon. The development in Oregon is projected to cost $1,300,000 with $400,000 for the equipment and $900,000 for the civil development for a single 400 kW turbine. Kleinschmidt tripled that cost to $3,900,000 for the three 400 kW turbine development for the Project. Kleinschmidt has spoken with the contractor building the development to discuss the projected costs. The contractor has nearly finished the excavation and anticipates the project meeting the budget. Conceptual equipment prices for other non-conventional turbine technologies indicate that this is reasonable. Further exploration into the details of this type of development and how it may apply will be required if GCPHA decides that an alternative technology path is should be explored further.

2.2 OTHER DEVELOPMENT COSTS

There are a number of other development costs to consider aside from the previously quantified direct initial construction and installation costs. These items include:

- engineering
- construction assistance
- licensing and permitting
- environmental studies
- marketing fees
- legal fees
- transaction fees
- land acquisition
- sales tax
- property tax
- GCPHA internal costs
- administration

Kleinschmidt estimates that under both Scenarios One and Two, 15% of the total construction cost analysis for Scenario One would cover the other development costs listed above. This was derived assuming cost-optimization design engineering and construction assistance would most likely increase in cost for Scenario Two compared to Scenario One as a percentage of construction cost. In addition, many of the items should remain the same for Scenario One and Two.

Scenario Three was based on construction cost. Scenario three would most likely have less design engineering construction assistance due to less infrastructure and also items such as sales tax and transaction fees would reduce due to the lower overall construction cost compared to the previous two scenarios.

2.3 SUMMARY OF DEVELOPMENT COSTS

The total development cost for each scenario, which includes the construction cost and other development costs discussed previously are provided in Table 4. Also included is a unit cost per kW for each scenario to compare each option.

TABLE 4 SUMMARY OF DEVELOPMENT COSTS – PEC 1973 MESA CHECK

	SCENARIO ONE	SCENARIO TWO	SCENARIO THREE
Construction Cost	$8,890,000	$6,670,000	$3,900,000
Other Development Costs	$1,340,000	$1,340,000	$590,000
Total Development Cost	$10,230,000	$8,010,000	$4,490,000
Turbine Rating (kW)	1800	1800	1200
Total Development Cost ($/kW)	$5,683	$4,450	$3,742

For each scenario, the total development cost is below one recently developed small hydro project in the Northwest that cost $6,000/kW (Juniper Ridge Hydro, 5MW, 2009). These costs are also within the range of a June 2013 Oak Ridge National Laboratory (ORNL) study of Oregon small hydro showing costs ranging from $1,500/kW for higher head, 3-5 megawatt (MW) projects to well over $10,000/kW for lower head/lower power projects.

2.4 OPERATION AND MAINTENANCE

O&M costs include internal maintenance staff, wheeling charges, administration, cost of consumables, and other costs. GCPHA provided cost information based on their current O&M practices for smaller-sized projects, and Kleinschmidt conducted a survey of available industry O&M data. This calculation results in an O&M cost estimate of approximately $30/MWh of generation. The pro forma increases this cost at an annual rate of 3%.

For Scenarios Two and Three, Kleinschmidt utilized an O&M cost of $15/MWh by relying on increased efficiency of existing staff and resources of other facilities to be available for the O&M work of this Project.

3.0 ANNUAL ENERGY ESTIMATE AND VALUE

The annual energy production was based on flow and head information provided by GCPHA, typical turbine efficiencies, and typical operational factors. For Scenario One and Two the average annual output is 6,860 MWh which results in a 44% capacity factor. For Scenario Three, the annual power output was estimated to be 5,500 MWh. This results in a 52% capacity factor since the alternate turbines have a smaller annual output and smaller installed capacity than Scenario One and Two. These estimates were determined through an energy model that calculated the average energy produced based on two flow points per month.

The two ways to value project output are through wholesale power value plus a Renewable Energy Credit (REC) value or through a power value that is comparable to similarly sized wind and solar projects. For the purpose of this study we assumed a power value comparable with wind and solar projects utilizing a power value of $60/MWh, with an escalation of 3% per year. A critical next step will be to confirm this power value and economics in the pro forma. See the Energy Market Assessment Report for more details.

4.0 FINANCIAL PERFORMANCE

Kleinschmidt completed a 20 year financial pro forma for each scenario to determine the net present value (NPV) of the Project. To determine the NPV, the pro forma calculates the annual power production cost and annual power sales. The power production cost includes O&M costs and payments made on debt service for the development costs. The study assumes the cost to develop the Project will be funded by bonds. In the pro forma, it is assumed the bonds have a 3.5% interest rate and a 20 year term. A summary of the pro forma results including the NPV and the cost of production and power sales for the first year are provided in Table 5. The detailed pro forma is provided in Appendix D.

TABLE 5 SUMMARY OF FINANCIAL PERFORMANCE – PEC 1973 MESA CHECK

	SCENARIO 1	SCENARIO 2	SCENARIO 3
First Year Power Production Cost ($/MWh)	$138	$96	$75
First Year Power Value ($/MWh)	$60	$60	$60
20 Year Net Present Value	-$6,540,000	-$2,130,000	-$110,000

The price of production for new wind with tax incentives is approximately $50/MWh and without incentives is approximately $70/MWh. Solar developers in the region have executed agreements with Idaho Power at levelized rates of approximately $64/MWh. Potential off-takers will compare the Project to a similarly sized wind or solar project that has power generation value in the range of $60/MWh. This power value includes selling the RECs with the power.

The pro formas for both Scenario One and Scenario Two show that the energy market value of output from the Project produces a significant negative cash flow in every year of operation. Calculation of the NPV of this cash flow (assuming a 4% discount rate) shows an overall loss. Scenario Three shows a small negative NPV over the 20 year term. This indicates that if the pricing can be similar to the Project in central Oregon it may break even over 20 years.

5.0 REGULATORY AND ENVIRONMENTAL

The Federal Energy Regulatory Commission (FERC) preliminary permit was issued on March 26, 2013 (P-14316) and expires February 28, 2016. GCPHA has filed three required 6-month progress reports for the Project to date. The first was filed on August 21, 2013; the second on February 25, 2014; the third on August 21, 2014; and the fourth on February 18, 2015. The next 6-month progress report for the preliminary permit will be due in August of 2015.

The Department of the Interior (DOI) by letter dated January 26, 2012, filed comments on GCPHA's application for preliminary permit. In the letter, DOI provided preliminary recommendations for coordinated operations, flow releases and reimbursement of U.S. Bureau of Reclamation (BOR) costs. However, no other stakeholders or agencies have commented on the preliminary permit or 6-month progress report filings.

The proposed facilities for the Project would be located on Potholes East Canal, which is an irrigation structure that is part of BOR's Columbia Basin Project. The Project, as currently designed then, will be located partially on BOR easements with fee title held by adjoining landowners.

Because the Project is not located on federal lands, several FERC processes are available including the FERC 40 MW Conduit Exemption Process and the licensing process. However, if the lands on which the canal is located are BOR fee title lands, the Project would be on federal reservation lands (i.e., those owned in fee title by BOR, regardless of management). If this is the case, the exemption process would be unavailable to GCPHA and licensing would be the only option. The Project may be subject to Federal Power Act Section 4(e) mandatory conditions imposed by the BOR. While the licensing process is generally longer and more costly than the exemption process, GCPHA could request a waiver of the three stage consultation requirement considering that environmental issues appear to be low. A downside to FERC licensing is the need to periodically relicense, generally every 30 to 50 years. FERC would assess annual charges of approximately $3,600, but FERC does not charge administrative processing fees for license applications. The cost of preparation and filing of an exemption application for the Project, not including any potential required studies, would be expected to be $22,500 and the cost of a license application would be expected to be approximately $47,500.

Alternatively, BOR's Small Conduit Lease of Power Privilege Process (LOPP) may be a viable option. Mandatory conditions are those as imposed/negotiated with BOR in consultation with the agencies. Because BOR is a mandatory conditioning authority (i.e., BOR has the authority to add conditions to the FERC license) in the FERC process for this project, that risk does not appear to be any different from the Small Conduit LOPP. Further, the Small Conduit LOPP allows for a categorical exclusion from the National Environmental Protection Act (NEPA) review, whereas the FERC licensing process would not. Annual charges for the Small Conduit LOPP are $2/MWh so that would cost the Project approximately $13,800 annually. The LOPP process does not prescribe a term to the lease so that creates undesirable uncertainty. An advantage of the LOPP process is that it may allow for construction sooner than the FERC process. In addition, BOR requires applicants to provide advance funding of all BOR application processing costs, which are unknown at this time. The cost of preparation and filing of a Small Conduit LOPP application for the Project, not including any potential required studies, would be expected to be less than $28,000, assuming NEPA exclusion.

It appears that there will be minimal environmental impacts as the Project site is currently developed as an access road and the adjacent area is developed as marginal farm land.

6.0 POTENTIAL NEXT STEPS

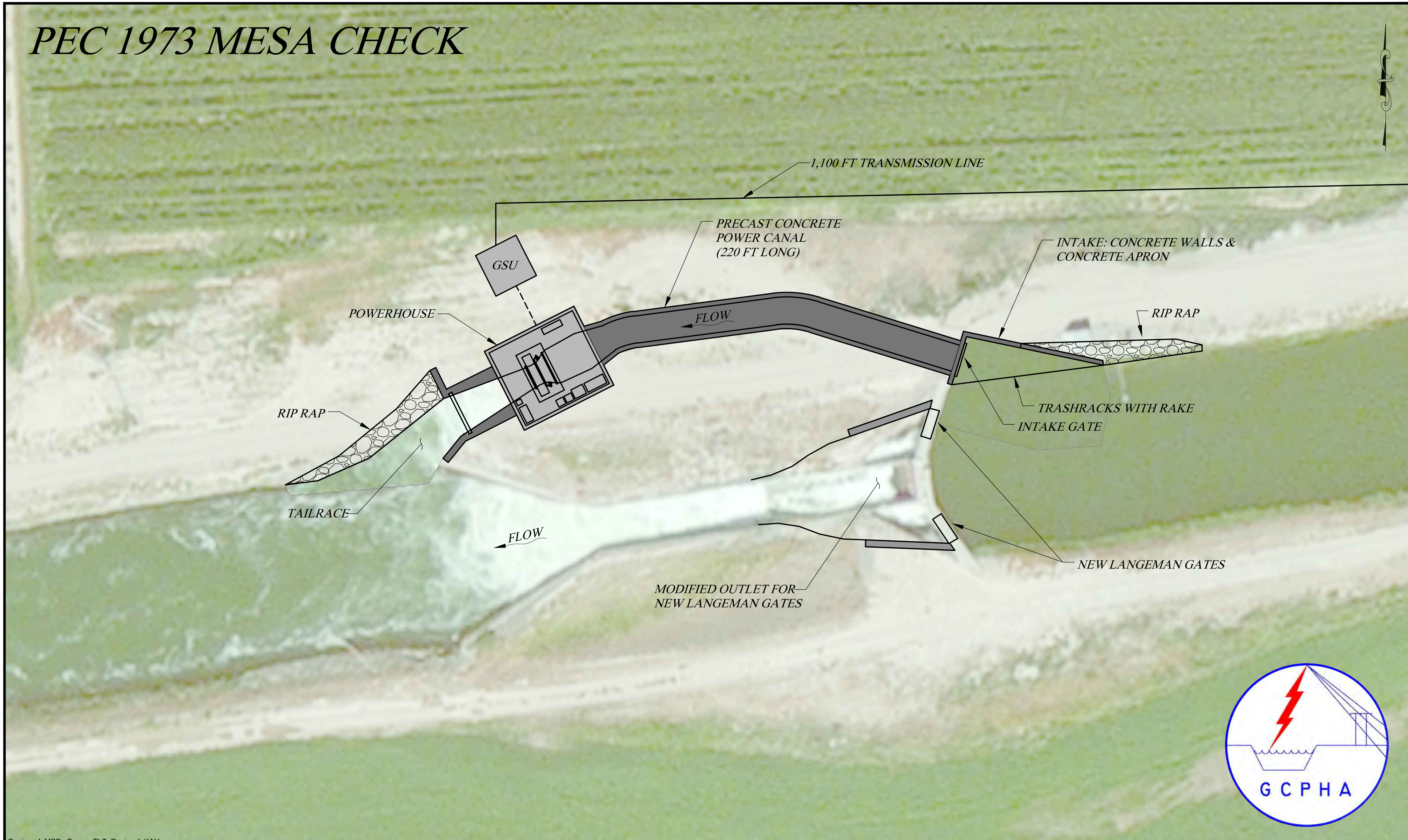
Based on the results of this study, the Project may be feasible if a new emerging technology development (Scenario Three) is considered. If GCPHA decides to pursue a new emerging technology option, the next steps are:

- Review the available unconventional emerging technologies that have lower equipment and more simple and inexpensive civil infrastructure costs compared to a conventional Kaplan pit turbine. Appendix E contains selected manufacturer literature from Natel Energy, VA Tech (Ecobulb), and Voith (StreamDiver) that illustrates various emerging low head technologies that could possibly produce a financially feasible project. Preliminary engineering and addressing any FERC licensing issues would only begin after a feasible concept has been further developed and confirmed. The review could involve contacting the low head T/G vendors to confirm site compatibility with their product. If the site is compatible, then vendors could submit quotes and a feasible concept could be developed.
- Continue discussions with Franklin PUD about purchasing Project output and a potential transmission interconnection. The study assumes interconnecting the Project to the BBEC system. This discussion would likely be focused on project costs and assumed power values as well as the contractual structure of a potential agreement.
- Apply for an extension and advancement of FERC licensing if the technology review results in a feasible concept and GCPHA decides to pursue preliminary engineering.

APPENDIX A

PROJECT LAYOUT

PEC 1973 MESA CHECK



Designed: MSP Drawn: TLT Reviewd: KAH

22x34 = FULL SCALE

J:\1823\003\Drawings\Working Drawings\1823-003 PEC 1973 MESA CHECK.dwg

PRINTED Jan. 20, 2015 - 3:39 PM

Kleinschmidt

20 0 20 40
SCALE IN FEET

GRAND COULEE PROJECT HYDROELECTRIC AUTHORITY
EPHRATA, WA

APPENDIX B

SITE PHOTOGRAPHS

PEC 1973 MESA CHECK
OCTOBER 2014

PHOTO 1 CHECK DROP AND STILLING POOL

PHOTO 2 PROPOSED PROJECT LOCATION RIGHT (NORTH) OF CANAL

PEC 1973 MESA CHECK
OCTOBER 2014

PHOTO 3 CHECK INTAKE STRUCTURE

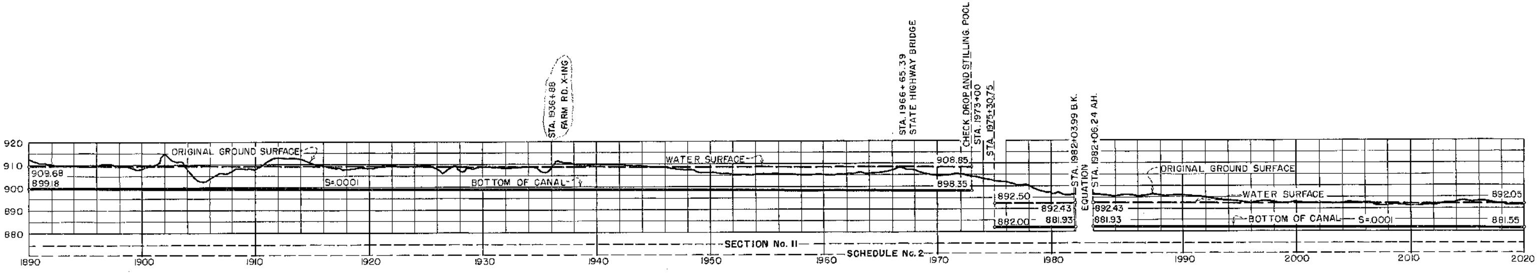
PHOTO 4 CHECK DROP AND STILLING POOL

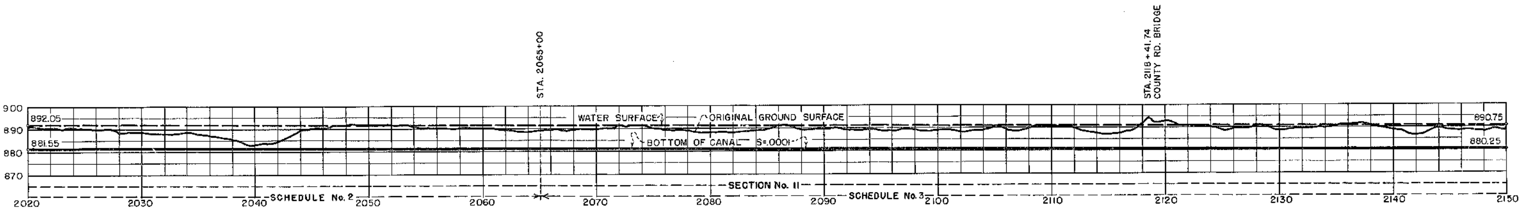
APPENDIX C

EXISTING DRAWINGS

NOT INCLUDED IN PUBLIC VERSION

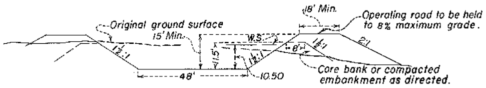
(THIS MATERIAL CONTAINS CONFIDENTIAL INFORMATION AND DISTRIBUTION TO THIRD PARTIES IS RESTRICTED BY NON-DISCLOSURE AGREEMENTS WITH THE U.S. BUREAU OF RECLAMATION.)





NOTE

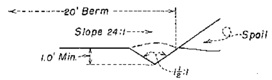
Top of embankment to slope 24:1 away from canal.



SECTION No. 11

TYPICAL CANAL SECTION

HYDRAULIC PROPERTIES									
SECTION	B	d	Area	r	S	V	Q	n	s:s
No. 11 Unlined	48.0	10.50	669.38	7.80	.0001	2.69	1800	.0225	1½:1



DETAIL OF BERM DITCH

(In cut sections as required for drainage)

2-10-56
AS BUILT

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT—WASHINGTON

POTHOLES EAST CANAL

STA. 1890+00 TO STA. 2150+00

PROFILES AND SECTIONS

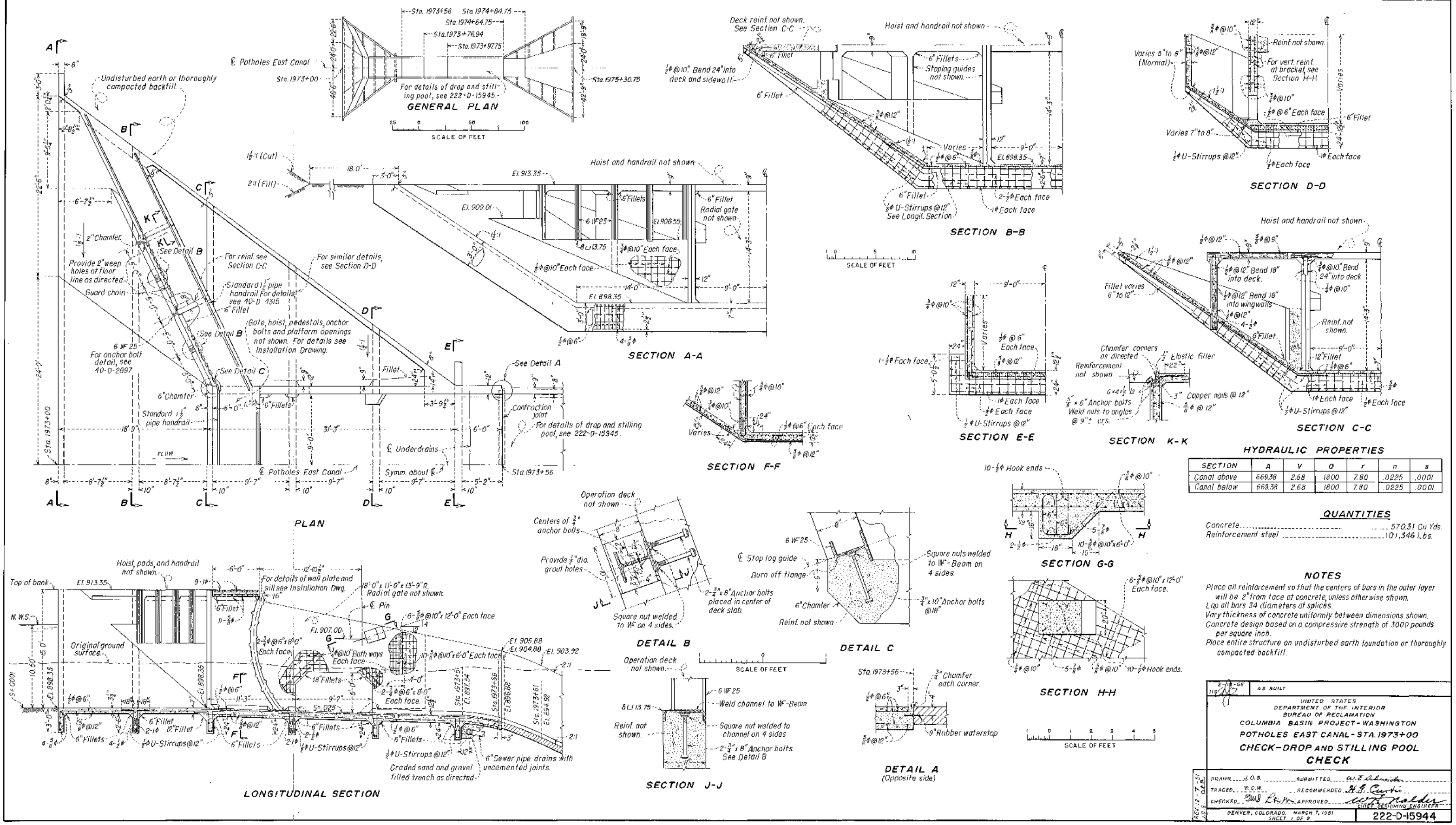
4-16-51 D.B.T.
REV. 1-18-51 EPHRATA

DRAWN M.A.K. SUBMITTED R.V. Dunne
TRACED E.R.P. RECOMMENDED W.H. Nalder
CHECKED Gre APPROVED W.E. Blomgren
ACT. CHIEF ENGINEER

EPHRATA, WASHINGTON SEPT. 13, 1950
SHEET 3 OF 5

222-116-20779

MICROFILMED MAY 1 1973



HYDRAULIC PROPERTIES

SECTION	A	V	Q	r	n	s
Canal above	669.38	2.68	1800	7.80	.0225	.0001
Canal below	669.38	2.68	1800	7.80	.0225	.0001

QUANTITIES

Concrete .... 570.31 Cu Yds.
Reinforcement steel .... 101,346 Lbs.

NOTES

Place all reinforcement so that the centers of bars in the outer layer will be 2" from face of concrete, unless otherwise shown.
Lap all bars 34 diameters at splices.
Vary thickness of concrete uniformly between dimensions shown.
Concrete design based on a compressive strength of 3000 pounds per square inch.
Place entire structure on undisturbed earth foundation or thoroughly compacted backfill.

2-16-56 AS BUILT

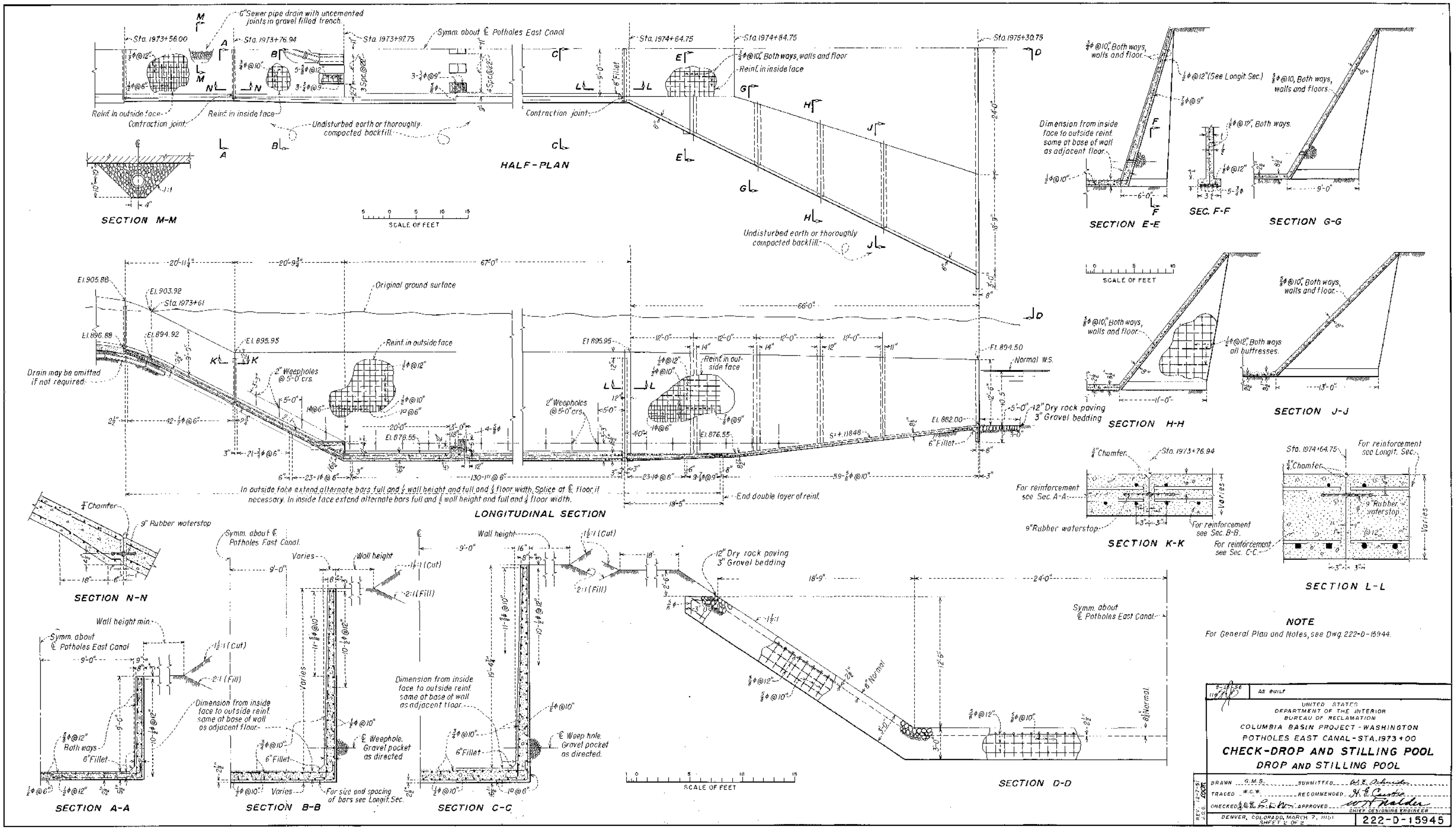
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT-WASHINGTON
POTHOLES EAST CANAL-STA.1973+00
CHECK-DROP AND STILLING POOL
CHECK

DRAWN J.O.G. SUBMITTED W.E. Schneider
TRACED W.C.W. RECOMMENDED H.G. Curtis
CHECKED L.H.M. APPROVED W.H. Nalder CHIEF DESIGNING ENGINEER

REV. 12-7-51

DENVER, COLORADO. MARCH 7, 1951
SHEET 1 OF 2

222-D-15944


HALF-PLAN
SECTION M-M
SCALE OF FEET
SECTION E-E
SEC. F-F
SECTION G-G
LONGITUDINAL SECTION
In outside face extend alternate bars full and ½ wall height and full and ½ floor width. Splice at ℄ Floor, if necessary. In inside face extend alternate bars full and ½ wall height and full and ½ floor width.
SECTION H-H
SECTION J-J
SECTION K-K
SECTION L-L
SECTION N-N
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
Original ground surface
Undisturbed earth or thoroughly compacted backfill.
Symm. about ℄ Potholes East Canal
12" Dry rock paving
3" Gravel bedding
Drain may be omitted if not required.
NOTE
For General Plan and Notes, see Dwg. 222-D-15944.
AS BUILT
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT - WASHINGTON
POTHOLES EAST CANAL - STA. 1973+00
CHECK-DROP AND STILLING POOL
DROP AND STILLING POOL
DRAWN G.M.S. SUBMITTED
TRACED W.C.W. RECOMMENDED
CHECKED APPROVED CHIEF DESIGNING ENGINEER
DENVER, COLORADO, MARCH 7, 1951
SHEET 2 OF 2
222-D-15945

APPENDIX D

20 YEAR PRO FORMAS

20 YEAR PRO FORMA — SCENARIO ONE

Pro Forma Cash Flow
Mesa Check
Scenario One

Assumptions			Cash Flow											
			Year	1	2	3	4	5	6	7	8	9	10	11
Capital Cost	$ 10,230,000		Debt Service	$752,741	$752,741	$752,741	$752,741	$752,741	$752,741	$752,741	$752,741	$752,741	$752,741	$752,741
Debt Period (Years)	20													
Interest Rate	4%		Operations Cost	$70,000	$72,100	$74,263	$76,491	$78,786	$81,149	$83,584	$86,091	$88,674	$91,334	$94,074
Operations Cost	$ 70,000		Maintenance Cost	$70,000	$72,100	$74,263	$76,491	$78,786	$81,149	$83,584	$86,091	$88,674	$91,334	$94,074
O&M Escalation	3%													
			Admin Cost	$70,000	$72,100	$74,263	$76,491	$78,786	$81,149	$83,584	$86,091	$88,674	$91,334	$94,074
Maintenance Cost	$ 70,000													
Maintenance Escalation	3%		Power Production Cost ($/MWH)	$138	$138	$139	$140	$141	$142	$143	$144	$146	$147	$148
Admin Cost	$ 70,000		Power Sales	$420,000	$432,600	$445,578	$458,945	$472,714	$486,895	$501,502	$516,547	$532,043	$548,005	$564,445
O&M Escalation	3%													
			Cash Flow (-)	($542,741)	($536,441)	($529,952)	($523,269)	($516,384)	($509,294)	($501,990)	($494,468)	($486,720)	($478,739)	($470,519)
Annual Energy (MWH)	7,000													
			Annual Power Value ($/MWH)	$60	$62	$64	$66	$68	$70	$72	$74	$76	$78	$81
Power Value ($/MWH)	60													
Power Value Escelation	3%		Power Value Gap ($/MWH)	$78	$77	$76	$75	$74	$73	$72	$71	$70	$68	$67
			Required Capacity and Environmental Attribute Value ($/kW-mo)	$30	$30	$29	$29	$29	$28	$28	$27	$27	$27	$26
			NPV (4% IRR)	($6,539,997)										

Pro Forma Cash Flow
Mesa Check
Scenario One

Cash Flow									
Year	12	13	14	15	16	17	18	19	20
Debt Service	$752,741	$752,741	$752,741	$752,741	$752,741	$752,741	$752,741	$752,741	$752,741
Operations Cost	$96,896	$99,803	$102,797	$105,881	$109,058	$112,329	$115,699	$119,170	$122,745
Maintenance Cost	$96,896	$99,803	$102,797	$105,881	$109,058	$112,329	$115,699	$119,170	$122,745
Admin Cost	$96,896	$99,803	$102,797	$105,881	$109,058	$112,329	$115,699	$119,170	$122,745
Power Production Cost ($/MWH)	$149	$150	$152	$153	$154	$156	$157	$159	$160
Power Sales	$581,378	$598,820	$616,784	$635,288	$654,346	$673,977	$694,196	$715,022	$736,473
Cash Flow (-)	($462,052)	($453,332)	($444,349)	($435,097)	($425,568)	($415,753)	($405,643)	($395,230)	($384,505)
Annual Power Value ($/MWH)	$83	$86	$88	$91	$93	$96	$99	$102	$105
Power Value Gap ($/MWH)	$66	$65	$63	$62	$61	$59	$58	$56	$55
Required Capacity and Environmental Attribute Value ($/kW-mo)	$26	$25	$25	$24	$24	$23	$23	$22	$21
NPV (4% IRR)									

20 YEAR PRO FORMA — SCENARIO TWO

Pro Forma Cash Flow
Mesa Check
Scenario Two

Assumptions			**Cash Flow**											
Best Case Cost Reduction	25%		**Year**	1	2	3	4	5	6	7	8	9	10	11
Capital Cost	$ 8,010,000		Debt Service	$563,592	$563,592	$563,592	$563,592	$563,592	$563,592	$563,592	$563,592	$563,592	$563,592	$563,592
Debt Period (Years)	20													
Interest Rate	3.5%		Operations Cost	$35,000	$36,050	$37,132	$38,245	$39,393	$40,575	$41,792	$43,046	$44,337	$45,667	$47,037
Operations Cost	$ 35,000		Maintenance Cost	$35,000	$36,050	$37,132	$38,245	$39,393	$40,575	$41,792	$43,046	$44,337	$45,667	$47,037
O&M Escalation	3%													
			Admin Cost	$35,000	$36,050	$37,132	$38,245	$39,393	$40,575	$41,792	$43,046	$44,337	$45,667	$47,037
Maintenance Cost	$ 35,000													
Maintenance Escalation	3%		Power Production Cost ($/MWH)	$96	$96	$96	$97	$97	$98	$98	$99	$100	$100	$101
Admin Cost	$ 35,000		Power Sales	$420,000	$432,600	$445,578	$458,945	$472,714	$486,895	$501,502	$516,547	$532,043	$548,005	$564,445
O&M Escalation	3%													
			Cash Flow (-)	($248,592)	($239,142)	($229,409)	($219,383)	($209,057)	($198,421)	($187,466)	($176,182)	($164,560)	($152,589)	($140,259)
Annual Energy (MWH)	7,000													
			Annual Power Value ($/MWH)	$60	$62	$64	$66	$68	$70	$72	$74	$76	$78	$81
Power Value ($/MWH)	60													
Power Value Escalation	3%		Power Value Gap ($/MWH)	$36	$34	$33	$31	$30	$28	$27	$25	$24	$22	$20
			Required Capacity and Environmental Attribute Value ($/kW-mo)	$14	$13	$13	$12	$12	$11	$10	$10	$9	$8	$8
			NPV (4% IRR)	($2,124,398)										

Pro Forma Cash Flow
Mesa Check
Scenario Two

Cash Flow									
Year	12	13	14	15	16	17	18	19	20
Debt Service	$563,592	$563,592	$563,592	$563,592	$563,592	$563,592	$563,592	$563,592	$563,592
Operations Cost	$48,448	$49,902	$51,399	$52,941	$54,529	$56,165	$57,850	$59,585	$61,373
Maintenance Cost	$48,448	$49,902	$51,399	$52,941	$54,529	$56,165	$57,850	$59,585	$61,373
Admin Cost	$48,448	$49,902	$51,399	$52,941	$54,529	$56,165	$57,850	$59,585	$61,373
Power Production Cost ($/MWH)	$101	$102	$103	$103	$104	$105	$105	$106	$107
Power Sales	$581,378	$598,820	$616,784	$635,288	$654,346	$673,977	$694,196	$715,022	$736,473
Cash Flow (-)	($127,559)	($114,478)	($101,004)	($87,126)	($72,832)	($58,110)	($42,945)	($27,326)	($11,238)
Annual Power Value ($/MWH)	$83	$86	$88	$91	$93	$96	$99	$102	$105
Power Value Gap ($/MWH)	$18	$16	$14	$12	$10	$8	$6	$4	$2
Required Capacity and Environmental Attribute Value ($/kW-mo)	$7	$6	$6	$5	$4	$3	$2	$2	$1
NPV (4% IRR)									

20 YEAR PRO FORMA — SCENARIO THREE

Pro Forma Cash Flow
Mesa Check
Scenario Three

Assumptions			**Cash Flow**											
			Year	1	2	3	4	5	6	7	8	9	10	11
Capital Cost	$ 4,490,000		Debt Service	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921
Debt Period (Years)	20													
Interest Rate	3.5%		Operations Cost	$26,500	$27,295	$28,114	$28,957	$29,826	$30,721	$31,642	$32,592	$33,569	$34,576	$35,614
Operations Cost	$ 26,500		Maintenance Cost	$26,500	$27,295	$28,114	$28,957	$29,826	$30,721	$31,642	$32,592	$33,569	$34,576	$35,614
O&M Escalation	3%													
			Admin Cost	$26,500	$27,295	$28,114	$28,957	$29,826	$30,721	$31,642	$32,592	$33,569	$34,576	$35,614
Maintenance Cost	$ 26,500													
Maintenance Escalation	3%		Power Production Cost ($/MWH)	$75	$75	$76	$76	$76	$77	$78	$78	$79	$79	$80
Admin Cost	$ 26,500		Power Sales	$318,000	$327,540	$337,366	$347,487	$357,912	$368,649	$379,709	$391,100	$402,833	$414,918	$427,365
O&M Escalation	3%													
			Cash Flow (-)	($77,421)	($70,266)	($62,897)	($55,306)	($47,487)	($39,434)	($31,140)	($22,596)	($13,797)	($4,733)	$4,603
Annual Energy (MWH)	5,300													
			Annual Power Value ($/MWH)	$60	$62	$64	$66	$68	$70	$72	$74	$76	$78	$81
Power Value ($/MWH)	60													
Power Value Escalation	3%		Power Value Gap ($/MWH)	$15	$13	$12	$10	$9	$7	$6	$4	$3	$1	($1)
			Required Capacity and Environmental Attribute Value ($/kW-mo)	$4	$4	$3	$3	$3	$2	$2	$1	$1	$0	($0)
			NPV (4% IRR)	($102,684)										

Pro Forma Cash Flow
Mesa Check
Scenario Three

Cash Flow									
Year	12	13	14	15	16	17	18	19	20
Debt Service	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921
Operations Cost	$36,682	$37,783	$38,916	$40,084	$41,286	$42,525	$43,800	$45,114	$46,468
Maintenance Cost	$36,682	$37,783	$38,916	$40,084	$41,286	$42,525	$43,800	$45,114	$46,468
Admin Cost	$36,682	$37,783	$38,916	$40,084	$41,286	$42,525	$43,800	$45,114	$46,468
Power Production Cost ($/MWH)	$80	$81	$82	$82	$83	$84	$84	$85	$86
Power Sales	$440,186	$453,392	$466,994	$481,004	$495,434	$510,297	$525,606	$541,374	$557,615
Cash Flow (-)	$14,219	$24,123	$34,324	$44,831	$55,654	$66,801	$78,283	$90,109	$102,290
Annual Power Value ($/MWH)	$83	$86	$88	$91	$93	$96	$99	$102	$105
Power Value Gap ($/MWH)	($3)	($5)	($6)	($8)	($11)	($13)	($15)	($17)	($19)
Required Capacity and Environmental Attribute Value ($/kW-mo)	($1)	($1)	($2)	($2)	($3)	($4)	($4)	($5)	($6)
NPV (4% IRR)									

APPENDIX E

ALTERNATIVE LOW-HEAD TURBINE TECHNOLOGIES

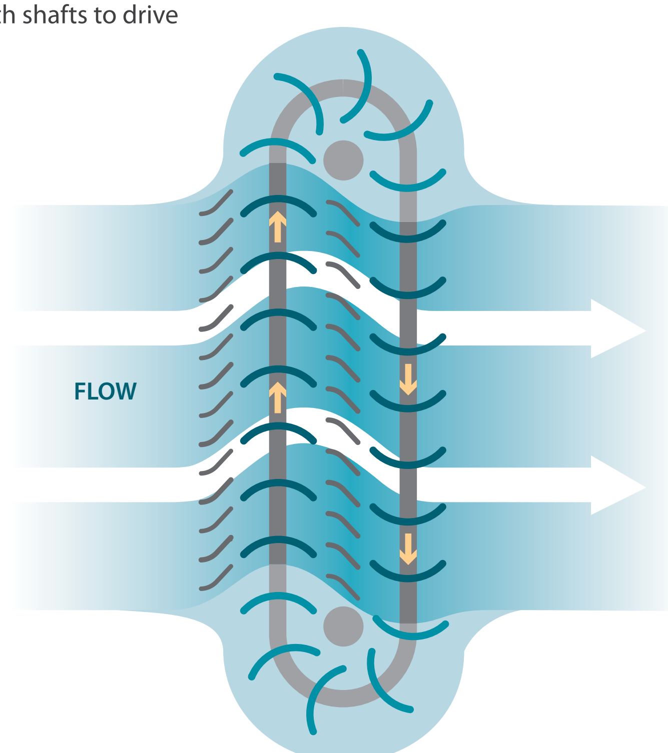
hydroEngine

a water-to-wire system for low head applications

Natel Energy, Inc. manufactures an innovative, patented hydraulic turbine called the hydroEngine, which operates with high efficiency in low head applications.

How it works

As water flows through the hydroEngine, the blades are driven in linear paths around two parallel shafts. Mechanical energy is taken off of either or both shafts to drive a conventional generator. Water enters the penstock, passes through the SLH unit, and exits the draft tube at or near stream velocity.



Technology Advantages

The hydroEngine has been specifically designed for high performance at low heads over a range of flows as low as 0.4 cms. Natel's water-to-wire packages featuring the hydroEngine can be installed in a range of settings, including irrigation canals and existing dams, with a minimum of civil works.

Additionally, the modular design of the hydroEngine ensures easy maintenance and repair. The moving components in each unit comprise a single cassette module that can be easily removed from the engine case with an overhead lift.

- Fish friendly
- No cavitation
- Minimizes need for site excavation
- Enables speedy maintenance
- Reduces costs associated with unit repair
- Delivers high performance at low head
- Maintains high efficiency as flow decreases

CURRENT PRODUCT

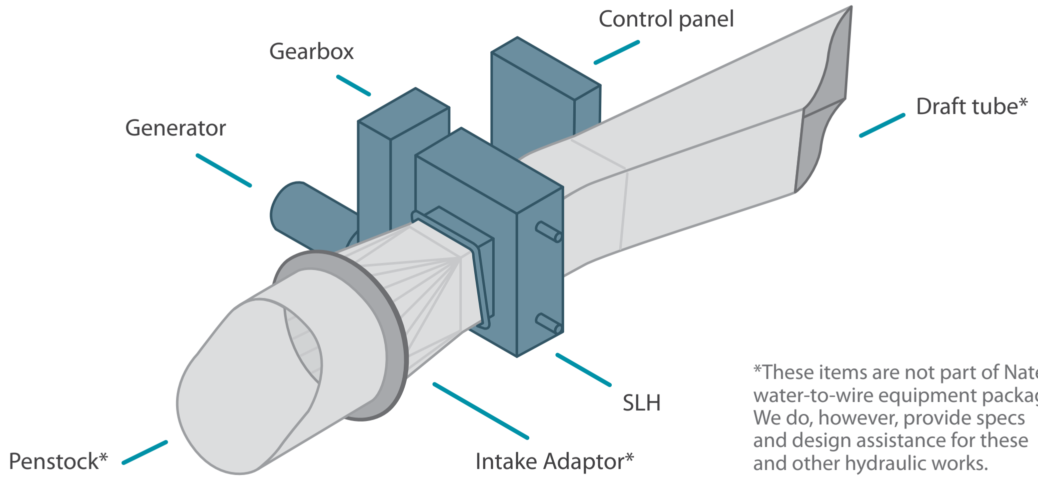
SLH100-L

500kW

Natel Energy, Inc.
2175 Monarch St.
Alameda, CA 94501
T: 510 342 5269
info@natelenergy.com
www.natelenergy.com

NATEL ENERGY

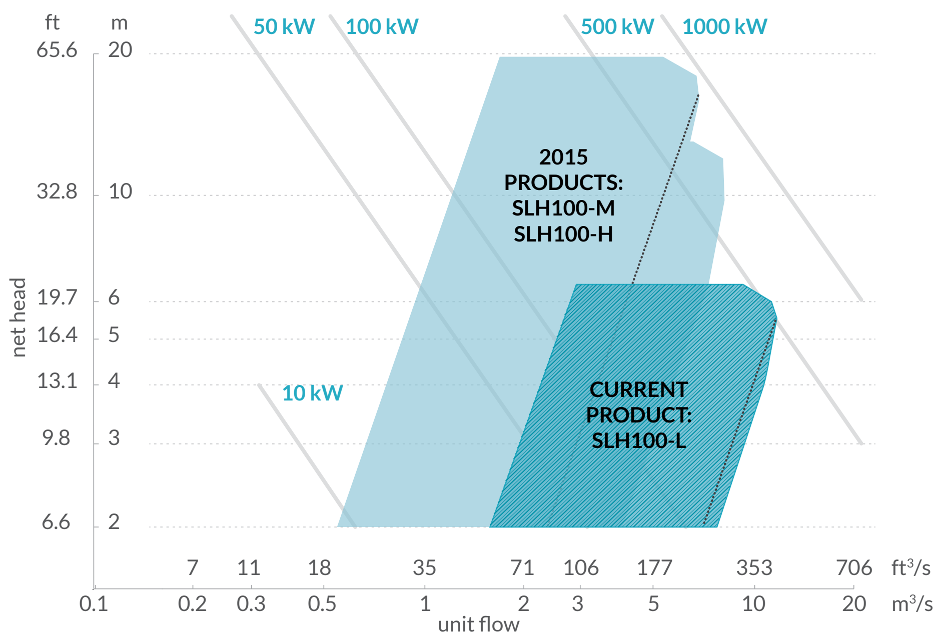
hydroEngine Equipment Package



*These items are not part of Natel's water-to-wire equipment package. We do, however, provide specs and design assistance for these and other hydraulic works.

The unique design of the hydroEngine, or SLH, enables the production of low cost renewable energy from flowing water at heads ranging from 2m (6 ft) to 18m (60 ft) high. Systems are integrated with a generator, switchgear, and SCADA compliant controls designed to work across multiple installations if needed. This provides a modular, easy-to-install solution, significantly reducing construction costs and speeding time to completion.

Operating Envelope

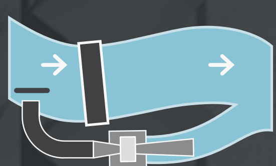


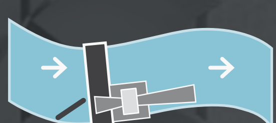
Operating History

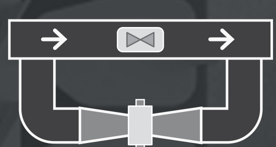
The SLH has demonstrated 75 to 80% hydraulic efficiency in hydraulic laboratory and field tests. Several different configurations have been installed and operated in field test and pilot commercial settings:

- A stream setting where a 35 kW hydroEngine ran for over 10,000 operating hours in the course of four years.
- Irrigation canal drops, including a 180 kW unit and a pilot of the SLH10 capable of producing 25 kW at 13 feet of head.
- A thermal power plant cooling water outfall.

TYPES OF INSTALLATION


Run of river


In dam


In pipe

Natel Energy, Inc.
2175 Monarch St.
Alameda, CA 94501
T: 510 342 5269
info@natelenergy.com
www.natelenergy.com

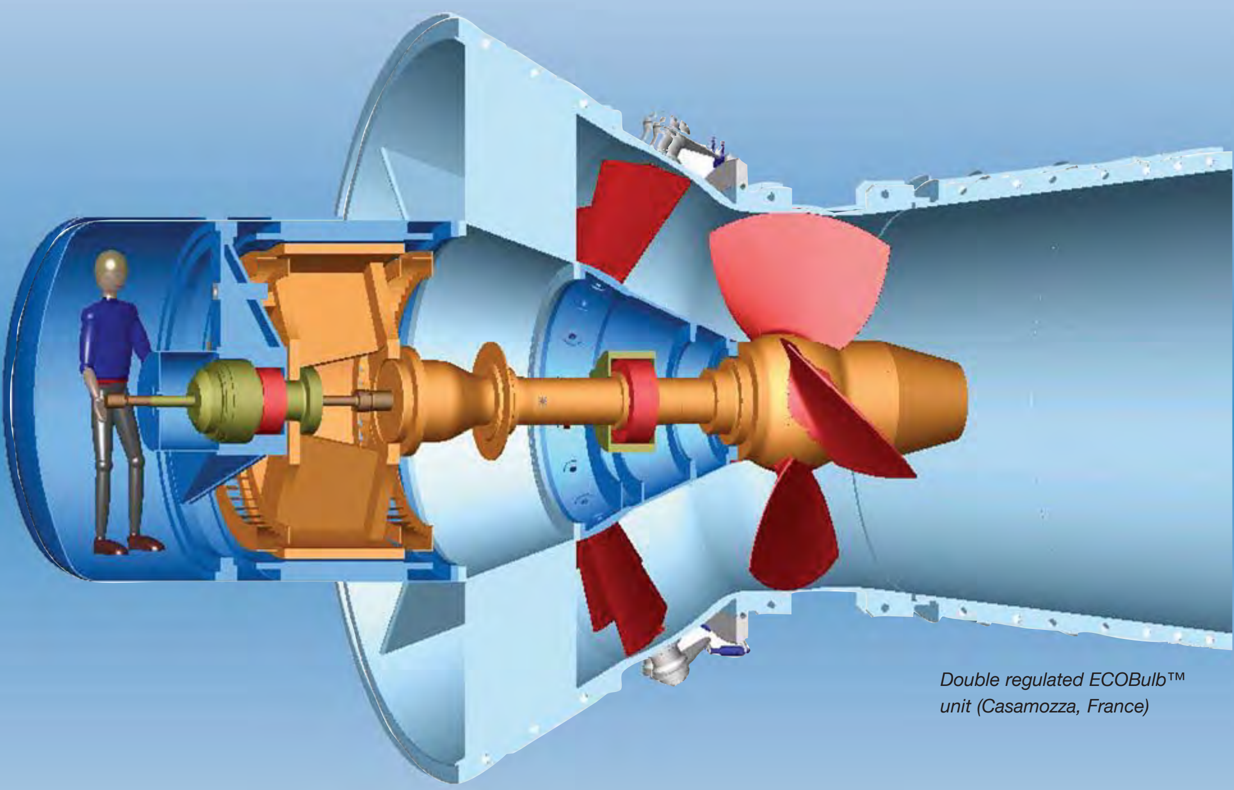
NATEL ENERGY

V4 - OCT 2014

VA TECH HYDRO

COMPACT ECOBulb™ TURBINE GENERATOR

We know how.



Double regulated ECOBulb™ unit (Casamozza, France)

A Compact Turbine Generator System for low head applications

Head between 2 and 15 m
Discharge between 15 and 100 m³/s
Output between 500 and 5000 kW

Hydro

sustainable solutions. for a better life.

www.vatech-hydro.com

ECOBulb™
TURBINE GENERATOR

VA TECH Hydro, a world leader in Compact turbines, introduces the development of the ECOBulb™ Turbine Generator. The unit design minimizes investment in civil work and electro-mechanical equipment and significantly reduces maintenance costs throughout the life cycle of the plant. The result is the economical development of sites having low head potential while minimizing the ecological impact.

The ECOBulb™ unit is the unique combination of a single or double regulated axial turbine with a direct coupled low speed synchronous generator including a permanent magnet rotor (PMG) integrated into an air pressurized bulb. The removal of the step-up gear allows a simplification of the mechanical elements, a reduction of the size of the bulb and a huge life extension of the generating unit.

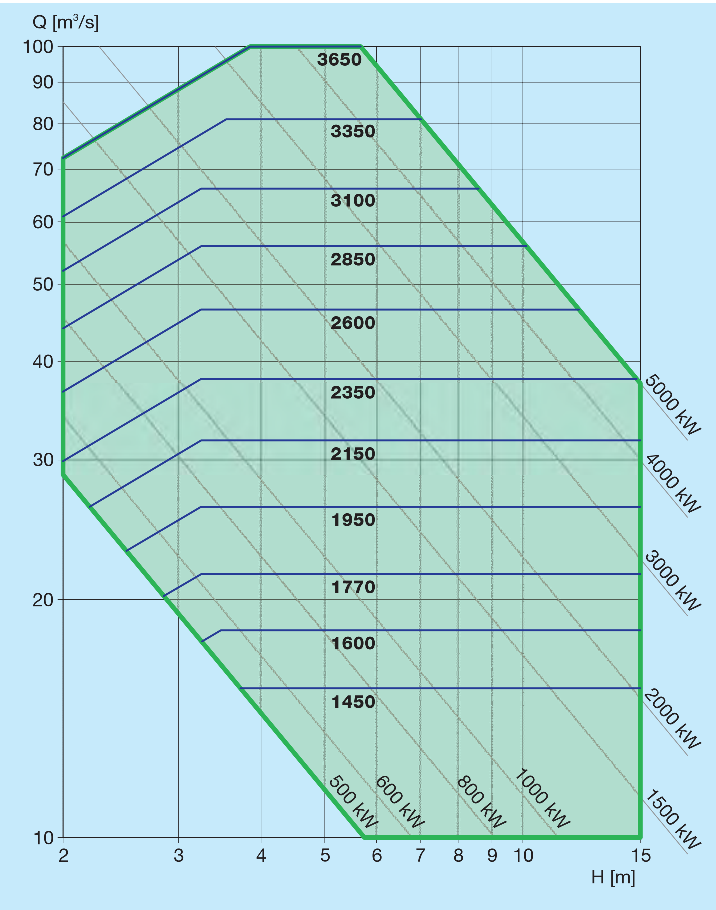
The ECOBulb™ turbine generator brings the industry unmatched advantages in investment costs for civil and electro-mechanical equipment as well as the ability to tap low head potential with high economic results.

The unit design minimizes maintenance costs and provides the maximum energy generation through high levels of hydraulic and electrical efficiencies.

The ECOBulb™ design also provides many ecological advantages. Generator cooling is achieved without external auxiliary systems by utilizing the bulb surfaces cooled by the surrounding river water. The two bearings supporting the shaft system are lubricated by biodegradable oil and grease. Since the units are completely submerged, the reduction in noise emission makes their installation in residential areas possible. Finally, the low profile of the ECOBulb™ allows an aesthetic integration of the unit's installation into the site's landscape.

The hydraulic profiles used have been developed and tested in our hydraulic laboratories and the electrical and thermal technologies are derived from large bulb generator units built by VA TECH HYDRO.

Application range



Technical data

- Head H between 2 and 15 m
- Flow Q between 15 and 100 m³/s
- Output P between 500 and 5000 kW

System features

- Integrated turbine generator unit with single-source engineering
- Single or double-regulated turbine for maximum energy generation
- High turbine and generator efficiencies at part and full load
- Reduced civil work costs in excavation and concreting thanks to the axial unit type and the high specific discharge
- Minimum maintenance through removal of the step-up gear and its large quantity of lubricating oil

▲ *Double regulated ECOBulb™ unit*

▲ *Rotor with Permanent Magnets (Aubas, France)*

Single regulated ECOBulb™ unit ready for operation (Paullo, Italy)





VA TECH HYDRO worldwide

VA TECH HYDRO GmbH & Co
Penzinger Strasse 76
A-1141 Vienna, P.O. Box 5
Phone (+43/1) 89 100-0
Fax (+43/1) 89 46 046

VA TECH BOUVIER HYDRO SAS
45/51 Boulevard Paul Langevin
BP No. 7
F-38601 Fontaine Cedex, France
Phone (+33/476) 85 95 23
Fax (+33/476) 26 16 20

VA TECH ESCHER WYSS GmbH
P.O. Box1380
D-88183 Ravensburg
Escher-Wyss-Strasse 25
D-88212 Ravensburg
Phone (+49/751) 83-00
Fax (+49/751) 83-2396

VA TECH ESCHER WYSS S.r.l.
Via Daniele Manin 16/18
Casella postale 274
I-36015 Schio (Vicenza)
Phone (+39/0445) 67 82 11
Fax (+39/0445) 67 82 18

VA TECH ESCHER WYSS S.L.
Paseo de la Castellana, 163
E-28046 Madrid
Phone (+34/91) 425 10 00
Fax (+34/91) 425 10 01

VA TECH ESCHER WYSS S.A. de C.V.
Av. Cd. Industrial No. 977
Col. Cd. Industrial
Mex-58200 Morelia, Mich.
Phone (+52/43) 23 15 30
Fax (+52/43) 23 15 38

VA TECH ESCHER WYSS Flovel Ltd.
Amar Nagar
P.O. 13/1 Mathura Road
IND-Faridabad/Haryana 121 003
Phone (+91/129) 527 43 19
Fax (+91/129) 527 43 20

VA TECH HYDRO BRASIL Limitada
Rua Gomes de Carvalho, 1306, 5 andar
Conjunto 51
Bairro Vila Olímpia
BR-04547-005 São Paulo SP
Phone (+55/11) 3704 5303
Fax (+55/11) 3704 5316

VA TECH HYDRO USA Corporation
University Research Park,
Five Resource Square
10715 David Taylor Drive, Suite 250
USA-Charlotte, NC 28262
Phone (+1/704) 943 4343
Fax (+1/704) 943 0200

VA TECH BOUVIER CANADA, Inc.
1550 A de Coulomb
Boucherville, P.Q.
Canada J4B 7Z7
Phone (+1/450) 449 1228
Fax (+1/450) 449 1229

VA TECH International SA
The Ferns Office Park VA HOUSE
364 Pretoria Avenue
SA-Johannesburg 2194
(Cramerview 2060)
Phone (+27/11) 886 0900
Fax (+27/11) 886 0941

VA TECH COLOMBIA Limitada
Carrera 12 No. 90 – 20, Piso 6
Edificio San Germán
Bogotá
Phone (+57/1) 622 85 70
Fax (+57/1) 622 86 04

VA TECH ESCHER WYSS AG
Stockenstrasse 27
CH-9249 Algetshausen
Phone (+41/71) 950 01 66
Fax (+41/71) 951 66 24

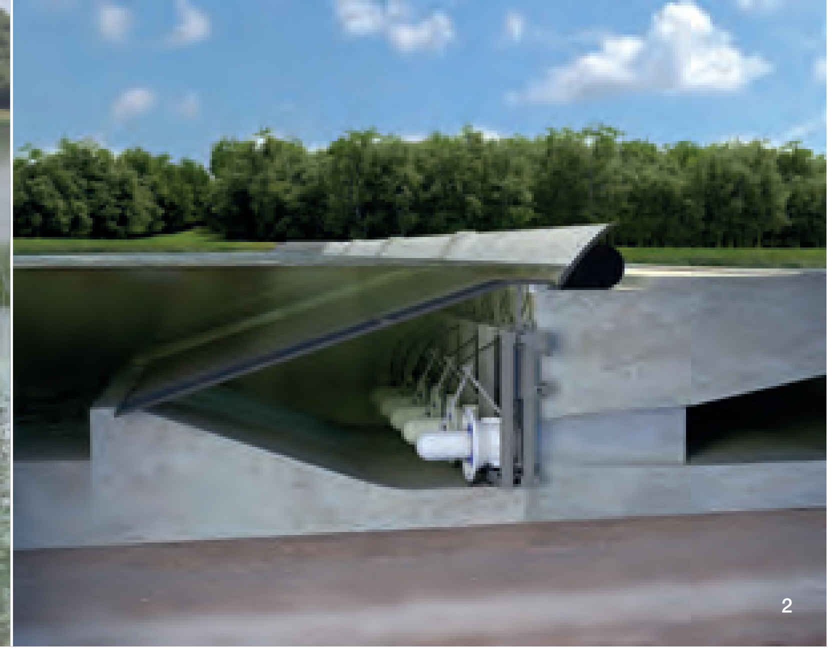
eHYD.29.500.Z.B04

sustainable solutions. for a better life.

www.vatech-hydro.com

VOITH

StreamDiver®
Utilizing New Hydropower Potential



1+2 Typical Power Plant Arrangement with StreamDiver

Challenges for low head hydropower plants

Over 85 percent of all existing dams in the world remain unused for hydropower generation. The StreamDiver turbine was developed to tap this potential, especially at low head sites which so far could not be exploited.

Even though hydropower accounts for the largest share of renewable energies worldwide, there is still sufficient potential for energetic development. Until recently, run of river plants with low heads were regarded as uneconomical and therefore often remained unused. In order to take advantage of this unused potential, in cooperation with its subsidiary Kössler, which acts as Voith's competence center for Small Hydro in Europe, Voith has developed the StreamDiver, a new compact propeller turbine particularly suited to taking over where conventional plants may not be viable. The set-up and eco-friendly features make the power unit especially feasible where weirs or dams already exist. The StreamDiver offers a compact, low-maintenance and oil-free alternative in the field of hydropower.

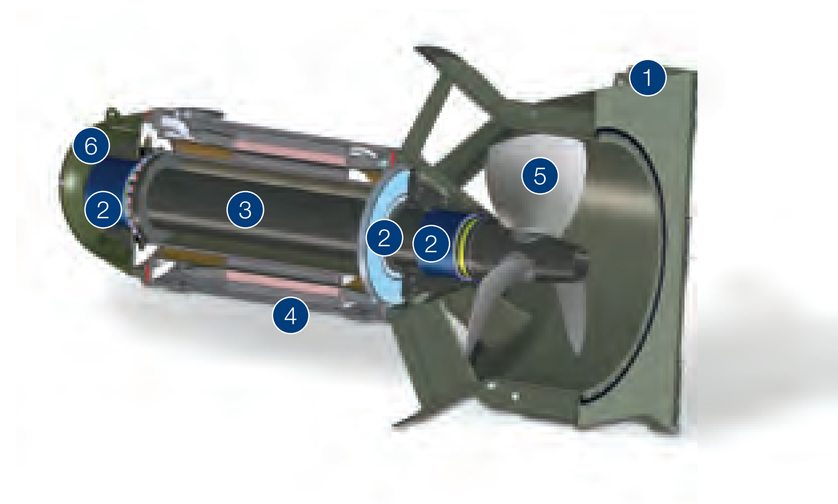
StreamDiver Features	Your benefits
Oil free turbine solution	+ environmental acceptance
Simplified technical complexity	+ low maintenance + high availability + no turbine peripheral equipment required
Standardized design	+ short delivery times + approved concept + minimized spare part administration
Compact and submersible turbine design	+ flexible plant integration + easy handling for maintenance and service + reduction of civil costs

Simplicity as key to reliability

Higher availability and less technical complexity: the StreamDiver's compact and modular design and its maintenance-free operation minimizes costs.

The StreamDiver will allow construction work to be kept at a minimum. The power unit is installed directly in the water with only the power cable exposed. The entire drivetrain, consisting of the turbine, shaft, bearings and generator, is situated in a bulb-turbine-type housing. In addition, the bulb is filled with water, which completely lubricates its bearings, ruling out any risk of water contamination.
The turbine itself is designed as a propeller turbine, meaning that neither rotor blades nor guide vanes are movable. These features negate the need for a visible or accessible power house.
By switching individual turbines on and off, or by regulating the turbine speed an operator can control the flow of his plant.
For shutdowns a separate gate is used, which simultaneously allows for speed to be controlled in order to start and synchronize the compact turbines. All these design solutions support a comparatively low total cost of ownership.
Conventional hydropower plants are designed according to individual requirements. The StreamDiver, in contrast, is an affordable serial product. It has numerous application possibilities around the world. The technical features of the StreamDiver represent the latest developments in the field of small hydropower.

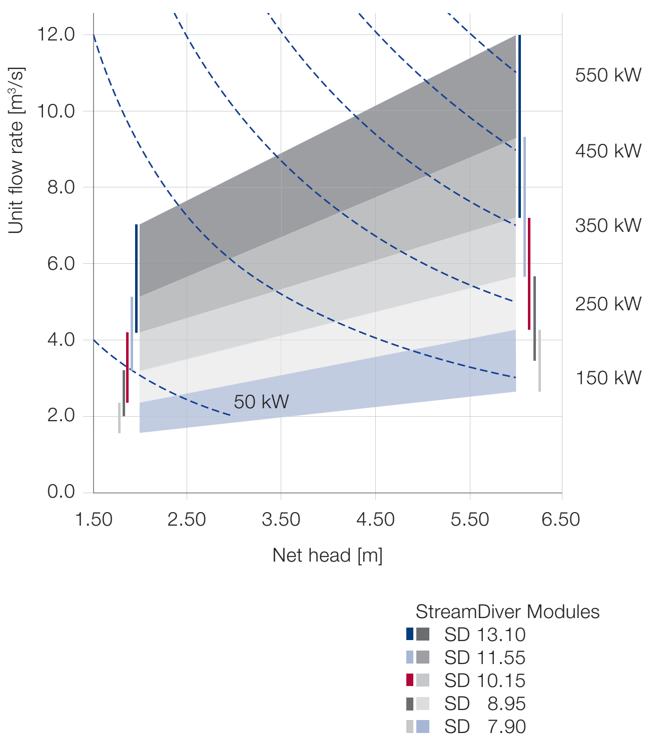
StreamDiver Main Components



1 Turbine housing with guide vanes
2 Radial and axial bearing coating on shaft ends
3 Shaft
4 Generator
5 Runner
6 Bulb nose

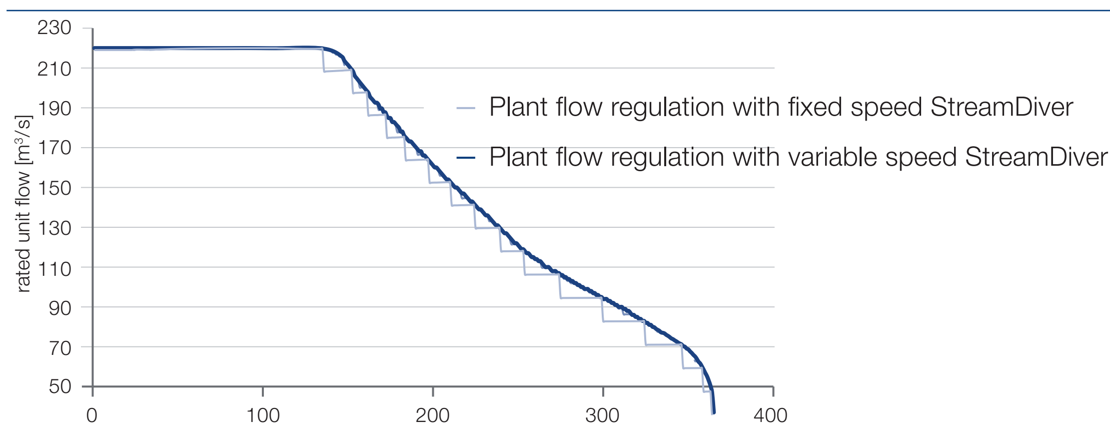
Application diagram:

The application diagram allows a preliminary module size selection based on rated head and flow. To find out the best array and number of compact turbines, conditions such as annual flow, head duration curve and overall physical limitations are also to be considered. For identifying the best project specific solution, the application range of the different modules is overlapping. The following operational criteria should be considered:



- The discharge through turbine for single unit is limited in a range of 2 - 12 m³/s.
- The typical head range for StreamDiver is 2 – 6 m. However, in certain cases the standardized design modules can be engineered for high heads up to 10 m if the project is economically attractive.
- The civil structure shall facilitate the minimum submergence of the machine for cavitation free operation of the StreamDiver.
- Unit flow is limited by the runner diameter.

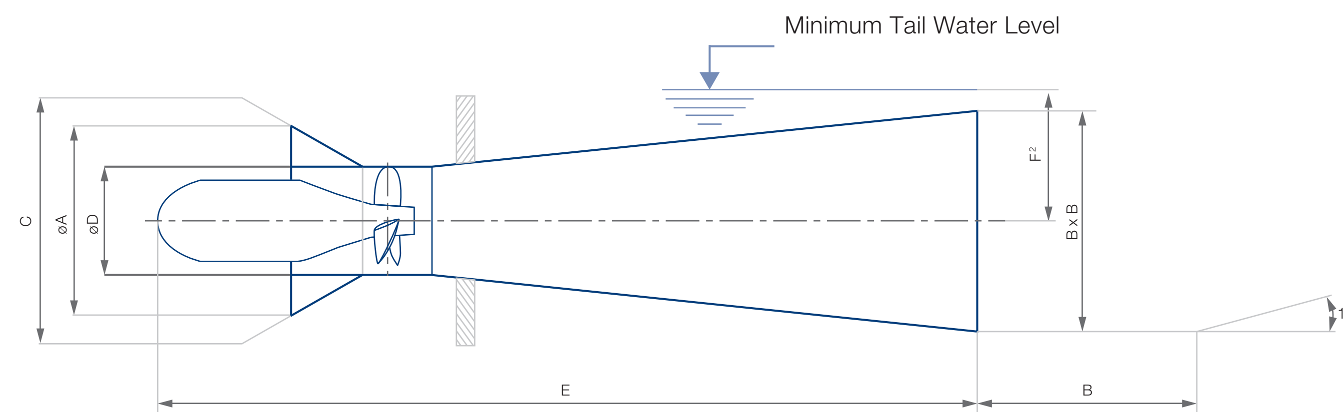
Typical multi unit operation diagram:



The StreamDiver is a non-regulated machine. In order to utilize the complete potential of any site, multiple number of units are required to be installed. Optionally, the StreamDiver can be equipped with a frequency converter to allow variable speed operation. In this case the StreamDiver unit can follow the available flow.

StreamDiver sizing:

The main dimensions of the StreamDiver will vary depending on the selected module size. The setting of the turbine will be given by the minimum tail water level. The below given turbine layout is basis for the preliminary planning. Nevertheless, the final plant and intake layout needs to be adopted to the local requirements with the support of Voith.

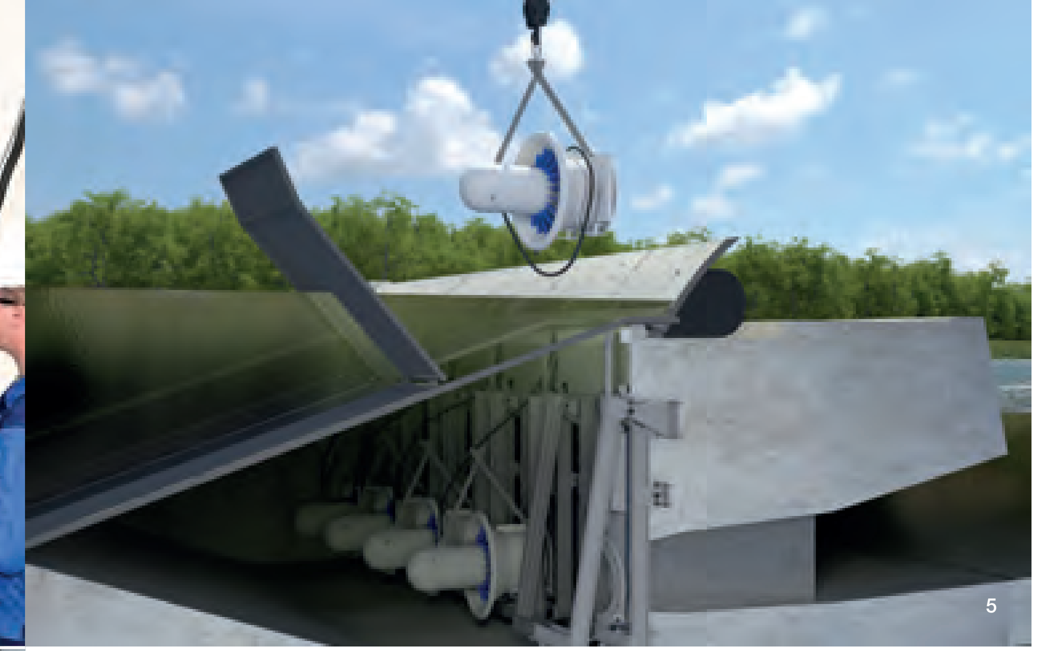


Main dimensions:

	A	B	C[1]	D	E
SD Module	mm	mm	m²	mm	mm
SD 7.9	1380	1580	2,2	790	6000
SD 8,95	1560	1790	2,7	900	6700
SD 10.15	1770	2030	3,5	1020	7600
SD 11.55	2020	2310	4,5	1160	8700
SD 13.10	2380	2620	5,7	1310	9900

[1] Minimum intake gross area in case of penstock or channel applications.

[2] Dimension F will be defined by Voith. In general the draft tube exit needs to be placed below the minimum tail water level.



1-4 Factory assembly of StreamDiver

5 Retrieval from power plant

Easy Assembly and Service

Flexible and easy to handle: Assembly and disassembly of the StreamDiver is a task done by a few hands. Before removing one turbine from an array, the machinery will be automatically shut down with a shut-off valve. Then mechanics remove the StreamDiver from the water with a mobile crane, since the power unit has a weight of less than ten tons.

Finally, with the help of an all encompassing steel structure, experts get access to the turbine's components. In four steps the StreamDiver can be dismantled in its main components (Fig. 1-4). No special tools are required for the disassembly process.

Power Plant Equipment

Shut-off valve

Depending on project specific requirements Voith may supply an automatic shut-off valve. The gate will be connected to the unit control cubicle and can be either placed at the inlet or the draft tube outlet.

Grid Connection Equipment

The standard voltage level of the StreamDiver is 400V. Voith will deliver an electrical low voltage cubical that contains a low voltage circuit breaker, an electrical protection and a synchronization unit. Additionally, an automation cubicle is foreseen. The StreamDiver will be equipped with temperature, vibration and leakage sensors. All sensors will be connected to a programmable logic control (PLC). The PLC allows a continous monitoring of the unit status and the automatic synchronization and shut down of the unit. The PLC will be placed in a control cubicle. Depending on the customer requirements, the plant control can also be integrated within the StreamDiver Control cubicle. The current standard foresees the StreamDiver to be connected directly to the grid. Due to local grid codes Voith is able to equip the unit with a reactive power control unit. A further variant considers to equip each StreamDiver with a full frequency converter; this allows a variable speed operation and a reactive power control in one. The decision if a frequency converter is mainly drifted depends on the local hydraulic site conditions and economical considerations.

Project Specific Site Equipment

In addition to the standard scope of supply, the following project equipment should be considered:

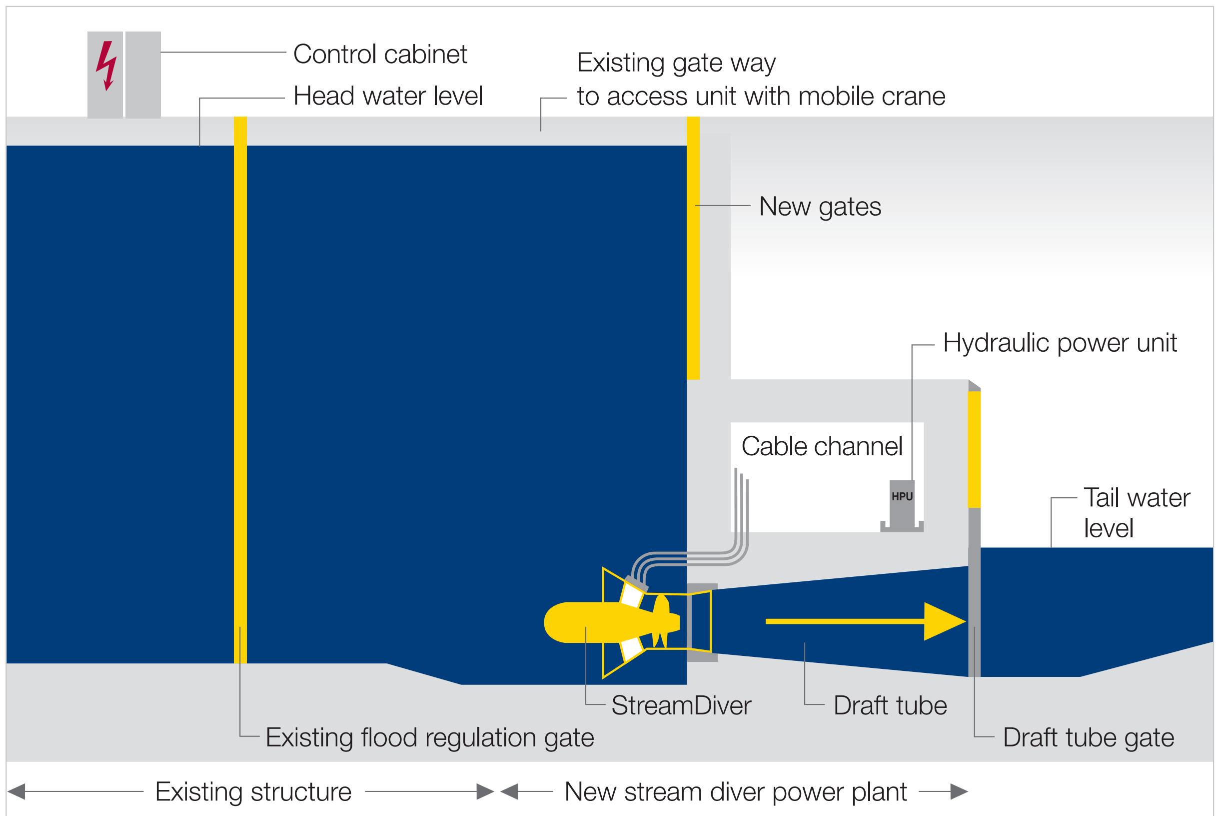
- Trash rack and cleaning system
- Stop logs to maintain the trash rack and its cleaning system
- Fish bypass system
- High voltage transformer and grid connection system

The arrangement and its necessity depend on the local site condition and customer specific requirements.

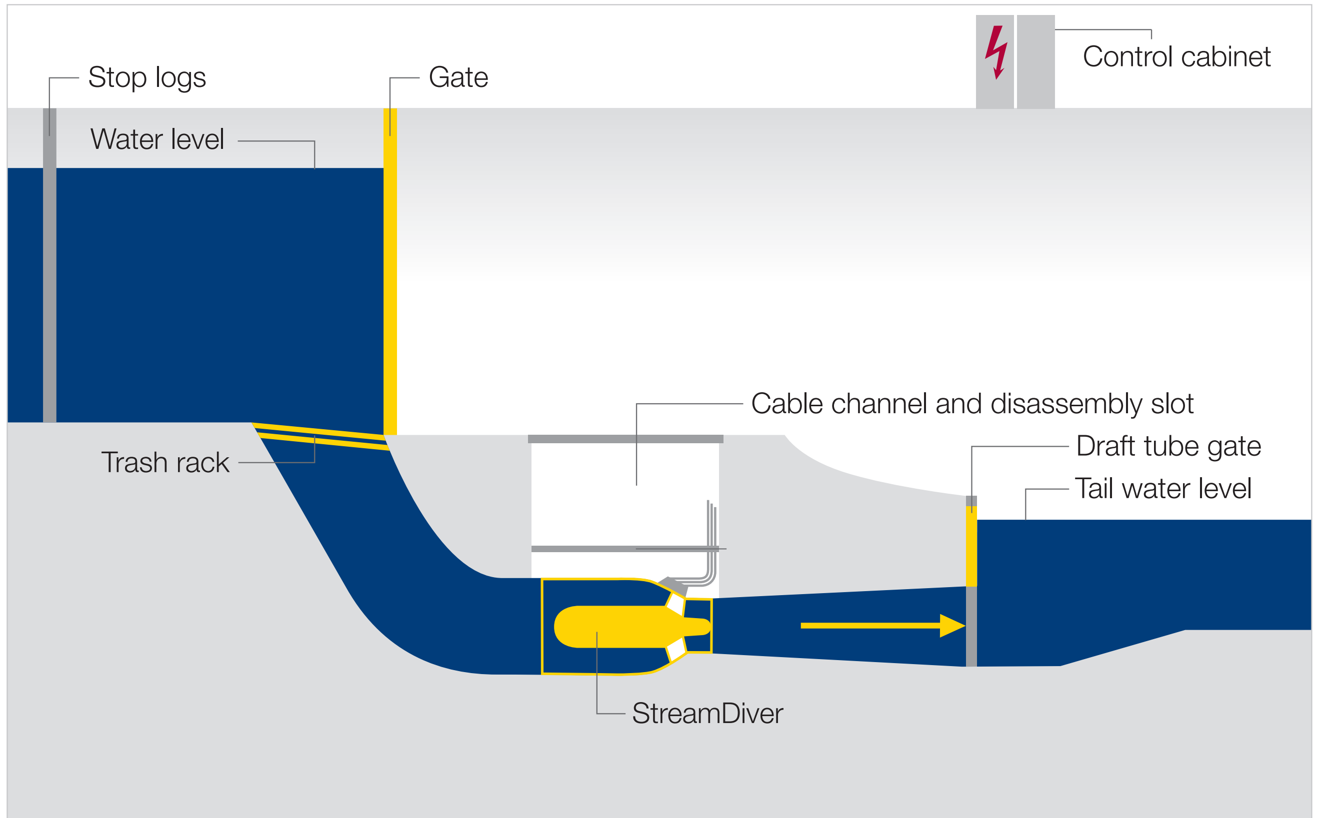
Hydropower Plant layout examples

The principle idea is to place the StreamDiver under water. The electrical and plant peripheral equipment can be placed safely and is easily accessible outside the river stream.

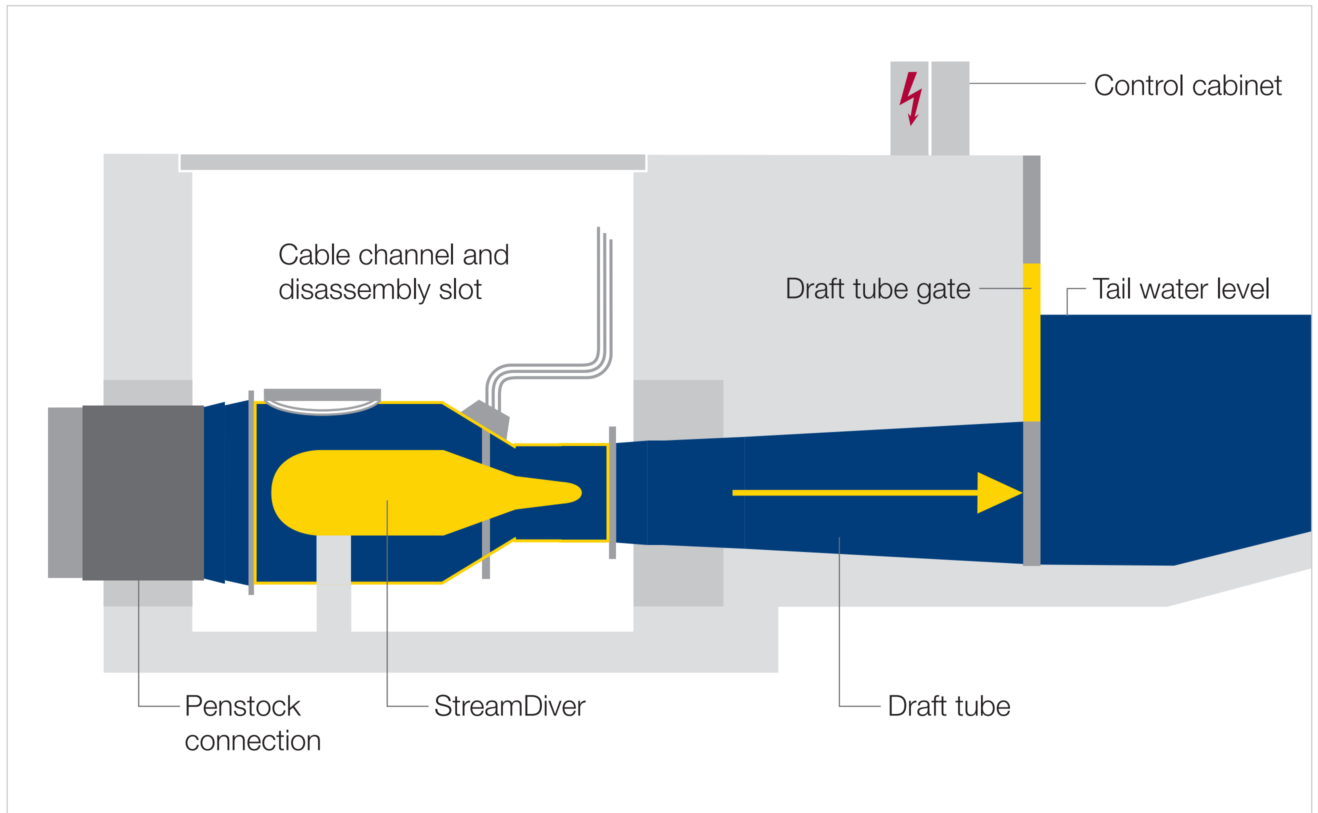
Case Study 1: Integration in existing flood regulation weir



Case Study 2: Residual flow power plant



Case Study 3: Integration in existing Penstock



t3390e

Voith Hydro Holding GmbH & Co. KG
Alexanderstraße 11
89522 Heidenheim, Germany
Tel. +49 7321 37 0
Fax +49 7321 37 7828
www.voith.com

A Voith and Siemens Company

Engineered Reliability

PE 16.4 WASTEWAY

SCREENING LEVEL FEASIBILITY REPORT

P.E. 16.4 WASTEWAY

FERC NO. P-14349

Prepared for:

Grand Coulee Project Hydroelectric Authority
Ephrata, Washington

Prepared by:

Kleinschmidt

Gresham, Oregon
www.KleinschmidtGroup.com

February 2015

SCREENING LEVEL FEASIBILITY REPORT

P.E. 16.4 WASTEWAY

FERC NO. P-14349

Prepared for:

Grand Coulee Project Hydroelectric Authority
Ephrata, Washington

Prepared by:

Kleinschmidt

Gresham, Oregon
www.KleinschmidtGroup.com

February 2015

SCREENING LEVEL FEASIBILITY REPORT

P.E. 16.4 WASTEWAY
FERC No. P-14349

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

EXECUTIVE SUMMARY

The proposed P.E. 16.4 Wasteway Hydroelectric Project (Project) would utilize irrigation water that flows down the wasteway chute and discharges into the Columbia River. Kleinschmidt Associates (Kleinschmidt) developed the Project concept through existing site information such as site specific flow data, topography, site visits, discussions with Grand Coulee Project Hydroelectric Authority (GCPHA), and information from equipment vendors.

The Project infrastructure includes a new concrete intake, a 4,900-foot long, buried high-density polyethylene (HDPE) penstock, a single vertical 1,500 kilowatt (kW) Kaplan unit, a powerstation with a concrete substructure and steel superstructure, and a concrete tailrace that ends with a fish diversion screen at the discharge into the existing canal (Appendix A). The fish screen is unique to this Project because this powerstation discharges into the Columbia River, and it is anticipated that fish and wildlife agencies will require a method to prevent anadromous fish from swimming up the tailrace.

The Project development has been evaluated in two ways. Scenario One was evaluated as a plant that would have all the features of a larger facility and with operation and maintenance (O&M) costs prorated from existing GCPHA small hydro sites. Scenario Two was then studied to determine if a lesser cost development is viable. This scenario assumes the development focuses on cost-effective features, decreased costs with lower construction contingencies, purchase of lower cost turbine generator equipment manufactured in China, and that O&M efficiencies can be made by using existing staff resources to operate and maintain the Project. Table 1 summarizes the results of this study for each scenario.

TABLE 1 SUMMARY OF STUDY RESULTS - P.E. 16.4 WASTEWAY

	SCENARIO ONE	SCENARIO TWO
Total Development Cost Analysis	$8,880,000	$6,950,000
20 Year Net Present Value	-$3,220,000	$1,270,000

Scenario Two shows a small positive net present value (NPV) over the 20 year pro forma, indicating that under the Scenario Two conditions the project is financially viable.

1.0 PROJECT DESCRIPTION

1.1 EXISTING CONDITIONS

P.E. 16.4 Wasteway is located in Franklin County, Washington, in the South Columbia Basin Irrigation District (SCBID), east of the Columbia River, and north of Pasco (Figure 1).

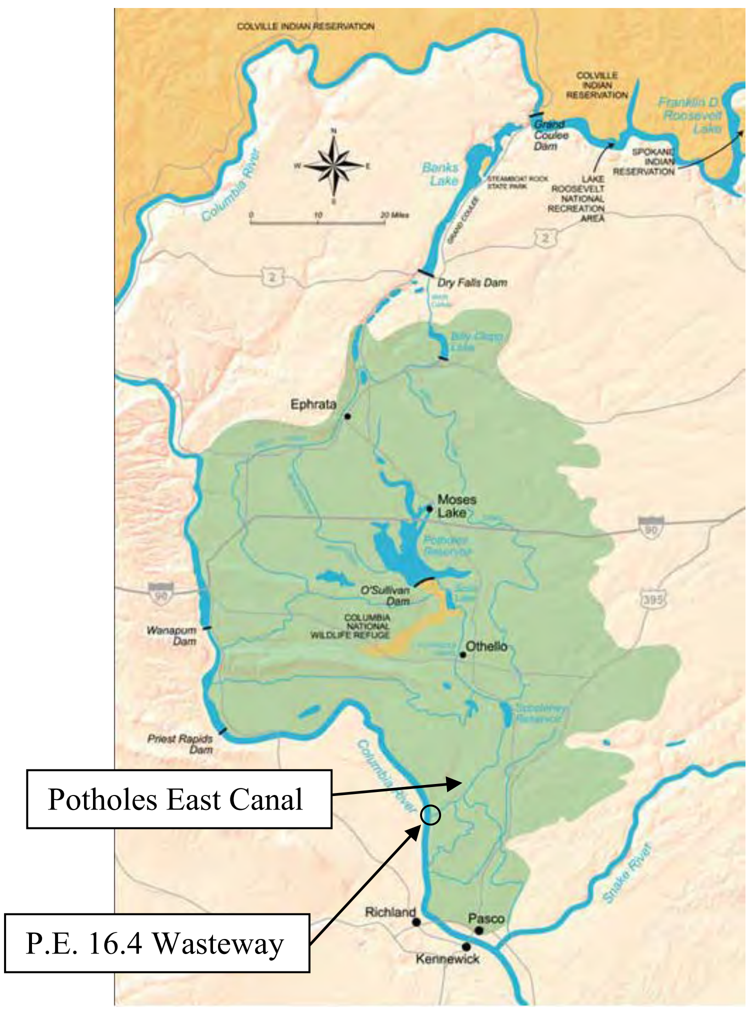


FIGURE 1 COLUMBIA BASIN PROJECT IRRIGATION AREA (BUREAU OF RECLAMATION MAP)

SCBID is part of the Columbia Basin Project which is owned by the United States Bureau of Reclamation (BOR). The P.E. 16.4 Wasteway is a Transferred Works Project, which means that it is owned by BOR but its O&M have been transferred to SCBID. The P.E. 16.4 Wasteway discharges irrigation return flows and canal system operational spills from the Potholes East Canal into the Columbia River and also serves as an emergency flood control discharge structure. Site photographs at the locations of the proposed intake and powerhouse are shown in Appendix B.

Within one mile of the canal discharge there are two concrete chutes built into the canal that dissipate energy of the canal flow over large changes in elevation. More details on the canal elevations, chutes, topography, and water elevations are provided on existing canal drawings in Appendix C. There is also an existing public boat launch to the Columbia River on the south side of the canal just west of the proposed powerhouse. The following site information was used to develop the Project concept and was provided by GCPHA, existing drawings, and data collected from site visits.

Water Elevations:

- Normal Headpond: 476 feet
- Normal Tailwater: 361 feet

Upstream Freeboard: 5.3 feet from the normal headpond to the top of bank

Site Hydraulics: P.E. 16.4 Wasteway transmits returned water out of the irrigation canals into the Columbia River and also serves as an emergency flow canal. The annual flow duration curve provided in Figure 2 is based on site flow data from 2007 to 2012.

- Annual Flow Patterns: Flow year round
- Emergency Flow Capacity: 7,700 cubic feet per second (cfs)

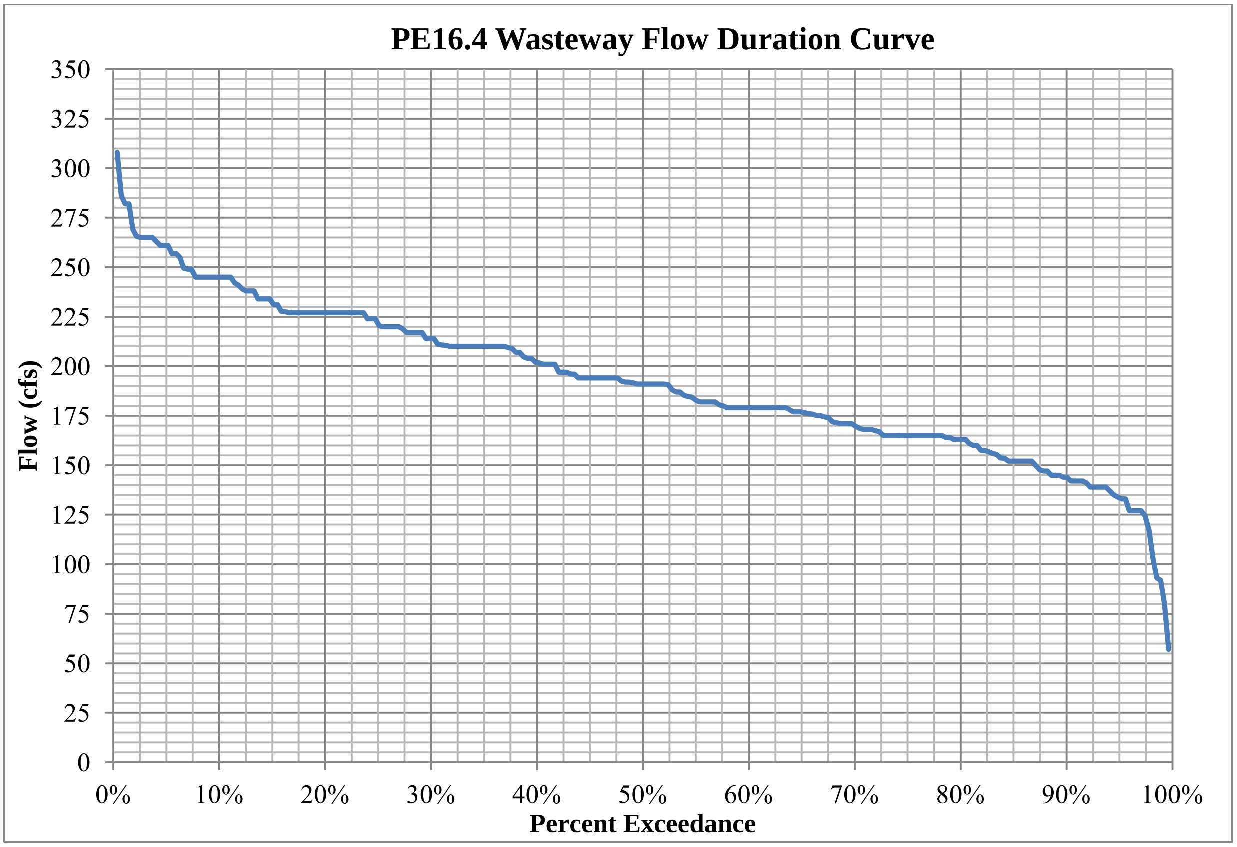


FIGURE 2 FLOW DURATION CURVE

Geotechnical Considerations: The site soil characteristics are assumed to be primarily sand and gravel. This assumption is based on a visual site assessment and existing drawings. Rock is assumed to be located within 20 feet below the soil surface. Further geotechnical investigation, such as site borings and test pits, would reduce the risk of encountering unexpected geotechnical conditions such as lower rock elevations and/or quality than presently assumed.

1.2 PROPOSED DEVELOPMENT

The P.E. 16.4 Wasteway Project concept layout is shown in Appendix A. This Project concept has the following basic features:

- Capacity: 1,500 kilowatts (kW)
- Turbine Type: Vertical Axial Flow Kaplan
- Turbine Max Flow: 225 cfs
- Gross Head: 115 feet
- Transmission Line Length: 1,000 feet

Water Control & Bypass: A consistently uniform water level is not critical at the Project site since there is more allowable freeboard. The concept for water control is to have a short weir that diverts flow into a wide and shallow rack structure upstream of a deeper intake channel to provide submergence for the penstock entrance. The proposed weir is assumed to be installed in two phases behind small cofferdams in order for installation to be completed in the dry and still allow water to pass through the chute intake. In addition, a mechanically synchronized turbine bypass valve will be located at the powerhouse to release flow in the event of a unit shutdown. Since the upstream canal offers negligible available storage volume and controlling water levels is important for reliable canal operations, the proposed plant operates in run-of-river mode without peaking. Flows in excess of those needed for generation will be bypassed over the control weir.

Intake: The concrete intake structure would support trashracks and an intake headgate at the penstock inlet. The trashracks at this site would require a trash rake since aquatic weeds in the canal can be a significant issue at certain times during the year.

Penstock: The penstock diameter is sized to balance initial construction cost with operational generation decrease due to the penstock's frictional head loss. The penstock is a buried high density polyethylene (HDPE) pipe which is less expensive to supply, faster to install, and, because it will not need to be painted, will have lower long term maintenance costs compared to a steel penstock. HDPE is possible for this project due to a combination of relatively low internal hydrostatic pressures and lack of dynamic pressures such as water hammer due to the presence of a bypass valve. HDPE is sometimes partially buried or supported along the bottom third of the pipe which is less expensive to install. However HDPE has a very high expansion rate due to temperature change. For example, under a positive 50 degree temperature change this penstock will grow more than 16 feet in length[1] which would require several large and expensive

[1] Using a thermal expansion coefficient of $67.0x10^{-6}$ in/inºF.

expansion joints. In addition, full burial protects the pipe from the ultraviolet light and weathering. Details for the penstock are as follows:

- Diameter: 4 feet
- Length: 4,890 feet
- Material: HDPE
- Support: Buried

Powerhouse: The powerhouse consists of a reinforced concrete substructure and prefabricated steel superstructure. The powerhouse is assumed to be founded on bedrock assuming bedrock is present at or above the bottom elevation of the powerstation. Of the Kaplan and Francis hydro turbine units, the Kaplan requires the substructure to be deeper than a vertical Francis unit of approximately the same size to achieve the required submergence of the unit draft tube. The powerhouse dimensions are approximately 20 feet long by 30 feet wide. A roof hatch provides access to the turbine unit and related plant items. A small monorail chain hoist is included in the powerhouse for basic operation and maintenance. The powerhouse has a small separate electrical room with climate control to extend the life of the controls, protective relaying, and switchgear equipment.

Generating Units: A vertical Kaplan unit has been selected for this Project as it generates energy over the entire range of flow shown in Figure 2. Also, due to the steep bank near the outlet canal a vertical Kaplan powerhouse’s more compact footprint will result in cost savings. Details on the turbine are as follows:

- Type: Vertical Axial Flow Kaplan
- Output: 1,500 kW
- Operational Range: 50 - 225cfs
- Setting: 2 feet above tailwater
- Number: 1

Access and Constructability: Access to the intake, penstock, and powerhouse areas will be achieved by the existing gravel access road. This access road is also used by the public to access an existing boat launch to the Columbia River just west of the proposed powerhouse site. Security fencing may be required to protect the Project.

A temporary cofferdam, most likely sheet pile, will be required at the intake to install the new intake structure and maintain canal flows. It is anticipated the majority of the powerhouse and tailrace will be constructed in the dry prior to removing the remaining existing berm and connecting the tailrace into the existing canal. Temporary shoring and dewatering will likely be installed during construction of the powerhouse.

The penstock route is located along the southern bank of the canal and will run under Ringold River Road and also under the gravel access road to the powerhouse just downstream of the existing chute exit structure. It is anticipated that trenching will be required to install the penstock under the roadways. A temporary bridge, road, or road widening for access to the boat launch may be required during installation of the penstock section under the existing access road.

Substation and Transmission Interconnection: A generator step-up transformer (GSU) is needed to match the voltage from the unit generator to the 13.2 kilovolt (kV) transmission line. Approximately 1,000 feet of three-phase transmission line and poles are needed to connect to the Project’s GSU to the nearby overhead distribution line owned by Big Bend Electric Cooperative (BBEC). Alternatively, there is the option of connecting into Franklin Public Utility District’s (Franklin PUD) line if a favorable arrangement cannot be reached with BBEC, or Franklin PUD becomes a power purchaser. Disconnect switches, metering, and protection equipment are assumed to be required by BBEC to interconnect to their system and are presently included in the cost analysis. System studies are required to finalize the design, equipment requirements, and potential system upgrades. The cost of these studies is included in the cost analysis for the Project.

2.0 COST ANALYSIS

2.1 CONSTRUCTION COST ANALYSIS

For Scenario One, an analysis of a probable construction cost is provided in Table **2**. The total construction cost includes work and equipment to complete the Project. Table **2** includes temporary construction features, permanent civil work, purchase and installation of the turbine/generator equipment, mechanical equipment, electrical equipment, substation and interconnection, and other related Project costs.

TABLE 2 CONSTRUCTION COST FOR SCENARIO ONE – P.E. 16.4 WASTEWAY

ITEM	DESCRIPTION	CONTINGENCY	CONSTRUCTION COST ANALYSIS[2]	NOTES
1	Mobilization and Demobilization	0%	$720,000	Site set up, soil erosion measures, site restoration
2	Cofferdams and Dewatering	25%	$170,000	Intake cofferdam, monthly dewatering, no tailrace cofferdam
3	Spillway Work	25%	$100,000	Selective demolition and repair of the canal wall, installation of the new weir
4	Intake	25%	$450,000	Concrete walls, trashracks, walkways, trash rake, headgate
5	Penstock	20%	$2,050,000	Buried 4'-ID, 4900'-long HDPE penstock
6	Powerhouse and Tailrace	25%	$1,460,000	Approx. 20'x30' powerhouse includes excavation and shoring, fish diversion measure
7	Turbine/Generator Supply and Install	10%	$1,960,000	Single vertical Kaplan turbine, generator, switchgear, PLC, etc.
8	Balance of Plant	20%	$190,000	Pumps, piping, wiring, HVAC, P&ID, etc.
9	Substation and Interconnection	20%	$410,000	GSU, transmission lines, metering, protection, and interconnection study
10	Other	5%	$210,000	Insurance and bonding
	Weighted Average Contingency	17%		
	CONSTRUCTION COST ANALYSIS TOTAL		**$7,720,000**	

[2] These numbers are based on 2014 costs.

The major development costs for this site include installation of the penstock, installation of the powerhouse and tailrace, and purchase and supply of the turbine/generator equipment. The penstock has the highest cost due to the overall length of the penstock (nearly one mile long). The powerhouse and tailrace costs were second highest due to excavation and depth of the concrete substructure necessary to achieve the runner setting. Additional costs were included for a simple tailrace fish barrier.

The civil/site costs such as temporary structures, excavation, concrete, etc. were developed based on quantities taken from the proposed concept layout and existing drawings of the canal combined with unit costs. The unit costs were prorated from the averages of actual costs from hydroelectric projects constructed in the northern United States within the last two years. In addition JR Merit, a Washington state contractor, provided input on regionally appropriate line item costs and construction considerations.

Turbine/generator equipment costs were based on vendor budgetary quotes solicited for this Project from established North American turbine suppliers. These water-to-wire equipment budgetary bids also include the unit switchgear; controls; hydraulic power unit; and balance of plant costs for valves, pumps, HVAC, piping, and instrumentation. Balance of plant equipment costs were derived from recent experience with prices from similar projects.

The substation and interconnection capital cost used in this cost analysis includes the overhead transmission line, primary metering, substation relay/protection equipment, system studies, a GSU, and GSU containment pad.

Table **2** also includes contingencies for each area of work. Any work that will occur near a body of water or that will require deeper excavation or pile driving, such as the spillway work, cofferdams, etc. were given a contingency of 25% due to unknowns with site geology. The penstock work was assigned a contingency of 20% due to shallower excavation with the possibility of unknown subsurface conditions. Balance of plant and interconnection costs were given a contingency of 20% due to more unknowns, as opposed to the 10% contingency used for turbine/generator equipment where budgetary quotes were provided by vendors.

Scenario Two incorporates features for safe and reliable Project operation. The costs were reduced in this cost analysis by considering the following factors:

- Favorable results of site geotechnical investigations such as lower top of rock elevations.
- Shared risk of construction costs with a qualified and reliable construction company. This could be done in several ways such as engaging a contractor to prepare an independent cost estimate or entering into various alternatives to traditional Design-Bid-Build such as Construction Management or Design Build contract delivery methods. The advantages and disadvantages of these project delivery methods are discussed in Section 6.0.
- Purchase of turbine and generator (T/G) equipment directly from Chinese manufacturers. North American turbine suppliers have been purchasing more Chinese fabricated equipment over the last 10 years in order to be more cost competitive. These suppliers have quality control and assurance programs in place to assure the foreign products meet specification standards. It is important that these standards are understood and properly specified. When purchasing equipment directly from Chinese manufacturers, owners often choose to hire a third party quality assurance company near the manufacturing facility. Kleinschmidt's experience with this method of T/G procurement is it results in savings compared to going through a North American supply company. Similar to Japanese supplied equipment, the Chinese manufactures do not have maintenance and rebuild crews in the United States and typically only offer a single individual for supervisory oversight.
- Construction cost-focused design. The powerhouse footprint and other civil infrastructure such as the intake would be optimized to achieve safe and reliable operation conditions but may sacrifice maintenance space. Also, instead of a trash rake, a less expensive air blast system could be installed on the trashracks that would essentially blow debris off the trashracks in order to sluice trash.

Table 3 shows the breakdown of each factor that could combine to create the overall savings of up to 25%. The 25% reduction shown in Table 2 was selected to be near the middle of the 10% and 37% range assuming that much but not all of the cost savings listed will be achieved under favorable conditions.

TABLE 3 CONTRIBUTING FACTORS FOR REDUCED CONSTRUCTION COST IN SCENARIO TWO – P.E. 16.4 WASTEWAY

ITEM	DESCRIPTION	POSSIBLE COST REDUCTION	NOTES
1	Reduced Contingency	0-17%	Possibility for site conditions or pricing to be more favorable than predicted
2	Economy Focused Design and Delivery	5-10%	Minimized civil works, minimized powerhouse footprint
3	Chinese Turbine Supply	5-10%	
	Overall Cost Reduction for Developer Grade	25%	
	CONSTRUCTION COST ANALYSIS TOTAL WITH 25% REDUCTION	**$5,790,000**	

2.2 OTHER DEVELOPMENT COSTS

There are a number of other development costs to consider aside from the previously quantified direct initial construction and installation. These items include:

- engineering
- construction assistance
- licensing and permitting
- environmental studies
- marketing fees
- legal fees
- transaction fees
- land acquisition
- sales tax
- property tax
- GCPHA internal costs
- administration

It is assumed that under both scenarios, 15% of the total construction cost will cover the other development costs listed above.

2.3 SUMMARY OF DEVELOPMENT COSTS

The total development cost for each scenario, which includes the construction cost and other development costs discussed previously, is provided in Table 4. Also included is a unit cost per kW for each scenario to compare each option.

TABLE 4 SUMMARY OF DEVELOPMENT COSTS – P.E. 16.4 WASTEWAY

	SCENARIO ONE	SCENARIO TWO
Construction Cost	$7,720,000	$5,790,000
Other Development Costs	$1,160,000	$1,160,000
Total Development Cost	$8,880,000	$6,950,000
Turbine Rating (kW)	1,500	1,500
Total Development Cost ($/kW)	$5,920	$4,633

For each scenario, the total development cost is in the range of or below one recently developed small hydro in the Northwest that cost $6,000/kW (Juniper Ridge Hydro, 3MW, 2009). A June 2013 Oak Ridge National Laboratory (ORNL) study of Oregon Small Hydro shows costs ranging from $1,500/kW for higher head, 3-5 megawatt (MW) projects to well over $10,000/kW for lower head and lower power projects.

2.4 OPERATION AND MAINTENANCE

O&M costs include internal maintenance staff, wheeling charges, administration, cost of consumables, and other costs. GCPHA provided cost information based on their current O&M practices for smaller-sized projects. This calculation results in an O&M cost estimate of approximately $30/megawatt hour (MWh) of generation. The pro forma increases this cost at an annual rate of 3%.

For Scenario Two, an O&M cost of $15/MWh was utilized by relying on increased efficiency of existing GCPHA staff and resources to operate and maintain the Project. This O&M cost does not include an $8/MWh power delivery charge for wheeling the Project output through the BBEC system because it is assumed that the power will be either directly integrated into the Franklin PUD system or a more favorable agreement could be reached with BBEC.

3.0 ANNUAL ENERGY ESTIMATE AND VALUE

Based on flow and head information provided by GCPHA, typical turbine efficiencies, and typical operational factors, it is estimated that the annual energy production will be 10,000 MWh. This is based on a 76% capacity factor. The estimate was obtained by an energy model that calculated the average energy produced based on two flow points per month.

The two ways to value project output are through wholesale power value plus a Renewable Energy Credit (REC) value or through a power value that is comparable to similarly sized wind and solar projects. For the purpose of this study we assumed a power value comparable with wind and solar projects utilizing a power value of $60/MWh, with an escalation of 3% per year. A critical next step will be to confirm this power value and economics in the pro forma. See the Energy Market Assessment Report for more details.

4.0 FINANCIAL PERFORMANCE

A 20 year financial pro forma was completed for each scenario to determine the net present value (NPV) of the Project. To determine the NPV, the pro forma calculates the annual power production cost and annual power sales. The power production cost includes O&M costs and payments made on debt service for the development costs. The study assumes the cost to develop the Project will be funded by bonds. In the pro forma, it is assumed the bonds have a 3.5% interest rate and a 20 year term. A summary of the pro forma results including the NPV and the cost of production and power sales for the first year are provided in Table 5. The detailed pro forma is provided in Appendix D.

TABLE 5 SUMMARY OF FINANCIAL PERFORMANCE – P.E. 16.4 WASTEWAY

	SCENARIO ONE	SCENARIO TWO
First Year Power Production Cost ($/MWH)	$92	$64
First Year Power Value ($/MWH)	$60	$60
20 Year Net Present Value	-$3,220,000	$1,270,000

The pro forma for Scenario One shows that the renewable energy value of output from the project produces significant negative cash flows in every year of operation. Calculation of the NPV of these cash flows (assuming a 4% discount rate) shows an overall loss.

The pro forma results for Scenario Two show an NPV gain over 20 years. Current projected generation values make it necessary to have a more economy-focused development and O&M budget for a financially viable project.

5.0 REGULATORY AND ENVIRONMENTAL

The Federal Energy Regulatory Commission (FERC) preliminary permit was issued on March 26, 2013, (P-14349) and expires February 28, 2016. GCPHA has filed three required 6-month progress reports for the Project to date. The first was filed on August 21, 2013; the second on February 25, 2014; the third on August 21, 2014; and the fourth on February 18, 2015. The next 6-month progress report for the preliminary permit will be due in August of 2015.

Some coordination between United States Bureau of Reclamation (BOR) and South Columbia Basin Irrigation District (SCBID) occurred as part of feasibility assessments conducted in support of the project without opposition. However, no other stakeholders or agencies have commented on the preliminary permit or 6-month progress report filings.

The proposed facilities for the Project would be located on, and adjacent to, the 16.4 Wasteway, which is an irrigation structure that is part of BOR's Columbia Basin Project. The Project will be located partially on BOR fee title land and partially on BOR easements with fee title held by adjoining landowners.

Because the Project is located on federal lands, several FERC processes are precluded, including the FERC 40 MW Conduit Exemption Process. As such, the available FERC authorization process would be licensing. The Project would be subject to Federal Power Act Section 4(e) mandatory conditions imposed by the BOR as the Project would be on federal reservation lands (i.e., those owned in fee title by BOR, regardless of management). While the licensing process is generally longer and more costly than the exemption process, GCPHA could request a waiver of the three stage consultation requirement considering that environmental issues appear to be low. Potential fisheries and Endangered Species Act issues will require agency coordination but may not preclude waiver of the three stage consultation requirement. A downside to FERC licensing is the need to periodically relicense; generally every 30 to 50 years. There would be no annual charges associated with the FERC licensing process as the proposed Project is less than or equal to 1,500 kW. However, FERC would assess land charges of approximately $40/acre for BOR fee title lands occupied by the project. FERC does not charge administrative processing fees for license applications. The cost of preparation and filing of a license application for the Project, not including any potential required studies, would be expected to be less than $50,000.

Alternatively, BOR's Small Conduit Lease of Power Privilege (LOPP) Process may be a viable option. Mandatory conditions are those as imposed/negotiated with BOR in consultation with the agencies. Because BOR is a mandatory conditioning authority (i.e., BOR has the authority to add conditions to the FERC license) in the FERC process for this project, that risk does not appear to be any different from the Small Conduit LOPP. Further, the Small Conduit LOPP allows for a categorical exclusion from the National Environmental Protection Act (NEPA) review, whereas the FERC licensing process would not. Annual charges for the Small Conduit LOPP are $2/MWh so that would cost the Project approximately $18,000 annually. The LOPP process does not prescribe a term to the lease so that creates undesirable uncertainty. An advantage of the LOPP process is that it may allow for construction sooner than the FERC process. In addition, BOR requires applicants to provide advance funding of all BOR application processing costs, which are unknown at this time. The cost of preparation and filing of a Small Conduit LOPP application for the Project, not including any potential required studies, would be expected to be less than $28,000, assuming NEPA exclusion.

There are two main environmental concerns at the Project site: (1) risk of fish in the Columbia River migrating upstream into the powerhouse; and (2) potential presence of the White Bluffs bladderpod, a federally listed threatened plant species. A survey of plant life at the site may be required by the U.S. Fish and Wildlife Service to determine if any White Bluffs bladderpod is present. Further studies or discussions with the National Oceanic and Atmospheric Administration Marine Fisheries Service, the Federal Columbia River Power System Biological Opinion, and other vested parties should be done to determine any development requirements to protect fisheries in the Columbia where the project discharges. It is assumed that a fish exclusion screen will be required for the discharge of the facility.

6.0 POTENTIAL NEXT STEPS

Based on the results of this study, the Project may be feasible if design and procurement of equipment is cost-focused (while still meeting specification standards) and operation and maintenance procedures are optimized. If GCPHA decides to move forward, the next steps are to start preliminary engineering to see what acceptable engineering, procurement, and construction tradeoffs are available to reduce the overall development cost; and to address any FERC/BOR licensing issues.

The preliminary engineering would include the following:

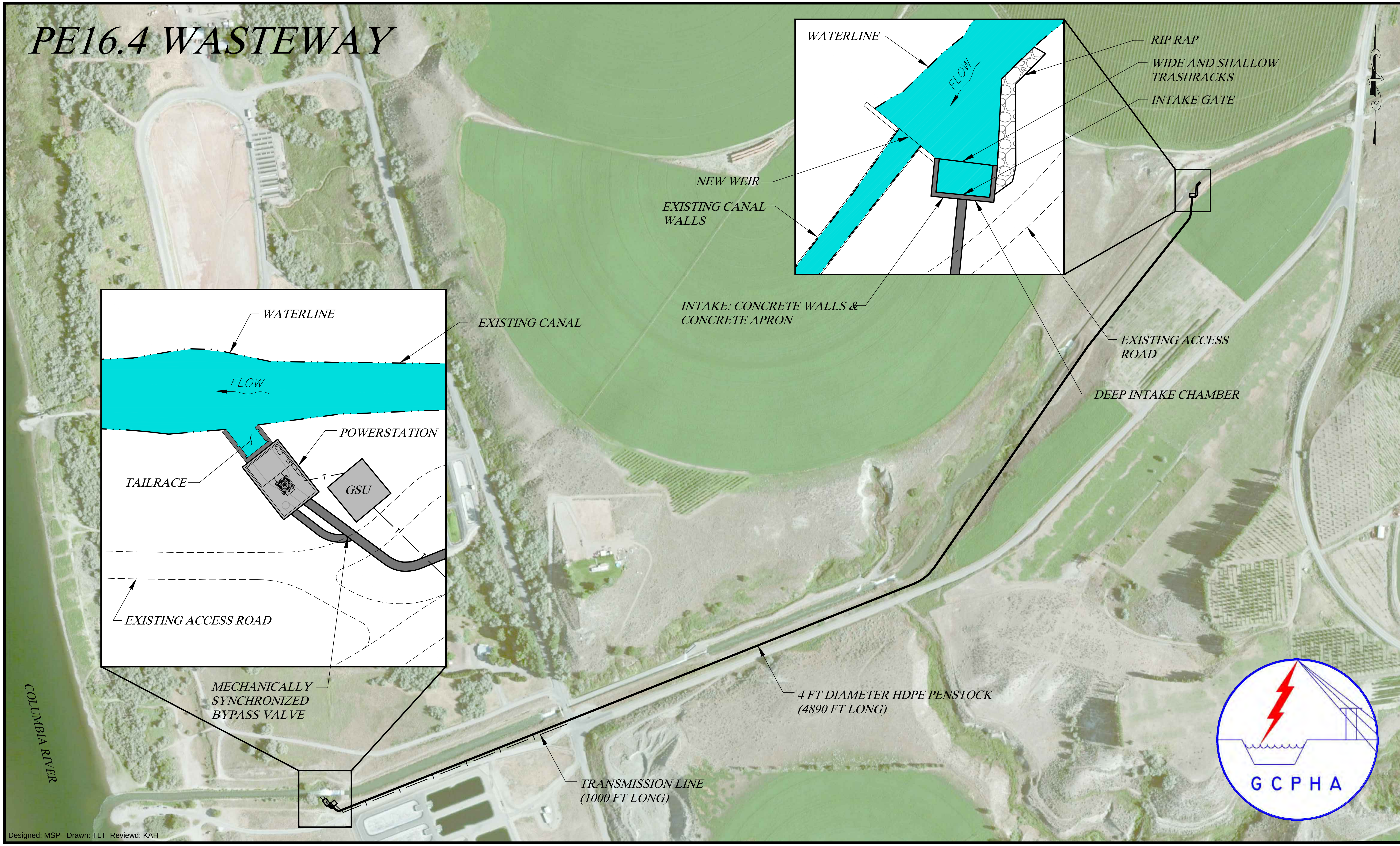
- Confirming the Project concept with basic field investigations and identifying any cost saving design items such as avoiding rock outcrops along the penstock route. A basic site survey may be conducted at this phase to confirm topographic information.
- Providing preliminary drawings up to 30%. Preliminary engineering includes sizing major civil infrastructure such as the penstock size and profile, intake layout, and powerhouse and tailrace layout. The level of detail includes major dimensions, wall thicknesses, and general comments on reinforcement and other significant construction requirements.
- Using the preliminary drawings to facilitate discussions with contractors to get budget pricing for the construction of the Project.
- Identifying any unique features required by vested parties such as the tailrace fish barrier. This will coincide with the permitting and licensing effort.
- Contacting Chinese T/G manufacturers and a third party quality assurance company to acquire pricing on supply, services, and shipping and discuss warranty and support. This would include development of a basic specification to acquire pricing that is for a high quality equipment package.
- Confirming assumptions for electrical interconnection facilities required with both Franklin PUD and BBEC.

An approximate cost for preliminary engineering and investigations would be between $50,000 and $100,000. The variability is largely around the degree of field investigation and survey by third parties that GCPHA decides to engage.

From a regulatory standpoint, this Project may warrant an application for an extension and advancement of FERC licensing should GCPHA decide to pursue the project after the preliminary engineering effort. Alternatively, GCPHA may further investigate the pros and cons of seeking regulatory approval through the lease of power privilege process with BOR. The key driver in this decision would likely be if the preliminary engineering effort confirms the assumptions made in Scenario Two.

APPENDIX A

PROJECT LAYOUT



22x34 = FULL SCALE

J:\1823\003\Drawings\Working Drawings\1823-003 PE16_4WW.dwg

PRINTED Jan. 20, 2015 - 3:27 PM

Kleinschmidt

200 0 200 400
SCALE IN FEET

GRAND COULEE PROJECT HYDROELECTRIC AUTHORITY
EPHRATA, WA

APPENDIX B

SITE PHOTOGRAPHS

P.E. 16.4 WASTEWAY
OCTOBER 2014

PHOTO 1 - POTENTIAL INTAKE LOCATION UPSTREAM OF CHUTE STRUCTURE

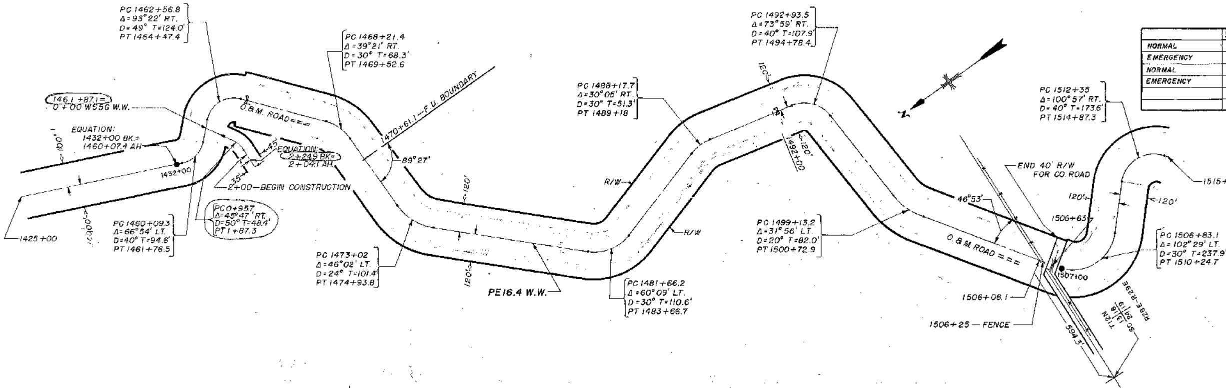
PHOTO 2 - DISCHARGE STRUCTURE UPSTREAM OF POWERHOUSE LOCATION

APPENDIX C

EXISTING DRAWINGS

NOT INCLUDED IN PUBLIC VERSION

(THIS MATERIAL CONTAINS CONFIDENTIAL INFORMATION AND DISTRIBUTION TO THIRD PARTIES IS RESTRICTED BY NON-DISCLOSURE AGREEMENTS WITH THE U.S. BUREAU OF RECLAMATION.)

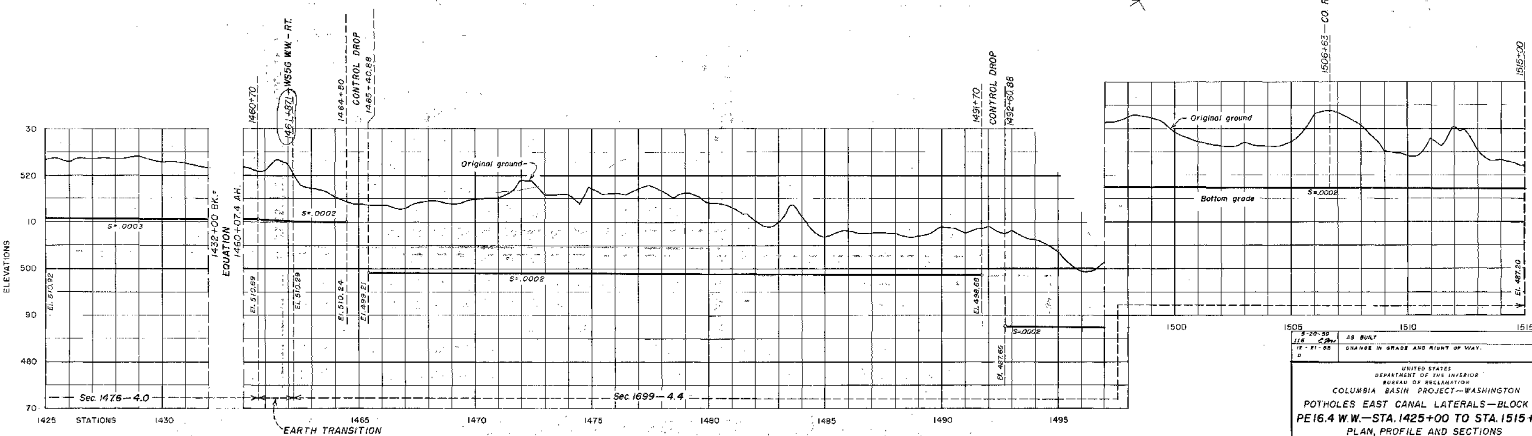


SECTIONS AND HYDRAULIC PROPERTIES

	Section	b	H	W	d	A	r	s	n	v	Q
NORMAL	1699	16	9.9	12	4.4	99.44	3.12	.0002	.025	1.79	178
EMERGENCY					8.9	261.21	5.42		.030	2.22	582
NORMAL	1476	14	7.6	10	4.0	80.00	2.81	.0003	.025	2.04	163
EMERGENCY					6.6	157.74	4.17		.030	2.25	355

NOTE

For typical section see Dwg. 222-116-27311



PE16.4 WASTEWAY

O.&M. Road on Right Side

CONCURRENCE		
Approved	By	Date
Irr. Div.	E.M.	5/4/55

5-20-59 118	AS BUILT
12-21-55 D	CHANGE IN GRADE AND RIGHT OF WAY.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT—WASHINGTON

POTHOLES EAST CANAL LATERALS—BLOCK 19

PE16.4 W.W.—STA. 1425+00 TO STA. 1515+00

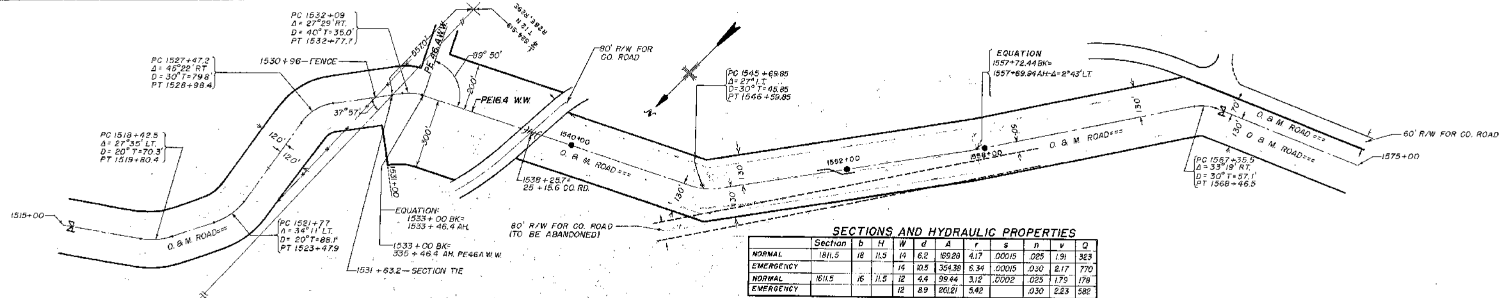
PLAN, PROFILE AND SECTIONS

DRAWN R.A.W. SUBMITTED J.D. Humes
TRACED C.F.D. RECOMMENDED
CHECKED APPROVED
CHIEF DESIGNING ENGINEER

EPHRATA, WASHINGTON MAY 3, 1955 SHEET 7 OF 17 222-116-27319

4571

MICROFILMED MAY 3 1973

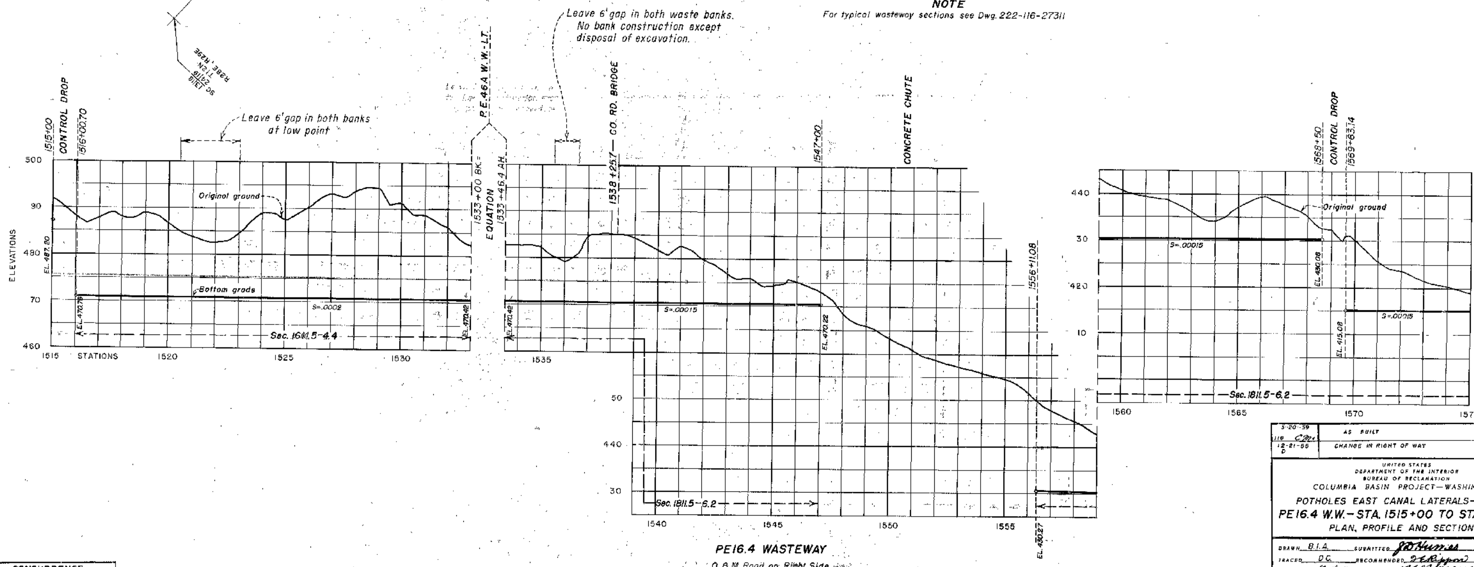


SECTIONS AND HYDRAULIC PROPERTIES

	Section	b	H	W	d	A	r	s	n	v	Q
NORMAL	1811.5	18	11.5	14	6.2	169.28	4.17	.00015	.025	1.91	323
EMERGENCY				14	10.5	354.38	6.34	.00015	.030	2.17	770
NORMAL	1611.5	16	11.5	12	4.4	99.44	3.12	.0002	.025	1.79	178
EMERGENCY				12	8.9	261.21	5.42		.030	2.23	582

NOTE

For typical wasteway sections see Dwg. 222-116-27311



PE16.4 WASTEWAY

O. & M. Road on Right Side

CONCURRENCE		
Approved	By	Date
Irr. Div.	E. N.	5/4/55

5-20-59 118 C.M.	AS BUILT
12-21-55 D	CHANGE IN RIGHT OF WAY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT—WASHINGTON

POTHOLES EAST CANAL LATERALS—BLOCK 19

PE16.4 W.W.—STA. 1515+00 TO STA. 1575+00

PLAN, PROFILE AND SECTIONS

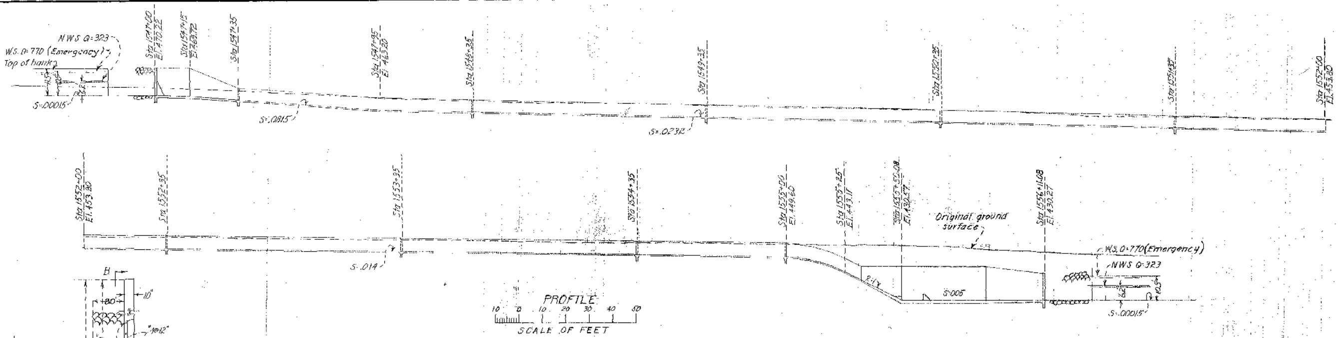
DRAWN B.I.A. SUBMITTED J.D. Humes
TRACED D.C. RECOMMENDED D.E. Rippon
CHECKED W.W.K. APPROVED T.W. Mermel
CHIEF DESIGNING ENGINEER

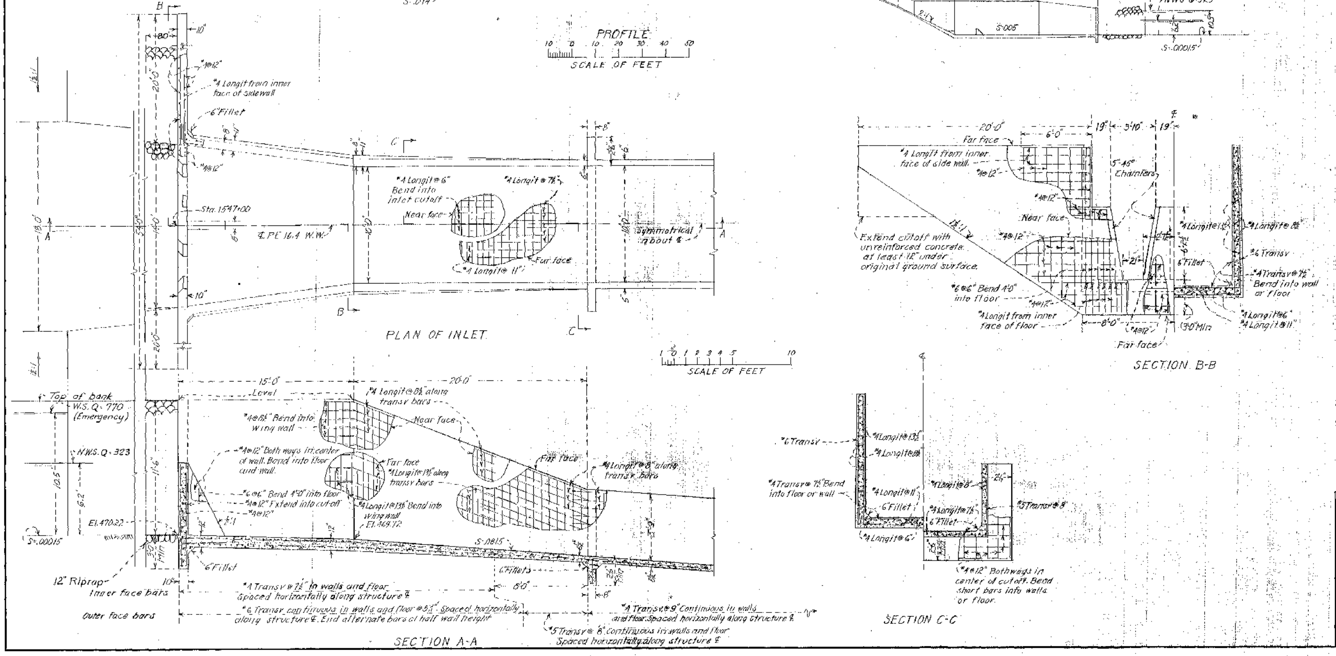
EPHRATA, WASHINGTON MAY 3, 1955
SHEET 8 OF 17

222-116-27320

4571

MICROFILMED MAY 3 1973





HYDRAULIC PROPERTIES

SECTION	A	V	Q	r	n	S
NORMAL	169.26	1.91	323	4.17	.025	.00015
EMERGENCY	354.38	2.17	770	6.34	.030	.00015

ESTIMATED QUANTITIES

Concrete ________________ 545 Cu. yds.
Reinforcement steel __________ 64,000 Lbs.

NOTES

Unless otherwise shown, place reinforcement so that the clear distance between face of concrete and nearest reinforcement is 1½" for #5 bars and less, and 2" for #6 bars and greater; except provide a clear distance from face of concrete placed against earth or rock of 2" where slab thickness is 9" or less, 3" where slab thickness is greater than 9".
Lap all bars 20 diameters at splices, unless otherwise shown.
Concrete design based on a compressive strength of 3000 lbs per sq. in.
For details of pool, see 222-D-18418

5-20-59	AS BUILT BY 116

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT-WASHINGTON
POTHOLES EAST CANAL LATERALS-BLOCK 19
P.E. 16.4 W.W. STA 1547+00
CONCRETE CHUTE
INLET DETAILS

DRAWN DEC SUBMITTED
TRACED RECOMMENDED
CHECKED S.E.R. APPROVED CHIEF DESIGNING ENGINEER

DENVER, COLORADO, OCT. 10, 1955 SHEET 1 OF 2 — 222-D-18417

4571

MICROFILMED NOV 1171

APPENDIX D

20 YEAR PRO FORMAS

20 YEAR PRO FORMA — SCENARIO ONE

Pro Forma Cash Flow
P.E. 16.4 Wasteway
Scenario 1

Assumptions			**Cash Flow**										
			Year	1	2	3	4	5	6	7	8	9	10
Capital Cost	$ 8,880,000		Debt Service	$624,806	$624,806	$624,806	$624,806	$624,806	$624,806	$624,806	$624,806	$624,806	$624,806
Debt Period (Years)	20												
Interest Rate	3.5%		Operations Cost	$100,000	$103,000	$106,090	$109,273	$112,551	$115,927	$119,405	$122,987	$126,677	$130,477
Operations Cost	$ 100,000		Maintenance Cost	$100,000	$103,000	$106,090	$109,273	$112,551	$115,927	$119,405	$122,987	$126,677	$130,477
O&M Escalation	3%												
			Admin Cost	$100,000	$103,000	$106,090	$109,273	$112,551	$115,927	$119,405	$122,987	$126,677	$130,477
Maintenance Cost	$ 100,000												
Maintenance Escalation	3%		Power Production Cost ($/MWh)	$92	$93	$94	$95	$96	$97	$98	$99	$100	$102
Admin Cost	$ 100,000		Power Sales	$600,000	$618,000	$636,540	$655,636	$675,305	$695,564	$716,431	$737,924	$760,062	$782,864
O&M Escalation	3%												
			Cash Flow (-)	($324,806)	($315,806)	($306,536)	($296,988)	($287,154)	($277,024)	($266,591)	($255,844)	($244,775)	($233,374)
Annual Energy (MWh)	10,000												
			Annual Power Value ($/MWh)	$60	$62	$64	$66	$68	$70	$72	$74	$76	$78
Power Value ($/MWh)	60												
Power Value Escalation	3%		Power Value Gap ($/MWh)	$32	$32	$31	$30	$29	$28	$27	$26	$24	$23
			Required Capacity and Environmental Attribute Value ($/kW-mo)	$18	$18	$17	$16	$16	$15	$15	$14	$14	$13
			NPV (4% IRR)	($3,219,890)									

Pro Forma Cash Flow
P.E. 16.4 Wasteway
Scenario 1

Cash Flow										
Year	11	12	13	14	15	16	17	18	19	20
Debt Service	$624,806	$624,806	$624,806	$624,806	$624,806	$624,806	$624,806	$624,806	$624,806	$624,806
Operations Cost	$134,392	$138,423	$142,576	$146,853	$151,259	$155,797	$160,471	$165,285	$170,243	$175,351
Maintenance Cost	$134,392	$138,423	$142,576	$146,853	$151,259	$155,797	$160,471	$165,285	$170,243	$175,351
Admin Cost	$134,392	$138,423	$142,576	$146,853	$151,259	$155,797	$160,471	$165,285	$170,243	$175,351
Power Production Cost ($/MWh)	$103	$104	$105	$107	$108	$109	$111	$112	$114	$115
Power Sales	$806,350	$830,540	$855,457	$881,120	$907,554	$934,780	$962,824	$991,709	$1,021,460	$1,052,104
Cash Flow (-)	($221,631)	($209,536)	($197,078)	($184,246)	($171,029)	($157,416)	($143,394)	($128,952)	($114,076)	($98,755)
Annual Power Value ($/MWh)	$81	$83	$86	$88	$91	$93	$96	$99	$102	$105
Power Value Gap ($/MWh)	$22	$21	$20	$18	$17	$16	$14	$13	$11	$10
Required Capacity and Environmental Attribute Value ($/kW-mo)	$12	$12	$11	$10	$10	$9	$8	$7	$6	$5
NPV (4% IRR)										

20 YEAR PRO FORMA — SCENARIO TWO

Pro Forma Cash Flow
P.E. 16.4 Wasteway
Scenario 2

Assumptions			**Cash Flow**											
Best Case Cost Reduction	25%		**Year**	1	2	3	4	5	6	7	8	9	10	11
Capital Cost	$ 6,950,000		Debt Service	$489,009	$489,009	$489,009	$489,009	$489,009	$489,009	$489,009	$489,009	$489,009	$489,009	$489,009
Debt Period (Years)	20													
Interest Rate	3.5%		Operations Cost	$50,000	$51,500	$53,045	$54,636	$56,275	$57,964	$59,703	$61,494	$63,339	$65,239	$67,196
Operations Cost	$ 50,000		Maintenance Cost	$50,000	$51,500	$53,045	$54,636	$56,275	$57,964	$59,703	$61,494	$63,339	$65,239	$67,196
O&M Escalation	3%													
			Admin Cost	$50,000	$51,500	$53,045	$54,636	$56,275	$57,964	$59,703	$61,494	$63,339	$65,239	$67,196
Maintenance Cost	$ 50,000													
Maintenance Escalation	3%		Power Production Cost ($/MWh)	$64	$64	$65	$65	$66	$66	$67	$67	$68	$68	$69
Admin Cost	$ 50,000		Power Sales	$600,000	$618,000	$636,540	$655,636	$675,305	$695,564	$716,431	$737,924	$760,062	$782,864	$806,350
O&M Escalation	3%													
			Cash Flow (-)	($39,009)	($25,509)	($11,604)	$2,718	$17,469	$32,664	$48,314	$64,434	$81,037	$98,138	$115,753
Annual Energy (MWh)	10,000													
			Annual Power Value ($/MWh)	$60	$62	$64	$66	$68	$70	$72	$74	$76	$78	$81
Power Value ($/MWh)	60													
Power Value Escalation	3%		Power Value Gap ($/MWh)	$4	$3	$1	($0)	($2)	($3)	($5)	($6)	($8)	($10)	($12)
			Required Capacity and Environmental Attribute Value ($/kW-mo)	$2	$1	$1	($0)	($1)	($2)	($3)	($4)	($5)	($5)	($6)
			NPV (4% IRR)	$1,261,350										

Pro Forma Cash Flow
P.E. 16.4 Wasteway
Scenario 2

Cash Flow									
Year	12	13	14	15	16	17	18	19	20
Debt Service	$489,009	$489,009	$489,009	$489,009	$489,009	$489,009	$489,009	$489,009	$489,009
Operations Cost	$69,212	$71,288	$73,427	$75,629	$77,898	$80,235	$82,642	$85,122	$87,675
Maintenance Cost	$69,212	$71,288	$73,427	$75,629	$77,898	$80,235	$82,642	$85,122	$87,675
Admin Cost	$69,212	$71,288	$73,427	$75,629	$77,898	$80,235	$82,642	$85,122	$87,675
Power Production Cost ($/MWh)	$70	$70	$71	$72	$72	$73	$74	$74	$75
Power Sales	$830,540	$855,457	$881,120	$907,554	$934,780	$962,824	$991,709	$1,021,460	$1,052,104
Cash Flow (-)	$133,896	$152,583	$171,831	$191,656	$212,076	$233,108	$254,772	$277,085	$300,068
Annual Power Value ($/MWh)	$83	$86	$88	$91	$93	$96	$99	$102	$105
Power Value Gap ($/MWh)	($13)	($15)	($17)	($19)	($21)	($23)	($25)	($28)	($30)
Required Capacity and Environmental Attribute Value ($/kW-mo)	($7)	($8)	($10)	($11)	($12)	($13)	($14)	($15)	($17)
NPV (4% IRR)									

PE46A WASTEWAY

SCREENING LEVEL FEASIBILITY REPORT

P.E. 46A WASTEWAY

FERC NO. P-14351

Prepared for:

Grand Coulee Project Hydroelectric Authority
Ephrata, Washington

Prepared by:

Kleinschmidt

Gresham, Oregon
www.KleinschmidtGroup.com

February 2015

Screening Level Feasibility Report

P.E. 46A Wasteway

FERC No. P-14351

Prepared for:

Grand Coulee Project Hydroelectric Authority
Ephrata, Washington

Prepared by:

Kleinschmidt

Gresham, Oregon
www.KleinschmidtGroup.com

February 2015

SCREENING LEVEL FEASIBILITY REPORT

P.E. 46A WASTEWAY
FERC No. P-14351

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

J:\1823\003\Docs\Project Sites _SharePoint\Final Deliverables\04 PE 46A Wasteway\001 P E 46A Wasteway-3-2-15.docx

EXECUTIVE SUMMARY

The proposed P.E. 46A Wasteway Hydroelectric Project (Project) would utilize return irrigation water that flows down the wasteway chute and into P.E. 16.4 Wasteway. Kleinschmidt Associates (Kleinschmidt) was developed the Project concept through existing site information such as site specific flow data, topography, site visits, discussions with Grand Coulee Project Hydroelectric Authority (GCPHA), and information from equipment vendors (Appendix A).

The Project infrastructure includes a new concrete intake, a Langemann ® Gate, an 820-foot long high-density polyethylene (HDPE) penstock (buried), a single horizontal Francis turbine with an output of 640 kilowatts (kW), a powerstation with a concrete slab foundation with thrust blocks and prefabricated steel building superstructure, and a steel draft tube that extends downward into the Potholes East Canal.

The Project development has been evaluated in two ways. Scenario One was evaluated as a plant that would have all the features of a larger facility and with operation and maintenance (O&M) costs prorated from existing GCPHA small hydro sites. Scenario Two was then studied with a more cost-focused development,lower construction contingencies, purchase of lower cost turbine generator equipment manufactured in China, and O&M efficiencies made by using existing staff resources to operate and maintain the Project. Table 1 summarizes the results of each scenario.

TABLE 1 SUMMARY OF STUDY RESULTS - P.E. 46A WASTEWAY

	SCENARIO ONE	SCENARIO TWO
Total Development Cost Analysis	$4,180,000	$3,280,000
20 Year Net Present Value	-$2,720,000	-$950,000

Scenario Two shows a much smaller loss over the 20 year term, but it still produces a negative net present value (NPV) over the 20 year pro forma. This indicates that under both scenarios the Project is not financially viable.

1.0 PROJECT DESCRIPTION

1.1 EXISTING CONDITIONS

P.E. 46A Wasteway is located in Franklin County, Washington, in the South Columbia Basin Irrigation District (SCBID), east of the Columbia River, and north of Pasco (Figure 1).

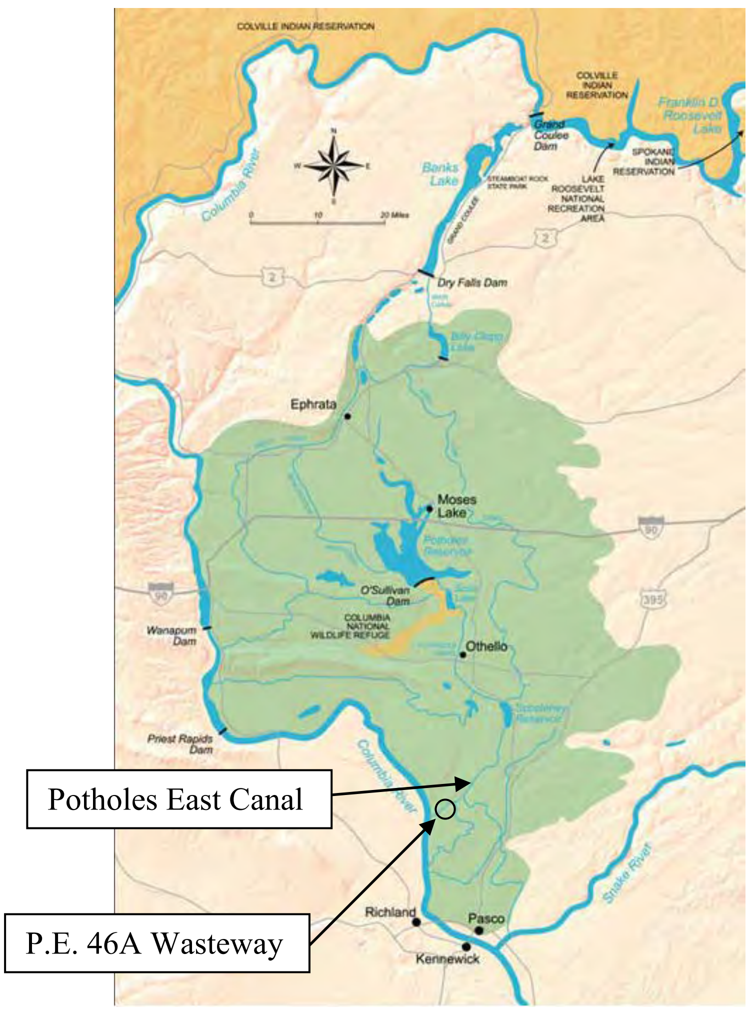


FIGURE 1 COLUMBIA BASIN PROJECT IRRIGATION AREA (BUREAU OF RECLAMATION MAP)

SCBID is part of the Columbia Basin Project which is owned by the United States Bureau of Reclamation (BOR). The P.E. 46A Wasteway is a Transferred Works Project, which means that it is owned by BOR, but its operation and maintenance have been transferred to SCBID. The P.E. 46A Wasteway discharges irrigation return flows and canal system operational spills into P.E. 16.4 Wasteway. Appendix B shows site photographs at the locations of the proposed intake and powerhouse.

The wasteway consists of a concrete intake, a buried high-density polyethylene (HDPE) pipe, and an energy dissipation structure at the bottom of the wasteway. There is also an intake to a bypass reach, but use of this bypass in the past has created significant damage to the steep sand and gravel bank. It is not part of the wasteway operating plan to utilize this bypass due to the continued slope degradation. More details on the canal elevations, wasteway, topography, and water elevations are provided on existing canal drawings in Appendix C. The Project conceptual design is based on existing drawings, information provided by GCPHA, and data gathered from a site visit.

Water Elevations:

- Normal Headpond: 620 feet
- Normal Tailwater: 475 feet

Upstream Freeboard: 2 feet from normal flow level to bypass intake invert

Site Hydraulics: P.E. 46A Wasteway conveys higher irrigation return flows during the irrigation season (late March through October) and minimal flows from runoff and drainage during the non-irrigation season (November through March). The annual flow duration curve provided in Figure 2 is based on site flow data from 2007 to 2012.

- Annual Flow Patterns: Flow only during irrigation season
Runoff and drainage flow during the off season
- Emergency Flow Capacity: 187 cubic feet per second (cfs)

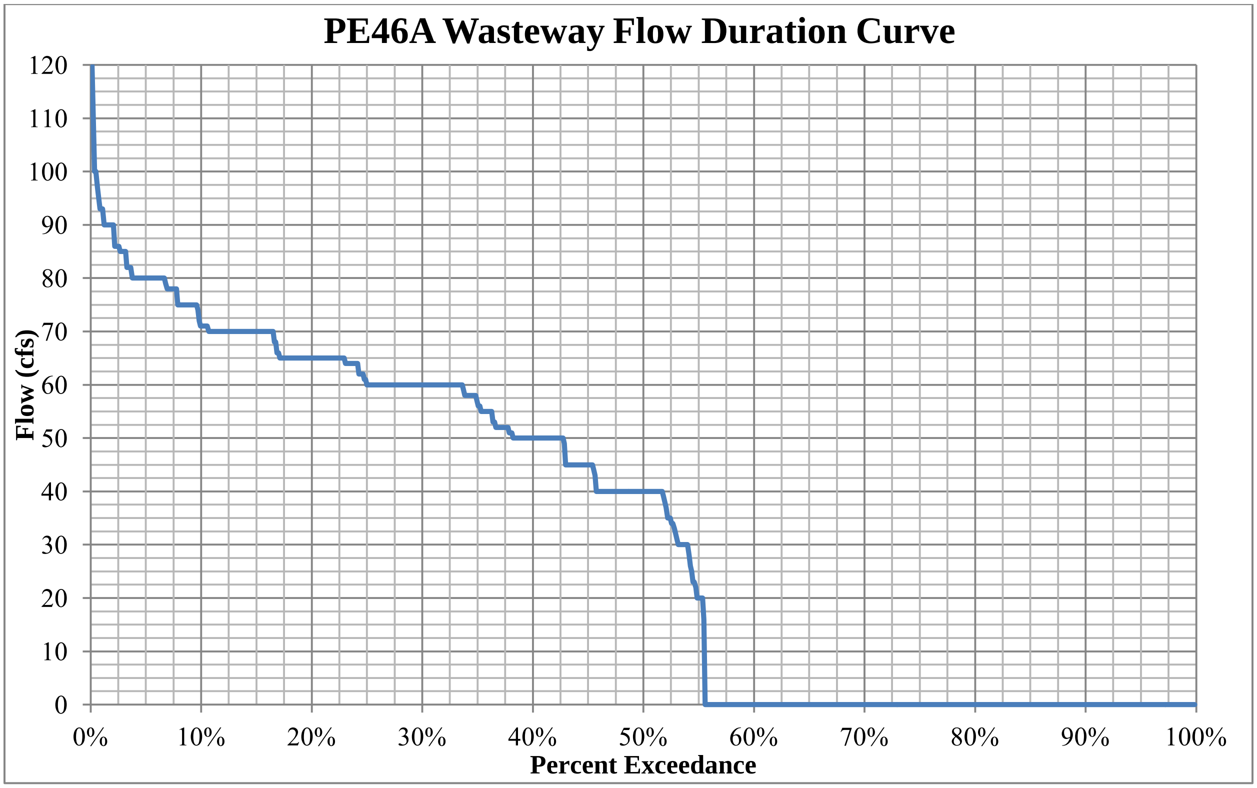


FIGURE 2 FLOW DURATION CURVE

Geotechnical Considerations: The site soil characteristics are assumed to be primarily sand and gravel along the lower half of the penstock and powerhouse area while clay deposits are assumed to be present near the intake and upper penstock area. These assumptions are based on a visual site assessment, existing drawings, and experience from SCBID during the installation of the Project's HDPE penstock adjacent to the proposed penstock location. Rock is assumed to be located within 20 feet below the soil surface. Further geotechnical investigation, such as site borings and test pits, would reduce the risk of unexpected geotechnical conditions such as encountering high or low rock elevations and/or quality than assumed in this study.

1.2 PROPOSED DEVELOPMENT

The P.E. 46A Wasteway Project concept layout is shown on Appendix A. This Project concept has the following basic features:

- Capacity: 640 kilowatts (kW)
- Turbine Type: Horizontal Francis

- Turbine Design Flow: 50 cfs
- Gross Head: 145 feet
- Transmission Line Length: 250 feet

Water Control & Bypass: Maintaining a constant upstream water level is critical at this site because there is an overflow structure that should never overtop. If the existing overflow structure does overtop, the flow will create significant slope damage downstream. Therefore, a new water level control structure is proposed at the inlet to the existing pipe that includes a Langemann® Gate. This structure would be installed during the off season and would only require sand bags for dewatering. In addition, a mechanically synchronized turbine bypass valve will be located at the powerhouse to release flow in the event of a unit shutdown.

Since the upstream canal offers negligible available storage volume, the Project will pass the flow available at the time with excess flow bypassing through the Langemann ® Gate.

Intake: The concrete intake structure would support trashracks and an intake headgate at the penstock inlet. The trashracks at this site would require a trash rake since aquatic weeds in the canal can be a significant issue at certain times during the year.

Penstock: The penstock diameter is sized to balance construction cost and headloss for the site. The penstock is a buried HDPE pipe which is less expensive to supply, faster to install, and, because it will not need to be painted, will have lower long term maintenance costs compared to a steel penstock. HDPE is possible for this Project due to a combination of relatively low internal hydrostatic pressures and lack of dynamic pressures (such as water hammer due to the presence of a bypass valve). HDPE is sometimes partially buried or supported along the bottom third of the pipe which is less expensive to install. However, HDPE has a very high expansion rate due to temperature change; therefore the pipe would require a number of expensive expansion joints removing the partial burial savings. Additionally, full burial protects the pipe from exposure to the environment such as deterioration due to ultraviolet exposure. Details for the penstock are as follows:

- Diameter: 2.5 feet
- Length: 820 feet
- Material: HDPE
- Support: Buried

Powerhouse: The powerhouse consists of a compact reinforced concrete substructure and prefabricated steel superstructure. The powerhouse will likely be founded on sand and gravel. The foundation consists of a concrete perimeter frost wall with a spread footing and a center concrete pedestal supporting the horizontal Francis unit. The Francis turbine is installed on the generator floor thereby reducing substructure costs. The remainder of the powerhouse floor consists of a concrete slab on compacted soil. A small monorail chain hoist will be installed for basic operation and maintenance. The powerhouse will have a small, separate electrical room with climate control to extend the life of the controls, protective relaying, and switchgear equipment. Kleinschmidt has assumed the Project is unmanned and remotely monitored via supervisory control and data acquisition (SCADA).

Generating Units: A single horizontal Francis unit has been selected for this Project as it is the most economical solution given the available head and flow of the site. The horizontal Francis unit requires less excavation and a more compact substructure, which saves on development costs. Details on the turbine are as follows:

- Type: Horizontal Francis
- Output: 640 kW
- Operational Range: 20 – 50 cfs
- Setting: 6 feet above tailwater
- Number: 1

Access and Constructability: Access to the intake, penstock, and powerhouse areas will be achieved by the existing gravel access roads. These access roads connect directly to public roads. Fencing may be required to secure the Project.

A small sandbag cofferdam will be required at the intake to keep the area dry from occasional winter flows when installing the new intake structure and the Langemann ® Gate. It is anticipated the majority of the powerhouse and tailrace construction will be completed prior to tying the tailrace into the existing canal. Temporary dewatering will likely be installed during construction of the powerhouse.

The penstock route is located to the eastern side of the wasteway pipe. The slope is steep so some additional cost may be required to achieve the excavation, installation, and backfill for the penstock.

Substation and Interconnection: A generator step-up transformer (GSU) is needed to match the voltage from the unit generator to the 13.2 kilovolt (kV) transmission line. Approximately 250 feet of three-phase transmission line and poles are needed to connect the GSU to the nearby overhead distribution line owned by Big Bend Electric Cooperative (BBEC).According to BBEC, about 1.5 miles (250 feet from GSU to interconnection point included) of 13.2 kV transmission line will be subject to a combination of new construction and upgrades to accommodate the interconnection of this Project to their system. Disconnect switches, relays, and protection are assumed to be required by the utility at the point of interconnection and are included in the cost analysis. BBEC will perform system studies to finalize the design, equipment requirements, and potential system upgrades. The cost of these studies is included in the cost analysis for the Project. Installation of a concrete containment pad for the GSU is also included in the cost analysis.

2.0 COST ANALYSIS

2.1 CONSTRUCTION COSTS ANALYSIS

For Scenario One, an analysis of a construction cost is provided in Table 2. The total construction cost includes all work and equipment to complete the Project. This includes all temporary construction features, permanent civil work, purchase and installation of the turbine/generator equipment, mechanical equipment, electrical equipment, and substation and interconnection costs.

TABLE 2 CONSTRUCTION COST FOR SCENARIO ONE – P.E. 46A WASTEWAY

ITEM	DESCRIPTION	CONTINGENCY	CONSTRUCTION COST ANALYSIS[1]	NOTES
1	Mobilization and Demobilization	0%	$210,000	Site set up, soil erosion measures, site restoration
2	Cofferdams and Dewatering	25%	$90,000	Intake cofferdam, monthly dewatering, no tailrace cofferdam
3	Spillway Work	25%	$130,000	Move an existing supply valve, new steel weir installed in the wet
4	Intake	25%	$350,000	Concrete walls, trashracks, walkways, trash rake, headgate
5	Penstock	20%	$270,000	Buried 2.5-foot HDPE penstock, 820 feet long
6	Powerhouse and Tailrace	25%	$380,000	Approx. 25'x30' powerstation horizontal Francis powerstation
7	Turbine/Generator Supply and Install	10%	$1,480,000	Water-to-wire package including turbine, generator, switchgear, PLC, etc.
8	Balance of Plant	20%	$150,000	Pumps, piping, wiring, HVAC, P&ID, etc.
9	Substation and Interconnection	20%	$470,000	GSU, transmission line, primary metering, protection, and interconnection study
10	Other	5%	$100,000	Insurance and bonding
Weighted Average Contingency		16%		
CONSTRUCTION COST ANALYSIS TOTAL			**$3,630,000**	

[1] These numbers are based on 2014 costs.

The major development costs for this site include supply and installation of the turbine/generator (T/G) equipment; construction of the powerstation, including all civil mechanical and electrical features; the substation/interconnection; and the penstock installation. The T/G equipment and installation cost was higher than the powerhouse cost because the powerhouse design is simplified, allowing the Francis unit to be installed above ground. Major costs for the powerhouse included excavation necessary to bring the penstock into the powerhouse, installation of adequate footings, and the Francis draft tube.

The civil/site costs such as temporary structures, excavation, concrete, etc. were developed based on quantities taken from the proposed concept layout and existing drawings of the canal combined with unit costs. The unit costs were prorated from the averages of actual costs from hydroelectric Projects constructed in the northern United States within the last two years. In addition JR Merit, a Washington state contractor, provided input on regionally appropriate line item costs and construction considerations.

Turbine/generator equipment costs were based on vendor budgetary quotes solicited for this Project from established North American turbine suppliers. These water-to-wire equipment budgetary bids also include the unit switchgear, controls, and hydraulic power unit (HPU). Remaining plant costs include valves, pumps, HVAC, piping, and instrumentation. These costs were derived from prices from similar Projects.

The estimated substation and interconnection capital cost includes the overhead transmission line, primary metering, special substation relay/protection equipment, system studies, a GSU, and GSU concrete containment pad/foundation.

Table 2 includes contingencies for each area of work. Work that will occur near a body of water or that will require deeper excavation or pile driving (e.g., spillway work and cofferdams) were given a higher contingency of 25% due to unknowns with site geology. The penstock work was assigned a contingency of 20% due to shallower excavation with the possibility of unknown subsurface conditions. Balance of plant and interconnection costs were also given a contingency of 20% due to more unknowns, as opposed to the 10% contingency used for turbine/generator equipment, where budgetary quotes provided by vendors.

Scenario Two incorporates features required for safe and reliable Project operation. The costs were reduced in this cost analysis by considering the following factors:

- Favorable results of site geotechnical investigations such as lower top of rock elevations.
- Shared risk of construction costs with a qualified and reliable construction company. This could be done in several ways such as engaging a contractor to prepare an independent cost estimate or entering into various alternatives to traditional Design-Bid-Build such as Construction Management or Design Build contract delivery methods. The advantages and disadvantages of these project delivery methods are discussed in Section 6.0.
- Purchase of T/G equipment directly from Chinese manufacturers. North American turbine suppliers have been purchasing more Chinese fabricated equipment over the last 10 years in order to be more cost competitive. These suppliers have quality control and assurance programs in place to assure the foreign products meet specification standards. It is important that these standards are understood and properly specified. When purchasing equipment directly from Chinese manufacturers, owners often choose to hire a third party quality assurance company near the manufacturing facility. Kleinschmidt has experienced this method of T/G procurement to be much less expensive than going through a North American supply company. Chinese manufactures do not have maintenance and rebuild crews in the United States; however, GCPHA operates Japanese T/G equipment without the benefit of domestic maintenance and rebuild crews. To date, GCPHA has experienced no resulting adverse reliability effects.
- Construction cost-focused design. The powerhouse footprint and other civil infrastructure such as the intake would be optimized to achieve safe and reliable operation conditions but sacrifice maintenance space. Also, instead of a trash rake a less expensive air blast system could be installed on the trashracks that would essentially blow debris off the trashracks in order to sluice trash.

Table 3 shows the breakdown of each factor that could combine to create the overall savings of up to 25%. The 25% reduction shown in Table 3 was selected from between 10% and 36% because it’s reasonable to assume that much but not all of the cost savings listed may be achieved under favorable conditions.

TABLE 3 CONTRIBUTING FACTORS FOR REDUCED COST IN SCENARIO TWO – P.E. 46A WASTEWAY

ITEM	DESCRIPTION	POSSIBLE COST REDUCTION	NOTES
1	Reduced Contingency	0-16%	Possibility for site conditions or pricing to be more favorable than predicted
2	Economy Focused Design and Delivery	5-10%	Minimized civil works, minimized powerhouse footprint
3	Chinese Turbine Supply	5-10%	
	Overall Cost Reduction for Developer Grade	25%	
	CONSTRUCTION COST ANALYSIS TOTAL WITH 25% REDUCTION	**$2,730,000**	

2.2 OTHER DEVELOPMENT COSTS

There are a number of other development costs to consider aside from the previously quantified direct initial construction and installation. These items include:

- engineering
- construction assistance
- licensing and permitting
- environmental studies
- marketing fees
- legal fees
- transaction fees
- land acquisition
- sales tax
- property tax
- GCPHA internal costs
- Administration

For this cost analysis, it is assumed that 15% of the total construction cost applies to the other development costs listed above for both scenarios.

2.3 Summary of Development Costs

The total development cost for each scenario (which includes the construction cost and other development costs) and a unit cost per kW are listed in Table 4 for comparison.

Table 4 Summary of Development Costs – P.E. 46A Wasteway

	Scenario One	Scenario Two
Construction Cost	$3,630,000	$2,730,000
Other Development Costs	$550,000	$550,000
Total Development Cost	$4,180,000	$3,280,000
Turbine Rating (kW)	640	640
Total Development Cost ($/kW)	$6,531	$5,125

For Scenario Two, the total development cost is in the range or below of a recently developed small hydro in the Northwest that cost $6,000/kW (Juniper Ridge Hydro, 3MW, 2009). A June 2013 Oak Ridge National Laboratory (ORNL) study of Oregon Small Hydro shows costs ranging from $1,500/kW for higher head, 3-5 megawatt (MW) projects to well over $10,000/kW for lower head/lower power projects.

2.4 Operation and Maintenance

O&M costs include internal maintenance staff, wheeling charges, administration, cost of consumables, and other costs. GCPHA provided cost information based on their current O&M practices for smaller-sized projects. This calculation results in an O&M cost estimate of approximately $30/megawatt hour (MWh) of generation. The pro forma increases this cost at an annual rate of 3%.

For Scenario Two, an O&M cost of $15/MWh was used, assuming there was increased efficiency by using existing staff and resources currently available for the O&M of other facilities. This cost would also include a $2/MWh to $3/MWh charge for power delivery over BBEC facilities.

3.0 ANNUAL ENERGY ESTIMATE AND VALUE

Based on flow and head information provided by GCPHA, typical turbine efficiencies, and typical operational factors, it is estimated that the annual energy production is 2,700 MWh. This is a 48% capacity factor. The estimate was obtained by an energy model that calculated the average energy produced based on two flow points per month.

The two ways to value project output are through wholesale power value plus a Renewable Energy Credit (REC) value or through a power value that is comparable to similarly sized wind and solar projects. For the purpose of this study we assumed a power value comparable with wind and solar projects utilizing a power value of $60/MWh, with an escalation of 3% per year. A critical next step will be to confirm this power value and economics in the pro forma. See the Energy Market Assessment Report for more details.

4.0 FINANCIAL PERFORMANCE

A 20 year financial pro forma was completed for each scenario to determine the net present value (NPV) of the Project. To determine the NPV the pro forma calculates the annual power production cost and annual power sales. The power production cost includes O&M costs and payments made on debt service for the development costs. The study assumes the cost to develop the Project will be funded by bonds. In the pro forma discussed, it is assumed the bonds have a 3.5% interest rate and a 20 year term. A summary of the pro forma results including the NPV and the cost of production and power sales for the first year are provided in Table 5. The detailed pro forma is provided in Appendix D.

TABLE 5 SUMMARY OF FINANCIAL PERFORMANCE – P.E. 46A WASTEWAY

	SCENARIO ONE	SCENARIO TWO
First Year Power Production Cost ($/MWh)	$142	$99
First Year Power Value ($/MWh)	$60	$60
20 Year Net Present Value	-$2,720,000	-$950,000

The pro forma for each scenario shows that the renewable energy value of output from the Project produces significant negative cash flows in every year of operation.

5.0 REGULATORY AND ENVIRONMENTAL

The Federal Energy Regulatory Commission (FERC) preliminary permit was issued on March 26, 2013 (P-14351) and expires on March 28, 2016. GCPHA has filed three required 6-month progress reports for the Project to date. The first was filed on August 25, 2013; the second on March 1, 2014; the third on August 25, 2014; and the fourth on February 18, 2015. The next 6-month progress report for the preliminary permit will be due in August of 2015.

The Department of the Interior filed a letter on April 6, 2012, regarding GCPHA's application for preliminary permit indicating they had no comments. A motion to intervene was filed by a competing applicant and was dismissed; however, no other stakeholders or agencies have commented on the preliminary permit or 6-month progress report filings.

The proposed facilities for the Project would be located on, and adjacent to, the 46A Wasteway, which is an irrigation structure that is part of United States Bureau of Reclamation's (BOR) Columbia Basin Project. The Project will be located on BOR easements, with fee title held by adjoining landowners. BOR has some fee title land to the west of the project, which the current project configuration avoids. BOR owns the Wasteway, with operation provided by the South Columbia Basin Irrigation District (SCBID).

Several FERC processes are potentially available to the Project, including the FERC 40 MW Conduit Exemption Process and the FERC licensing process. However, if the lands on which the Wasteway channel is located are BOR fee title lands, the Project would be on federal reservation lands (i.e., those owned in fee title by BOR, regardless of management). If this is the case, the exemption process would be unavailable to GCPHA and licensing would be the only option. The Project may be subject to Federal Power Act Section 4(e) mandatory conditions imposed by the BOR. While the licensing process is generally longer and more costly than the exemption process, GCPHA could request a waiver of the three stage consultation requirement considering that environmental issues appear to be low. A downside to FERC licensing is the need to periodically relicense; generally every 30 to 50 years, which is not required of the FERC exemption process. There would be no annual charges associated with the FERC licensing process as the proposed Project is less than 1,500 kW. In addition, FERC does not charge administrative processing fees for license applications. The cost of preparation and filing of an exemption application for the Project, not including any potential required studies, would be expected to be less than $25,000 and less than $50,000 for a license application.

Alternatively, BOR's Small Conduit Lease of Power Privilege (LOPP) Process may be a viable option. Mandatory conditions are those as imposed or negotiated with BOR in consultation with the agencies. Because BOR is likely a mandatory conditioning authority (i.e., BOR has the authority to add conditions to the FERC license) in the FERC process for this Project, that risk does not appear to be any different from the Small Conduit (LOPP). Further, the Small Conduit LOPP allows for a categorical exclusion from the National Environmental Protection Act (NEPA) review, as does the FERC exemption process. However, the FERC licensing process would not allow this exclusion. Annual charges for the Small Conduit LOPP would be estimated at $5,600 at the discounted rate anticipating shared maintenance costs with SCBID. In addition, BOR requires applicants to provide advance funding of all BOR application processing costs, which are unknown at this time. The cost of preparation and filing of a Small Conduit LOPP application for the Project, not including any potential required studies, would be expected to be less than $28,000, assuming NEPA exclusion.

The main environmental concern at the site is the potential presence of the White Bluffs bladderpod, a federally listed threatened plant species. A survey of plant life at the site may be required by the U.S. Fish and Wildlife Service to determine if any White Bluff bladderpod is present.

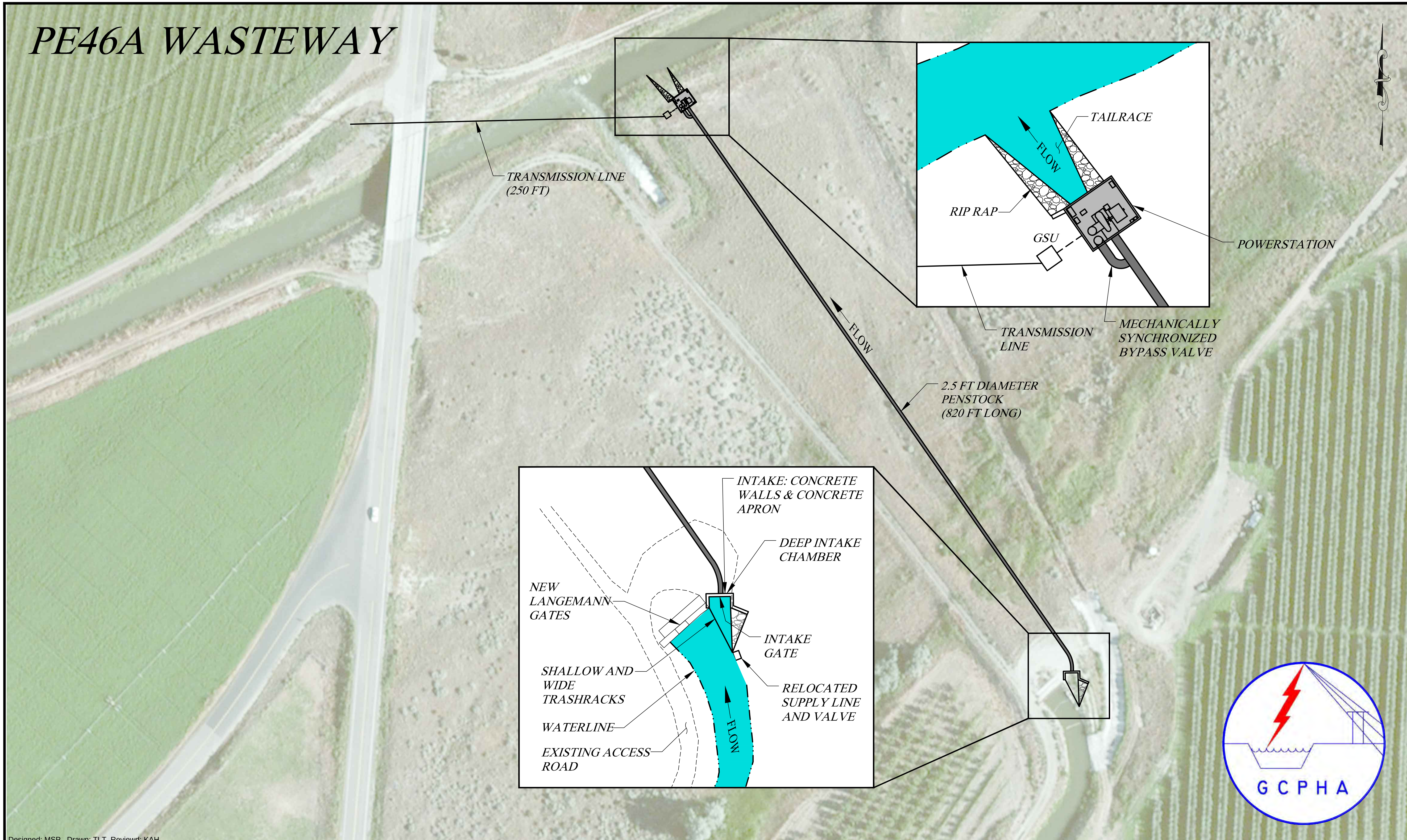
6.0 POTENTIAL NEXT STEPS

Based on the results of the pro forma, the Project appears uneconomic for either development scenario. Kleinschmidt recommends that GCPHA put the Project on hold. Factors that may warrant re-examination include:

- grant or tax incentives to defray the development cost; or
- changes in market conditions that may make the project economically feasible.

APPENDIX A

PROJECT LAYOUT



22x34 = FULL SCALE

J:\1823\003\Drawings\Working Drawings\1823-003 PE46WW.dwg

PRINTED Jan. 20, 2015 - 3:26 PM

Kleinschmidt

50 0 50 100
SCALE IN FEET

GRAND COULEE PROJECT HYDROELECTRIC AUTHORITY
EPHRATA, WA

APPENDIX B

SITE PHOTOGRAPHS

P.E. 46A WASTEWAY
OCTOBER 2014

PHOTO 1 WASTEWAY CHUTE INLET STRUCTURE

PHOTO 2 PROPOSED INTAKE LOCATION ON RIGHT BANK

PHOTO 3 **BURIED CHUTE AND STILLING POOL LOOKING DOWNSTREAM**

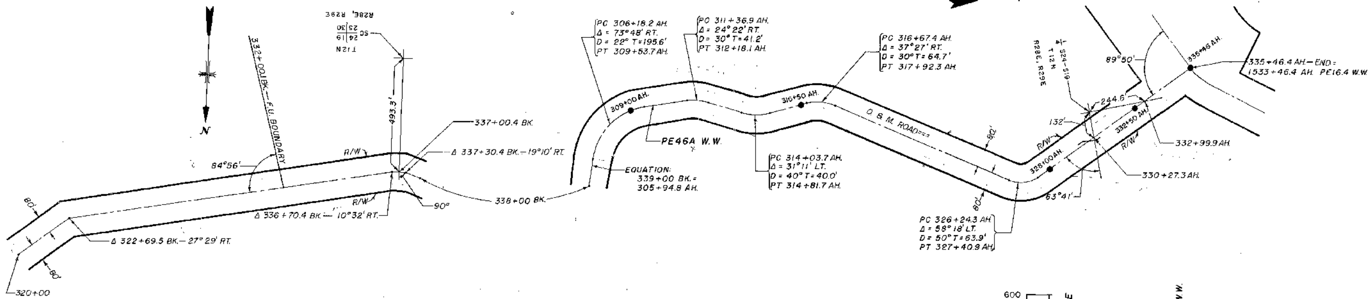
PHOTO 4 **BURIED CHUTE AND STILLING POOL LOOKING UPSTREAM**

APPENDIX C

EXISTING DRAWINGS

NOT INCLUDED IN PUBLIC VERSION

(THIS MATERIAL CONTAINS CONFIDENTIAL INFORMATION AND DISTRIBUTION TO THIRD PARTIES IS RESTRICTED BY NON-DISCLOSURE AGREEMENTS WITH THE U.S. BUREAU OF RECLAMATION.)

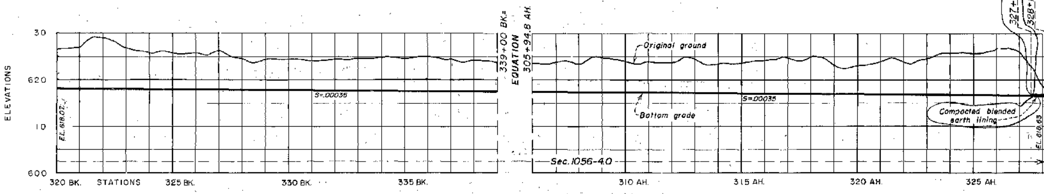


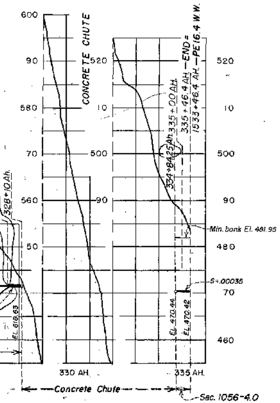
SECTIONS AND HYDRAULIC PROPERTIES

	Section	b	H	W	d	A	r	s	n	v	Q
NORMAL	1056	10	5.6	10	4.0	64.00	2.62	.00035	.025	2.09	135
EMERGENCY					5.2	92.56	3.22		.030	2.02	187

NOTE

For typical sections see Dwg. 222-116-27311





PE46A WASTEWAY

O. B. M. Road on Left Side

CONCURRENCE		
Approved	By	Date
Irr. Div.	E. N.	5/4/56

5-20-55 C.J.M. AS BUILT

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT—WASHINGTON

POTHOLES EAST CANAL LATERALS—BLOCK 19

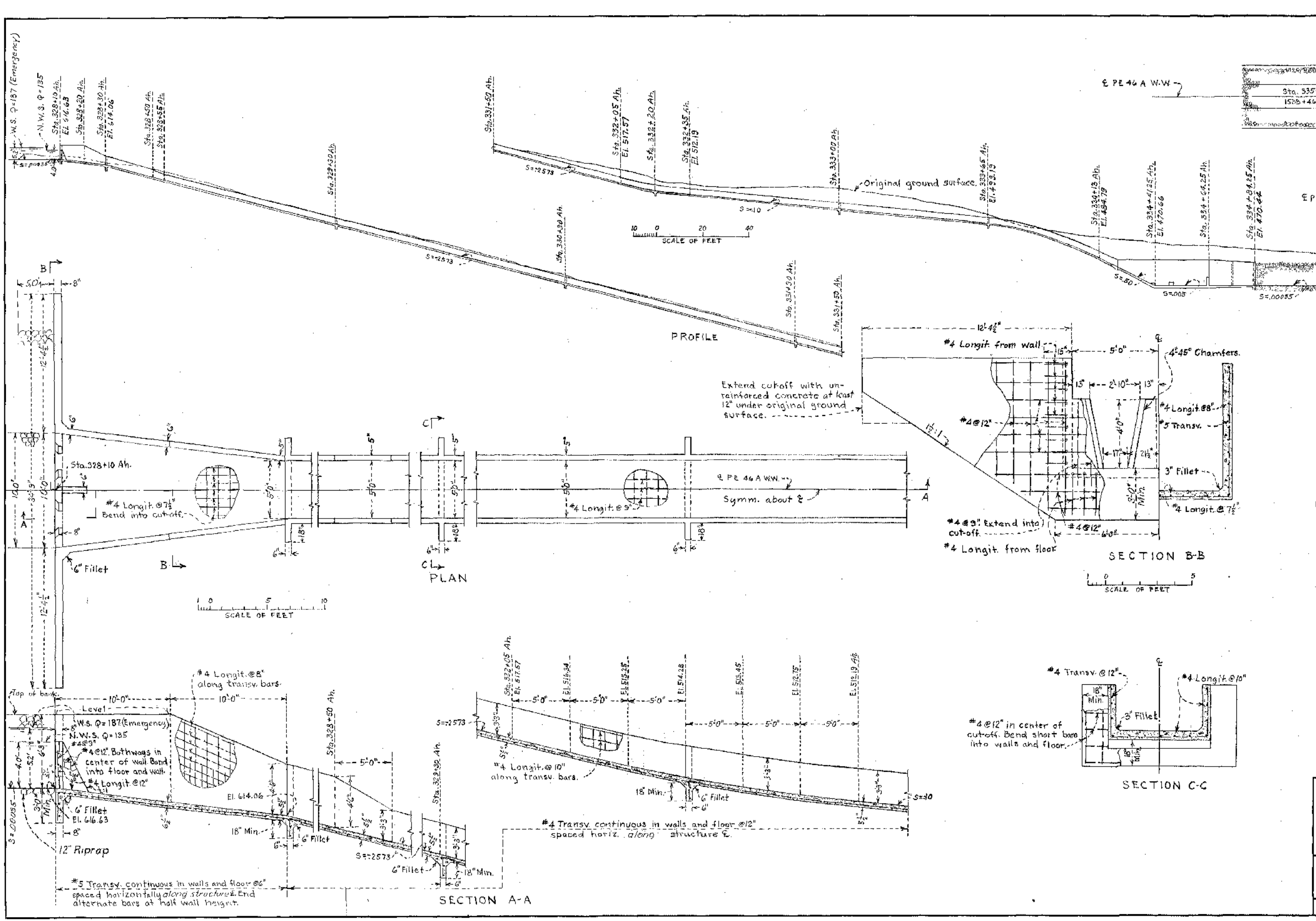
PE46A W.W.—STA. 320+00 BK. TO END

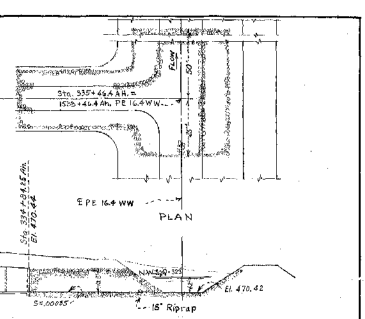
PLAN, PROFILE AND SECTIONS

DRAWN J.L.E.–G.W. SUBMITTED J.B. Hunes
TRACED D.C. RECOMMENDED
CHECKED APPROVED
CHIEF DESIGNING ENGINEER
EPHRATA, WASHINGTON MAY 3, 1955 SHEET 16 OF 17

222-116-27328

4571





HYDRAULIC PROPERTIES

SECTION	A	V	Q	r	n	s
Emergency	92.56	2.02	187	3.22	.030	.00035
Normal	64.00	2.09	135	2.62	.025	.00035

ESTIMATED QUANTITIES

Concrete .... 205 Cu.Yds.
Reinforcement steel .... 20,000 Lbs.

NOTES

Unless otherwise shown, place reinforcement so that the clear distance between face of concrete and nearest reinforcement is 1½" for #5 bars and less and 2" for #6 bars and greater; except provide a clear distance from face of concrete placed against earth or rock of 2" where slab thickness is 9" or less and 3" where slab thickness is greater than 9".
Lap all bars 20 diameters at splices, unless otherwise shown.
Elevations refer to invert unless otherwise shown.
Concrete design based on a compressive strength of 3000 lbs. per sq. inch.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT-WASHINGTON
POTHOLES EAST CANAL LATERALS-BLOCK 19
PE 46 A WW STA. 328+10 AH.
CONCRETE CHUTE
INLET DETAILS

DRAWN E.L.R. SUBMITTED
TRACED RECOMMENDED
CHECKED APPROVED CHIEF DESIGNING ENGINEER
DENVER, COLORADO OCT. 10, 1955 SHEET 1 of 2 222-D-18426

MICROFILMED NOV 1 1971 KEYPUNCHED

APPENDIX D

20 YEAR PRO FORMAS

20 YEAR PRO FORMA — SCENARIO ONE

Pro Forma Cash Flow
46A Wasteway
Scenario One

Assumptions			Cash Flow											
			Year	1	2	3	4	5	6	7	8	9	10	11
Capital Cost	$ 4,300,000		Debt Service	$302,553	$302,553	$302,553	$302,553	$302,553	$302,553	$302,553	$302,553	$302,553	$302,553	$302,553
Debt Period (Years)	20													
Interest Rate	4%		Operations Cost	$28,119	$28,963	$29,831	$30,726	$31,648	$32,598	$33,576	$34,583	$35,620	$36,689	$37,790
Operations Cost	$ 27,300		Maintenace Cost	$28,119	$28,963	$29,831	$30,726	$31,648	$32,598	$33,576	$34,583	$35,620	$36,689	$37,790
O&M Escalation	3%													
			Admin Cost	$28,119	$28,963	$29,831	$30,726	$31,648	$32,598	$33,576	$34,583	$35,620	$36,689	$37,790
Maintenance Cost	$ 27,300													
Maintenance Escalation	3%		Power Production Cost ($/MWH)	$142	$143	$144	$145	$146	$147	$148	$149	$150	$151	$152
Admin Cost	$ 27,300		Power Sales	$163,800	$168,714	$173,775	$178,989	$184,358	$189,889	$195,586	$201,453	$207,497	$213,722	$220,134
O&M Escalation	3%													
			Cash Flow (-)	($223,110)	($220,726)	($218,272)	($215,743)	($213,139)	($210,456)	($207,694)	($204,848)	($201,917)	($198,898)	($195,788)
Annual Energy (MWH)	2,730													
			Annaul Power Value ($/MWH)	$60	$62	$64	$66	$68	$70	$72	$74	$76	$78	$81
Power Value ($/MWH)	60													
Power Value Eselation	3%		Power Value Gap ($/MWH)	$82	$81	$80	$79	$78	$77	$76	$75	$74	$73	$72
			Required Capacity and Environmental Attribute Value ($/kW-mo)	$12	$12	$12	$12	$12	$12	$12	$11	$11	$11	$11
			NPV (4% IRR)	($2,715,861)										

Pro Forma Cash Flow
46A Wasteway
Scenario One

Cash Flow									
Year	12	13	14	15	16	17	18	19	20
Debt Service	$302,553	$302,553	$302,553	$302,553	$302,553	$302,553	$302,553	$302,553	$302,553
Operations Cost	$38,923	$40,091	$41,294	$42,533	$43,808	$45,123	$46,476	$47,871	$49,307
Maintenace Cost	$38,923	$40,091	$41,294	$42,533	$43,808	$45,123	$46,476	$47,871	$49,307
Admin Cost	$38,923	$40,091	$41,294	$42,533	$43,808	$45,123	$46,476	$47,871	$49,307
Power Production Cost ($/MWH)	$154	$155	$156	$158	$159	$160	$162	$163	$165
Power Sales	$226,738	$233,540	$240,546	$247,762	$255,195	$262,851	$270,736	$278,859	$287,224
Cash Flow (-)	($192,585)	($189,286)	($185,888)	($182,388)	($178,783)	($175,070)	($171,245)	($167,306)	($163,249)
Annaul Power Value ($/MWH)	$83	$86	$88	$91	$93	$96	$99	$102	$105
Power Value Gap ($/MWH)	$71	$69	$68	$67	$65	$64	$63	$61	$60
Required Capacity and Environmental Attribute Value ($/kW-mo)	$11	$11	$10	$10	$10	$10	$10	$9	$9
NPV (4% IRR)									

20 Year Pro Forma — Scenario Two

Pro Forma Cash Flow
46A Wasteway
Scenario Two

Assumptions			**Cash Flow**											
Best Case Cost Reduction	25%		**Year**	1	2	3	4	5	6	7	8	9	10	11
Capital Cost	$ 3,225,000		Debt Service	$226,914	$226,914	$226,914	$226,914	$226,914	$226,914	$226,914	$226,914	$226,914	$226,914	$226,914
Debt Period (Years)	20													
Interest Rate	3.5%		Operations Cost	$14,060	$14,481	$14,916	$15,363	$15,824	$16,299	$16,788	$17,291	$17,810	$18,344	$18,895
Operations Cost	$ 13,650		Maintenace Cost	$14,060	$14,481	$14,916	$15,363	$15,824	$16,299	$16,788	$17,291	$17,810	$18,344	$18,895
O&M Escalation	3%													
			Admin Cost	$14,060	$14,481	$14,916	$15,363	$15,824	$16,299	$16,788	$17,291	$17,810	$18,344	$18,895
Maintenance Cost	$ 13,650													
Maintenance Escalation	3%		Power Production Cost ($/MWH)	$99	$99	$100	$100	$101	$101	$102	$102	$103	$103	$104
Admin Cost	$ 13,650		Power Sales	$163,800	$168,714	$173,775	$178,989	$184,358	$189,889	$195,586	$201,453	$207,497	$213,722	$220,134
O&M Escalation	3%													
			Cash Flow (-)	($105,293)	($101,644)	($97,886)	($94,015)	($90,028)	($85,922)	($81,692)	($77,335)	($72,848)	($68,226)	($63,465)
Annual Energy (MWH)	2,730													
			Annaul Power Value ($/MWH)	$60	$62	$64	$66	$68	$70	$72	$74	$76	$78	$81
Power Value ($/MWH)	60													
Power Value Eselation	3%		Power Value Gap ($/MWH)	$39	$37	$36	$34	$33	$31	$30	$28	$27	$25	$23
			Required Capacity and Environmental Attribute Value ($/kW-mo)	$6	$6	$5	$5	$5	$5	$5	$4	$4	$4	$4
			NPV (4% IRR)	($946,777)										

Pro Forma Cash Flow
46A Wasteway
Scenario Two

Cash Flow									
Year	12	13	14	15	16	17	18	19	20
Debt Service	$226,914	$226,914	$226,914	$226,914	$226,914	$226,914	$226,914	$226,914	$226,914
Operations Cost	$19,462	$20,045	$20,647	$21,266	$21,904	$22,561	$23,238	$23,935	$24,653
Maintenace Cost	$19,462	$20,045	$20,647	$21,266	$21,904	$22,561	$23,238	$23,935	$24,653
Admin Cost	$19,462	$20,045	$20,647	$21,266	$21,904	$22,561	$23,238	$23,935	$24,653
Power Production Cost ($/MWH)	$105	$105	$106	$106	$107	$108	$109	$109	$110
Power Sales	$226,738	$233,540	$240,546	$247,762	$255,195	$262,851	$270,736	$278,859	$287,224
Cash Flow (-)	($58,562)	($53,511)	($48,309)	($42,951)	($37,432)	($31,748)	($25,893)	($19,862)	($13,650)
Annaul Power Value ($/MWH)	$83	$86	$88	$91	$93	$96	$99	$102	$105
Power Value Gap ($/MWH)	$21	$20	$18	$16	$14	$12	$9	$7	$5
Required Capacity and Environmental Attribute Value ($/kW-mo)	$3	$3	$3	$2	$2	$2	$1	$1	$1
NPV (4% IRR)									

SCOOTENEY INTLET

SCREENING LEVEL FEASIBILITY REPORT

SCOOTENEY INLET

FERC NO. P-14318

Prepared for:

Grand Coulee Project Hydroelectric Authority
Ephrata, Washington

Prepared by:

Kleinschmidt

Gresham, Oregon
www.KleinschmidtGroup.com

February 2015

SCREENING LEVEL FEASIBILITY REPORT

SCOOTENEY INLET

FERC NO. P-14318

Prepared for:

Grand Coulee Project Hydroelectric Authority
Ephrata, Washington

Prepared by:

Kleinschmidt

Gresham, Oregon
www.KleinschmidtGroup.com

February 2015

SCREENING LEVEL FEASIBILITY REPORT

SCOOTENEY INLET
FERC No. P-14318

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

SCOOTENEY INLET
FERC No. P-14318

EXECUTIVE SUMMARY

The proposed Scooteney Inlet Hydroelectric Project (Project) would utilize irrigation water conveyed by the Potholes East Canal (PEC). The Project is located adjacent to the Scooteney Inlet drop structure which regulates water elevations in the canal and passes flow down into Scooteney Reservoir. Kleinschmidt Associates (Kleinschmidt) developed the Project concept through existing site information including flow data, topography, site visits, discussions with Grand Coulee Project Hydroelectric Authority (GCPHA), and information from equipment vendors.

The proposed Project infrastructure includes a new concrete intake, a 60-foot long concrete water power canal, Langemann® Gates, a single 2,400 kilowatt (kW) vertical axial flow Kaplan turbine, a powerhouse with a concrete substructure and steel superstructure, and a concrete tailrace (Appendix A). The project would produce approximately 7,670 MWh of energy annually using the conventional technology approach (Scenarios One and Two) and 6,500 MWh annually with alternative technology approach (Scenario Three).

Kleinschmidt has evaluated the proposed Project development in three scenarios. The first two scenarios considered conventional equipment described in the previous paragraph and the third scenario used new emerging technology equipment. Scenario One was evaluated as a plant that would have all the features of a larger facility and with operation and maintenance (O&M) costs prorated from existing GCPHA small hydro sites. Scenario Two was studied to determine if a lesser cost development is viable using the same conventional technology as Scenario One. For this Scenario, Kleinschmidt assumed the design would focus on cost-effective features, lower construction contingencies, purchase of lower cost turbine generator equipment manufactured in China, and that O&M efficiencies can be made by using existing staff resources to operate and maintain the Project. Scenario Three assumes the use of lower cost emerging technology for low head hydro equipment. For example, Natel Energy is currently installing a similar project in

Oregon. The development costs for Scenario Three were pro-rated from a current development being built in central Oregon. Table 1 summarizes the results of each of the three scenarios.

TABLE 1 SUMMARY OF STUDY RESULTS - SCOOTENEY INLET

	SCENARIO ONE	SCENARIO TWO	SCENARIO THREE
Total Development Cost Analysis	$12,220,000	$9,570,000	$4,490,000
20 Year Net Present Value	-$8,180,000	-$3,090,000	$850,000

The results from this study show that under Scenario One and Two the Project is not financially viable. However, Scenario Three shows that the Project has a positive net present value (NPV) over the 20 year term indicating further exploration of the alternative technology development may be attractive.

1.0 PROJECT DESCRIPTION

1.1 EXISTING CONDITIONS

The Scooteney Inlet drop structure is located in Franklin County, Washington, in the South Columbia Basin Irrigation District (SCBID), east of the Columbia River, and north of Pasco, Washington, at Station 1369 of the Potholes East Canal (Figure 1).

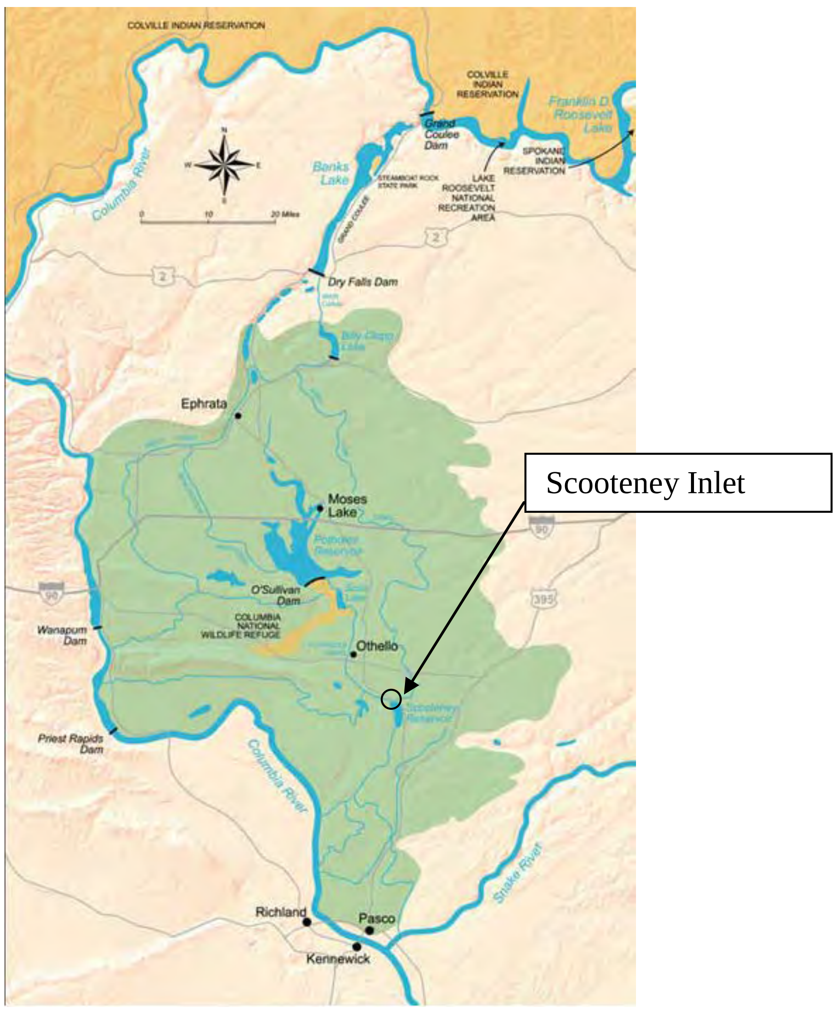


FIGURE 1 COLUMBIA BASIN PROJECT IRRIGATION AREA (BUREAU OF RECLAMATION MAP)

SCBID is part of the Columbia Basin Project which is owned by the United States Bureau of Reclamation (BOR). Potholes East Canal is a Transferred Works Project, which means that it is owned by BOR but its O&M have been transferred to SCBID. The Scooteney Inlet drop structure is used to maintain water elevations in the canal and to regulate flow into Scooteney Reservoir. More details on the canal elevations, drop structure, and water elevations are provided on existing canal drawings in Appendix C. Kleinschmidt used the following site information that was provided by GCPHA, including existing drawings and data collected from site visits.

Water Elevations:

- Headpond: 940 feet
- Normal Tailwater: 915 feet
- Maximum Tailwater 925 feet

Upstream Freeboard: 1 foot above normal water level to top of canal wall core

Site Hydraulics: The PEC and Scooteney Inlet see irrigation delivery flows during the irrigation season of late March through October and little flows from runoff and drainage during the non-irrigation season from November through March. The annual flow duration curve provided in Figure 2 is based on site flow data from Scooteney Outlet that is assumed to be very close to the flow at Scooteney Inlet.

- Annual Flow Patterns: Flow only during irrigation season
Runoff and drainage flow during the off season
- Emergency Flow Capacity: 3,900 cubic feet per second (cfs)

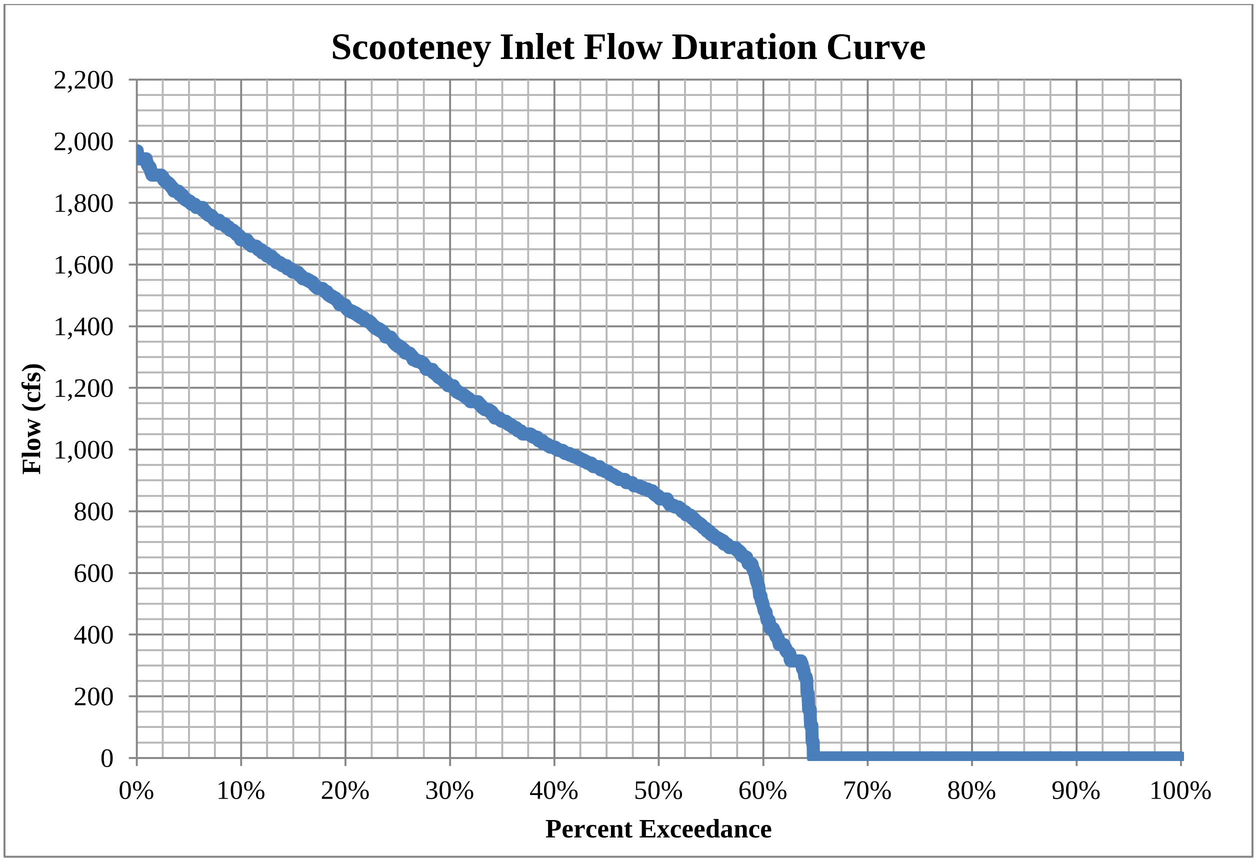


FIGURE 2 FLOW DURATION CURVE

Geotechnical Considerations: The site soil characteristics in the proposed locations of the intake, water channel, and powerhouse appear to have rock near the foundation of the proposed structures base on limited boring log information on the existing drop structure drawings. Further geotechnical investigation, such as site borings and test pits, would reduce the risk of encountering unexpected geotechnical conditions such as lower rock elevations and/or quality then presently assumed.

1.2 PROPOSED DEVELOPMENT

The Scooteney Inlet Project concept layout is shown on Appendix A. This Project concept is located west of the Scooteney Inlet Drop Structure and adjacent to the existing canal structure.

Site photos of the proposed Project location are provided in Appendix B. The Project has the following basic features:

- Capacity: 2,400 kilowatts (kW)
- Turbine Type: Vertical Axial Flow Kaplan Turbine
- Turbine Maximum Flow: 1,400 cfs
- Gross Head: 23 feet
- Transmission Line Length: 2,500 feet

Water Control & Bypass: Water elevations upstream of the drop structure are tightly maintained during the irrigation season to provide deliveries upstream. Water levels downstream vary based on the level of Scooteney Reservoir. Any project layout will need to reliably pass irrigation flows under all operating scenarios. Therefore, Kleinschmidt is proposing a three method approach to pass flow in the event of a sudden unit trip in order to maintain water elevations.

1. The turbine will be specified to operate for an extended period of time in over speed. Over speed is when the unit is no longer electrically connected to the grid and loses rotational resistance from the generator and increases speed until it reaches an internal equilibrium. At over speed the turbine will pass nearly all the water that it did at normal operation; however the increased speed will put more stress on the runner, shaft, and bearings. Therefore, these components must be designed to withstand these additional stresses for an extended period time. This arrangement does not require the operation of any other gates and is a reliable way to pass flows, but induces additional wear on the unit.
2. To limit unit over speed two new Langemann® Gates, which GCPHA has reported to have had good reliability performance, are proposed on the intake side chutes of the drop structure. Modifications to the existing drop structure will be required to accommodate the increased capacity of the side chutes with two new gates.
3. Finally, upgrades to the existing drop structure gate operator are proposed to increase reliability.

Intake: A new concrete intake structure would be built just upstream of the existing drop structure inlet. The intake includes a headwall and gate structure leading to the water power canal, a new concrete canal wall and apron, and trashracks, and new repairs to the concrete canal wall. The trashracks at this site require a trash rake since aquatic weeds in the canal can be a significant issue at certain times during the year.

Power Canal: An open flume concrete power canal will convey water from the intake to the powerhouse. An open canal is possible for this Project due to the low available head and high flow. The concrete canal is less expensive to construct than a large diameter steel penstock due to low procurement and installation costs of concrete compared to spiral wound steel and approximately equal excavation and backfill requirements for both options. The concrete canal was sized to deliver the maximum design flow and head to the unit while also providing 1 foot of free board from the normal water elevation to the top of the canal wall. Details of the canal are as follows:

- Length: 60 feet
- Canal Opening: 11 feet deep, 11 feet wide
- Material: Concrete

Powerhouse: The powerhouse consists of a reinforced concrete substructure and steel superstructure. The powerhouse is assumed to be founded on bedrock assuming bedrock is present at or above the bottom elevation of the powerhouse. Due to the size of the unit, the powerhouse footprint dimensions are approximately 30 feet long by 20 feet wide. A roof hatch will be installed for access to the unit and a small monorail chain hoist will be installed for basic operation and maintenance. The powerhouse will have a small separate electrical room with climate control to extend the life of the control, protective relaying, and switchgear equipment. The powerhouse will be unmanned, automated, and operated remotely.

Generating Unit: Kleinschmidt selected a Vertical Axial Flow Kaplan Turbine for this Project as it generates energy over nearly the entire range of flow shown in Figure 2. Details on the turbine are as follows:

- Type: Vertical Axial Flow Kaplan Turbine
- Operational Range: 350-1400 cfs
- Setting: 3 feet above tailwater
- Number: 1

There is also an opportunity to explore an additional small minimum flow unit that would capture generation with flows under the 350 cfs minimum operational range of the Kaplan unit. Kleinschmidt did not explore adding a minimum flow unit as part of this study; however further research could be done if GCPHA is interested in pursuing conventional turbine/generator (T/G) technology for this Project.

Access and Constructability: Access to the intake, penstock, and powerhouse areas will be achieved by the existing access road off of Coyan Road and approximately 0.5 mile off of Route 17. During the winter the PEC carries drain out-water from irrigated lands above the canal and occasional storm and snowmelt flows which are captured and stored in Scooteney Reservoir. These flows are not large enough for generation purposes, but they will be an issue during construction and also must be bypassed if a plant is constructed here.

Substation and Transmission Interconnection: A generator step-up transformer (GSU) is needed to match the voltage from the unit generator to the 13.2 kilovolt (kV) transmission line. Approximately 2,500 feet of three-phase transmission line and poles are needed to connect the Project's GSU to an overhead distribution line owned by Big Bend Electric Cooperative (BBEC). Disconnect switches, metering, and protection equipment are assumed to be required by BBEC to interconnect to their system and are presently included in the cost estimate. Unless GCPHA can negotiate a favorable wheeling rate with BBEC to deliver the power into Franklin Public Utility District's (PUD) system or the Bonneville Power Administration transmission system, GCPHA may consider and elect to construct a longer transmission line that interconnects directly to Franklin PUD's electric system or to the 34.5 kV transmission line that connects to the BPA Scooteney Substation. System studies are required to finalize the design, equipment requirements, and potential system upgrades. The cost of these studies is included in the cost analysis for the Project.

1.3 SCENARIO THREE – NEW EMERGING TECHNOLOGY DEVELOPMENT

The two primary costs for the initial conventional development with a vertical Kaplan turbine are the water-to-wire equipment and powerhouse costs (see Section 2.0). Because this conventional development approach is financially unfeasible, utilization of new unconventional low head hydroelectric technologies with lower equipment costs was considered. These technologies include the Natel Energy's turbine and Andritz's EcoBulb, which do not require a powerhouse, and Voith's StreamDiver matrix turbine. Appendix A provides more information on these technologies. Although these technologies typically have disadvantages of lower efficiencies and limited operational histories, the intent of conceptually reviewing these options was to determine if they warrant further consideration.

For Scenario Three, Kleinschmidt selected three low head Natel Energy units similar to a project currently being developed nearby in Oregon, so that we could consider actual costs of an on-going project. New infrastructure to support these units includes a combined intake/powerhouse that is integrated into the existing drop structure. Kleinschmidt did not complete a conceptual layout and a detailed cost analysis for this scenario. Instead the development cost was determined by pro-rating actual costs from the project being developed in central Oregon which has one 400kW Natel unit. Kleinschmidt estimated the rating of each Natel unit at Scooteney Inlet to be 500 kW for a total capacity of 1,500 kW and the annual energy generation to be 5,500 MWh.

The advantage of this scenario is the anticipated lower costs of development. The disadvantage is that this technology is new, which means the design life of these units are not yet proven, energy production will be lower, and O&M costs are unknown. However, Natel has offered the option of providing project funding or a development partnership that would allow them to carry the technology risk.

2.0 COST ANALYSIS

2.1 CONSTRUCTION COST ANALYSIS

For Scenario One, an analysis of construction cost is provided in Table 2. The total construction cost includes the work and equipment to complete the Project. This table includes temporary construction features, permanent civil work, purchase and installation of the turbine/generator equipment, mechanical equipment, electrical equipment, substation and interconnection, and other related Project costs.

TABLE 2 CONSTRUCTION COST FOR SCENARIO ONE - SCOOTENEY INLET

ITEM	DESCRIPTION	CONTINGENCY	CONSTRUCTION COST ANALYSIS[1]	NOTES
1	Mobilization and Demobilization	0%	$730,000	Site set up, soil erosion measures, site restoration
2	Cofferdams and Dewatering	25%	$100,000	Small cofferdam upstream
3	Spillway Work	25%	$280,000	Two new Langemann® Gates and chute modifications
4	Intake	20%	$610,000	Intake structure concrete, trashracks, walkways, trashrake, headgate and stoplogs
5	Power Canal	20%	$340,000	Open flume concrete power canal, 220' long
6	Powerhouse and Tailrace	20%	$2,970,000	Concrete substructure and superstructure
7	Turbine/Generator Supply and Install	10%	$4,590,000	Vertical axial Kaplan Turbine, water-to-wire package including controls, switchgear, etc.
8	Balance of Plant	20%	$90,000	HPU, HVAC, P&ID, etc.
9	Substation and Interconnection	25%	$620,000	GSU, transmission line, primary metering, protection, and interconnection study
10	Other	5%	$290,000	Insurance and bonding
	Weighted Average Contingency	14%		
	CONSTRUCTION COST ANALYSIS TOTAL		**$10,620,000**	

[1] These numbers are based on 2014 costs.

The major cost item, which is close to half of the construction cost, is for the water-to-wire package which includes supply and installation of a Kaplan turbine unit, the generator, programmable logic controller (PLC), and switchgear, etc. The second largest cost is construction of the powerhouse and tailrace due to the size of the unit.

The civil/site costs, including temporary structures, excavation, and concrete were developed based on quantities taken from the proposed concept layout and existing drawings of the canal combined with unit costs. The unit costs were prorated from the averages of actual costs from hydroelectric projects constructed in the northern United States within the last two years. In addition JR Merit, a Washington state contractor, provided input on regionally appropriate line item costs and construction considerations.

Turbine/generator equipment costs were based on vendor budgetary quotes solicited for this Project from several established North American turbine suppliers. These water-to-wire equipment budgetary bids also include the unit switchgear, controls, and hydraulic power unit. Balance of plant costs included valves, pumps, HVAC, piping, and instrumentation. Balance of plant equipment costs were derived from recent experience with prices from similar projects.

The estimated substation and interconnection capital cost includes the overhead transmission line, primary metering, special substation relay/protection equipment, system studies, a GSU, and a GSU containment pad.

Table 2 also includes contingencies for each area of work. Any work that will occur near a body of water or that will require deeper excavation or pile driving, such as the spillway work, cofferdams, etc. were given a contingency of 25% due to unknowns with site geology. The water conveyance work was assigned a contingency of 20% due to the possibility of unknown subsurface conditions. Balance of plant and interconnection costs were given a contingency of 20% due to more unknowns as opposed to the 10% contingency used for turbine/generator equipment where budgetary quotes were provided by vendors.

Scenario Two incorporates features required for safe and reliable operation. The costs were reduced in this cost analysis by considering the following factors:

- Shared risk of construction costs with a qualified and reliable construction company. This could be done in several ways such as engaging a contractor to prepare an independent cost estimate or entering into various alternatives to traditional Design-Bid-Build such as Construction Management or Design Build contract delivery methods.
- Purchase of T/G equipment directly from Chinese manufacturers. North American turbine suppliers have been purchasing more Chinese fabricated equipment over the last 10 years in order to be more cost competitive. These suppliers have quality control and assurance programs in place to assure the foreign products meet specification standards. It is important that these standards are understood and properly specified. When purchasing equipment directly from Chinese manufacturers, owners often choose to hire a third party quality assurance company near the manufacturing facility. Kleinschmidt's experience with this method of T/G procurement results in savings compared to going through a North American supply company. Similar to Japanese supplied equipment, the Chinese manufactures do not have maintenance and rebuild crews in the United States. However, GCPHA operates Japanese T/G equipment without the benefit of domestic maintenance and rebuild crews and to date has not experienced any adverse reliability effects.
- Construction cost-focused design. The powerhouse footprint and other civil infrastructure such as the intake would be optimized to achieve safe and reliable operation conditions but may sacrifice maintenance space. Also, instead of a trash rake a less expensive air blast system could be installed on the trashracks that would essentially blow debris off the trashracks to sluice trash.
- Favorable results of site geotechnical investigations such lower top of rock elevations that could reduce excavation costs.

Table 3 shows the breakdown of each factor that could combine to create the overall savings of up to 25%. Kleinschmidt selected a 25% reduction shown in Table 3 to be near the middle of the 10% and 34% range, assuming that much but not all of the cost savings listed will be achieved under favorable conditions.

TABLE 3 CONTRIBUTING FACTORS FOR REDUCED CONSTRUCTION COST IN SCENARIO TWO - SCOOTENEY INLET

ITEM	DESCRIPTION	POSSIBLE COST REDUCTION	NOTES
1	Reduced Contingency	0-14%	Possibility for site conditions or pricing to be more favorable than predicted
2	Economy Focused Design and Delivery	5-10%	Minimized civil works, minimized powerhouse footprint
3	Chinese Turbine Supply	5-10%	
	Overall Cost Reduction	25%	
	CONSTRUCTION COST ANALYSIS TOTAL WITH 25% REDUCTION	$7,970,000	

Kleinschmidt assumed Scenario Three construction costs would scale from a current development in central Oregon. The development in Oregon is projected to cost $1,300,000 with $400,000 for the equipment and $900,000 for the civil development for a single 500 kW turbine. Kleinschmidt tripled that cost to $3,900,000 for three 400 kW turbine development for the Project. Kleinschmidt contacted the contractor building the Oregon development to discuss the projected costs. The contractor is nearly finished with the excavation and anticipates the project meeting the budget. Conceptual equipment prices for other non-conventional turbine technologies indicate that this is reasonable. Further exploration into the details of this type of development and how it may apply will be required if GCPHA decides that an alternative technology path should be explored further.

2.2 OTHER DEVELOPMENT COSTS

There are a number of other development costs to consider aside from the previously quantified direct initial construction and installation costs. These items include:

- engineering
- construction assistance
- licensing and permitting
- environmental studies
- marketing fees
- legal fees
- transaction fees
- land acquisition
- sales tax
- property tax
- GCPHA internal costs
- administration

Kleinschmidt estimates that under both Scenarios One and Two, 15% of the total construction cost analysis for Scenario One would cover the other development costs listed above.

Scenario Three was based on its construction cost. Scenario Three would most likely have less design engineering construction assistance due to less infrastructure and also items such as sales tax and transaction fees would reduce due to the lower overall construction cost compared to the previous two scenarios.

2.3 SUMMARY OF DEVELOPMENT COSTS

The total development cost for each scenario, which includes the construction cost and other development costs discussed previously, are provided in Table 4. Also included is a unit cost per kW for each scenario to compare each option.

TABLE 4 SUMMARY OF DEVELOPMENT COSTS – SCOOTENEY INLET

	SCENARIO ONE	SCENARIO TWO	SCENARIO THREE
Construction Cost	$10,620,000	$7,970,000	$3,900,000
Other Development Costs	$1,600,000	$1,600,000	$590,000
Total Development Cost	$12,220,000	$9,570,000	$4,490,000
Turbine Rating (kW)	1800	1800	1500
Total Development Cost ($/kW)	$6,789	$5,317	$2,993

Scenario Two is close to one developed small hydro project in the Northwest that cost $6,000/kW (Juniper Ridge Hydro, 3MW, 2009). However, all the total development costs are within the range of a June 2013 Oak Ridge National Laboratory (ORNL) study of Oregon small hydro that shows costs ranging from $1,500/kW for higher head, 3-5 megawatt (MW) projects to well over $10,000/kW for lower head/lower power projects.

2.4 OPERATION AND MAINTENANCE

GCPHA provided cost estimates based on their current small project O&M practices. These costs approximate $30/MWh of generation. This cost increases 3% annually in the pro forma provided in Appendix B. This analysis assumes Project will connect directly to the BBEC system, and the project output will be subject to a wheeling charge of $8/MWh.

For Scenario Two and Three, an O&M cost of $15/MWh was used by relying on increased efficiency of existing operations and maintenance staff and resources already available for the operation of other facilities. To achieve this level of O&M cost, GCPHA would require a direct connection to Franklin PUD distribution facilities in the area in order to avoid the BBEC wheeling cost.

3.0 ANNUAL ENERGY ESTIMATE AND VALUE

The annual energy production estimate was based on flow and head information provided by GCPHA, typical turbine efficiencies, and typical operational factors. For Scenarios One and Two, the annual energy production is estimated to be 7,670 MWh which results in a 47% capacity factor. For Scenario Three, the annual power output is 6,500 MWh. This results in a 49% capacity factor since the alternate turbines have a smaller annual output and smaller installed capacity than Scenario One and Two. These estimates were determined through an energy model that calculated the average energy produced based on two flow points per month.

The two ways to value project output are through wholesale power value plus a Renewable Energy Credit (REC) value or through a power value that is comparable to similarly sized wind and solar projects. For the purpose of this study we assumed a power value comparable with wind and solar projects utilizing a power value of $60/MWh, with an escalation of 3% per year. A critical next step will be to confirm this power value and economics in the pro forma. See the Energy Market Assessment Report for more details.

4.0 FINANCIAL PERFORMANCE

Kleinschmidt completed a 20 year financial pro forma for each scenario to determine the net present value (NPV) of the Project. To determine the NPV, the pro forma calculates the annual power production cost and annual power sales. The power production cost includes O&M costs and payments made on debt service for the development costs. The study assumes the cost to develop the Project will be funded by bonds. In the pro forma, it is assumed the bonds have a 3.5% interest rate and a 20 year term. A summary of the pro forma results including the NPV and the cost of production and power sales for the first year are provided in Table 5. The detailed pro forma is provided in Appendix D.

TABLE 5 SUMMARY OF FINANCIAL PERFORMANCE – SCOOTENEY INLET

	SCENARIO 1	SCENARIO 2	SCENARIO 3
First Year Power Production Cost ($/MWh)	$147	$103	$64
First Year Power Value ($/MWh)	$60	$60	$60
20 Year Net Present Value	-$8,180,000	-$3,090,000	$850,000

The price of production for new wind with tax incentives is approximately $50/MWh and without incentives is approximately $70/MWh. Solar developers in the region have executed agreements with Idaho Power at levelized rates of approximately $64/MWh. Potential off-takers will compare the Project to a similarly sized wind or solar project that has power generation values of $60/MWh. This power value includes selling the RECs with the power.

The pro formas for both Scenario One and Scenario Two show that the energy market value of output from the project produces significant negative cash flow in every year of operation. Calculation of the NPV of these cash flows (assuming a 4% discount rate) shows an overall loss. Successful development of the Project at these costs will require a power purchaser willing to pay a substantial premium to the current market for newly constructed renewable resource projects. Scenario Three shows a small positive NPV over the 20 year term. This indicates that if the pricing can be similar on this Project to the central Oregon project, the Project may break even over 20 years.

5.0 REGULATORY AND ENVIRONMENTAL

The Federal Energy Regulatory Commission (FERC) preliminary permit was issued on March 26, 2013 (P-14318) and expires February 28, 2016. GCPHA has filed three required 6-month progress reports for the Project to date. The first was filed on August 21, 2013; the second on February 25, 2014; the third on August 21, 2014; and the fourth on February 18, 2015. The next 6-month progress report for the preliminary permit will be due in August of 2015.

The Department of the Interior (DOI) filed comments on GCPHA's application for preliminary permit on January 26, 2012. In the letter, DOI clarified that because the Project would be located upon BOR fee title land, the Project is ineligible for the FERC exemption process, as discussed in greater detail below. DOI also provided preliminary recommendations for coordinated operations, flow releases, and reimbursement of BOR costs. No other stakeholders or agencies have commented on the preliminary permit or 6-month progress report filings.

The proposed Scooteney Inlet Hydroelectric Project (Project) would utilize irrigation water transported by the Potholes East Canal (PEC). The Project is located adjacent to the Scooteney Inlet drop structure which regulates water elevations in the canal and passes flow down into Scooteney Reservoir. The Project, as currently designed, will be located partially on BOR fee title land and partially on BOR easements, with fee title held by adjoining landowners.

Because the Project is located on federal lands, several FERC processes are precluded including the FERC 40 MW Conduit Exemption Process. As such, the available FERC authorization process would be licensing. The Project would be subject to Federal Power Act Section 4(e) mandatory conditions imposed by the BOR as the Project would be on federal reservation lands (i.e., those owned in fee title by BOR, regardless of management). While the licensing process is generally longer and more costly than the exemption process, GCPHA could request a waiver of the three stage consultation requirement considering that environmental issues appear to be low. A downside to FERC licensing is the need to periodically relicense; generally every 30 to 50 years. FERC would assess annual charges of approximately $4,500 though FERC does not charge administrative processing fees for license applications. The cost of preparation and filing of a license application for the Project, not including any potential required studies, would be expected to be approximately $23,000.

Alternatively, BOR's Small Conduit Lease of Power Privilege Process (LOPP) may be a viable option. Mandatory conditions are those as imposed/negotiated with BOR in consultation with the agencies. Because BOR is a mandatory conditioning authority (i.e., BOR has the authority to add conditions to the FERC license) in the FERC process for this project, that risk does not appear to be any different from the Small Conduit LOPP. Further, the Small Conduit LOPP allows for a categorical exclusion from the National Environmental Protection Act (NEPA) review, whereas the FERC licensing process would not. Annual charges for the Small Conduit LOPP are $2/MWh so that would cost the Project approximately $15,000 annually. The LOPP process does not prescribe a term to the lease so that creates undesirable uncertainty. An advantage of the LOPP process is that it may allow for construction sooner than the FERC process. In addition, BOR requires applicants to provide advance funding of all BOR application processing costs, which are unknown at this time. The cost of preparation and filing of a Small Conduit LOPP application for the Project, not including any potential required studies, would be expected to be less than $28,000, assuming NEPA exclusion.

It appears that the Project will cause minimal environmental impacts as the Project site is currently developed as an access road.

6.0 POTENTIAL NEXT STEPS

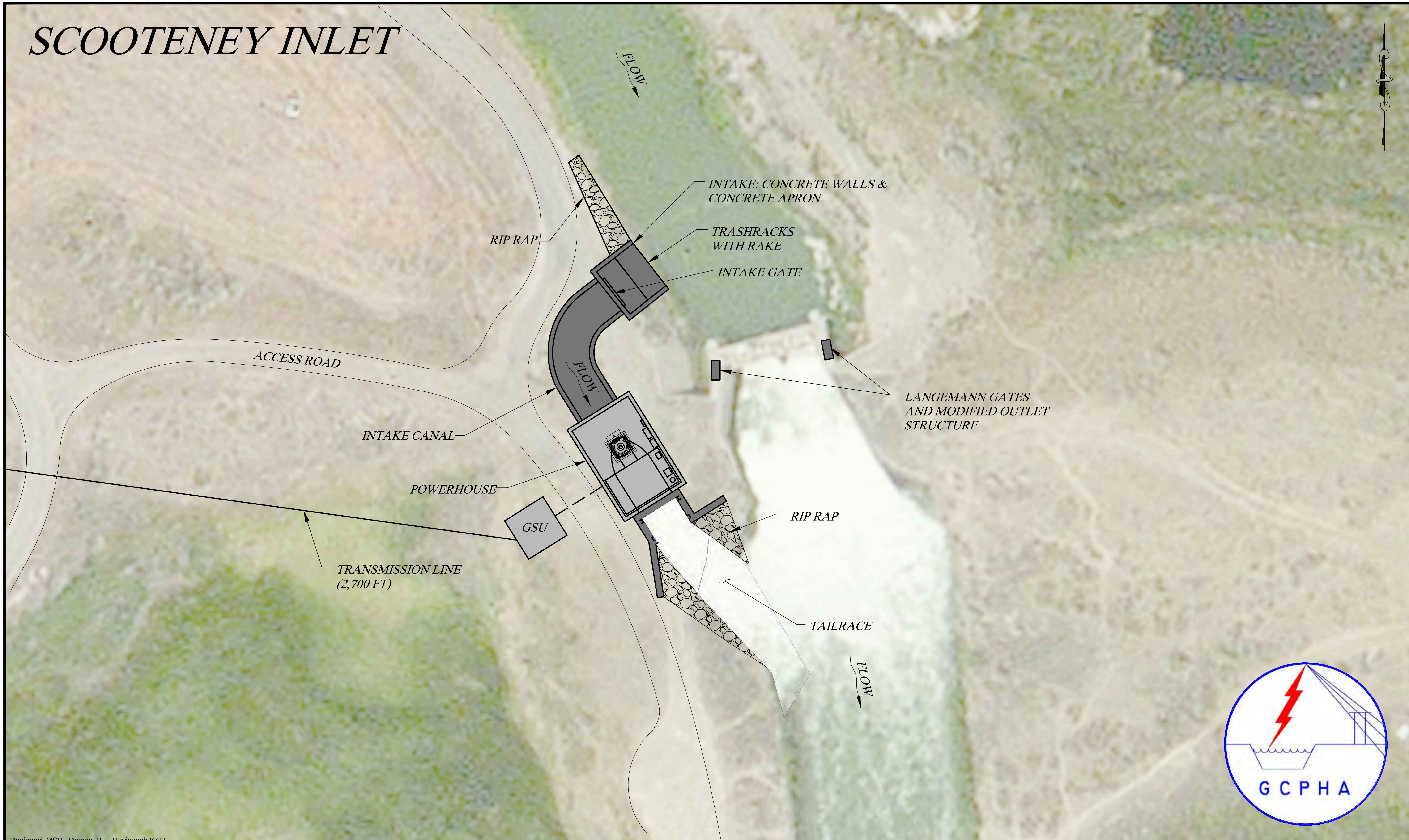
Based on the results of this study, the Project may be feasible if a new emerging technology development (Scenario Three) is considered. If GCPHA decides to pursue a new emerging technology option, the next steps are:

- Review the available unconventional emerging technologies that have lower equipment and more simple and inexpensive civil infrastructure costs compared to a conventional Kaplan pit turbine. Appendix A contains selected manufacturer literature from Natel Energy, VA Tech (Ecobulb), and Voith (StreamDiver) that illustrates various emerging low head technologies that could possibly produce a financially feasible project. Preliminary engineering and addressing any FERC licensing issues would only begin after a feasible concept has been further developed and confirmed. The review could involve contacting the low head T/G vendors to confirm site compatibility with their product. If compatible then vendors could submit quotes and a feasible concept could be developed.
- Continue discussions with Franklin PUD about purchasing Project output and a potential transmission interconnection. The study assumes interconnecting the Project to the BBEC system. This discussion would likely be focused on project costs and assumed power values as well as the contractual structure of a potential agreement.
- Apply for an extension and advancement of FERC licensing if the technology review results in a feasible concept and GCPHA decides to pursue preliminary engineering.

APPENDIX A

PROJECT LAYOUT

SCOOTENEY INLET



Designed: MSP Drawn: TLT Reviewed: KAH

22x34 = FULL SCALE

J:\1823\003\Drawings\Working Drawings\1823-003 SCOOTENEY INLET.dwg

PRINTED Jan. 20, 2015 - 3:26 PM

Kleinschmidt

20 0 20 40
SCALE IN FEET

GRAND COULEE PROJECT HYDROELECTRIC AUTHORITY
EPHRATA, WA

APPENDIX B

SITE PHOTOGRAPHS

SCOOTENEY INLET
OCTOBER 2014

PHOTO 1 **INTAKE FOR RADIAL GATE CHECK DROP**

PHOTO 2 **DOWNSTREAM END OF CHECK DROP**

SCOOTENEY INLET
OCTOBER 2014

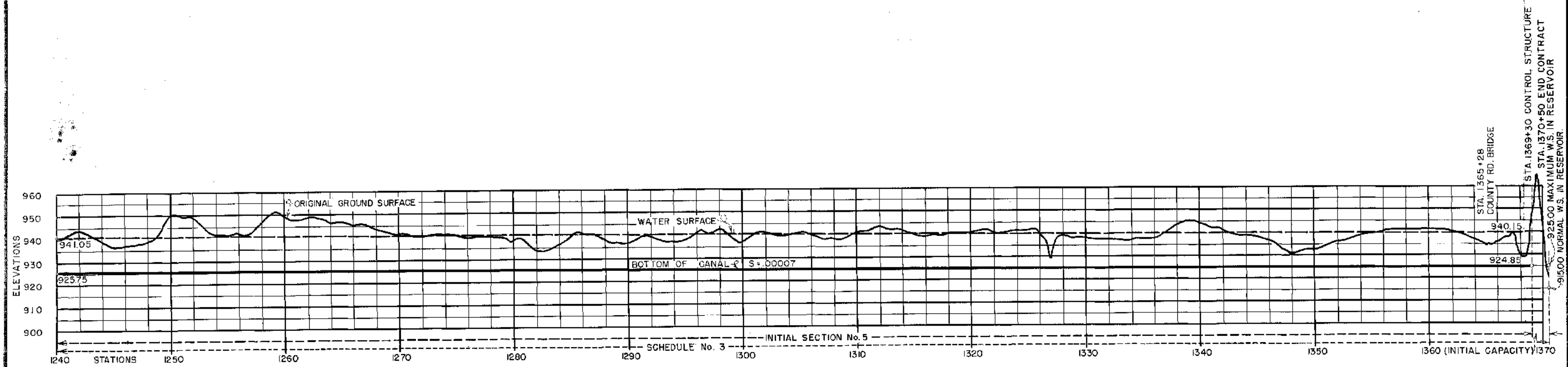
PHOTO 3 PROPOSED LOCATION FOR POWERHOUSE AND WATER CHANNEL

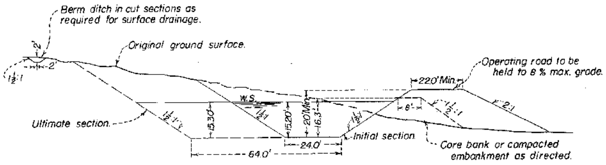
APPENDIX C

EXISTING DRAWINGS

NOT INCLUDED IN PUBLIC VERSION

(THIS MATERIAL CONTAINS CONFIDENTIAL INFORMATION AND DISTRIBUTION TO THIRD PARTIES IS RESTRICTED BY NON-DISCLOSURE AGREEMENTS WITH THE U.S. BUREAU OF RECLAMATION.)





SECTION NO. 5

TYPICAL CANAL SECTION

HYDRAULIC PROPERTIES								
INITIAL DEVELOPMENT								
SECTION	B	d	Area	r	S	V	Q	n
No. 5 Unlined	24.0	15.30	718.34	9.07	.00007	2.51	1800	.0225
ULTIMATE DEVELOPMENT								
No. 5 Unlined	64.0	15.30	1330.34	11.16	.00007	2.93	3900	.0225

NOTES

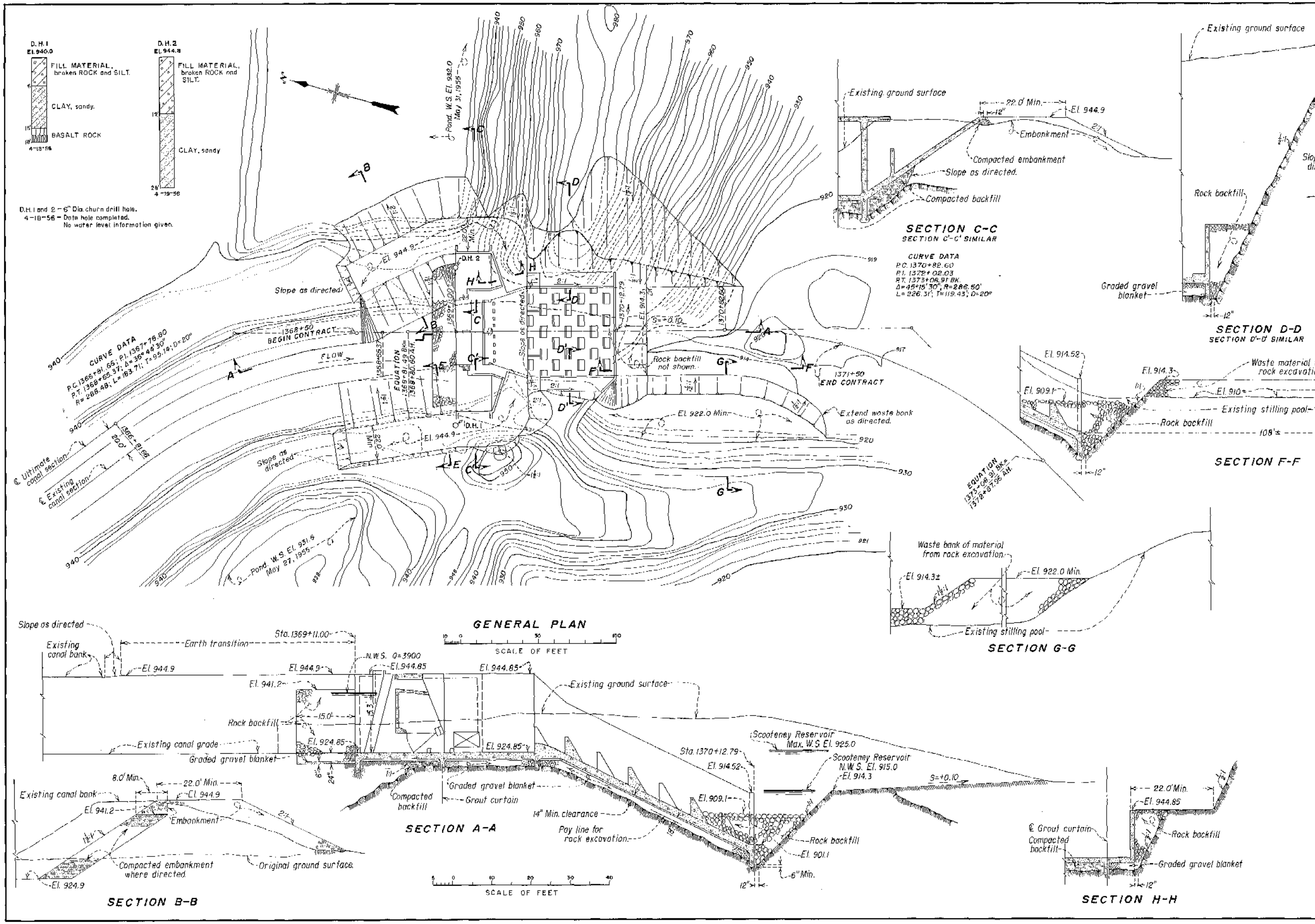
No uphill embankment required.
Waste on right side only.
Top of embankment to slope 24:1 away from canal.

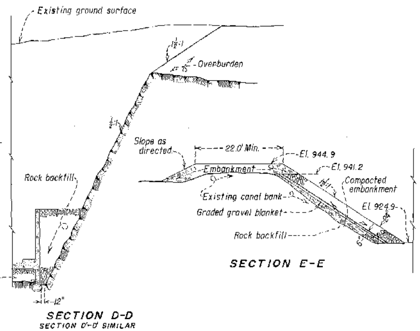
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT—WASHINGTON
POTHOLES EAST CANAL
PROFILE AND SECTIONS
STA. 1240+00 TO STA. 1370+50

DRAWN H.O. SUBMITTED
TRACED E.R.P. RECOMMENDED O. J. Rice
CHECKED APPROVED CHIEF ENGINEER

REV 4-18-50 C.C.P.

222-P-8091 | EPHRATA, WASHINGTON OCT. 10, 1949 SHEET 4 OF 4 | 222-D-15312





ESTIMATED QUANTITIES

Concrete	850	Cu. Yds.
Reinforcement steel	105,000	Lbs.
Miscellaneous metalwork	5,800	Lbs.

REFERENCE DRAWINGS

LOCATION MAP	222-D-19088
RADIAL GATE CHECK DROP-SHEET 1 OF 2	222-D-19090
RADIAL GATE CHECK DROP-SHEET 2 OF 2	222-D-19091

NOTES

Existing reinforced concrete control structure approximately 25' right of Station 1369+48 to be removed.
Reinforcement not shown.

4-15-63 AS BUILT BY 116, LTR. 10-29-62.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT - WASHINGTON
POTHOLES EAST CANAL - STA. 1369+11
RADIAL GATE CHECK DROP
GENERAL PLAN AND SECTIONS

DRAWN E.V.S. SUBMITTED H.J. Curtis
TRACED G.G.B. RECOMMENDED
CHECKED APPROVED CHIEF DESIGNING ENGINEER
DENVER, COLORADO, JUNE 29, 1956
222-D-19089

APPENDIX D

20 YEAR PRO FORMAS

20 YEAR PRO FORMA — SCENARIO ONE

Pro Forma Cash Flow
Scooteney Inlet
Scenario One

Assumptions			**Cash Flow**											
			Year	1	2	3	4	5	6	7	8	9	10	11
Capital Cost	$ 12,220,000		Debt Service	$899,169	$899,169	$899,169	$899,169	$899,169	$899,169	$899,169	$899,169	$899,169	$899,169	$899,169
Debt Period (Years)	20													
Interest Rate	4%		Operations Cost	$76,700	$79,001	$81,371	$83,812	$86,327	$88,916	$91,584	$94,331	$97,161	$100,076	$103,078
Operations Cost	$ 76,700		Maintenance Cost	$76,700	$79,001	$81,371	$83,812	$86,327	$88,916	$91,584	$94,331	$97,161	$100,076	$103,078
O&M Escalation	3%													
			Admin Cost	$76,700	$79,001	$81,371	$83,812	$86,327	$88,916	$91,584	$94,331	$97,161	$100,076	$103,078
Maintenance Cost	$ 76,700													
Maintenance Escalation	3%		Power Production Cost ($/MWH)	$147	$148	$149	$150	$151	$152	$153	$154	$155	$156	$158
Admin Cost	$ 76,700		Power Sales	$460,200	$474,006	$488,226	$502,873	$517,959	$533,498	$549,503	$565,988	$582,968	$600,457	$618,470
O&M Escalation	3%													
			Cash Flow (-)	($669,069)	($662,166)	($655,056)	($647,733)	($640,189)	($632,420)	($624,418)	($616,175)	($607,685)	($598,941)	($589,934)
Annual Energy (MWH)	7,670													
			Annual Power Value ($/MWH)	$60	$62	$64	$66	$68	$70	$72	$74	$76	$78	$81
Power Value ($/MWH)	60													
Power Value Escelation	3%		Power Value Gap ($/MWH)	$87	$86	$85	$84	$83	$82	$81	$80	$79	$78	$77
			Required Capacity and Environmental Attribute Value ($/kW-mo)	$37	$37	$36	$36	$36	$35	$35	$34	$34	$33	$33
			NPV (4% IRR)	($8,176,811)										

Pro Forma Cash Flow
Scooteney Inlet
Scenario One

Cash Flow									
Year	12	13	14	15	16	17	18	19	20
Debt Service	$899,169	$899,169	$899,169	$899,169	$899,169	$899,169	$899,169	$899,169	$899,169
Operations Cost	$106,171	$109,356	$112,637	$116,016	$119,496	$123,081	$126,773	$130,577	$134,494
Maintenance Cost	$106,171	$109,356	$112,637	$116,016	$119,496	$123,081	$126,773	$130,577	$134,494
Admin Cost	$106,171	$109,356	$112,637	$116,016	$119,496	$123,081	$126,773	$130,577	$134,494
Power Production Cost ($/MWH)	$159	$160	$161	$163	$164	$165	$167	$168	$170
Power Sales	$637,024	$656,135	$675,819	$696,094	$716,977	$738,486	$760,640	$783,460	$806,963
Cash Flow (-)	($580,657)	($571,101)	($561,259)	($551,122)	($540,681)	($529,926)	($518,849)	($507,439)	($495,687)
Annual Power Value ($/MWH)	$83	$86	$88	$91	$93	$96	$99	$102	$105
Power Value Gap ($/MWH)	$76	$74	$73	$72	$70	$69	$68	$66	$65
Required Capacity and Environmental Attribute Value ($/kW-mo)	$32	$32	$31	$31	$30	$29	$29	$28	$28
NPV (4% IRR)									

20 YEAR PRO FORMA — SCENARIO TWO

Pro Forma Cash Flow
Scooteney Inlet
Scenario Two

Assumptions			**Cash Flow**											
Best Case Cost Reduction	25%		**Year**	1	2	3	4	5	6	7	8	9	10	11
Capital Cost	$ 9,570,000		Debt Service	$673,356	$673,356	$673,356	$673,356	$673,356	$673,356	$673,356	$673,356	$673,356	$673,356	$673,356
Debt Period (Years)	20													
Interest Rate	3.5%		Operations Cost	$38,350	$39,501	$40,686	$41,906	$43,163	$44,458	$45,792	$47,166	$48,581	$50,038	$51,539
Operations Cost	$ 38,350		Maintenance Cost	$38,350	$39,501	$40,686	$41,906	$43,163	$44,458	$45,792	$47,166	$48,581	$50,038	$51,539
O&M Escalation	3%													
			Admin Cost	$38,350	$39,501	$40,686	$41,906	$43,163	$44,458	$45,792	$47,166	$48,581	$50,038	$51,539
Maintenance Cost	$ 38,350													
Maintenance Escalation	3%		Power Production Cost ($/MWH)	$103	$103	$104	$104	$105	$105	$106	$106	$107	$107	$108
Admin Cost	$ 38,350		Power Sales	$460,200	$474,006	$488,226	$502,873	$517,959	$533,498	$549,503	$565,988	$582,968	$600,457	$618,470
O&M Escalation	3%													
			Cash Flow (-)	($328,206)	($317,851)	($307,186)	($296,201)	($284,886)	($273,232)	($261,228)	($248,865)	($236,130)	($223,013)	($209,503)
Annual Energy (MWH)	7,670													
			Annual Power Value ($/MWH)	$60	$62	$64	$66	$68	$70	$72	$74	$76	$78	$81
Power Value ($/MWH)	60													
Power Value Escalation	3%		Power Value Gap ($/MWH)	$43	$41	$40	$39	$37	$36	$34	$32	$31	$29	$27
			Required Capacity and Environmental Attribute Value ($/kW-mo)	$18	$18	$17	$16	$16	$15	$15	$14	$13	$12	$12
			NPV (4% IRR)	($3,086,338)										

Pro Forma Cash Flow
Scooteney Inlet
Scenario Two

Cash Flow									
Year	12	13	14	15	16	17	18	19	20
Debt Service	$673,356	$673,356	$673,356	$673,356	$673,356	$673,356	$673,356	$673,356	$673,356
Operations Cost	$53,085	$54,678	$56,318	$58,008	$59,748	$61,540	$63,387	$65,288	$67,247
Maintenance Cost	$53,085	$54,678	$56,318	$58,008	$59,748	$61,540	$63,387	$65,288	$67,247
Admin Cost	$53,085	$54,678	$56,318	$58,008	$59,748	$61,540	$63,387	$65,288	$67,247
Power Production Cost ($/MWH)	$109	$109	$110	$110	$111	$112	$113	$113	$114
Power Sales	$637,024	$656,135	$675,819	$696,094	$716,977	$738,486	$760,640	$783,460	$806,963
Cash Flow (-)	($195,587)	($181,254)	($166,491)	($151,285)	($135,623)	($119,491)	($102,875)	($85,761)	($68,133)
Annual Power Value ($/MWH)	$83	$86	$88	$91	$93	$96	$99	$102	$105
Power Value Gap ($/MWH)	$26	$24	$22	$20	$18	$16	$13	$11	$9
Required Capacity and Environmental Attribute Value ($/kW-mo)	$11	$10	$9	$8	$8	$7	$6	$5	$4
NPV (4% IRR)									

20 Year Pro Forma — Scenario Three

Pro Forma Cash Flow
Scooteney Inlet
Scenario Three

Assumptions			**Cash Flow**											
			Year	1	2	3	4	5	6	7	8	9	10	11
Capital Cost	$ 4,490,000		Debt Service	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921
Debt Period (Years)	20													
Interest Rate	3.5%		Operations Cost	$32,500	$33,475	$34,479	$35,514	$36,579	$37,676	$38,807	$39,971	$41,170	$42,405	$43,677
Operations Cost	$ 32,500		Maintenance Cost	$32,500	$33,475	$34,479	$35,514	$36,579	$37,676	$38,807	$39,971	$41,170	$42,405	$43,677
O&M Escalation	3%													
			Admin Cost	$32,500	$33,475	$34,479	$35,514	$36,579	$37,676	$38,807	$39,971	$41,170	$42,405	$43,677
Maintenance Cost	$ 32,500													
Maintenance Escalation	3%		Power Production Cost ($/MWH)	$64	$64	$65	$65	$65	$66	$67	$67	$68	$68	$69
Admin Cost	$ 32,500		Power Sales	$390,000	$401,700	$413,751	$426,164	$438,948	$452,117	$465,680	$479,651	$494,040	$508,862	$524,127
O&M Escalation	3%													
			Cash Flow (-)	($23,421)	($14,646)	($5,608)	$3,701	$13,290	$23,166	$33,339	$43,817	$54,609	$65,725	$77,174
Annual Energy (MWH)	6,500													
			Annual Power Value ($/MWH)	$60	$62	$64	$66	$68	$70	$72	$74	$76	$78	$81
Power Value ($/MWH)	60													
Power Value Escalation	3%		Power Value Gap ($/MWH)	$4	$2	$1	($1)	($2)	($4)	($5)	($7)	($8)	($10)	($12)
			Required Capacity and Environmental Attribute Value ($/kW-mo)	$1	$1	$0	($0)	($1)	($1)	($2)	($2)	($3)	($4)	($4)
			NPV (4% IRR)	$846,174										

Pro Forma Cash Flow
Scooteney Inlet
Scenario Three

Cash Flow									
Year	12	13	14	15	16	17	18	19	20
Debt Service	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921
Operations Cost	$44,988	$46,337	$47,727	$49,159	$50,634	$52,153	$53,718	$55,329	$56,989
Maintenance Cost	$44,988	$46,337	$47,727	$49,159	$50,634	$52,153	$53,718	$55,329	$56,989
Admin Cost	$44,988	$46,337	$47,727	$49,159	$50,634	$52,153	$53,718	$55,329	$56,989
Power Production Cost ($/MWH)	$69	$70	$71	$71	$72	$73	$73	$74	$75
Power Sales	$539,851	$556,047	$572,728	$589,910	$607,607	$625,836	$644,611	$663,949	$683,867
Cash Flow (-)	$88,967	$101,114	$113,625	$126,511	$139,784	$153,455	$167,537	$182,040	$196,979
Annual Power Value ($/MWH)	$83	$86	$88	$91	$93	$96	$99	$102	$105
Power Value Gap ($/MWH)	($14)	($16)	($17)	($19)	($22)	($24)	($26)	($28)	($30)
Required Capacity and Environmental Attribute Value ($/kW-mo)	($5)	($6)	($6)	($7)	($8)	($9)	($9)	($10)	($11)
NPV (4% IRR)									

APPENDIX E

ALTERNATIVE LOW-HEAD TURBINE TECHNOLOGIES

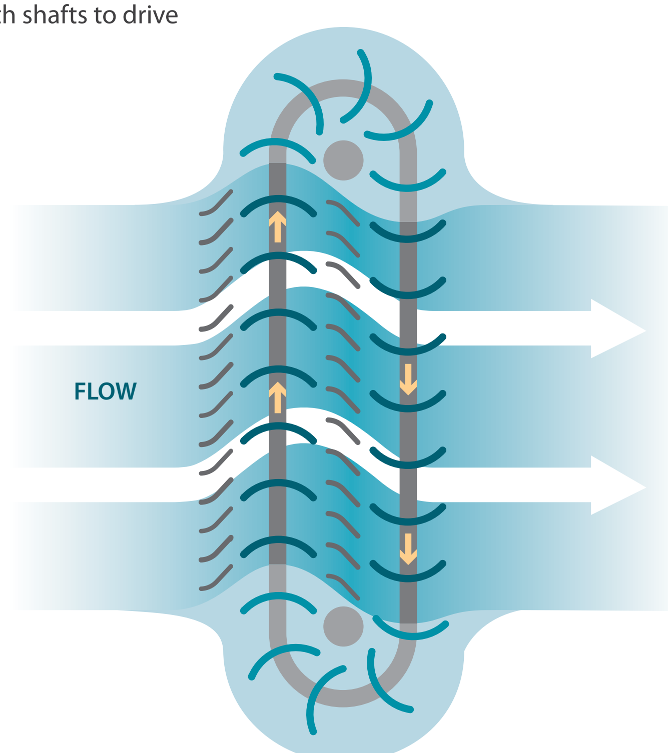
hydroEngine

a water-to-wire system for low head applications

Natel Energy, Inc. manufactures an innovative, patented hydraulic turbine called the hydroEngine, which operates with high efficiency in low head applications.

How it works

As water flows through the hydroEngine, the blades are driven in linear paths around two parallel shafts. Mechanical energy is taken off of either or both shafts to drive a conventional generator. Water enters the penstock, passes through the SLH unit, and exits the draft tube at or near stream velocity.



Technology Advantages

The hydroEngine has been specifically designed for high performance at low heads over a range of flows as low as 0.4 cms. Natel's water-to-wire packages featuring the hydroEngine can be installed in a range of settings, including irrigation canals and existing dams, with a minimum of civil works.

Additionally, the modular design of the hydroEngine ensures easy maintenance and repair. The moving components in each unit comprise a single cassette module that can be easily removed from the engine case with an overhead lift.

- Fish friendly
- No cavitation
- Minimizes need for site excavation
- Enables speedy maintenance
- Reduces costs associated with unit repair
- Delivers high performance at low head
- Maintains high efficiency as flow decreases

CURRENT PRODUCT

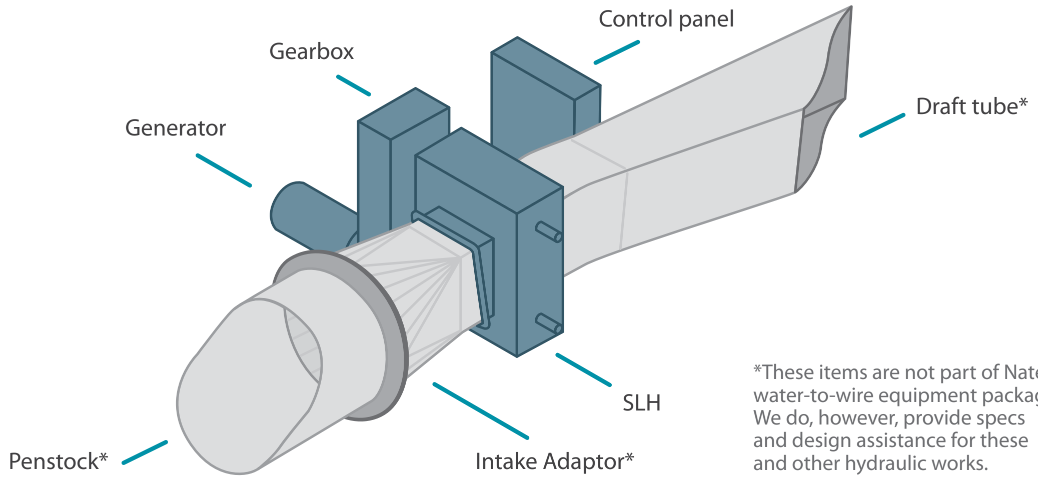
SLH100-L

500kW

Natel Energy, Inc.
2175 Monarch St.
Alameda, CA 94501
T: 510 342 5269
info@natelenergy.com
www.natelenergy.com

NATEL ENERGY

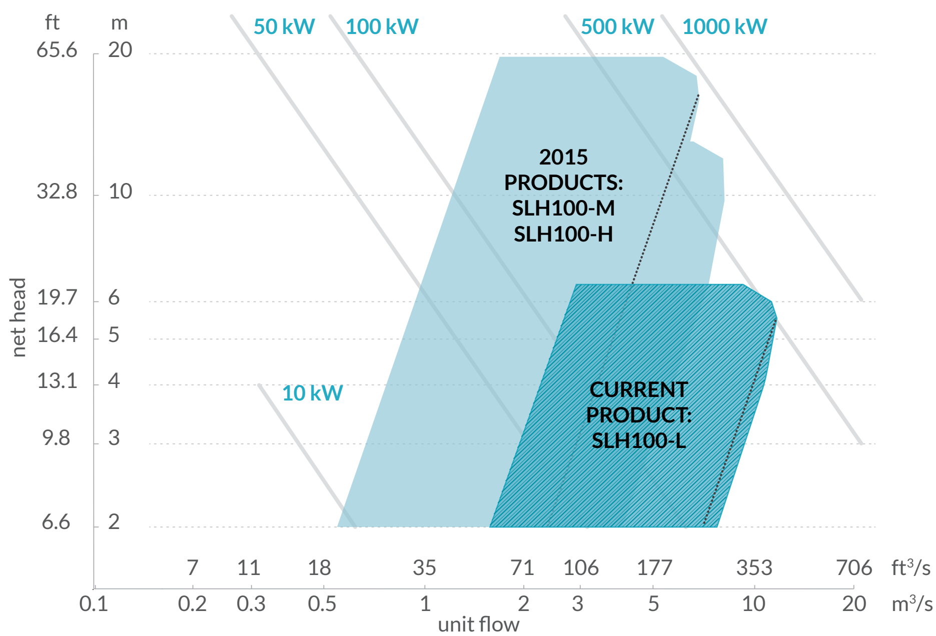
hydroEngine Equipment Package



*These items are not part of Natel's water-to-wire equipment package. We do, however, provide specs and design assistance for these and other hydraulic works.

The unique design of the hydroEngine, or SLH, enables the production of low cost renewable energy from flowing water at heads ranging from 2m (6 ft) to 18m (60 ft) high. Systems are integrated with a generator, switchgear, and SCADA compliant controls designed to work across multiple installations if needed. This provides a modular, easy-to-install solution, significantly reducing construction costs and speeding time to completion.

Operating Envelope



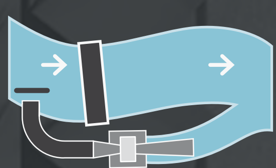
Operating History

The SLH has demonstrated 75 to 80% hydraulic efficiency in hydraulic laboratory and field tests. Several different configurations have been installed and operated in field test and pilot commercial settings:

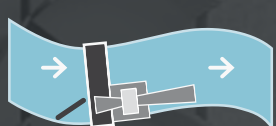
- A stream setting where a 35 kW hydroEngine ran for over 10,000 operating hours in the course of four years.
- Irrigation canal drops, including a 180 kW unit and a pilot of the SLH10 capable of producing 25 kW at 13 feet of head.
- A thermal power plant cooling water outfall.

V4 - OCT 2014

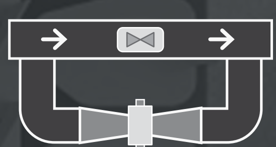
TYPES OF INSTALLATION



Run of river



In dam



In pipe

Natel Energy, Inc.
2175 Monarch St.
Alameda, CA 94501
T: 510 342 5269
info@natelenergy.com
www.natelenergy.com

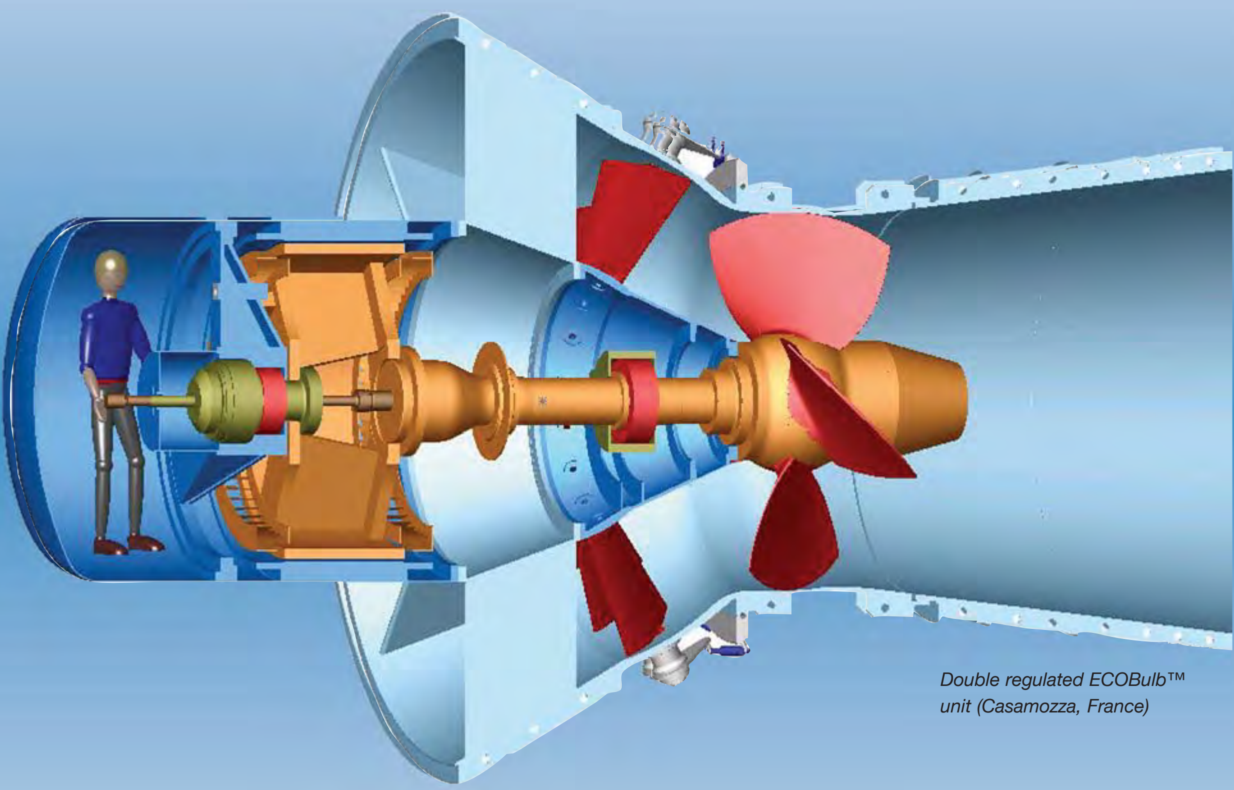
NATEL ENERGY

VA TECH

VA TECH HYDRO

COMPACT ECOBulb™ TURBINE GENERATOR

We know how.



Double regulated ECOBulb™ unit (Casamozza, France)

A Compact Turbine Generator System for low head applications

Head between 2 and 15 m
Discharge between 15 and 100 m³/s
Output between 500 and 5000 kW

sustainable solutions. for a better life.

www.vatech-hydro.com

ECOBulb™ TURBINE GENERATOR

VA TECH Hydro, a world leader in Compact turbines, introduces the development of the ECOBulb™ Turbine Generator. The unit design minimizes investment in civil work and electromechanical equipment and significantly reduces maintenance costs throughout the life cycle of the plant. The result is the economical development of sites having low head potential while minimizing the ecological impact.

The ECOBulb™ unit is the unique combination of a single or double regulated axial turbine with a direct coupled low speed synchronous generator including a permanent magnet rotor (PMG) integrated into an air pressurized bulb. The removal of the step-up gear allows a simplification of the mechanical elements, a reduction of the size of the bulb and a huge life extension of the generating unit.

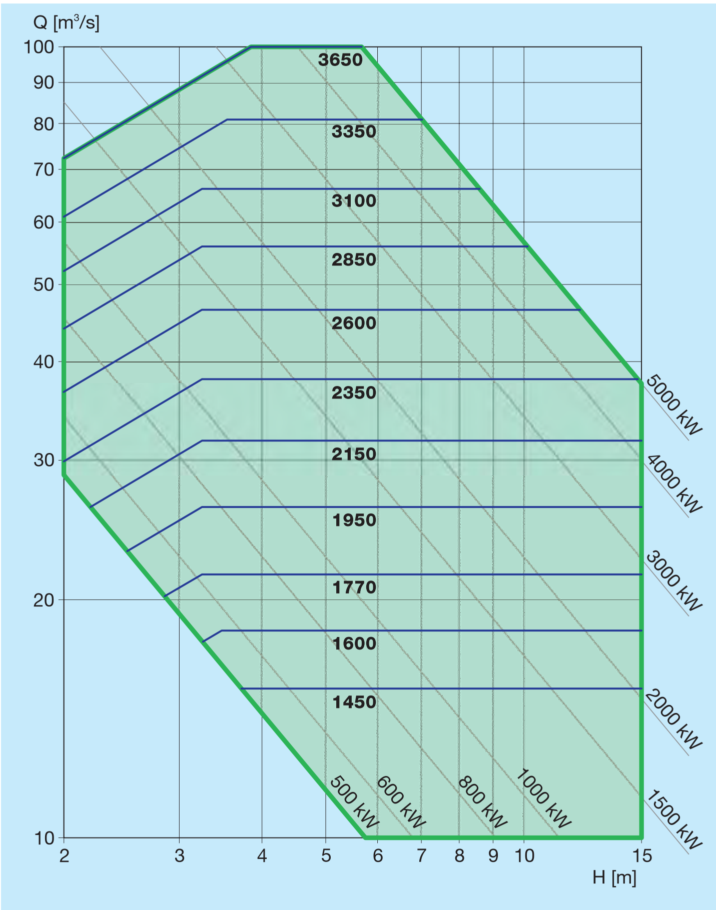
The ECOBulb™ turbine generator brings the industry unmatched advantages in investment costs for civil and electro-mechanical equipment as well as the ability to tap low head potential with high economic results.

The unit design minimizes maintenance costs and provides the maximum energy generation through high levels of hydraulic and electrical efficiencies.

The ECOBulb™ design also provides many ecological advantages. Generator cooling is achieved without external auxiliary systems by utilizing the bulb surfaces cooled by the surrounding river water. The two bearings supporting the shaft system are lubricated by biodegradable oil and grease. Since the units are completely submerged, the reduction in noise emission makes their installation in residential areas possible. Finally, the low profile of the ECOBulb™ allows an aesthetic integration of the unit's installation into the site's landscape.

The hydraulic profiles used have been developed and tested in our hydraulic laboratories and the electrical and thermal technologies are derived from large bulb generator units built by VA TECH HYDRO.

Application range



Technical data

- Head H between 2 and 15 m
- Flow Q between 15 and 100 m³/s
- Output P between 500 and 5000 kW

System features

- Integrated turbine generator unit with single-source engineering
- Single or double-regulated turbine for maximum energy generation
- High turbine and generator efficiencies at part and full load
- Reduced civil work costs in excavation and concreting thanks to the axial unit type and the high specific discharge
- Minimum maintenance through removal of the step-up gear and its large quantity of lubricating oil

▲ *Double regulated ECOBulb™ unit*

▲ *Rotor with Permanent Magnets (Aubas, France)*

Single regulated ECOBulb™ unit ready for operation (Paullo, Italy)

VA TECH HYDRO worldwide

VA TECH HYDRO GmbH & Co
Penzinger Strasse 76
A-1141 Vienna, P.O. Box 5
Phone (+43/1) 89 100-0
Fax (+43/1) 89 46 046

VA TECH BOUVIER HYDRO SAS
45/51 Boulevard Paul Langevin
BP No. 7
F-38601 Fontaine Cedex, France
Phone (+33/476) 85 95 23
Fax (+33/476) 26 16 20

VA TECH ESCHER WYSS GmbH
P.O. Box1380
D-88183 Ravensburg
Escher-Wyss-Strasse 25
D-88212 Ravensburg
Phone (+49/751) 83-00
Fax (+49/751) 83-2396

VA TECH ESCHER WYSS S.r.l.
Via Daniele Manin 16/18
Casella postale 274
I-36015 Schio (Vicenza)
Phone (+39/0445) 67 82 11
Fax (+39/0445) 67 82 18

VA TECH ESCHER WYSS S.L.
Paseo de la Castellana, 163
E-28046 Madrid
Phone (+34/91) 425 10 00
Fax (+34/91) 425 10 01

VA TECH ESCHER WYSS S.A. de C.V.
Av. Cd. Industrial No. 977
Col. Cd. Industrial
Mex-58200 Morelia, Mich.
Phone (+52/43) 23 15 30
Fax (+52/43) 23 15 38

VA TECH ESCHER WYSS Flovel Ltd.
Amar Nagar
P.O. 13/1 Mathura Road
IND-Faridabad/Haryana 121 003
Phone (+91/129) 527 43 19
Fax (+91/129) 527 43 20

VA TECH HYDRO BRASIL Limitada
Rua Gomes de Carvalho, 1306, 5 andar
Conjunto 51
Bairro Vila Olímpia
BR-04547-005 São Paulo SP
Phone (+55/11) 3704 5303
Fax (+55/11) 3704 5316

VA TECH HYDRO USA Corporation
University Research Park,
Five Resource Square
10715 David Taylor Drive, Suite 250
USA-Charlotte, NC 28262
Phone (+1/704) 943 4343
Fax (+1/704) 943 0200

VA TECH BOUVIER CANADA, Inc.
1550 A de Coulomb
Boucherville, P.Q.
Canada J4B 7Z7
Phone (+1/450) 449 1228
Fax (+1/450) 449 1229

VA TECH International SA
The Ferns Office Park VA HOUSE
364 Pretoria Avenue
SA-Johannesburg 2194
(Cramerview 2060)
Phone (+27/11) 886 0900
Fax (+27/11) 886 0941

VA TECH COLOMBIA Limitada
Carrera 12 No. 90 – 20, Piso 6
Edificio San Germán
Bogotá
Phone (+57/1) 622 85 70
Fax (+57/1) 622 86 04

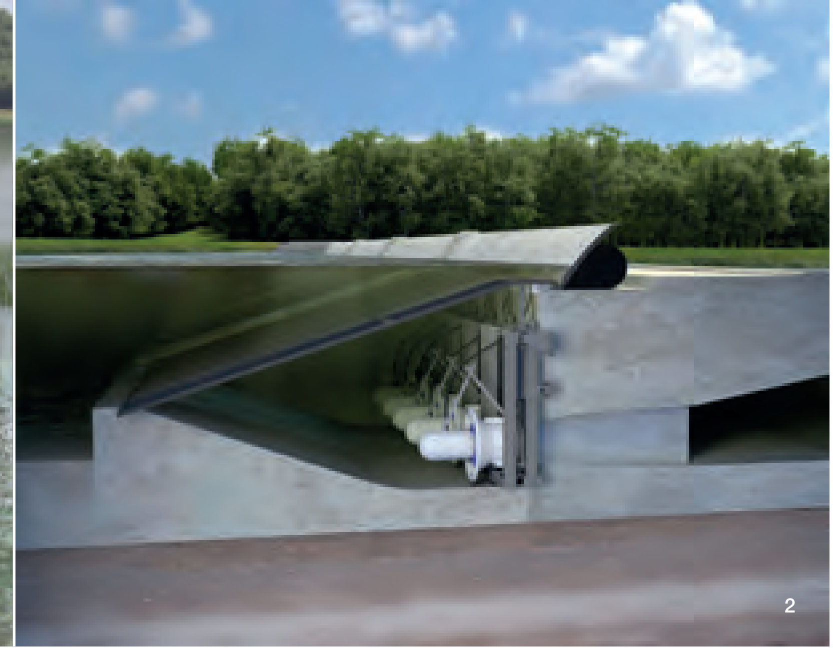
VA TECH ESCHER WYSS AG
Stockenstrasse 27
CH-9249 Algetshausen
Phone (+41/71) 950 01 66
Fax (+41/71) 951 66 24

eHYD.29.500.Z.B04

sustainable solutions. for a better life.

www.vatech-hydro.com

StreamDiver®
Utilizing New Hydropower Potential



1+2 Typical Power Plant Arrangement with StreamDiver

Challenges for low head hydropower plants

Over 85 percent of all existing dams in the world remain unused for hydropower generation. The StreamDiver turbine was developed to tap this potential, especially at low head sites which so far could not be exploited.

Even though hydropower accounts for the largest share of renewable energies worldwide, there is still sufficient potential for energetic development. Until recently, run of river plants with low heads were regarded as uneconomical and therefore often remained unused. In order to take advantage of this unused potential, in cooperation with its subsidiary Kössler, which acts as Voith's competence center for Small Hydro in Europe, Voith has developed the StreamDiver, a new compact propeller turbine particularly suited to taking over where conventional plants may not be viable. The set-up and eco-friendly features make the power unit especially feasible where weirs or dams already exist. The StreamDiver offers a compact, low-maintenance and oil-free alternative in the field of hydropower.

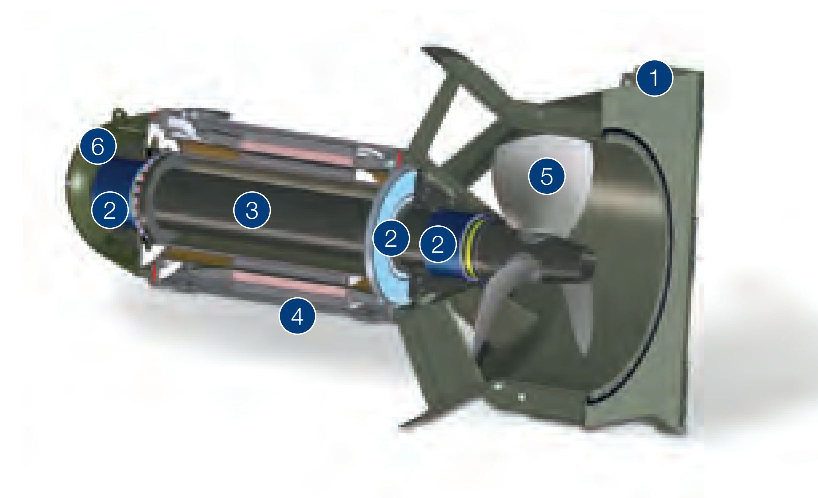
StreamDiver Features	Your benefits
Oil free turbine solution	+ environmental acceptance
Simplified technical complexity	+ low maintenance + high availability + no turbine peripheral equipment required
Standardized design	+ short delivery times + approved concept + minimized spare part administration
Compact and submersible turbine design	+ flexible plant integration + easy handling for maintenance and service + reduction of civil costs

Simplicity as key to reliability

Higher availability and less technical complexity: the StreamDiver's compact and modular design and its maintenance-free operation minimizes costs.

The StreamDiver will allow construction work to be kept at a minimum. The power unit is installed directly in the water with only the power cable exposed. The entire drivetrain, consisting of the turbine, shaft, bearings and generator, is situated in a bulb-turbine-type housing. In addition, the bulb is filled with water, which completely lubricates its bearings, ruling out any risk of water contamination.
The turbine itself is designed as a propeller turbine, meaning that neither rotor blades nor guide vanes are movable. These features negate the need for a visible or accessible power house.
By switching individual turbines on and off, or by regulating the turbine speed an operator can control the flow of his plant.
For shutdowns a separate gate is used, which simultaneously allows for speed to be controlled in order to start and synchronize the compact turbines. All these design solutions support a comparatively low total cost of ownership.
Conventional hydropower plants are designed according to individual requirements. The StreamDiver, in contrast, is an affordable serial product. It has numerous application possibilities around the world. The technical features of the StreamDiver represent the latest developments in the field of small hydropower.

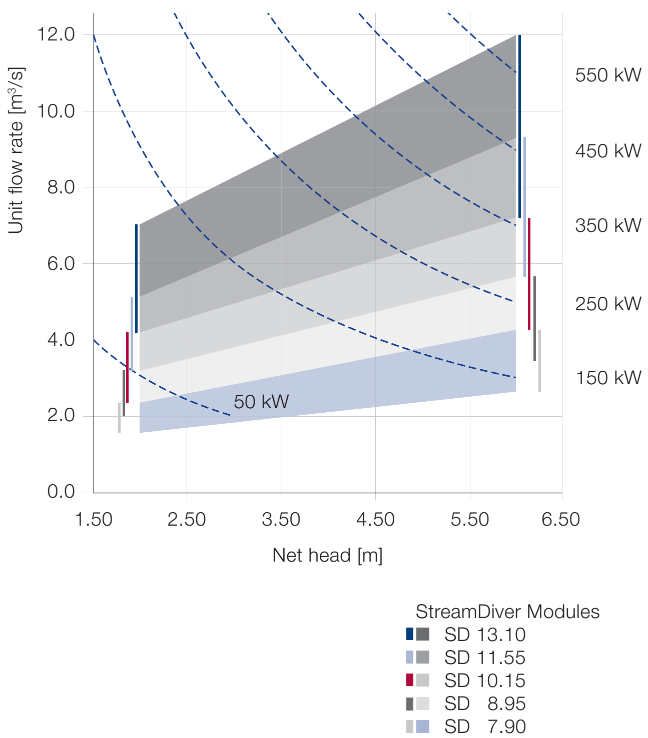
StreamDiver Main Components



1 Turbine housing with guide vanes
2 Radial and axial bearing coating on shaft ends
3 Shaft
4 Generator
5 Runner
6 Bulb nose

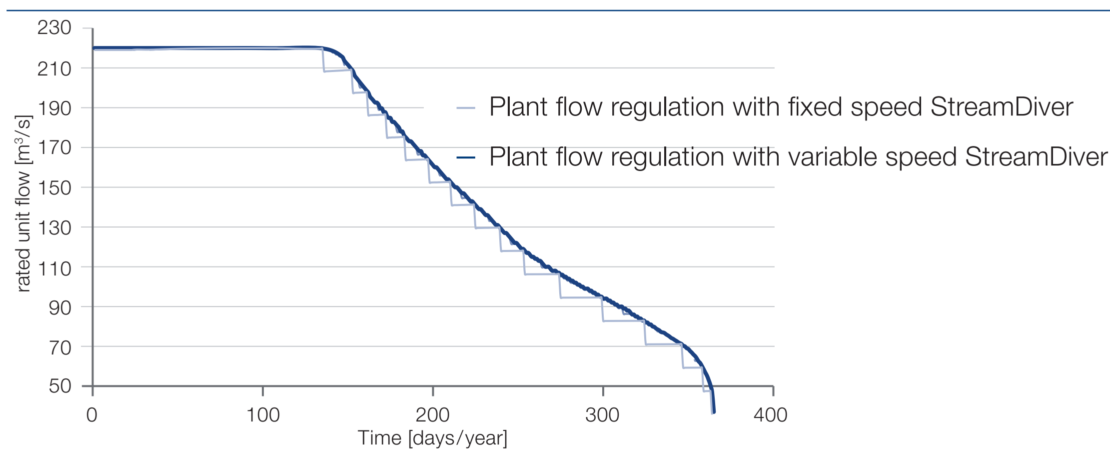
Application diagram:

The application diagram allows a preliminary module size selection based on rated head and flow. To find out the best array and number of compact turbines, conditions such as annual flow, head duration curve and overall physical limitations are also to be considered. For identifying the best project specific solution, the application range of the different modules is overlapping. The following operational criteria should be considered:



- The discharge through turbine for single unit is limited in a range of 2 - 12 m^3/s.
- The typical head range for StreamDiver is 2 – 6 m. However, in certain cases the standardized design modules can be engineered for high heads up to 10 m if the project is economically attractive.
- The civil structure shall facilitate the minimum submergence of the machine for cavitation free operation of the StreamDiver.
- Unit flow is limited by the runner diameter.

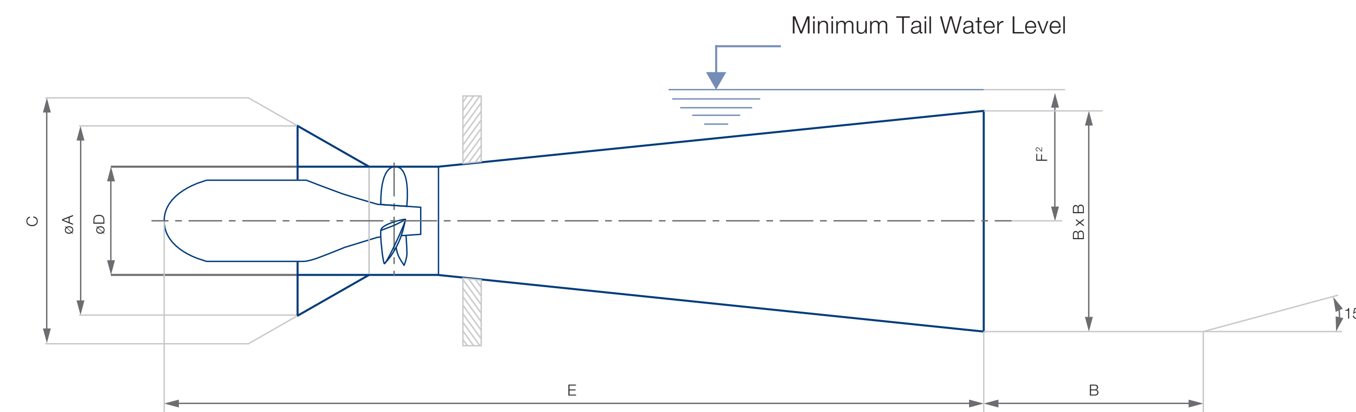
Typical multi unit operation diagram:



The StreamDiver is a non-regulated machine. In order to utilize the complete potential of any site, multiple number of units are required to be installed. Optionally, the StreamDiver can be equipped with a frequency converter to allow variable speed operation. In this case the StreamDiver unit can follow the available flow.

StreamDiver sizing:

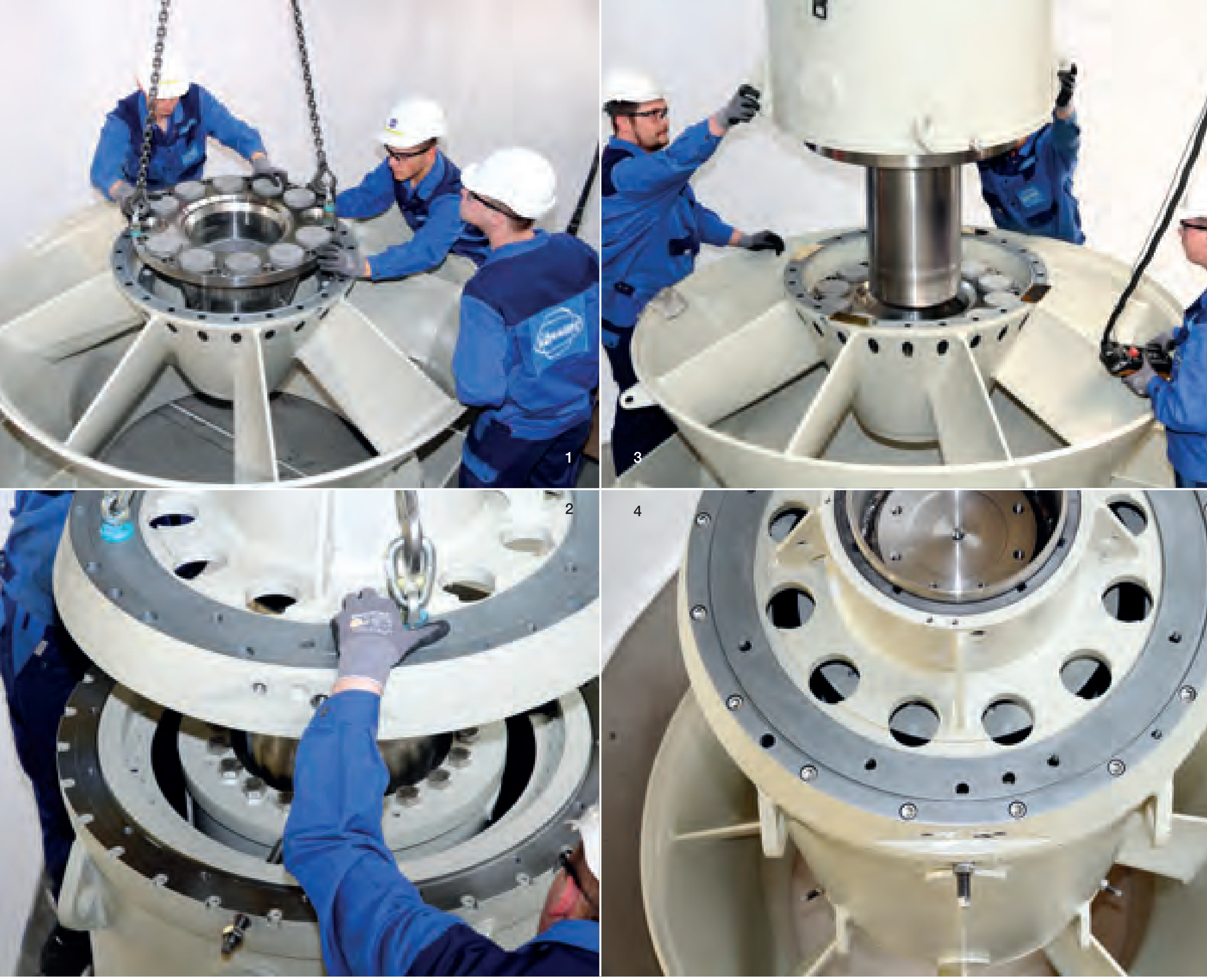
The main dimensions of the StreamDiver will vary depending on the selected module size. The setting of the turbine will be given by the minimum tail water level. The below given turbine layout is basis for the preliminary planning. Nevertheless, the final plant and intake layout needs to be adopted to the local requirements with the support of Voith.

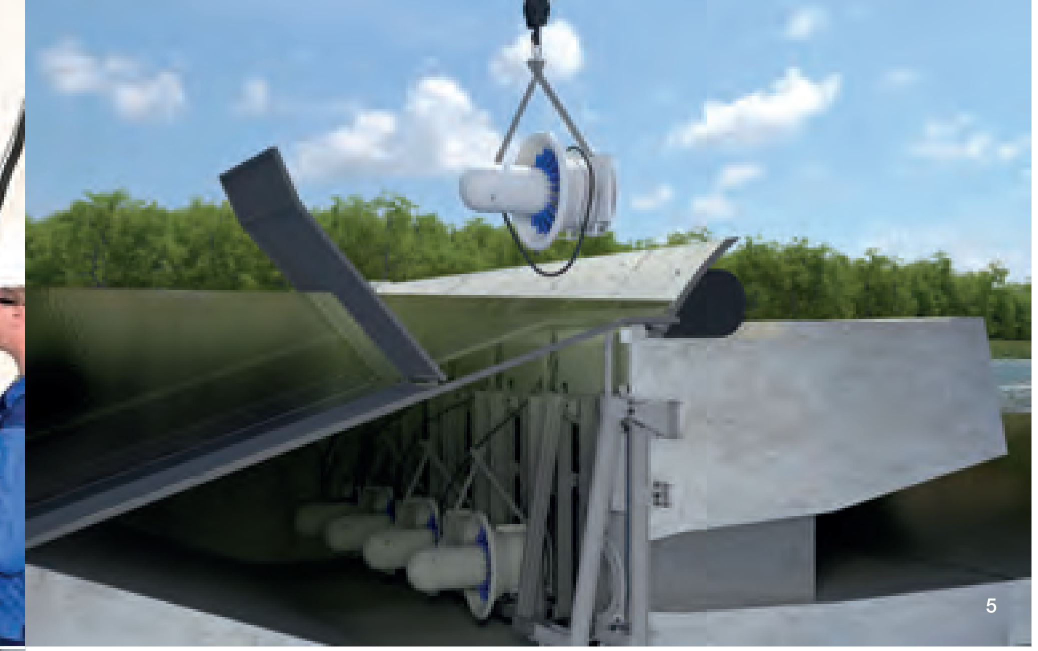


Main dimensions:

	A	B	C[1]	D	E
SD Module	mm	mm	m^2	mm	mm
SD 7.9	1380	1580	2,2	790	6000
SD 8,95	1560	1790	2,7	900	6700
SD 10.15	1770	2030	3,5	1020	7600
SD 11.55	2020	2310	4,5	1160	8700
SD 13.10	2380	2620	5,7	1310	9900

[1] Minimum intake gross area in case of penstock or channel applications.
[2] Dimension F will be defined by Voith. In general the draft tube exit needs to be placed below the minimum tail water level.





1-4 Factory assembly of StreamDiver

5 Retrieval from power plant

Easy Assembly and Service

Flexible and easy to handle: Assembly and disassembly of the StreamDiver is a task done by a few hands. Before removing one turbine from an array, the machinery will be automatically shut down with a shut-off valve. Then mechanics remove the StreamDiver from the water with a mobile crane, since the power unit has a weight of less than ten tons.

Finally, with the help of an all encompassing steel structure, experts get access to the turbine's components. In four steps the StreamDiver can be dismantled in its main components (Fig. 1-4). No special tools are required for the disassembly process.

Power Plant Equipment

Shut-off valve

Depending on project specific requirements Voith may supply an automatic shut-off valve. The gate will be connected to the unit control cubicle and can be either placed at the inlet or the draft tube outlet.

Grid Connection Equipment

The standard voltage level of the StreamDiver is 400V. Voith will deliver an electrical low voltage cubical that contains a low voltage circuit breaker, an electrical protection and a synchronization unit. Additionally, an automation cubicle is foreseen. The StreamDiver will be equipped with temperature, vibration and leakage sensors. All sensors will be connected to a programmable logic control (PLC). The PLC allows a continous monitoring of the unit status and the automatic synchronization and shut down of the unit. The PLC will be placed in a control cubicle. Depending on the customer requirements, the plant control can also be integrated within the StreamDiver Control cubicle. The current standard foresees the StreamDiver to be connected directly to the grid. Due to local grid codes Voith is able to equip the unit with a reactive power control unit. A further variant considers to equip each StreamDiver with a full frequency converter; this allows a variable speed operation and a reactive power control in one. The decision if a frequency converter is mainly drifted depends on the local hydraulic site conditions and economical considerations.

Project Specific Site Equipment

In addition to the standard scope of supply, the following project equipment should be considered:

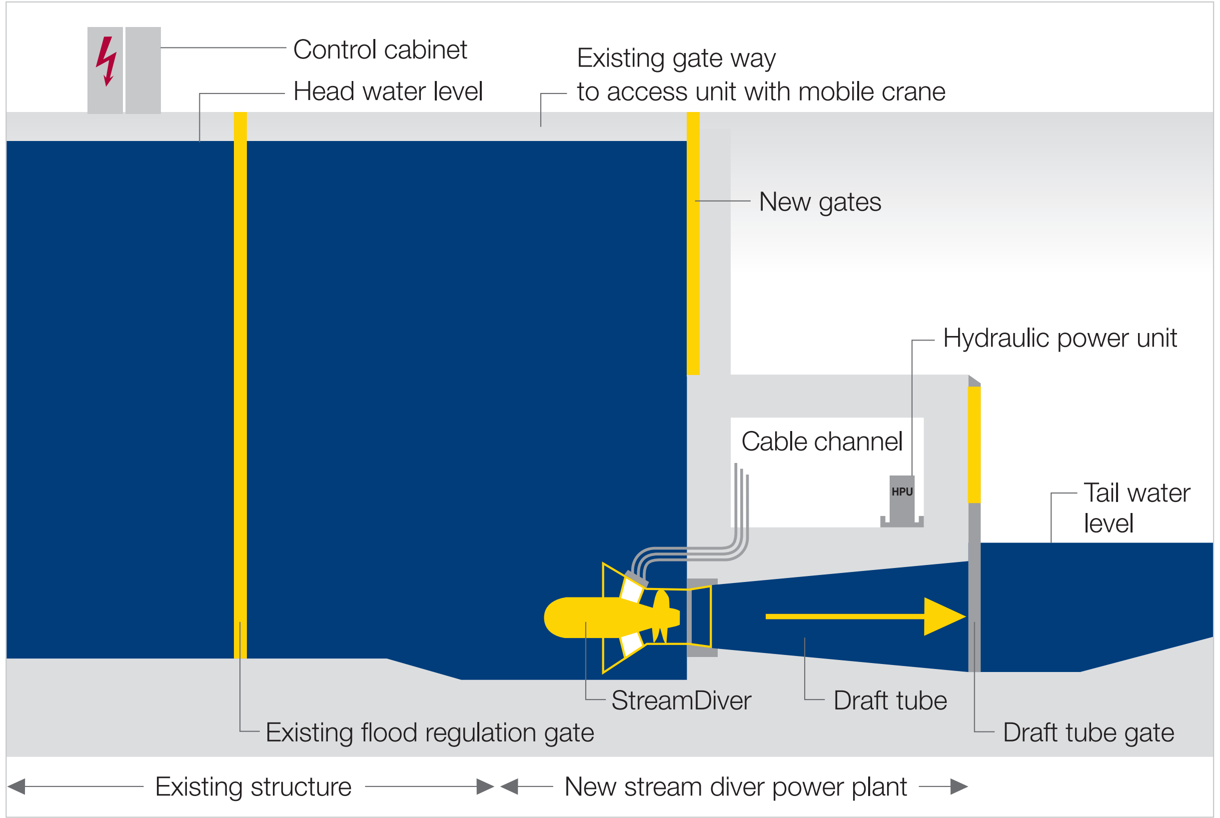
- Trash rack and cleaning system
- Stop logs to maintain the trash rack and its cleaning system
- Fish bypass system
- High voltage transformer and grid connection system

The arrangement and its necessity depend on the local site condition and customer specific requirements.

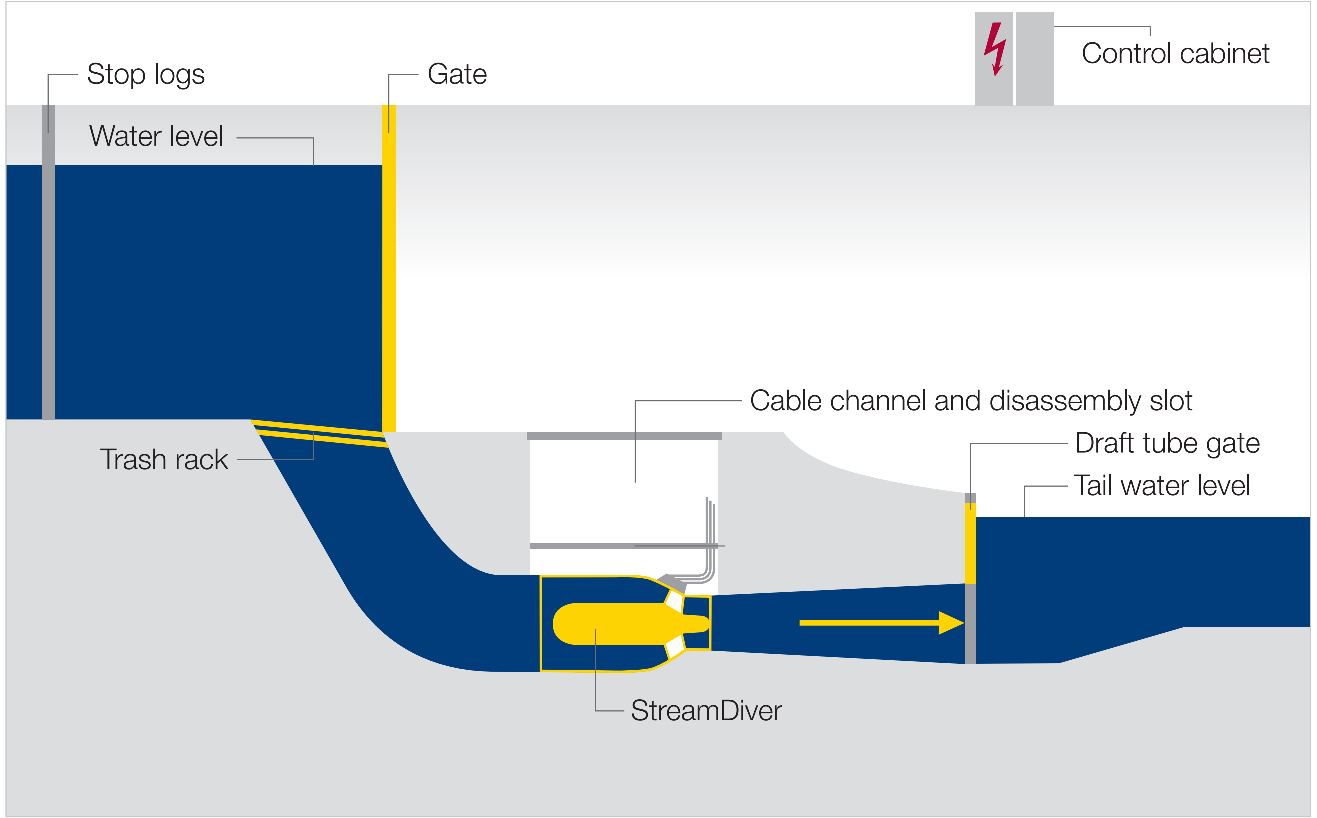
Hydropower Plant layout examples

The principle idea is to place the StreamDiver under water. The electrical and plant peripheral equipment can be placed safely and is easily accessible outside the river stream.

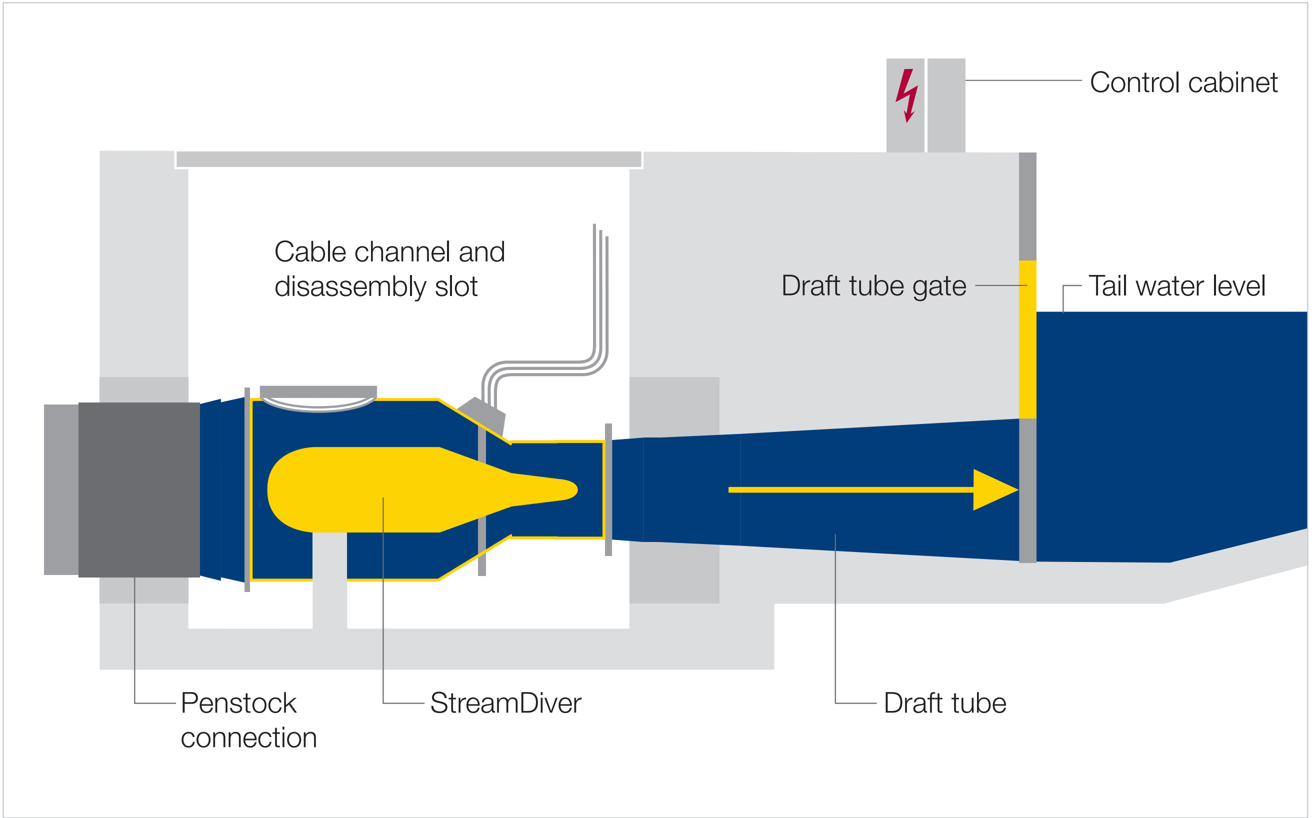
Case Study 1: Integration in existing flood regulation weir



Case Study 2: Residual flow power plant



Case Study 3: Integration in existing Penstock



t3390e

Voith Hydro Holding GmbH & Co. KG
Alexanderstraße 11
89522 Heidenheim, Germany
Tel. +49 7321 37 0
Fax +49 7321 37 7828
www.voith.com

A Voith and Siemens Company

VOITH
Engineered Reliability

SCOOTENEY OUTLET

SCREENING LEVEL FEASIBILITY REPORT

SCOOTENEY OUTLET

FERC NO. P-14317

Prepared for:

Grand Coulee Project Hydroelectric Authority
Ephrata, Washington

Prepared by:

Kleinschmidt

Gresham, Oregon
www.KleinschmidtGroup.com

February 2015

SCREENING LEVEL FEASIBILITY REPORT

SCOOTENEY OUTLET

FERC NO. P-14317

Prepared for:

Grand Coulee Project Hydroelectric Authority
Ephrata, Washington

Prepared by:

Kleinschmidt

Gresham, Oregon
www.KleinschmidtGroup.com

February 2015

SCREENING LEVEL FEASIBILITY REPORT

SCOOTENEY OUTLET
FERC No. P-14317

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

EXECUTIVE SUMMARY

The proposed Scooteney Outlet Hydroelectric Project (Project) would utilize irrigation water released from the Scooteney Reservoir. The Project is located directly downstream from the Scooteney Outlet drop structure, which regulates the release of water from Scooteney Reservoir. Kleinschmidt Associates (Kleinschmidt) developed the project concept through existing site information, including site flow data, topography, site visits, discussions with Grand Coulee Project Hydroelectric Authority (GCPHA), and information from equipment vendors.

The proposed Project development was evaluated under two scenarios both of which consider emerging turbine and generator technologies. The first scenario includes two new 500 kilowatt (kW) Very Low Head (VLH) units with integrated crest gates, a new controls and power equipment enclosure, a transformer, and transmission line. Infrastructure for the VLH units includes an extension of the concrete canal walls downstream of the outlet structure, a new center concrete support pier, and a new frame for lifting the unit. The second scenario considers an alternative emerging technology, specifically Natel low-head units, which have a reduced capital cost, but produce less power than the first scenario VLH units for this site. The Project would produce approximately 4,500 megawatt hour (MWh) of energy annually using Scenario One, the VLH technology approach, and approximately 3,500 MWh annually with the Scenario Two approach using Natel technology.

Development costs for Scenario One, the VLH units, were based on vendor quotes and a preliminary layout while the development costs for Scenario Two, the Natel unit, were pro-rated based on costs from a current development being built in central Oregon. It was assumed efficiencies would be made for the operation and maintenance (O&M) costs for both scenarios by using existing staff resources to operate and maintain the Project. Table 1 summarizes the results of each of the two scenarios.

TABLE 1 SUMMARY OF STUDY RESULTS - SCOOTENEY OUTLET

	SCENARIO ONE	SCENARIO TWO
Total Development Cost Analysis	$5,080,000	$4,490,000
20 Year Net Present Value	-$1,300,000	-$1,530,000

The results from this study show that the Project is not financially viable under either scenario.

1.0 PROJECT DESCRIPTION

1.1 EXISTING CONDITIONS

The Scooteney Outlet drop structure is located in Franklin County, Washington, in the South Columbia Basin Irrigation District (SCBID), east of the Columbia River, and north of Pasco, Washington (Figure 1).

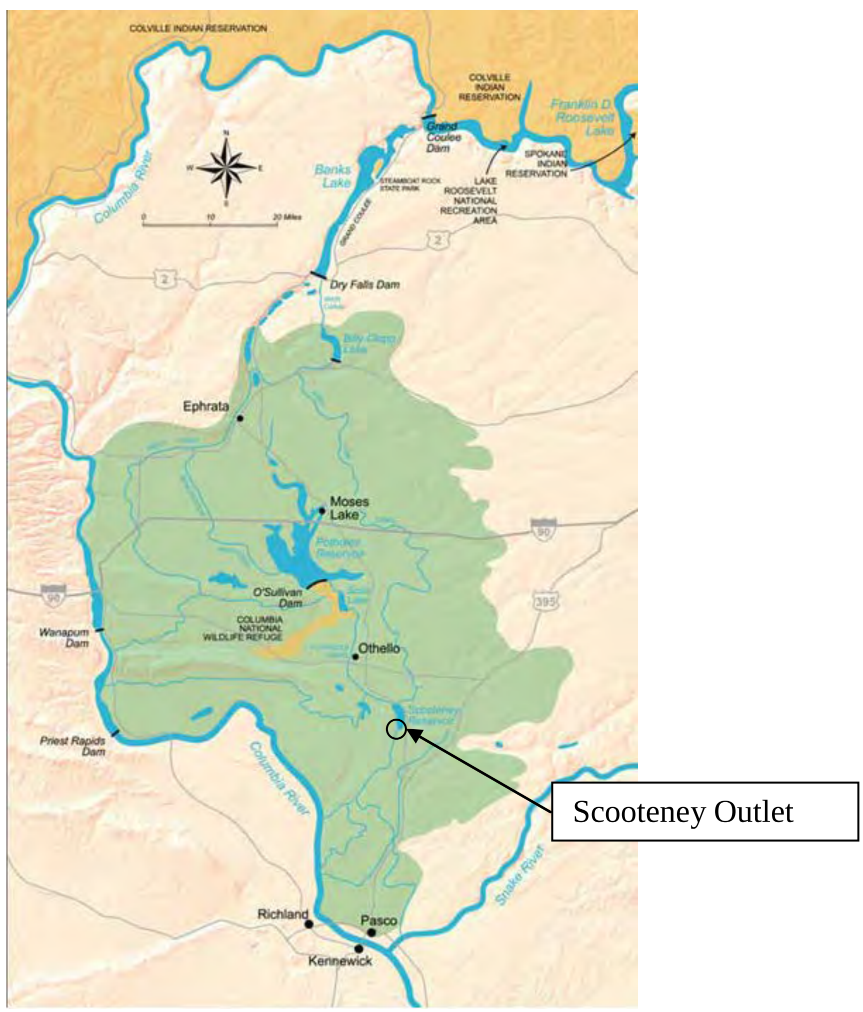


FIGURE 1 COLUMBIA BASIN PROJECT IRRIGATION AREA (BUREAU OF RECLAMATION MAP)

SCBID is part of the Columbia Basin Project which is owned by the United States Bureau of Reclamation (BOR). Scooteney Outlet, located on the Potholes East Canal, is a Transferred Works Project. This means that it is owned by BOR, but its operation and maintenance have been transferred to SCBID. The Scooteney Outlet drop structure is used to release water from Scooteney Reservoir. More details on the reservoir and canal elevations, drop structure, and water elevations are provided on existing canal drawings in Appendix C. The following site information was used to develop the Project concept and was provided by GCPHA, existing drawings, and data collected from site visits.

Water Elevations:

- Headpond: 917 feet
- Tailwater: 905 feet

Upstream Freeboard: The Scooteney Reservoir has significant storage capacity so level control from the Project is not required to be as instantaneous as at other sites.

Site Hydraulics: Scooteney Outlet releases irrigation delivery flows during the irrigation season of late March through October. The annual flow duration curve provided in Figure 2 is based on historical site flow data from Scooteney Outlet.

- Annual Flow Patterns: Flow only during irrigation season
- Emergency Flow Capacity: 1,800 cubic feet per second (cfs)

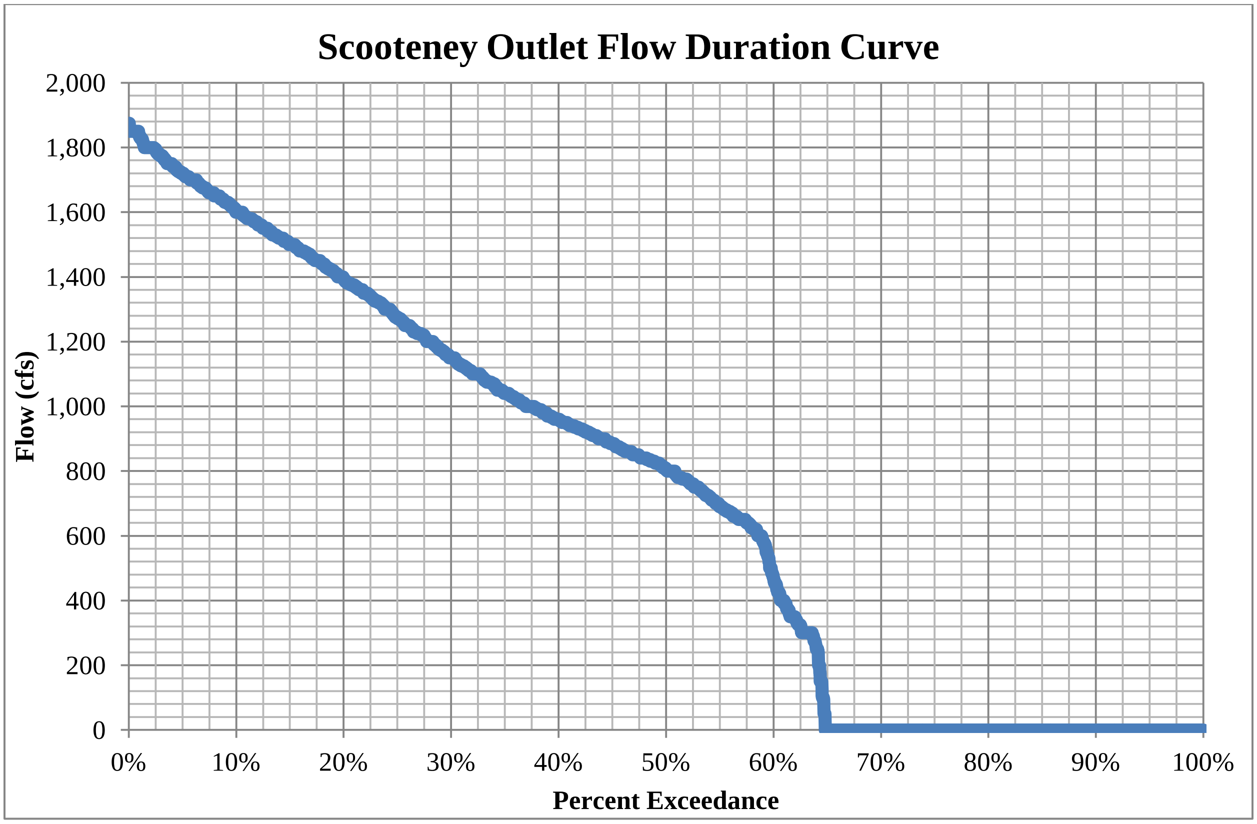


FIGURE 2 FLOW DURATION CURVE

Geotechnical Considerations: The proposed VLH structure is within the existing canal system. Based on a visual assessment the base and walls of the canal appear to be basalt bedrock topped with loose stone.

1.2 PROPOSED DEVELOPMENT - SCENARIO ONE

The Project concept layout for Scenario One with two VLH units is shown on Appendix A. The Project concept is located primarily in the canal downstream of the drop structure. Site photographs of the proposed Project location are provided in Appendix B. Scenario One has the following features:

- Capacity: 1,000 kilowatts (kW)
- Turbine Type: 2 VLH Turbines
- Turbine Maximum Flow: 1,200 cfs
- Gross Head: 12 feet
- Transmission Line Length: 2,700 feet

Water Control & Bypass: The upstream of the Project intake is the Scooteney Reservoir which has significant storage volume. This means that the ability to instantaneously pass flow after a unit shutdown is not critical as long as release can be re-established within a reasonable timeframe. Therefore, Kleinschmidt proposes two methods for flow passage in the event of an overflow or unit shut down.

1. The first method is a downward opening flap gate attached to the top of the VLH unit.
2. The second is to use a hoist to remove the VLH units from the water passage completely. The photographs in Figure 3 show VLH units with flap gates. The flap gates proposed for the Project would be approximately three times the height shown in the photographs (Figure 3).

FIGURE 3 VHL UNIT EXAMPLE PHOTOS

Intake: The existing tainter gates would act as the start of the intake with the extended canal walls creating a forebay area. Each VLH unit has an integrated trashrack screen on the face and an integrated trash sweeping arm.

Powerhouse: No powerhouse will be required as the VLH units will be set in the canal. A small building on a slab-on-grade will be required to house the controls and power electronics equipment.

Generating Units: Two VLH units are proposed because they cover the majority of the flow range shown in Figure 2. The higher end of the flow was not captured because a third unit would not fit in the canal width and even if it did it's likely the marginal return would not justify a third unit.

- Type: VLH
- Operational Range: 95-600 cfs (each unit)
- Number: 2

Access and Constructability: Access to the turbine areas will be by the existing access road that is approximately 500 feet long off of Hendricks Road and 1.5 miles off of Route 17. The canal does not discharge from Scooteney Reservoir in the winter. There will be some minor surface water that will need to be controlled during construction.

Substation and Transmission Interconnection: A generator step-up transformer (GSU) is needed to match the voltage from the unit generator to the 13.2 kilovolt (kV) transmission line. Approximately 2,700 feet of three-phase transmission line and poles are needed to connect the Project's GSU to the overhead distribution line owned by Big Bend Electric Cooperative (BBEC). Unless GCPHA can negotiate a favorable wheeling rate with BBEC to deliver the power into Franklin Public Utility District's (PUD) system or the Bonneville Power Administration transmission system, GCPHA may consider and elect to construct a longer transmission line that interconnects directly to Franklin PUD's electric system or to the 34.5 kV transmission project line that connects to the BPA Scooteney Substation. System studies are required to finalize the design, equipment requirements, and potential system upgrades. The cost of these studies is included in the cost analysis for the Project.

1.3 PROPOSED DEVELOPMENT - SCENARIO TWO

The Scenario One development using the VLH technology does not show financial viability. Therefore, Kleinschmidt looked at utilizing other new unconventional low-head hydroelectric technologies. These technologies have either lower equipment costs, such as the Natel Energy's turbine and Andritz's EcoBulb, or do not require a powerhouse, such as Voith's StreamDiver matrix turbine. Appendix E provides more information on these technologies. Although these technologies typically have disadvantages of lower efficiencies and limited operational histories, the intent of conceptually reviewing these options was to determine if they warrant more detailed consideration.

For Scenario Two, Kleinschmidt selected three low-head Natel Energy units similar to a project currently being developed in Oregon, so that actual costs of an on-going project can be further considered. New infrastructure to support these units includes a combined intake/powerhouse that is integrated into the existing drop structure. A conceptual layout and a detailed cost analysis were not developed for this scenario. Instead, the development cost was determined by pro-rating actual costs from the project being developed in central Oregon, which has only one 400kW Natel unit. The rating of each Natel unit at Scooteney Outlet is estimated to be 240 kW for a total capacity of 720 kW, and the annual energy generation is estimated to be 3,500 MWh.

The advantage of this scenario is the anticipated lower costs of development. The disadvantage is that this technology is new, which means the design life of these units are not yet proven, energy production will be lower, and operation and maintenance costs are unknown. To offset the risk of unknowns, Natel has offered the option of providing project funding or a development partnership that would allow them to carry the technology risk.

2.0 COST ANALYSIS

2.1 CONSTRUCTION COST ANALYSIS

For Scenario One, an analysis of construction cost is provided in Table 2. The total construction cost includes the work and equipment to complete the Project. This table includes construction features, permanent civil work, purchase and installation of the turbine/generator equipment, mechanical equipment, electrical equipment, substation and interconnection and other related Project costs.

TABLE 2 CONSTRUCTION COST FOR SCENARIO ONE - SCOOTENEY OUTLET

ITEM	DESCRIPTION	CONTINGENCY	CONSTRUCTION COST ANALYSIS[1]	NOTES
1	Mobilization and Demobilization	0%	$90,000	Site set up, soil erosion measures, site restoration
2	Cofferdams and Dewatering	0%	$0	Project dewatered with existing gates
3	Spillway Work	0%	$0	Flow spilled through gates in unit or through lifting unit
4	VLH Support Structure	25%	$370,000	Concrete work to support VLH units, slab, pier, walkways
5	Controls Building	20%	$90,000	15' by 15' building for controls and power devices
6	Turbine/Generator Supply and Install	10%	$3,250,000	Water-to-wire package including power equipment, and controls
7	Balance of Plant	20%	$60,000	HVAC, misc. electrical work
8	Substation and Interconnection	25%	$430,000	GSU, transmission lines, primary metering, protection, and interconnection study
9	Other	5%	$120,000	Insurance and bonding
	Weighted Average Contingency	13%		
	CONSTRUCTION COST ANALYSIS TOTAL		**$4,410,000**	

[1] These numbers are based on 2014 costs.

The VLH turbine package is very expensive due to a submerged generator and expensive power equipment to allow for variable speed operation. The T/G supply constitutes nearly 75% of the total construction cost.

The civil/site costs were developed based on quantities taken from the proposed concept layout and existing drawings of the canal combined with unit costs. The unit costs were from the manufacturer of the VLH's budgetary cost. In addition JR Merit, a Washington state contractor, provided input on regionally appropriate line item costs and construction considerations.

The estimated substation and interconnection capital cost includes the overhead transmission line, primary metering, special substation relay/protection equipment, system studies, a GSU, and GSU containment pad.

Table 2 includes contingencies for each area of work. Any work that will occur near a body of water or that will require deeper excavation or pile driving such as the spillway work, cofferdams, etc. was given a contingency of 25% due to unknowns with site geology. The water conveyance work was assigned a contingency of 20% due to the possibility of unknown subsurface conditions. Balance of plant and interconnection costs were given a contingency of 20% due to more unknowns as opposed to the 10% contingency used for turbine/generator equipment where budgetary quotes were provided by vendors.

Scenario Two construction costs were scaled from a current development in central Oregon. The development in Oregon is projected to cost $1,300,000 with $400,000 for the equipment and $900,000 for the civil development for a single 400 kW turbine. That cost was tripled to $3,900,000 for a three 240 kW turbine development for the Project. Kleinschmidt contacted the contractor building the development to discuss the projected costs. The contractor is nearly finished with the excavation and expects the project will meet the budget. Conceptual equipment prices for other non conventional turbine technologies indicate that this is reasonable. Further exploration into the details of this type of development and how it may apply will be required if GCPHA decides this option should be further considered.

2.2 OTHER DEVELOPMENT COSTS

There are a number of other development costs to consider aside from the previously quantified direct initial construction and installation. These items include:

- engineering
- construction assistance
- licensing and permitting
- environmental studies
- marketing fees
- legal fees
- transaction fees
- land acquisition
- sales tax
- property tax
- GCPHA internal costs
- administration

Kleinschmidt assumed that 15% of the total construction cost analysis for Scenario One and Two would cover the other development costs. This results in less cost for Scenario Two because this scenario would most likely have less design engineering and construction assistance due to less infrastructure. Sales tax and transaction fees would also be lower for Scenario Two due to the lower overall construction cost.

2.3 SUMMARY OF DEVELOPMENT COSTS

For each scenario the total development cost, which includes the construction cost and other development costs discussed previously, are provided in Table 3. Also included is a unit cost per kW for each scenario to equally compare each option.

TABLE 3 SUMMARY OF DEVELOPMENT COSTS – SCOOTENEY OUTLET

	SCENARIO ONE	SCENARIO TWO
Construction Cost	$4,410,000	$3,900,000
Other Development Costs	$670,000	$590,000
Total Development Cost	$5,080,000	$4,490,000
Turbine Rating (kW)	1000	720
Total Development Cost ($/kW)	$5,080	$6,236

Both scenarios are near or under the range of one developed small hydro project in the Northwest that cost $6,000/kW (Juniper Ridge Hydro, 5MW, 2009). Also these costs are within the range of a June 2013 Oak Ridge National Laboratory (ORNL) study of Oregon small hydro showing costs ranging from $1,500/kW for higher head, 3-5 megawatt (MW) projects to well over $10,000/kW for lower head/lower power projects.

2.4 OPERATION AND MAINTENANCE

O&M costs include internal maintenance staff, wheeling charges, administration, cost of consumables, and other costs. GCPHA provided cost information based on their current O&M practices for smaller-sized projects, and Kleinschmidt conducted a survey of available industry O&M data. Based on this information, and an assumed efficiency of using existing GCPHA staff and resources, an O&M cost of 15$/MWh was utilized in the cost analysis. The pro forma, provided in Appendix D, increases this cost at an annual rate of 3%

3.0 ANNUAL ENERGY ESTIMATE AND VALUE

The annual energy production was estimated based on flow and head information provided by GCPHA, typical turbine efficiencies, and typical operational factors. For Scenario One the average annual output is 4,500 MWh which results in a 51% capacity factor. For Scenario Two the annual power output is 3,500 MWh which results in a 55% capacity factor. These estimates were determined through an energy model that calculated the average energy produced based on two flow points per month.

The two ways to value project output are through wholesale power value plus a Renewable Energy Credit (REC) value or through a power value that is comparable to similarly sized wind and solar projects. For the purpose of this study we assumed a power value comparable with wind and solar projects utilizing a power value of $60/MWh, with an escalation of 3% per year. A critical next step will be to confirm this power value and economics in the pro forma. See the Energy Market Assessment Report for more details.

4.0 FINANCIAL PERFORMANCE

Kleinschmidt completed a 20 year financial pro forma for each scenario to determine the net present value (NPV) of the Project. To determine the NPV, the pro forma calculates the annual power production cost and annual power sales. The power production cost includes O&M costs and payments made on debt service for the development costs. The study assumes the cost to develop the Project will be funded by bonds. In the pro forma, it is assumed the bonds have a 3.5% interest rate and a 20 year term. A summary of the pro forma results including the NPV and the cost of production and power sales for the first year are provided in Table 4. The detailed pro forma is provided in Appendix D.

TABLE 4 SUMMARY OF FINANCIAL PERFORMANCE - SCOOTENEY OUTLET

	SCENARIO ONE	SCENARIO TWO
First Year Power Production Cost ($/MWh)	$94	$105
First Year Power Value ($/MWh)	$60	$60
20 Year Net Present Value	-$1,300,000	-$1,530,000

The price of production for new wind projects with tax incentives is approximately $50/MWh and without incentives is approximately $70/MWh. Solar developers in the region have executed agreements with Idaho Power at levelized rates of approximately $64/MWh levelized. Potential off-takers will compare the Project to a similarly sized wind or solar project that has power generation values of $60/MWh. This power value includes selling the RECs with the power.

The pro forma for all scenarios shows that the energy market value of output from the Project produces negative cash flows in every year of operation. Calculation of the NPV of these cash flows (assuming a 4% discount rate) shows an overall loss.

5.0 REGULATORY AND ENVIRONMENTAL

The Federal Energy Regulatory Commission (FERC) preliminary permit was issued on March 26, 2013, (P-14317) and expires February 28, 2016. GCPHA has filed three required 6-month progress reports for the Project to date. The first was filed on August 21, 2013; the second on February 25, 2014; the third on August 21, 2014; and the fourth on February 18, 2015. The next 6-month progress report for the preliminary permit will be due in August of 2015.

In response to GCPHA's preliminary permit application, the Washington Department of Fish and Wildlife filed an intervention and a comment letter dated March 8, 2012, indicating that the Project has the potential to affect fish and wildlife resources and continued agency coordination is recommended. However, no other stakeholders or agencies have commented on the preliminary permit or 6-month progress report filings.

The proposed Scooteney Outlet Hydroelectric Project (Project) would utilize irrigation water transported by the Potholes East Canal (PEC). The Project is located adjacent to the Scooteney Outlet drop structure which regulates water elevations in the canal and passes flow down into Scooteney Reservoir. The Project, as currently designed, will be located fully on BOR fee title lands.

Because the Project is located on federal lands, several FERC processes are precluded including the FERC 40 MW Conduit Exemption Process. As such, the available FERC authorization process would be licensing. The Project would be subject to Federal Power Act Section 4(e) mandatory conditions imposed by the BOR as the Project would be on federal reservation lands (i.e., those owned in fee title by BOR, regardless of management). While the licensing process is generally longer and more costly than the exemption process, GCPHA could request a waiver of the three stage consultation requirement considering that environmental issues appear to be low. A downside to FERC licensing is the need to periodically relicense, generally every 30 to 50 years. There would be no annual charges associated with the FERC licensing process as the proposed Project is less than or equal to 1,500 kW. In addition, FERC does not charge administrative processing fees for license applications. However, FERC would charge land charges for the occupation of BOR lands at $40.10/acre. The cost of preparation and filing of a license application for the Project, not including any potential required studies, would be expected to be approximately $47,500.

Alternatively, BOR's Small Conduit Lease of Power Privilege Process (LOPP) may be a viable option. Mandatory conditions are those as imposed/negotiated with BOR in consultation with the agencies. Because BOR is a mandatory conditioning authority (i.e., BOR has the authority to add conditions to the FERC license) in the FERC process for this project, that risk does not appear to be any different from the Small Conduit LOPP. Further, the Small Conduit LOPP allows for a categorical exclusion from the National Environmental Protection Act (NEPA) review, whereas the FERC licensing process would not. Annual charges for the Small Conduit LOPP are $2/MWh so that would cost the Project approximately $9,000 annually. The LOPP process does not prescribe a term to the lease so that creates undesirable uncertainty. An advantage of the LOPP process is that it may allow for construction sooner than the FERC process. In addition, BOR requires applicants to provide advance funding of all BOR application processing costs, which are unknown at this time. The cost of preparation and filing of a Small Conduit LOPP application for the Project, not including any potential required studies, would be expected to be less than $28,000, assuming NEPA exclusion.

It appears that there will be minimal environmental impacts as the Project site will primarily be in the existing canal and on the existing access road.

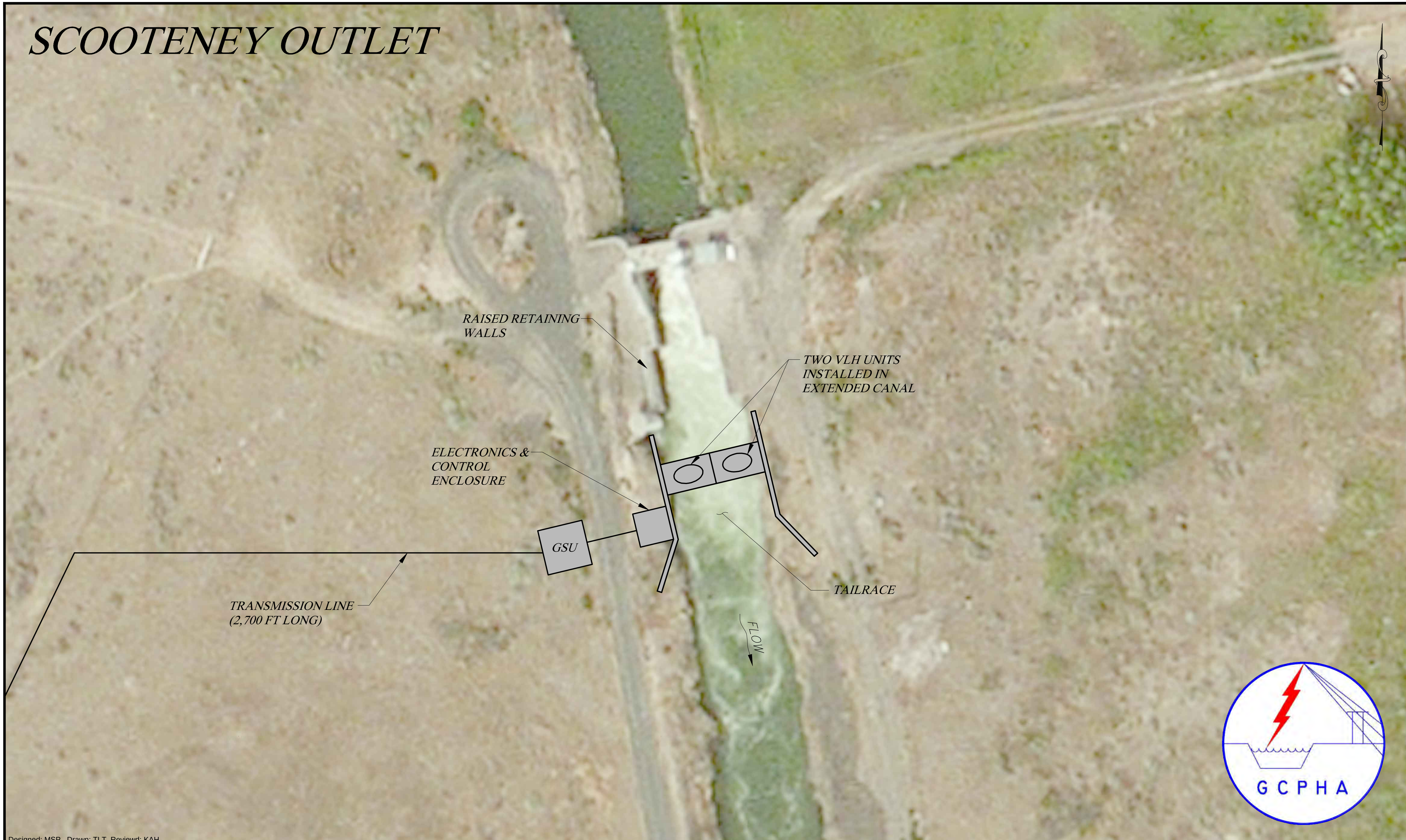
6.0 POTENTIAL NEXT STEPS

Based on the results of the pro forma, the Project appears uneconomic for both development scenarios. This result is due to the short generation season and low energy production. Factors that may warrant reexamination include:

- grant or tax incentives are available to defray the development cost; and
- changes in the market conditions that make the project economically feasible.

APPENDIX A

PROJECT LAYOUT



Kleinschmidt

20 0 20 40
SCALE IN FEET

GRAND COULEE PROJECT HYDROELECTRIC AUTHORITY
EPHRATA, WA

22x34 = FULL SCALE

J:\1823\003\Drawings\Working Drawings\1823-003 SCOOTENY OUTLET.dwg

PRINTED Jan. 23, 2015 - 3:16 PM

APPENDIX B

SITE PHOTOGRAPHS

SCOOTENEY OUTLET
OCTOBER 2014

PHOTO 1 HEADWORKS UPSTREAM VIEW

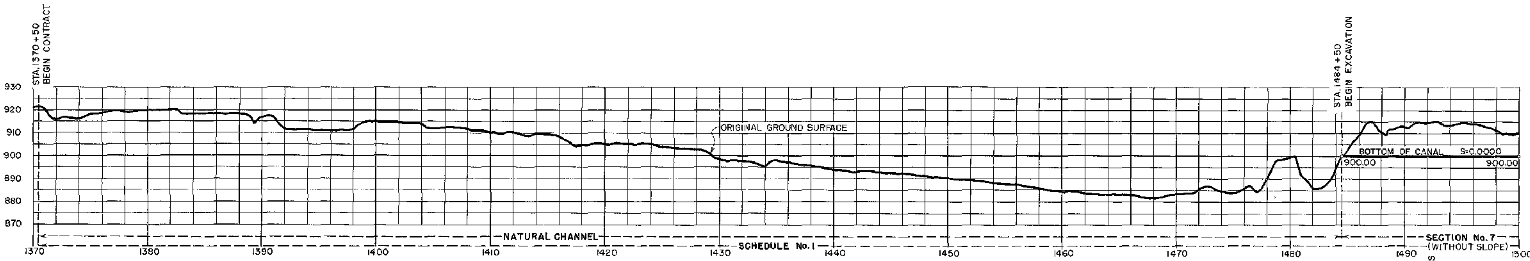
PHOTO 2 HEADWORKS DOWNSTREAM VIEW

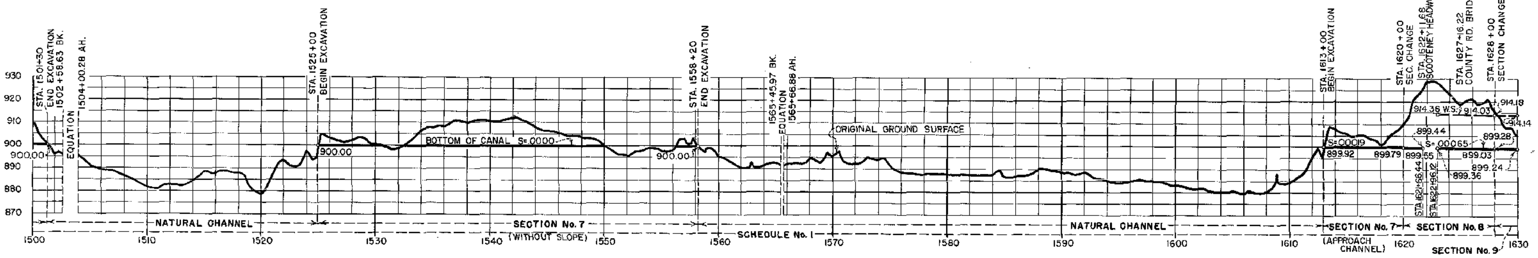
Appendix C

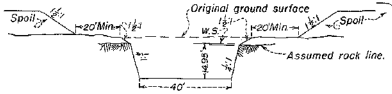
Existing Drawings

Not Included in Public Version

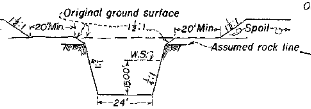
(THIS MATERIAL CONTAINS CONFIDENTIAL INFORMATION AND DISTRIBUTION TO THIRD PARTIES IS RESTRICTED BY NON-DISCLOSURE AGREEMENTS WITH THE U.S. BUREAU OF RECLAMATION.)



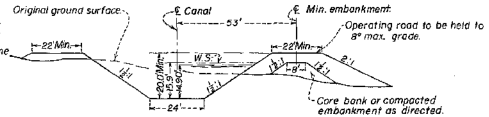




SECTION No. 7
TYPICAL CANAL SECTION



SECTION No. 8
TYPICAL CANAL SECTION



SECTION No. 9
TYPICAL CANAL SECTION

HYDRAULIC PROPERTIES									
SECTION	B	d	Area	r	S	V	Q	n	S:S
No.7 Unlined	40	14.95	653.87	9.23	.00019	2.75	1800	.035	$\frac{1}{4}$:1
No.8 Unlined	24	15.00	416.25	7.57	.00065	4.33	1800	.035	$\frac{1}{4}$:1
No.9 Unlined	24	14.90	690.62	8.89	.00018	2.61	1800	.035	$1\frac{1}{2}$:1

NOTE

Top of embankment to slope 24:1 away from canal.

2-15-56 AS BUILT

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT—WASHINGTON

POTHOLES EAST CANAL

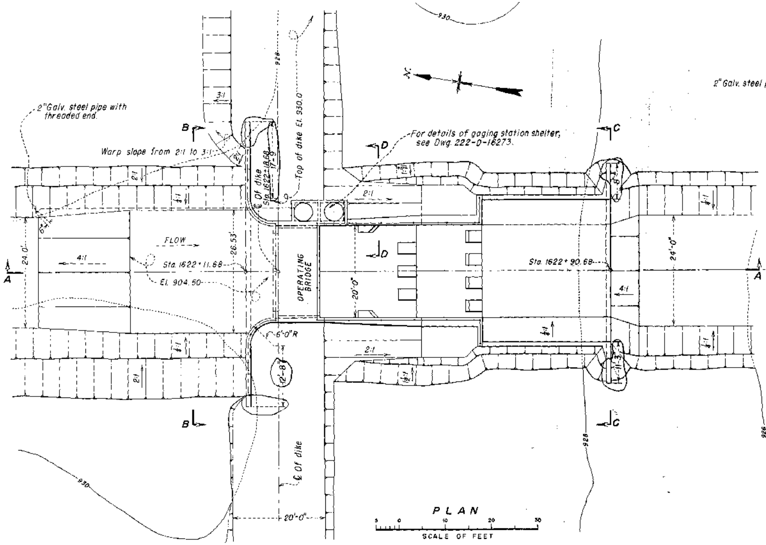
STA. 1370+50 TO STA. 1630+00
PROFILES AND SECTIONS

DRAWN L.G.F. SUBMITTED R.V. Downs
TRACED R.W.A. RECOMMENDED W.H. Nalder
CHECKED G.H.C. APPROVED W. E. Blomgren
ACT. CHIEF ENGINEER

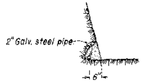
REV. 5-21-51 F.D.M.

EPHRATA, WASHINGTON SEPT. 21, 1950
SHEET 1 OF 3

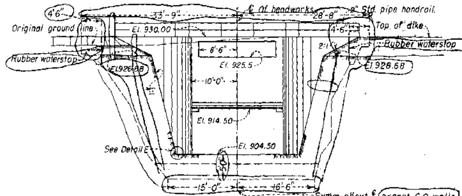
222-116-20777



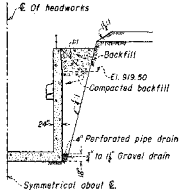
PLAN



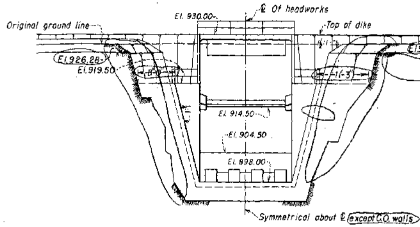
DETAIL E



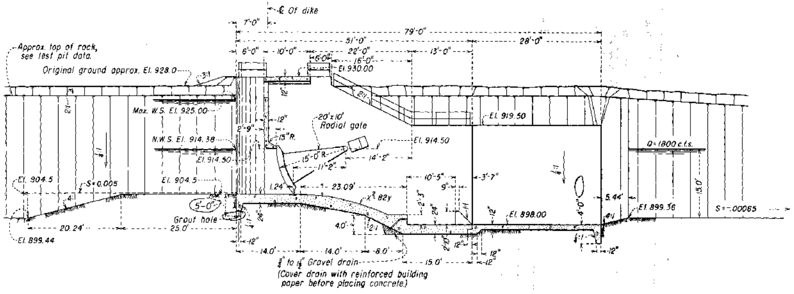
SECTION B-B



SECTION D-D



ELEVATION C-C



SECTION A-A

QUANTITIES

Concrete	42983 Cu. Yds.
Reinforcement steel	69,090 Lbs.

REFERENCE DRAWINGS

DETAIL TOPOGRAPHY AND TEST PIT DATA	222-116-20782 AND 20787
CONCRETE AND REINFORCEMENT DETAILS	222-D-15885 AND 15886
TOP SEAL RADIAL GATE AND HOIST INSTALLATION	222-D-15859
20' BY 10' TOP SEAL RADIAL GATE	222-D-15860
HANDRAIL DETAILS	40-D-4315
REINFORCED CONCRETE HOUSE AND WELL	222-116-21417
48" CORRUGATED METAL GAGING STATION SHELTER	222-D-16273
15" STEEL LADDER	40-D-3432

GENERAL NOTES

Concrete design based on a compressive strength of 3000 lbs. per sq. in.
Provide 3/4 inch chamfer on all exposed edges of concrete.
Place all reinforcement so that the center of bars in the outer layers will be 2 inches from face of concrete unless otherwise shown.
Lap all bars a minimum of 34 bar diameters at splices.

AS BUILT

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

COLUMBIA BASIN PROJECT-WASHINGTON

POTHOLES EAST CANAL - STA. 1622+11.68

SCOOTENEY HEADWORKS
PLAN AND SECTIONS

DRAWN W.W.H. SUBMITTED A.W. Kelder
TRACED G.P.B. RECOMMENDED H.G. Curtis
CHECKED APPROVED CHIEF DESIGNING ENGINEER

DENVER, COLORADO, FEBRUARY 5, 1951 | 222-D-15884

KEYPUNCHED

APPENDIX D

20 YEAR PRO FORMAS

20 YEAR PRO FORMA — SCENARIO ONE

Pro Forma Cash Flow
Scooteney Outlet
Scenario One

Assumptions		**Cash Flow**											
Best Case Cost Reduction	0%	**Year**	1	2	3	4	5	6	7	8	9	10	11
Capital Cost	$ 5,080,000	Debt Service	$357,434	$357,434	$357,434	$357,434	$357,434	$357,434	$357,434	$357,434	$357,434	$357,434	$357,434
Debt Period (Years)	20												
Interest Rate	3.5%	Operations Cost	$22,500	$23,175	$23,870	$24,586	$25,324	$26,084	$26,866	$27,672	$28,502	$29,357	$30,238
Operations Cost	$ 22,500	Maintenance Cost	$22,500	$23,175	$23,870	$24,586	$25,324	$26,084	$26,866	$27,672	$28,502	$29,357	$30,238
O&M Escalation	3%												
		Admin Cost	$22,500	$23,175	$23,870	$24,586	$25,324	$26,084	$26,866	$27,672	$28,502	$29,357	$30,238
Maintenance Cost	$ 22,500												
Maintenance Escalation	3%	Power Production Cost ($/MWH)	$94	$95	$95	$96	$96	$97	$97	$98	$98	$99	$100
Admin Cost	$ 22,500	Power Sales	$270,000	$278,100	$286,443	$295,036	$303,887	$313,004	$322,394	$332,066	$342,028	$352,289	$362,857
O&M Escalation	3%												
		Cash Flow (-)	($154,934)	($148,859)	($142,602)	($136,157)	($129,519)	($122,681)	($115,639)	($108,385)	($100,913)	($93,218)	($85,291)
Annual Energy (MWH)	4,500												
		Annual Power Value ($/MWH)	$60	$62	$64	$66	$68	$70	$72	$74	$76	$78	$81
Power Value ($/MWH)	60												
Power Value Escalation	3%	Power Value Gap ($/MWH)	$34	$33	$32	$30	$29	$27	$26	$24	$22	$21	$19
		Required Capacity and Environmental Attribute Value ($/kW-mo)	$9	$8	$8	$8	$7	$7	$6	$6	$6	$5	$5
		NPV (4% IRR)	($1,299,432)										

Pro Forma Cash Flow
Scooteney Outlet
Scenario One

Cash Flow									
Year	12	13	14	15	16	17	18	19	20
Debt Service	$357,434	$357,434	$357,434	$357,434	$357,434	$357,434	$357,434	$357,434	$357,434
Operations Cost	$31,145	$32,080	$33,042	$34,033	$35,054	$36,106	$37,189	$38,305	$39,454
Maintenance Cost	$31,145	$32,080	$33,042	$34,033	$35,054	$36,106	$37,189	$38,305	$39,454
Admin Cost	$31,145	$32,080	$33,042	$34,033	$35,054	$36,106	$37,189	$38,305	$39,454
Power Production Cost ($/MWH)	$100	$101	$101	$102	$103	$104	$104	$105	$106
Power Sales	$373,743	$384,955	$396,504	$408,399	$420,651	$433,271	$446,269	$459,657	$473,447
Cash Flow (-)	($77,127)	($68,718)	($60,056)	($51,135)	($41,946)	($32,481)	($22,733)	($12,692)	($2,349)
Annual Power Value ($/MWH)	$83	$86	$88	$91	$93	$96	$99	$102	$105
Power Value Gap ($/MWH)	$17	$15	$13	$11	$9	$7	$5	$3	$1
Required Capacity and Environmental Attribute Value ($/kW-mo)	$4	$4	$3	$3	$2	$2	$1	$1	$0
NPV (4% IRR)									

20 YEAR PRO FORMA — SCENARIO TWO

Pro Forma Cash Flow
Scooteney Outlet
Scenario Two

Assumptions			Cash Flow											
			Year	1	2	3	4	5	6	7	8	9	10	11
Capital Cost	$ 4,490,000		Debt Service	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921
Debt Period (Years)	20													
Interest Rate	3.5%		Operations Cost	$17,500	$18,025	$18,566	$19,123	$19,696	$20,287	$20,896	$21,523	$22,168	$22,834	$23,519
Operations Cost	$ 17,500		Maintenance Cost	$17,500	$18,025	$18,566	$19,123	$19,696	$20,287	$20,896	$21,523	$22,168	$22,834	$23,519
O&M Escalation	3%													
			Admin Cost	$17,500	$18,025	$18,566	$19,123	$19,696	$20,287	$20,896	$21,523	$22,168	$22,834	$23,519
Maintenance Cost	$ 17,500													
Maintenance Escalation	3%		Power Production Cost ($/MWH)	$105	$106	$106	$107	$107	$108	$108	$109	$109	$110	$110
Admin Cost	$ 17,500		Power Sales	$210,000	$216,300	$222,789	$229,473	$236,357	$243,448	$250,751	$258,274	$266,022	$274,002	$282,222
O&M Escalation	3%													
			Cash Flow (-)	($158,421)	($153,696)	($148,829)	($143,817)	($138,654)	($133,336)	($127,858)	($122,216)	($116,405)	($110,419)	($104,254)
Annual Energy (MWH)	3,500													
			Annual Power Value ($/MWH)	$60	$62	$64	$66	$68	$70	$72	$74	$76	$78	$81
Power Value ($/MWH)	60													
Power Value Escalation	3%		Power Value Gap ($/MWH)	$45	$44	$43	$41	$40	$38	$37	$35	$33	$32	$30
			Required Capacity and Environmental Attribute Value ($/kW-mo)	$9	$9	$8	$8	$8	$7	$7	$7	$6	$6	$6
			NPV (4% IRR)	($1,525,971)										

Pro Forma Cash Flow
Scooteney Outlet
Scenario Two

Cash Flow									
Year	12	13	14	15	16	17	18	19	20
Debt Service	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921	$315,921
Operations Cost	$24,224	$24,951	$25,699	$26,470	$27,264	$28,082	$28,925	$29,793	$30,686
Maintenance Cost	$24,224	$24,951	$25,699	$26,470	$27,264	$28,082	$28,925	$29,793	$30,686
Admin Cost	$24,224	$24,951	$25,699	$26,470	$27,264	$28,082	$28,925	$29,793	$30,686
Power Production Cost ($/MWH)	$111	$112	$112	$113	$114	$114	$115	$116	$117
Power Sales	$290,689	$299,410	$308,392	$317,644	$327,173	$336,988	$347,098	$357,511	$368,236
Cash Flow (-)	($97,904)	($91,364)	($84,627)	($77,688)	($70,541)	($63,180)	($55,598)	($47,788)	($39,744)
Annual Power Value ($/MWH)	$83	$86	$88	$91	$93	$96	$99	$102	$105
Power Value Gap ($/MWH)	$28	$26	$24	$22	$20	$18	$16	$14	$11
Required Capacity and Environmental Attribute Value ($/kW-mo)	$5	$5	$5	$4	$4	$4	$3	$3	$2
NPV (4% IRR)									

APPENDIX E

ALTERNATIVE LOW-HEAD TURBINE TECHNOLOGIES

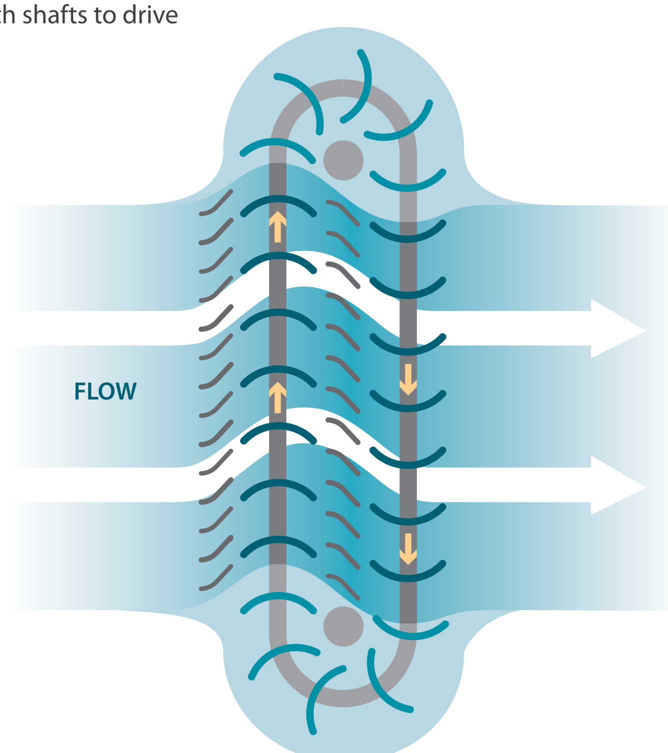
hydroEngine

a water-to-wire system for low head applications

Natel Energy, Inc. manufactures an innovative, patented hydraulic turbine called the hydroEngine, which operates with high efficiency in low head applications.

How it works

As water flows through the hydroEngine, the blades are driven in linear paths around two parallel shafts. Mechanical energy is taken off of either or both shafts to drive a conventional generator. Water enters the penstock, passes through the SLH unit, and exits the draft tube at or near stream velocity.



Technology Advantages

The hydroEngine has been specifically designed for high performance at low heads over a range of flows as low as 0.4 cms. Natel's water-to-wire packages featuring the hydroEngine can be installed in a range of settings, including irrigation canals and existing dams, with a minimum of civil works.

Additionally, the modular design of the hydroEngine ensures easy maintenance and repair. The moving components in each unit comprise a single cassette module that can be easily removed from the engine case with an overhead lift.

- Fish friendly
- No cavitation
- Minimizes need for site excavation
- Enables speedy maintenance
- Reduces costs associated with unit repair
- Delivers high performance at low head
- Maintains high efficiency as flow decreases

CURRENT PRODUCT

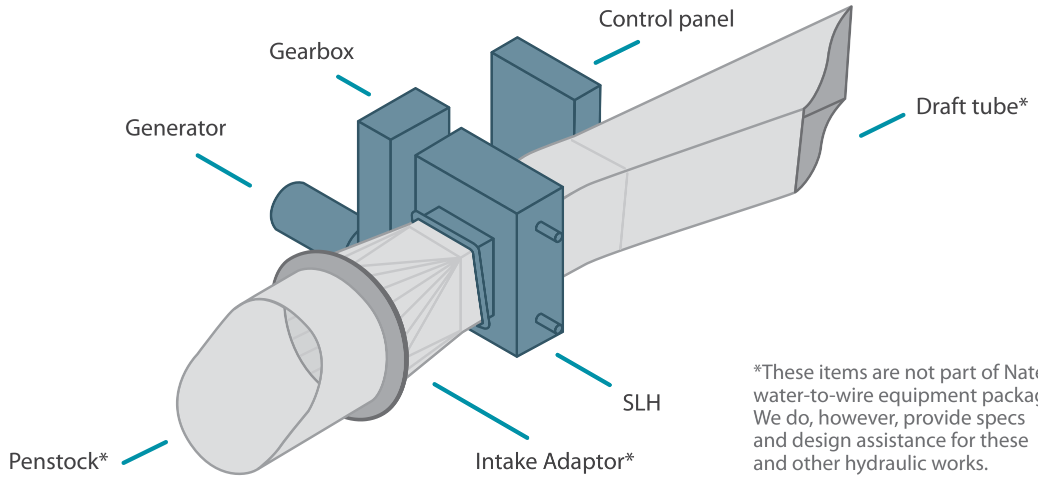
SLH100-L

500kW

Natel Energy, Inc.
2175 Monarch St.
Alameda, CA 94501
T: 510 342 5269
info@natelenergy.com
www.natelenergy.com

NATEL ENERGY

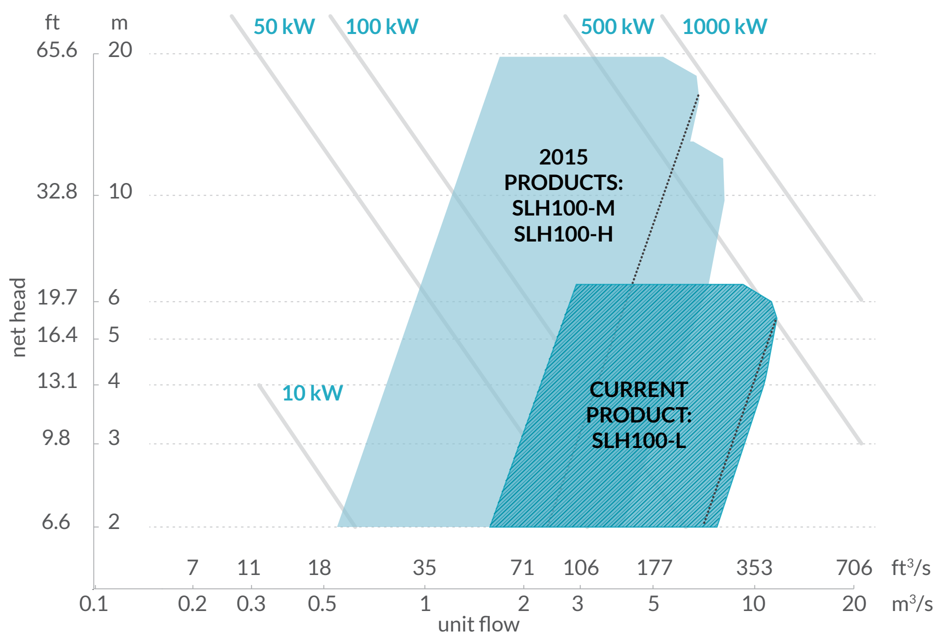
hydroEngine Equipment Package



*These items are not part of Natel's water-to-wire equipment package. We do, however, provide specs and design assistance for these and other hydraulic works.

The unique design of the hydroEngine, or SLH, enables the production of low cost renewable energy from flowing water at heads ranging from 2m (6 ft) to 18m (60 ft) high. Systems are integrated with a generator, switchgear, and SCADA compliant controls designed to work across multiple installations if needed. This provides a modular, easy-to-install solution, significantly reducing construction costs and speeding time to completion.

Operating Envelope

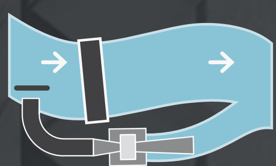


Operating History

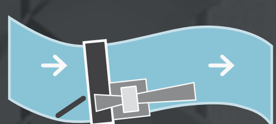
The SLH has demonstrated 75 to 80% hydraulic efficiency in hydraulic laboratory and field tests. Several different configurations have been installed and operated in field test and pilot commercial settings:

- A stream setting where a 35 kW hydroEngine ran for over 10,000 operating hours in the course of four years.
- Irrigation canal drops, including a 180 kW unit and a pilot of the SLH10 capable of producing 25 kW at 13 feet of head.
- A thermal power plant cooling water outfall.

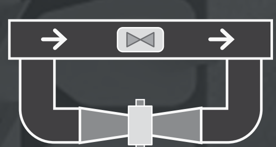
TYPES OF INSTALLATION



Run of river



In dam



In pipe

Natel Energy, Inc.
2175 Monarch St.
Alameda, CA 94501
T: 510 342 5269
info@natelenergy.com
www.natelenergy.com

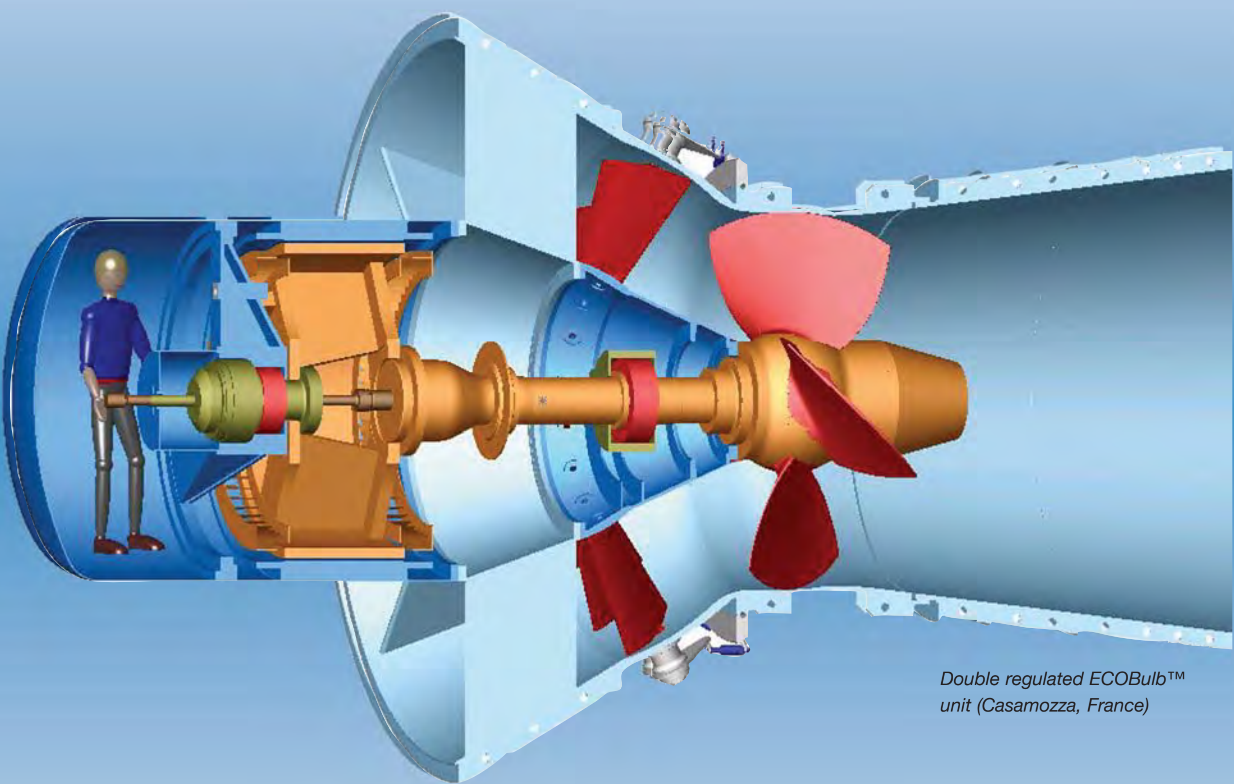
NATEL ENERGY

V4 - OCT 2014

VA TECH HYDRO

COMPACT ECOBulb™ TURBINE GENERATOR

We know how.



Double regulated ECOBulb™ unit (Casamozza, France)

A Compact Turbine Generator System for low head applications

Head between 2 and 15 m
Discharge between 15 and 100 m^3/s
Output between 500 and 5000 kW

Hydro

sustainable solutions. for a better life.

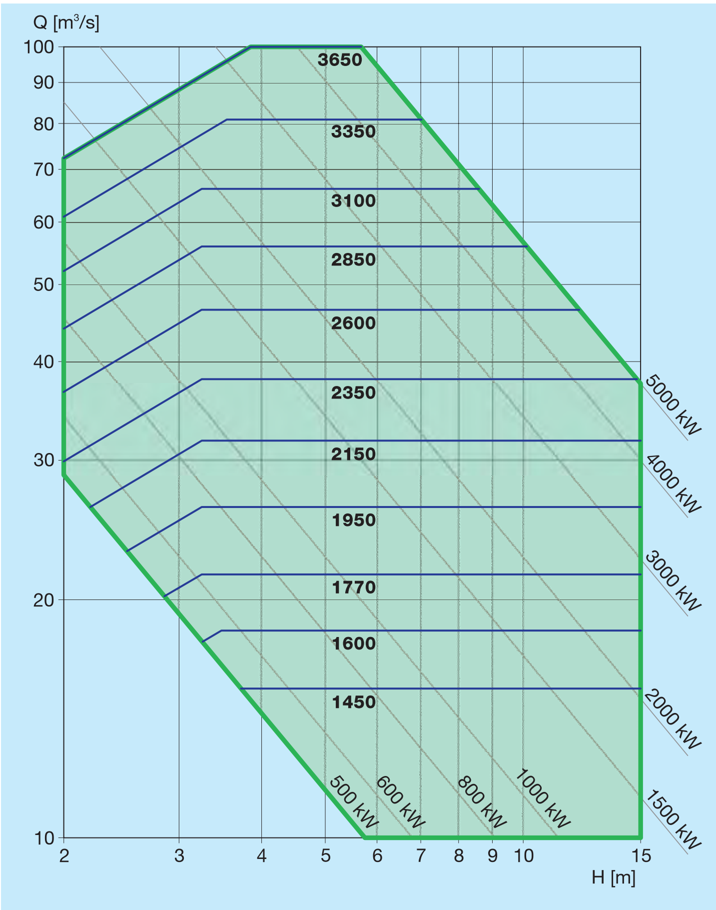
www.vatech-hydro.com

ECOBulb™
TURBINE GENERATOR

VA TECH Hydro, a world leader in Compact turbines, introduces the development of the ECOBulb™ Turbine Generator. The unit design minimizes investment in civil work and electromechanical equipment and significantly reduces maintenance costs throughout the life cycle of the plant. The result is the economical development of sites having low head potential while minimizing the ecological impact.

The ECOBulb™ unit is the unique combination of a single or double regulated axial turbine with a direct coupled low speed synchronous generator including a permanent magnet rotor (PMG) integrated into an air pressurized bulb. The removal of the step-up gear allows a simplification of the mechanical elements, a reduction of the size of the bulb and a huge life extension of the generating unit.

Application range



The ECOBulb™ turbine generator brings the industry unmatched advantages in investment costs for civil and electro-mechanical equipment as well as the ability to tap low head potential with high economic results.

The unit design minimizes maintenance costs and provides the maximum energy generation through high levels of hydraulic and electrical efficiencies.

The ECOBulb™ design also provides many ecological advantages. Generator cooling is achieved without external auxiliary systems by utilizing the bulb surfaces cooled by the surrounding river water. The two bearings supporting the shaft system are lubricated by biodegradable oil and grease. Since the units are completely submerged, the reduction in noise emission makes their installation in residential areas possible. Finally, the low profile of the ECOBulb™ allows an aesthetic integration of the unit's installation into the site's landscape.

The hydraulic profiles used have been developed and tested in our hydraulic laboratories and the electrical and thermal technologies are derived from large bulb generator units built by VA TECH HYDRO.

Technical data

- Head H between 2 and 15 m
- Flow Q between 15 and 100 m³/s
- Output P between 500 and 5000 kW

System features

- Integrated turbine generator unit with single-source engineering
- Single or double-regulated turbine for maximum energy generation
- High turbine and generator efficiencies at part and full load
- Reduced civil work costs in excavation and concreting thanks to the axial unit type and the high specific discharge
- Minimum maintenance through removal of the step-up gear and its large quantity of lubricating oil

▲ *Double regulated ECOBulb™ unit*

▲ *Rotor with Permanent Magnets (Aubas, France)*

Single regulated ECOBulb™ unit ready for operation (Paullo, Italy)





VA TECH HYDRO worldwide

VA TECH HYDRO GmbH & Co
Penzinger Strasse 76
A-1141 Vienna, P.O. Box 5
Phone (+43/1) 89 100-0
Fax (+43/1) 89 46 046

VA TECH BOUVIER HYDRO SAS
45/51 Boulevard Paul Langevin
BP No. 7
F-38601 Fontaine Cedex, France
Phone (+33/476) 85 95 23
Fax (+33/476) 26 16 20

VA TECH ESCHER WYSS GmbH
P.O. Box1380
D-88183 Ravensburg
Escher-Wyss-Strasse 25
D-88212 Ravensburg
Phone (+49/751) 83-00
Fax (+49/751) 83-2396

VA TECH ESCHER WYSS S.r.l.
Via Daniele Manin 16/18
Casella postale 274
I-36015 Schio (Vicenza)
Phone (+39/0445) 67 82 11
Fax (+39/0445) 67 82 18

VA TECH ESCHER WYSS S.L.
Paseo de la Castellana, 163
E-28046 Madrid
Phone (+34/91) 425 10 00
Fax (+34/91) 425 10 01

VA TECH ESCHER WYSS S.A. de C.V.
Av. Cd. Industrial No. 977
Col. Cd. Industrial
Mex-58200 Morelia, Mich.
Phone (+52/43) 23 15 30
Fax (+52/43) 23 15 38

VA TECH ESCHER WYSS Flovel Ltd.
Amar Nagar
P.O. 13/1 Mathura Road
IND-Faridabad/Haryana 121 003
Phone (+91/129) 527 43 19
Fax (+91/129) 527 43 20

VA TECH HYDRO BRASIL Limitada
Rua Gomes de Carvalho, 1306, 5 andar
Conjunto 51
Bairro Vila Olímpia
BR-04547-005 São Paulo SP
Phone (+55/11) 3704 5303
Fax (+55/11) 3704 5316

VA TECH HYDRO USA Corporation
University Research Park,
Five Resource Square
10715 David Taylor Drive, Suite 250
USA-Charlotte, NC 28262
Phone (+1/704) 943 4343
Fax (+1/704) 943 0200

VA TECH BOUVIER CANADA, Inc.
1550 A de Coulomb
Boucherville, P.Q.
Canada J4B 7Z7
Phone (+1/450) 449 1228
Fax (+1/450) 449 1229

VA TECH International SA
The Ferns Office Park VA HOUSE
364 Pretoria Avenue
SA-Johannesburg 2194
(Cramerview 2060)
Phone (+27/11) 886 0900
Fax (+27/11) 886 0941

VA TECH COLOMBIA Limitada
Carrera 12 No. 90 – 20, Piso 6
Edificio San Germán
Bogotá
Phone (+57/1) 622 85 70
Fax (+57/1) 622 86 04

VA TECH ESCHER WYSS AG
Stockenstrasse 27
CH-9249 Algetshausen
Phone (+41/71) 950 01 66
Fax (+41/71) 951 66 24

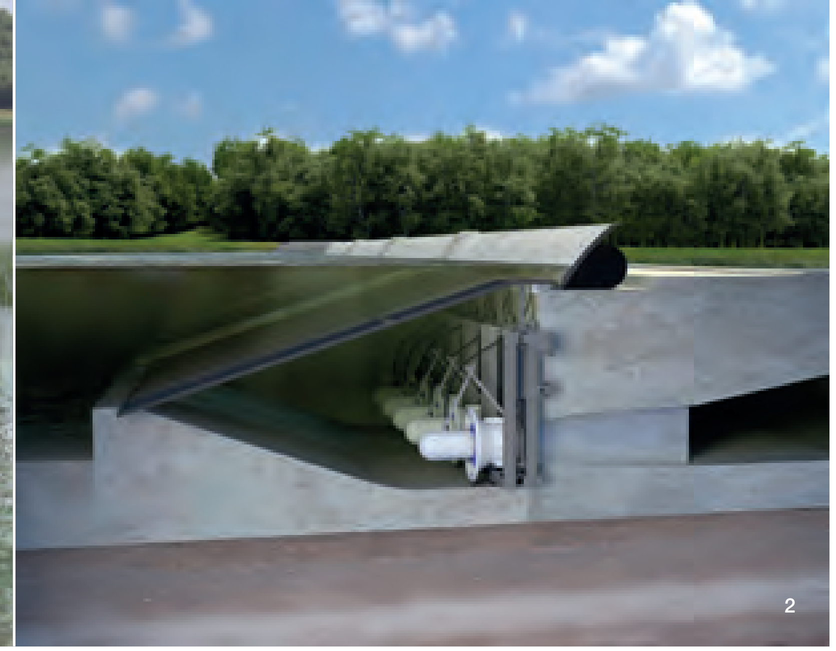
eHYD.29.500.Z.B04

sustainable solutions. for a better life.

www.vatech-hydro.com

StreamDiver®

Utilizing New Hydropower Potential



1+2 Typical Power Plant Arrangement with StreamDiver

Challenges for low head hydropower plants

Over 85 percent of all existing dams in the world remain unused for hydropower generation. The StreamDiver turbine was developed to tap this potential, especially at low head sites which so far could not be exploited.

Even though hydropower accounts for the largest share of renewable energies worldwide, there is still sufficient potential for energetic development. Until recently, run of river plants with low heads were regarded as uneconomical and therefore often remained unused. In order to take advantage of this unused potential, in cooperation with its subsidiary Kössler, which acts as Voith's competence center for Small Hydro in Europe, Voith has developed the StreamDiver, a new compact propeller turbine particularly suited to taking over where conventional plants may not be viable. The set-up and eco-friendly features make the power unit especially feasible where weirs or dams already exist. The StreamDiver offers a compact, low-maintenance and oil-free alternative in the field of hydropower.

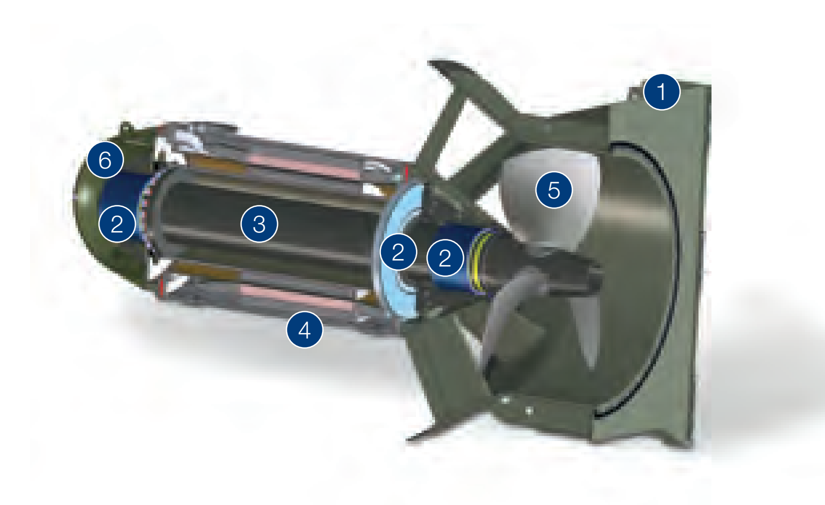
StreamDiver Features	Your benefits
Oil free turbine solution	+ environmental acceptance
Simplified technical complexity	+ low maintenance + high availability + no turbine peripheral equipment required
Standardized design	+ short delivery times + approved concept + minimized spare part administration
Compact and submersible turbine design	+ flexible plant integration + easy handling for maintenance and service + reduction of civil costs

Simplicity as key to reliability

Higher availability and less technical complexity: the StreamDiver's compact and modular design and its maintenance-free operation minimizes costs.

The StreamDiver will allow construction work to be kept at a minimum. The power unit is installed directly in the water with only the power cable exposed. The entire drivetrain, consisting of the turbine, shaft, bearings and generator, is situated in a bulb-turbine-type housing. In addition, the bulb is filled with water, which completely lubricates its bearings, ruling out any risk of water contamination.
The turbine itself is designed as a propeller turbine, meaning that neither rotor blades nor guide vanes are movable. These features negate the need for a visible or accessible power house.
By switching individual turbines on and off, or by regulating the turbine speed an operator can control the flow of his plant.
For shutdowns a separate gate is used, which simultaneously allows for speed to be controlled in order to start and synchronize the compact turbines. All these design solutions support a comparatively low total cost of ownership.
Conventional hydropower plants are designed according to individual requirements. The StreamDiver, in contrast, is an affordable serial product. It has numerous application possibilities around the world. The technical features of the StreamDiver represent the latest developments in the field of small hydropower.

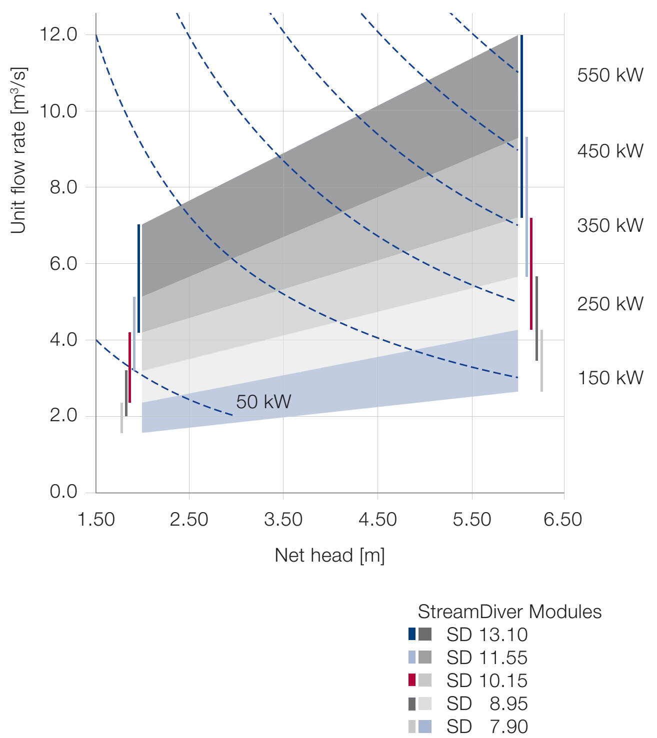
StreamDiver Main Components



1 Turbine housing with guide vanes
2 Radial and axial bearing coating on shaft ends
3 Shaft
4 Generator
5 Runner
6 Bulb nose

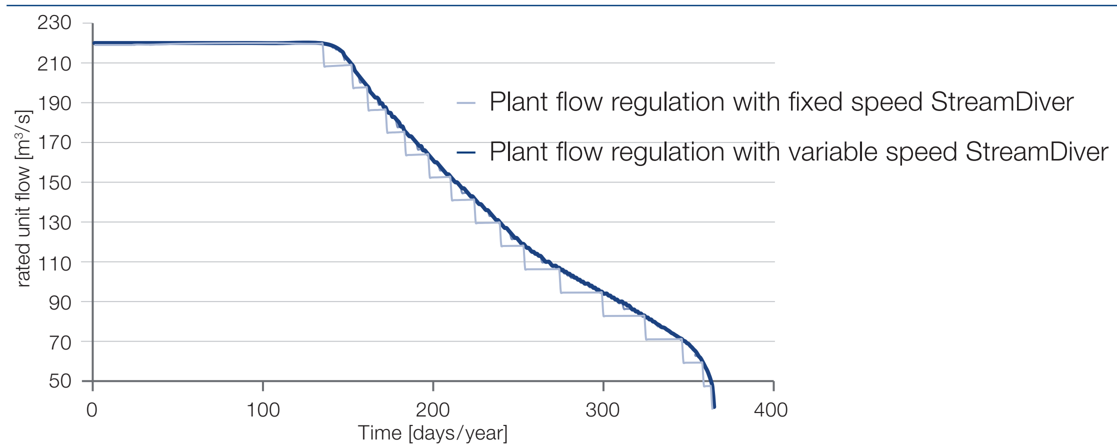
Application diagram:

The application diagram allows a preliminary module size selection based on rated head and flow. To find out the best array and number of compact turbines, conditions such as annual flow, head duration curve and overall physical limitations are also to be considered. For identifying the best project specific solution, the application range of the different modules is overlapping. The following operational criteria should be considered:



- The discharge through turbine for single unit is limited in a range of 2 - 12 m^3/s.
- The typical head range for StreamDiver is 2 – 6 m. However, in certain cases the standardized design modules can be engineered for high heads up to 10 m if the project is economically attractive.
- The civil structure shall facilitate the minimum submergence of the machine for cavitation free operation of the StreamDiver.
- Unit flow is limited by the runner diameter.

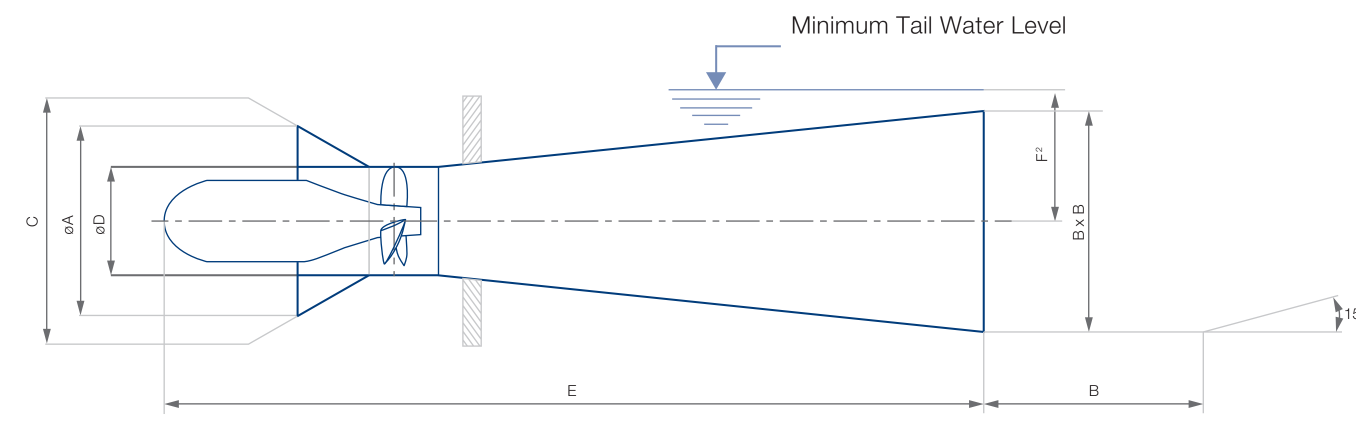
Typical multi unit operation diagram:



The StreamDiver is a non-regulated machine. In order to utilize the complete potential of any site, multiple number of units are required to be installed. Optionally, the StreamDiver can be equipped with a frequency converter to allow variable speed operation. In this case the StreamDiver unit can follow the available flow.

StreamDiver sizing:

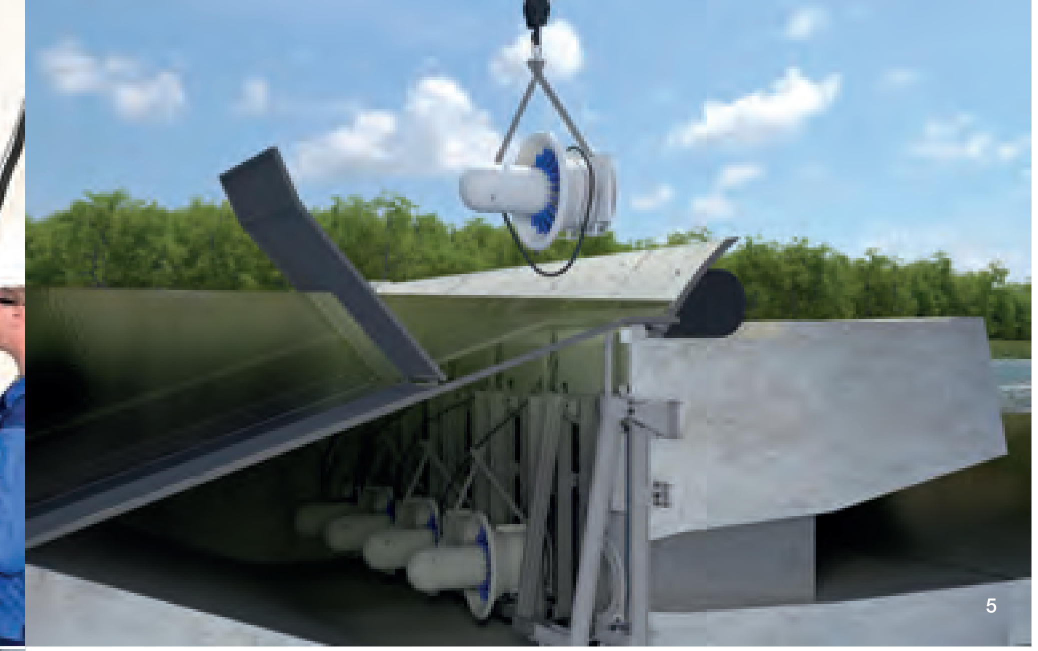
The main dimensions of the StreamDiver will vary depending on the selected module size. The setting of the turbine will be given by the minimum tail water level. The below given turbine layout is basis for the preliminary planning. Nevertheless, the final plant and intake layout needs to be adopted to the local requirements with the support of Voith.



Main dimensions:

	A	B	C[1]	D	E
SD Module	mm	mm	m²	mm	mm
SD 7.9	1380	1580	2,2	790	6000
SD 8,95	1560	1790	2,7	900	6700
SD 10.15	1770	2030	3,5	1020	7600
SD 11.55	2020	2310	4,5	1160	8700
SD 13.10	2380	2620	5,7	1310	9900

[1] Minimum intake gross area in case of penstock or channel applications.
[2] Dimension F will be defined by Voith. In general the draft tube exit needs to be placed below the minimum tail water level.



1-4 Factory assembly of StreamDiver

5 Retrieval from power plant

Easy Assembly and Service

Flexible and easy to handle: Assembly and disassembly of the StreamDiver is a task done by a few hands. Before removing one turbine from an array, the machinery will be automatically shut down with a shut-off valve. Then mechanics remove the StreamDiver from the water with a mobile crane, since the power unit has a weight of less than ten tons.

Finally, with the help of an all encompassing steel structure, experts get access to the turbine's components. In four steps the StreamDiver can be dismantled in its main components (Fig. 1-4). No special tools are required for the disassembly process.

Power Plant Equipment

Shut-off valve
Depending on project specific requirements Voith may supply an automatic shut-off valve. The gate will be connected to the unit control cubicle and can be either placed at the inlet or the draft tube outlet.

Grid Connection Equipment
The standard voltage level of the StreamDiver is 400V. Voith will deliver an electrical low voltage cubical that contains a low voltage circuit breaker, an electrical protection and a synchronization unit. Additionally, an automation cubicle is foreseen. The StreamDiver will be equipped with temperature, vibration and leakage sensors. All sensors will be connected to a programmable logic control (PLC). The PLC allows a continous monitoring of the unit status and the automatic synchronization and shut down of the unit. The PLC will be placed in a control cubicle. Depending on the customer requirements, the plant control can also be integrated within the StreamDiver Control cubicle. The current standard foresees the StreamDiver to be connected directly to the grid. Due to local grid codes Voith is able to equip the unit with a reactive power control unit. A further variant considers to equip each StreamDiver with a full frequency converter; this allows a variable speed operation and a reactive power control in one. The decision if a frequency converter is mainly drifted depends on the local hydraulic site conditions and economical considerations.

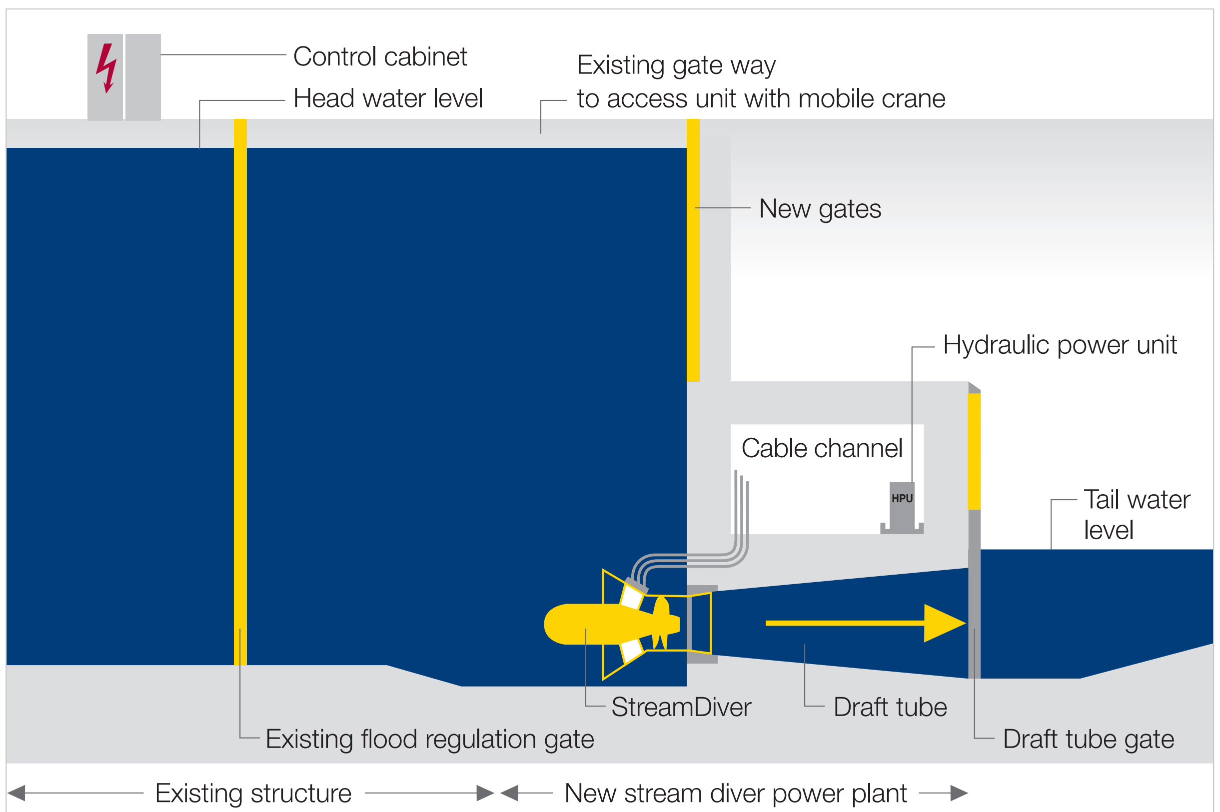
Project Specific Site Equipment
In addition to the standard scope of supply, the following project equipment should be considered:
- Trash rack and cleaning system
- Stop logs to maintain the trash rack and its cleaning system
- Fish bypass system
- High voltage transformer and grid connection system

The arrangement and its necessity depend on the local site condition and customer specific requirements.

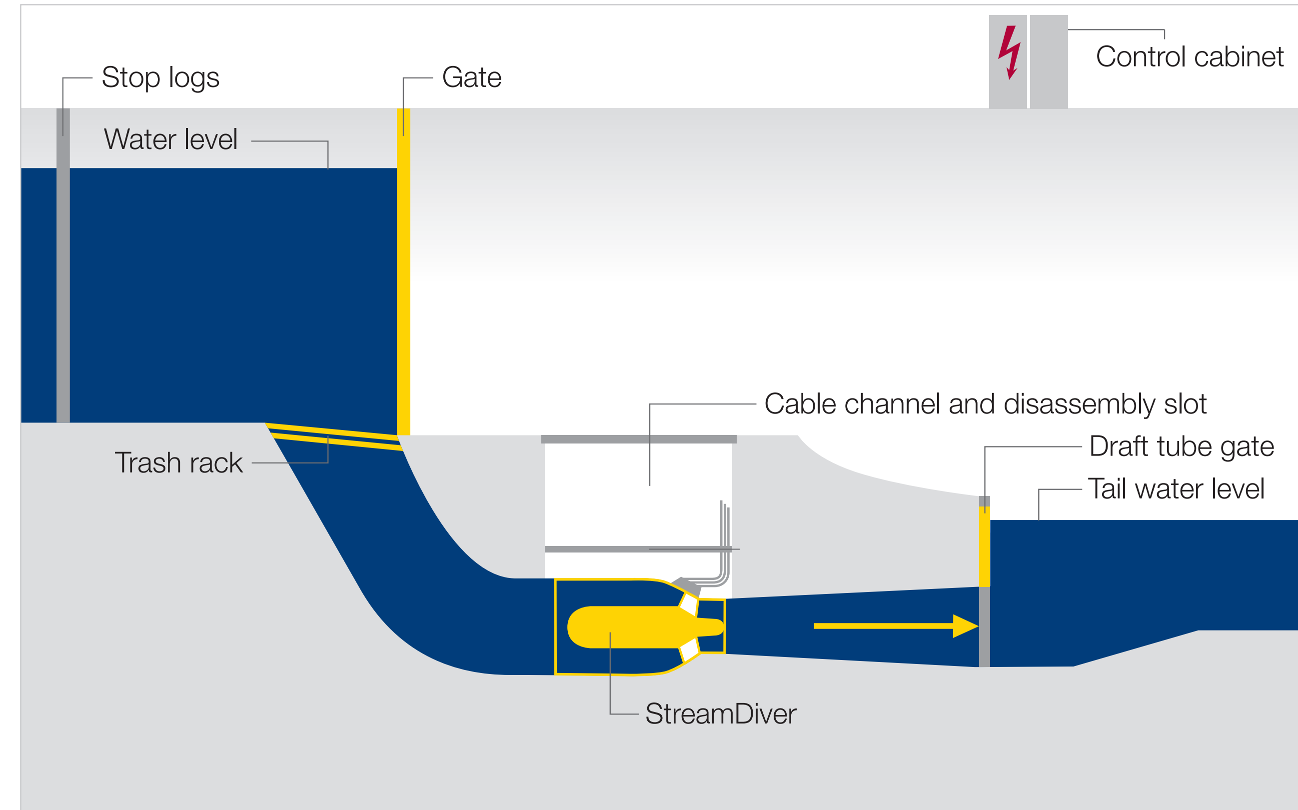
Hydropower Plant layout examples

The principle idea is to place the StreamDiver under water. The electrical and plant peripheral equipment can be placed safely and is easily accessible outside the river stream.

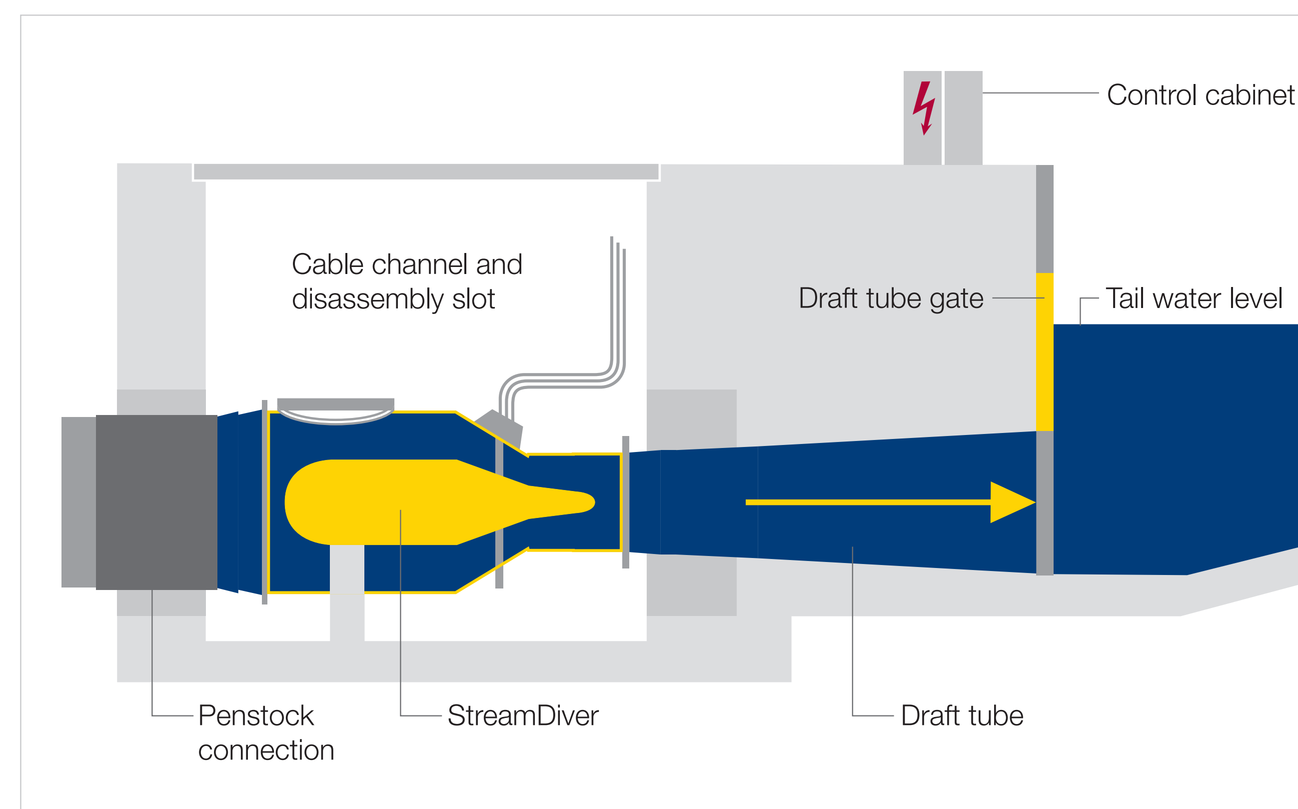
Case Study 1: Integration in existing flood regulation weir



Case Study 2: Residual flow power plant



Case Study 3: Integration in existing Penstock



t3390e

Voith Hydro Holding GmbH & Co. KG
Alexanderstraße 11
89522 Heidenheim, Germany
Tel. +49 7321 37 0
Fax +49 7321 37 7828
www.voith.com

A Voith and Siemens Company

VOITH
Engineered Reliability