REGIONAL HYDROPOWER POTENTIAL SCOPING STUDY

Prepared for the

Northwest Power & Conservation Council

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Submitted by the ***Northwest Hydroelectric Association***

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PACIFIC NORTHWEST HYDROPOWER POTENTIAL SCOPING STUDY

SUMMARY OF KEY FINDINGS

The Northwest Power and Conservation Council ("the Council") in August 2014 sought to understand if the substantial new hydropower potential identified in several recent studies could be used to determine a reasonable, realistic estimate of regional hydropower potential capacity and generation. The intent of this report is to provide a preliminary analysis of the data included in those studies and to address whether the data is of sufficient quality to determine an identified hydropower potential for the region.

The Northwest Hydroelectric Association (NWHA), as the contractor, added to the scope of work additional areas to be explored to better validate the hydropower potential that may be available for the next 20 year period for which the Council is planning. Those additional items included:

- a survey of utility and non-utility generators planning hydropower projects;
- a review of applications before the Federal Energy Regulatory Commission (FERC); and
- mapping of the Council's "protected areas" designation as compared to the U.S. Department of Energy[1] study landscape which identifies a very sizeable amount of potential hydropower for the Pacific Northwest available as run-of-the-river projects.

Adding the survey and the FERC application review provides an opportunity to see not only what may be potentially available from the studies, but what is actually under current consideration by project sponsors for implementation in the near term.

To affirm the location of the projects identified in the DOE study NWHA intends to provide a map of the proposed project reaches from the Department of Energy study developed by Oak Ridge National Laboratory as an overlay to the map from the Council's protected areas program stream reaches prepared by the Pacific States Marine Fisheries Commission in the StreamNet model format. The resulting overlay map will compare how the two sets of stream reaches correlate in location to better ascertain potential project capacity numbers more reflective of the region's regulatory process. This task is still ongoing due to the complexity of matching up the two systems' polygons in an effective manner to produce that overlay, but it is anticipated the map can still be produced in November 2014 to make the comparison.

Project Studies Reviewed

A total of 24 studies developed from 2003 through 2014 were reviewed. Appendix A provides a list of the studies along with the date, author, contractor, document link and whether the study was national or specific to the Pacific Northwest. Appendix B provides the parameters or characteristics of each study as well as the model used for developing the study. The studies are classified in groups, including:

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[1] "New Stream-reach Development: A Comprehensive Assessment of Hydropower Energy Potential in the United States", April 2014, Oak Ridge National Laboratory for U.S. Department of Energy Wind and Water Power Technologies Office.

- projects at existing non-powered dams;
- conduit and kinetic projects within canals, pipelines or other manmade conveyances;
- pumped storage/energy storage projects;
- tidal and wave energy projects; and
- general project assessments including a mix of projects.

The studies identify a broad and varying range of hydropower potential for the Pacific Northwest. Many of the studies are based on physical and hydrologic potential and do not take into account screens for environmental attributes which could provide conflict with fish and wildlife and resource habitats. Some studies do not consider protected land use areas such as state and national parks or watershed landscapes, nor state and federal scenic water programs. None of the studies address the Council's "protected area" designations identified in its Fish and Wildlife program,[2] designed to ensure that new hydroelectric development is carried out in a manner that protects the fish and wildlife resources of the Columbia River Basin and the Pacific Northwest and does not further obligate the region's ratepayers for mitigation measures.

There are hydropower projects identified in the studies that can be developed at existing diversions: projects at existing non-powered dams; conduit and kinetic projects within canals, pipelines or other manmade conveyances; additions to existing hydropower facilities; and some of the pumped storage or stored energy projects. These projects have a less significant impact on the region's rivers and streams as they do not require a new diversion and therefore are not subject to Council review under the protected areas designation. Relicensing of existing projects or the addition of generation to an existing hydropower facility are also exempt from the protected areas designation. This is important as a large number of Northwest streams are identified in the program because of regional commitments to fish and wildlife resources and environmental benefits.

Hydropower projects that require new diversions from a river or stream within protected areas, as of the new October 2014 measures[3] for the Council's Fish and Wildlife Program, now allow an exception process under which the Council may consider a project with a run-of-the-river project at a new diversion from the stream. That exception process was not available in the prior version of the program. The process allows for a "petition for an exception to the protected areas designation for proposed projects that will provide exceptional benefits to fish and wildlife."

It is not presumed that because a project is may not be regulated under the protected areas that it is automatically deemed environmentally acceptable, as each project must be reviewed by a myriad of state and federal agencies for its impact on water quality, quantity, fish and wildlife and habitat resources, as well as land use and other parameters. Existing non-powered dams and conduit projects are subject to state and federal requirements for fish screening and fish passage in some cases. Projects located on water bodies that require new diversions or are not within or on existing manmade conveyance structures will require a higher level of standards to be met as set by reviewing agencies.

The U.S. Department of Energy (DOE) funded the Oak Ridge National Laboratory study, "New Stream-reach Development: A Comprehensive Assessment of Hydropower Energy Potential in the United

[2] Columbia River Basin Fish and Wildlife Program, Protected Areas: https://www.nwcouncil.org/fw/protectedareas/home/

[3] Columbia River Basin Fish and Wildlife Program, Pre-publication version 2014, pages 169-170: https://www.nwcouncil.org/fw/program/2014-12/

States", in April this year.[4] The assessment identified the Pacific Northwest region as having the highest amount of energy available from new hydropower potential of the 18 regions assessed nationally, 32% of the nation's identified supply. U.S. Department of Energy Secretary Dr. Ernest Moniz recently outlined the Department of Energy's goal of doubling U.S. hydropower by 2030. The release of the study as a resource assessment detailing new hydropower development potential launches a partnership with industry to develop a long-term vision, the next step in DOE's strategy aiming to increase the nation's access to hydropower. The Department's visioning process for 2025 will result in a number of tools being developed, including cost estimating procedures and regulatory approaches. At the same time the Hydro Research Foundation[5] has been commissioned by the Oak Ridge National Laboratory to identify technology and policy innovations and on-line technology resources, such as an on-line searchable technology catalog, and improved tools for pre-qualification of sites and feasibility to reduce costs and barriers and enable more hydropower deployment.

The amount of capacity identified within the assessment for the Pacific Northwest region is 25,226 megawatts (MW) of capacity and 148,999,000 megawatt hours (MWh) annually in energy production, at a capacity factor of 67%. The capacity of 25,226 MW is equal to 76% of the region's existing hydropower capacity. The undeveloped energy calculated for the region from this study equates to 118% of the region's existing energy produced from hydropower. The methodology used is targeted at a higher reconnaissance level designed to calculate the potential from run-of-the-river projects, those not sited at existing diversions. As a result, it is anticipated that many of the identified projects may not be able to be developed without exceptional benefits to fish and wildlife in the region if they are located within the Council's protected areas designation as identified by the current map.[6] See Chapter 5 for a more thorough discussion.

NWHA has analyzed the studies listed in Appendix A that propose hydropower projects in the Pacific Northwest region. The review identifies which studies contain projects that can be successfully developed without impact to the protected areas designations because they incorporate an existing diversion from the stream or do not require a diversion to implement. The studies are grouped by the type of hydropower project technology and summarized in chapters detailing each project type:

- Chapter 1 - adding power to existing non-powered dams;
- Chapter 2 – developing generation within or at the end of existing conduits (pipelines or canals) or other manmade conveyance structures constructed for water delivery systems for irrigation, domestic water supply and wastewater treatment; or kinetic energy projects not requiring a diversion structure, placed in either manmade conveyances or in streams;
- Chapter 3 – pumped storage with or without reservoir storage facilities;
- Chapter 4 - tidal and wave energy projects in rivers and the Pacific Ocean;
- Chapter 5 - general project assessments that provide a variety of projects, both run-of-the-river with no existing diversion, as well as some of the projects mentioned above

Chapter 6 provides a review of six existing tool sets that can be used to define project parameters as a pre-feasibility tool.

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4 Chapter 5, Study E-1, U.S. Department of Energy, April 2014

5 Hydro Research Foundation (www.hydrofoundation.org)

6 Northwest Power and Conservation Council Fish and Wildlife Plan, Protected Areas StreamNet map https://www.nwcouncil.org/media/16834/protectedareas_sm.jpg

The various hydropower technologies provide a renewable resource without fuel and without greenhouse gas emissions, but pumped storage, as described in Chapter 3, is a technology that can provide additional benefits to the region. Ancillary benefits include storage capacity and transmission benefits, including load balancing, frequency control and reserve generation capacity. This type of energy storage project can firm the variability of non-dispatchable renewable power resources, such as wind and solar power energy. Pumped storage projects are able to absorb excess load at times of high output and low demand. The value of using pumped storage to balance and integrate with wind energy output offers maximum flexibility to resolve the challenge of wind integration and restoration of operational flexibility on a more immediate basis to the Federal Columbia River Power System. The region has one existing pumped storage facility and as the FERC applications confirm, others are in the planning stage.

Additional Supply Identification

To firm up numbers addressed in all of the studies reviewed, as well as to identify projects in current planning not identified within the studies, NWHA has provided two additional components to this report: 1) review of existing Federal Energy Regulatory Commission (FERC) applications as provided in tables in Appendix C; and 2) the development of a survey provided to project developers, both utility and non-utility generators, to assess pending projects. The survey and the results are detailed in Appendix C.

NWHA pulled all of the applications for the Pacific Northwest states from the FERC records as of September 2014. Those records were then divided into tables showing each type of hydropower technology and include project proposed capacity and energy figures. The tables provide a picture in time of what is being studied or recently approved for construction. The tables are defined by "pending" and "issued" applications. Issued permits and approvals provide a more near-term review of potential hydropower development as the developer has moved past the original preliminary feasibility period to a period of specific studies and planning to implement a project.

NWHA also pulled data from FERC which identifies some of the incremental or upgrade hydropower projects in process which have received federal tax credits. Those projects are enhancements adding generation to existing projects and are summarized in Appendix C as Table 8.

Second, NWHA conducted a survey of northwest generators, both utilities and non-utility producers, to ascertain their plans for future hydropower development. The questions for which responses were sought are identified in Appendix C. In addition to individual entity responses NWHA received information from the U.S. Bureau of Reclamation (Reclamation) regarding proposals that are now in progress on their non-powered dams or canal systems outside the Federal Columbia River Power System (FCRPS). NWHA did not query the federal agencies for specific information regarding the FCRPS system in its survey process as the Council staff derives direct information from the federal entities operating the system. Reports from some state agencies approving water rights for development of hydropower projects were also provided as a result of the survey. In some cases the responder asked for anonymity, especially if an application had not yet been filed with FERC and identifying the site could result in competition or other issues.

Appendix C compiles all the potential projects identified by source: from the studies reviewed, from current FERC records and from the survey conducted by NWHA. Numbers derived from those tables are then correlated to develop a range of potential future power available within the next 20 year period for which the Seventh Power Plan addresses regional resources.

Environment for Additional Hydropower Generation

Legislative and Regulatory Environment

An array of federal legislation and pending regulatory approaches that will affect operation and development of the hydropower system as well as other energy resources is important for the region's ability to produce additional hydropower. Chapter 7 provides a discussion of two major pieces of legislation enacted by the U.S. Congress in 2013 that significantly streamline the process for conduit exemptions, raise the capacity limitation for exempt projects (those at existing diversions) and provide for a pilot process for an expedited two-year license term for other projects that require a full licensing process.

The third major piece is a rulemaking by the Environmental Protection Agency (EPA) requiring significant reduction in coal plant emissions to promote cleaner and more efficient alternative energy solutions. The Sixth Power Plan indicated that 85% of the carbon dioxide from the regional power system was from coal operation emissions as of the Plan's adoption in 2010. Reducing and replacing half the existing coal-fired generation serving the region with efficiency measures and renewable energy generation could reduce the carbon emissions to 18% below 1990 levels, the plan related in one of its scenarios. The Sixth Power Plan indicated that a fixed carbon price of $45 per ton has a similar effect on carbon emissions as retiring half of the existing coal-fired generation. Either strategy, the plan stated, would meet carbon reduction targets for 2020, with more certainty in meeting the target provided by coal plant retirement.

In addition, both the Corps of Engineers and the Bureau of Reclamation, whose major hydroelectric projects are the core of the Federal Columbia River Power System, have been encouraged by the U.S. Department of Energy and Congress to cooperate with non-federal developers in adding power to any non-powered dams both in the region and nationally. The Bureau of Reclamation has developed a "Lease of Power Privilege" (LOPP) agreement process to allow non-federal development on its facilities. The Corps recently issued a Section 408 approval process for non-federal development on its facilities. In addition to non-powered dams, federal facilities such as canals and levees provide infrastructure for further hydropower development.

Potential Hydropower Supply from Studies Reviewed

Each chapter identifies project sites or stream reaches in the Pacific Northwest that may provide future hydropower potential, as referenced in Figure 1.

TYPE OF PROJECT	NO. OF PROJECTS	CAPACITY (MW)	ENERGY (MWh)
Chapter 1: Non-powered Dams	19	143.786	275,226.39
Chapter 2: Conduit and Hydrokinetic	51	92.616	295,645.00
Chapter 3: Pumped Storage	8	6,295.000	99,681.00
Chapter 4: Tidal and Wave Energy	-	731.000	-
Chapter 5: General/Multiple Type Assessments	-	40,266.610	164,792,000.00

Figure 1.0: Study Potential in the Pacific Northwest

For chapters 1, 2 and 3 projects were identified specifically enough to calculate the capacity and energy shown in the chart.

Chapter 1: non-powered dams

Chapter 1 identified non-powered dam sites and includes detailed information which in some cases allows cost to be determined. The studies developed by the Bureau of Reclamation (A-3, B-5 and B-6 appearing in Chapters 1 and 2) are more specific and include some cost information and provide tools for addressing feasibility that could be applied to other projects. Study A-3 (Chapter 1) provides a Hydropower Assessment Tool that enables a developer to determine a preliminary cost and also addresses identifying annual operation and maintenance costs. The cost estimates from the study apply primarily to existing non-powered dams. The Bureau of Reclamation LOPP process table identifies a few projects which are actually in progress as the developer has begun the agreement process with Reclamation and/or has filed a FERC application (see FERC tables in Appendix C). These projects are the most likely to move forward in the near future. Both the Army Corps of Engineers and the Bureau of Reclamation have been encouraged by the U.S. Department of Energy and Congress to actively offer the opportunity to developers to seek cooperative agreements with the agencies to add power to non-powered dams.

Chapter 2: conduit and hydrokinetic projects

Chapter 2 identifies conduit and hydrokinetic projects which do not require a new diversion structure. These projects are located at specific sites and may likely be developed over the next 20 year period if financial conditions can be met. The "conduit exemption" process regulated by FERC is based on a newer technology approach of adding or inserting generation equipment within conveyance structures. This type of project has begun to be developed in the region within the last five years using manmade conveyance structures in irrigation, water supply and wastewater systems. The projects within water supply and wastewater systems are smaller in size, generally less than 100 kW capacity and up to 250 kW capacity. The City of Portland has developed a number of small projects within its municipal drinking water system recently, as an example. The conduit exemption projects within irrigation districts tend to be larger in capacity due to the size of piping and water flows. Central Oregon irrigation districts have developed several of these projects within the last five years with pipelines varying from 36" diameter to 120" diameter with energy generation from .75 MW to 5.0 MW generation. Recent Congressional legislation has streamlined the process for these project so that they can be approved in 6 months or less generally.

Chapter 3: pumped energy storage

In Chapter 3 the overall studies showed some very high totals for the region, but the experienced consultants authoring Chapter 3 were able to address the studies and select the most viable projects. Table 2.0 in Chapter 3 provides an estimate of the potential. The energy total reflects reserved energy instead of gross energy. The FERC application numbers in Appendix C show gross energy and overestimate what will be available from the project as net energy as a portion of the energy generated is needed to run reverse pumping required by the technology.

Chapter 4: tidal and wave energy

The tidal and wave energy total from Chapter 4 was taken from the Georgia Tech study, which was the only study to show total capacity by state. The other studies were a reflection of the total ocean potential along the West Coast. The Georgia Tech study did not indicate the energy component for the capacity identified. The tidal and wave energy technology is very new and most of the projects proposed in the region are pilots to determine feasibility and demonstrate new equipment models. At this point three earlier projects that are addressed in Chapter 4 appear to have been abandoned for the time being. The East River project in New York, one of the very first completed, failed; but it is in the process of being replaced with the use of a newer equipment technology.

Chapter 5: general assessments of hydropower

The general assessments include all types of hydropower technologies. These numbers reflect a very high range of what can be developed. The 2014 study developed by Oak Ridge National Laboratory for the U.S. Department of Energy is the newest analysis (2014) of general project data; the projects would be run-of-the-river, creating new diversions from a water body. Overlaying this study with the protected areas map (in development) will be critical to determine how viable projects on the enumerated stream reaches may be. The mapping project may also be helpful in reaching a preliminary decision on the viability of other projects within the general assessments that are not at existing diversions.

Feasibility of Potential Hydropower Supply Identification from Studies

The Council requested a determination as to whether there is enough information in the studies to identify the power potential in the Pacific Northwest over the next 20 year period of the Seventh Power Plan. The answer varies among studies, based on the components addressed in each of the studies. The studies reviewed and summarized in this report were developed over the last decade by a wide variety of entities ranging from national laboratories to consulting firms working for government and private entities. The criteria used to develop each study, the hydrologic data and the topographic information available to predict new and upgraded hydropower capacity, varies in quality and specifics. Studies that provide the most factors (cost; protected lands; fish, wildlife and habitat sensitive areas and other components as listed in Appendix B) at specific site locations provide the highest level of probability. Other studies, such as the general assessments in Chapter 5, are often not site specific enough to make a determination. While they provide information regarding sensitive areas, there is the need for matching up the results with the protected area designations as some of the studies are based on flow and hydraulics of river stretches versus sites.

In the mid-1980s NWHA developed a study for the Bonneville Power Administration that sought to identify a very defined range of specific components for each project that had a preliminary permit[7] as the need for power in the early 1980s drove power sales agreement prices to a level that resulted in a substantial number of hydropower projects identified in applications to FERC. The process required talking to the proposing developer by telephone to complete fields for sensitive species and lands, cost, timing for development, etc. That is the kind of process that would need to be undertaken by Council staff or their designate to further verify which projects may be viable in the near future and whether they can meet regulatory requirements and cost-effectiveness.

Potential Hydropower Supply from FERC Applications and the NWHA Survey

While the information from the studies varies in determination of viability at sites which may be developed within the near future, the information provided by actual FERC applications (see Appendix C,

[7] "Status of New Hydroelectric Development – Costs and Seasonality" by the Northwest Hydroelectric Association for the Bonneville Power Administration, Contract DE-AC79-84BP16229, 1984

Tables 1-8) is more reliable in that some preliminary analysis and studies have been conducted at specific sites (Figure 2.0).

Review of FERC Applications

Federal Energy Regulatory (FERC) Tables *Identification of applications in process*

PROJECT TYPE	TABLE	NO. OF PROJECTS	STATUS	CAPACITY (MW)	ENERGY (MWh)
Conduit Exemptions	1	9	Issued	3.099	10,837
Conduit Exemptions	2	11	Issued	6.258	4,000
Licensed Marine	3	2	Issued	2.500	299,500
Conventional Hydro - Permits	4	2	Pending	65.000	401,870
Conventional Hydro - Permits	5	22	Issued	125.270	498,436
Conventional Hydro - Licenses	6	9	Pending	46.525	95,952
Pumped Storage - Permits	7	9	Pending	7,294.000	15,123,686
TOTAL		**64**		**7,542.652**	**16,434281**

Figure 2.0 FERC Applications

- Issued Conduit Exemptions
  Projects approved by FERC and project development can be underway, including
  - Applications filed before the new legislation (chapter 7) requiring exemption permit (Table 1)
  - Applications filed after legislation enacted in 2013requiring only a notice of intent (Table 2) which must be 5 MW or less capacity; conduit exemptions more than 5 MW and up to 40 MW must file an exemption permit)

  Conduit exemption projects are those with generation equipment within or at the end of canals, pipelines, ditches and other man-made conveyance structures that as their primary purpose supply water to agriculture, municipal or industrial purposes, as required by FERC.

- Permits (Tables 4, 5 and 7)
  A preliminary permit allows a 3 year study period for project planning purposes; potential extensions are available under approved circumstances for up to 4 years.

- Licenses (Tables 3, 6)
  Licenses are awarded after necessary studies and public process are completed, generally after the permit stage, although it is possible to start at the license level without applying for a pre-liminary permit. Once a license is awarded, then construction can begin.

- FERC listing of tax credits for project upgrades (Table 8)

See tables 1-8 in Appendix C for project site lists.

Survey of Hydropower Potential

In addition to reviewing FERC applications, NWHA conducted a survey over 30 days' time requesting a broad range of utilities and non-utility developers to identify imminent hydropower projects. A copy of the survey is located in Appendix C. The information from the survey was self-reported and identifies a number of projects of various types. The information could be further validated identifying higher potential with the ability to seek more detailed information from each respondent and to follow up with those potential generators not responding to the survey. Refer to Table 9 in Appendix C which lists the projects individually.

Summary of Hydropower Estimates

Supply Estimate

Table A on pages S-14 and S-15 represents a reasonable estimate of the projects that may be developed over the next 20 year period. The theoretical future hydropower potential for the Northwest appears to be in range of 3,200 MW capacity with an annual 23 million MWhs of energy production. Table A lists the projects that are included in that capacity. This project list represents projects from the studies, from the NWHA survey and from FERC (Federal Energy Regulatory Commission) applications, often from two or more of those sources. These are the projects that appear to be either more readily available in time (such as conduit projects), have utility commitment as planned upgrades, or are projects that appear to be into the licensing process from existing information available. See pages S-16 and S-17 for further explanation of the determinations.

Cost Estimates

The diversity of the types of hydropower development as well as the specifics for each project based on their siting makes it difficult to assign a specific configuration or unit price. However, a number of the studies reviewed make an attempt to define cost within certain parameters.

<u>Non-powered Dams</u>

Study A-1 provides cost estimates derived from the Idaho National Engineering and Environmental Laboratory (INEEL) 2003 study "Estimation of Economic Parameters of US Hydropower Resources" and from the Bureau of Reclamation 2011 study "Hydropower Resource Assessment of Existing Reclamation Facilities." Costs were then indexed to 2012 based on applicable indices from the Civil Works Construct Cost Index System (CWCCIS) and from ENR's skilled labor index.

Those costs include the full range of developments costs as well as annual operation and maintenance costs. Costs include construction, non-structural development costs such as permitting and land rights, generation equipment, fish and wildlife mitigation and water quality monitoring. Operation and maintenance costs include fixed and variable operational costs, FERC annual charges, insurance, taxes, management and major repair costs.

The study provides a number of parametric equations for determining direct costs. Although costs were not determined for each of the projects defined in the Northwest, the five projects listed on page 2 of Chapter 1 are the top 5 projects identified in this region by the study author. Of those 5 projects, only the Howard Hanson Dam was determined to be highly feasible. Costs were not identified for each of the sites listed, but formulas and models could be used to determine costs of individual sites as described in the study.

Study A-2 did not provide costs. Study A-3 identifies 13 sites in the Northwest with a benefit cost ratio greater than .75, making them feasible according to the study authors. The cost per kW of capacity ranges from $1,889 to $5,075 per kW. An average for the 13 sites in region is $3,518 per installed kW of capacity. The annual O&M for all sites identified in the Pacific Northwest (34 sites) ranged from $1,889 to $32,368. View the table on page 5-34 of the study for O & M cost analysis.

Based on the studies reviewed for non-powered dams, the average cost per kW of capacity falls into the $3,500 per kW range.

Conduit Projects

Conduit projects (generation within or at the end of a manmade conveyance structure) are difficult to define from a cost perspective because there are other indirect benefits that skew the cost/benefit ratio if only the capital costs and power sales agreement revenues are considered. Many of the projects recently completed or in process will provide considerable water conservation benefits. Some of the project developers have dedicated the conserved water instream to provide fish and wildlife, water quality and scenic values. In some of those cases, non-profit or government entities defrayed project expenses by providing some funding to support the transfer of water to instream benefits. This is primarily a process that occurs in Oregon based on incentive programs provided by state lottery funding and state and federal programs, such as the Bureau of Reclamation's water conservation programs.

The generation facility added to an irrigation district's water infrastructure may cost $2 million for a 1 MW capacity project, based on two recently developed projects in the Deschutes River Basin in Oregon. However, the pipeline necessary to pipe an open canal for 3-5 miles to use the water pressure for generation and to conserve water both for the irrigation district's patrons as well as providing water for instream benefits, may cost in the range of $10 million. Some of the costs should be attributed to the district's conveyance system and some to public benefit for water supplied instream. As a result, it is difficult to determine the cost without separating the benefits. The figures provided in the studies do not make that kind of assessment.

Study B-1, resulting from the U.S. Department of Energy support provided to the Oak Ridge National Laboratory, provides a software tool to consistently evaluate the energy and economic feasibility of potential hydropower sites. The ORNL-Hydropower Energy and Economic Assessment (HEEA) Tool (Version 1.0) is an excel workbook with embedded macro functions programmed in Visual Basic using Microsoft Excel 2010. That tool was used in this basin assessment as a model and continues to be enhanced for future use. The Deschutes River Basin in Oregon was used as a pilot area to develop the tool. The study analyzed 6 non-powered dams as well as a number of conduit exemption projects. The 6 non-powered dams are also listed in study A-3 above. The other sites reviewed are conduit projects. A total of 15 conduit sites were modeled and estimates of cost were provided based on a kW of capacity. The cost per kW installed ranged from $2,140 to $11,867, with an average of $4,391.

Costs included site preparation, licensing and civil works, transmission, environmental indicator mitigation, and land and water rights. The costs are defined as the "overnight development costs." Those costs do not include financing or cost escalation during construction. The tool used in the study does include interest during construction, escalation/inflation factors and the discount rate of capital. Annual operation and maintenance costs are also addressed, including the cost of equipment replacement. Potential revenue was derived from the base price projection of the Council's Sixth Power Plan and state-level electricity prices from the EIA (Energy Information Administration). Green incentive benefits are included from federal and state resources. Although GHG (greenhouse gases) would be avoided, since there's no carbon market in Oregon, no value was assigned. Study B-2 is a pre-cursor to study B-1 and provides no additional cost information.

Study B-3 provides a range of potential costs for conduit projects. The costs identified in that study include equipment, installation, permitting, interconnection, design and other fees. A sample project with output of 968 kW capacity with a cost of between $5,362,500 to $9,418,750 has a cost benefit ratio of .333 to .586, dependent upon final project cost between the two figures. Taking an average cost between the two results in an average cost of $7,634 per kW installed capacity.

Study B-4 only includes equipment and installation costs. Based on 2009 costs, conduit projects range from $5,000-10,000 kW average.

Studies B-5, B-6 and B-7 have no costs based on actual projects.

Based on the studies in Chapter 2 for conduit projects, the costs average in the range of $5,000-7,500 per kW. Each site is fairly specific to site requirements so there is a broad variation in costs and the costs include development of conveyance infrastructure in addition to the energy component.

<u>Pumped Storage Projects</u>
The projected costs for pumped storage range from $1800 kW to $3500/kW of installed capacity. This range is driven by tunnel lengths, the overall head, the amount of above ground civil infrastructure required and the variable speed technology for the pump/turbines. See Chapter 3 for discussion.

Based on study reviews, the cost of pumped storage projects is $1800 to $3500/kW of capacity.

<u>Tidal and Wave Energy Projects</u>
No costs were provided in any of the studies reviewed for tidal and wave energy projects. The technology is new and there have been no successful installations in the Northwest.

<u>General Project Assessments</u>
Studies E-1 and E-2 did not include cost information, nor did studies E-4, E-5 or E-6. Study E-7 is not relevant as it is based on 2002 prices.

Study E-3 of Oregon irrigation district potential projects resulted in costs ranging from $1,571,419 to $19,750,000 per project for .10 to 2.5 MW installed capacity. The cost per kW ranged from $2,487 to as high as $21,062 kW. The average was $8,464 per kW with many projects in the $3,000-9,000 range. But again, the major cost in these projects is the pipeline infrastructure necessary to conserve the energy and water benefits.

Costs in the study included pipeline installation, interconnection, civil construction and equipment, design, permitting, and land use siting. The only mitigation costs included were for fish screening of diversions where necessary.

Revenue and Financing Environment
The Northwest has been favored in having the flexibility, efficiency and lower cost afforded from a hydropower system with emission-free and abundant renewable energy as its source of electricity. While capital costs may be high for some projects, the life of hydropower projects as compared to other

renewables is extremely long. Some facilities in the region have operated over 100 years. The ability to provide generation using existing facilities--non-powered dams, pumped storage at existing reservoirs, and conduit generation within existing water delivery systems—provides effective alternatives for thermal projects. There is no fluctuating fuel cost for hydropower production. Developing a comparison among generation projects needs to take into account the long project life and the lack of fuel costs in a more complete strategy.

Currently the cost of energy produced by a natural gas-fired generation facility drives the revenue new hydropower facilities can obtain in a power sales agreement (PSA) from a utility when projects are developed by non-utility generators. As a result low gas prices result in higher capital cost hydropower projects sitting on the shelf awaiting a viable revenue stream to begin construction. As gas prices rise, since natural gas-fired generation has become the Northwest surrogate for developing PURPA pricing as the basis for PSAs, prices will rise allowing for a higher investment in the capital necessary to develop additional renewable energy production from the hydropower resource.

Given federal proposals to cut carbon emissions, if the region were to incorporate a value for displacement of emissions, the potential to enlarge the existing hydropower system in an environmentally sound approach would provide more opportunities for financing hydropower projects identified in the studies as well as other renewable energy production. Study A-1 (Chapter 1) developed by the Hydropower Analysis Center of the U.S. Army Corps of Engineers uses a formula for the Pacific NW Region to show the environmental and cost benefit associated with hydropower generation in avoiding emissions from greenhouse gases generated by fossil fuel resources. The EPA eGrid 9th edition of 2010 (http://www.epa.gov/cleanenergy/enrgy-resources/egrid/index.html) is a comprehensive database of environmental attributes of electric systems, incorporating data from several federal agencies. One of the fields of data in the eGrid chart is emission rates for 26 eGrid subregions. The WECC Northwest eGrid subregion as of 2010 shows the annual total output emission rates for this region. The output emission rates are shown as:

1,340.34 lb/MWh of carbon dioxide
41.38 lb/GWh of methane
17.84 lb/GWh of nitrous oxide

The annual total output emission rates for greenhouse gases (GHGs) can be used as default factors for estimating GHG emissions from electricity use when developing a carbon footprint or emission inventory. Both the earlier 4th Power Plan and study A-3 attempted to calculate a rate for incentivizing the reduction of GHGs.

Existing "renewable portfolio standards" (RPS) developed by some of the Northwest states promote renewable acquisition and development of hydropower projects as do a number of incentive programs developed by the Northwest states. It is difficult to make a financial determination as to the value of incentive programs generally, but study A-3 (Chapter 1) provides an analysis of benefits by state and by federal program.

Supply Curve

Information provided in the studies does not indicate completion dates for projects. Some information was provided in the survey but there is not adequate information supplied to determine a supply curve based on a timeline. While there is some cost information for future potential hydropower, even the small conduit projects with little impact will not go forward without a structural marketplace that provides benefit for the advantages of hydroelectric power:

- Long plant life
- No greenhouse gas emissions
- Provision of stability in balancing other renewable resources
- No fluctuating fuel cost

The current marketplace is dominated by a gas-fired generation base that doesn’t promote an adequate pricing structure to develop hydropower components effectively given the upfront capital costs. With the current pricing structure, utility upgrades and some small projects may move forward but the supply capability is not predictable given the current environment.

Potential Hydropower

November 2014

Anticipated 2015-2035

Non-Powered Dams

	FERC No	Study #	Date Opr.	Developer	State	Project Information	River	Capacity MW	Generation MWh
Identified in Survey and FERC Applications									
Tongue River Dam	P-14602		N/A	State of Montana, DNR	MT	Add capacity	Ruby	2.200	7,344.0
Gibson Dam	P-12478		2016	Tollhouse Energy/Greenfield I.	MT	New project at existing dam	Sun	15.000	43,217.0
Mason Dam	P-12686		N/A	Baker County	OR	New project at existing dam	Powder	3.400	8,100.0
Pinto Dam	P-14380		2019	GCHPA*	WA	New project at existing dam	Columbia	2.929	9,700.0
Warmsprings Dam Hydro	P-13570		N/A	Warmsprings Irrigation Distric	OR	New project at existing dam	Malheur	2.700	7,442.0
Studies A-1, A-2, A-3 & FERC Applications									
McKay Dam	P-14205	A-3	N/A	McKay Dam Hydropower	OR	New project at existing dam	Umatilla	3.000	7,400.0
Howard A. Hanson Dam	P-14594	A-1, 2	N/A	Howard A. Hanson Power, LL(	WA	New project at existing dam	Green	5.000	26,000.0
Scooteney Wasteway	P-14352	A-3	2019	GCHPA	WA	New project at existing dam	Columbia	1.100	1,480.0
Easton Diversion Dam	P-13850	A-3	N/A	Qualified Hydro 15 LLC	WA	New project at existing dam	Yakima	1.200	5,000.0
Blue River Dam	P-14381	A-1	N/A	Qualified Hydro 15 LLC	OR	New project at existing dam	Blue	20.630	32,565.3
NON-POWERED DAMS POTENTIAL							10 Projects:	57.159	148,248.3

Conduit Exemptions & Hydrokinetic Projects

	FERC No	Study #	Date Opr.	Developer	State	Project Information	River	Capacity MW	Generation MWh
Studies B-1 and B-2		B-2	N/A	Various irrigation districts	OR	4 Conduit projects	Deschutes	5.317	21,508.0
Study B-3		B-3	N/A	Various irrigation districts	OR	2 Conduit projects	Deschutes	1.579	6,172.0
Stiudy B-5		B-5	N/A	Various canal sites	NW	111 Conduit projects	NW Rivers	34.000	116,596.77
Survey Responses		SR	N/A	Various canal/pipeline sites	NW	15 Conduit projects	NW Rivers	14.627	47,918.0
Hydrokinetic Demo Project		SR	2015	Hydrokinetic unit in canal	WA	1 Hydrokinetic conduit project	Yakima	0.01	N/A
FERC apps. Issued		FERC	N/A	Approved projects/canals	NW	7 Conduit projects	NW Rivers	2.099	6,433.0
FERC approved NOIs		FERC	N/A	Approved projects/canals	NW	3 Conduit projects	NW Rivers	6.065	27,480.0
CONDUIT EXEMPTIONS AND HYDROKINETIC PROJECTS							143 Projects:	63.697	226,107.8

Pumped Storage Projects

	FERC No	Study #	Date Opr.	Developer	State	Project Information	River	Capacity MW	Generation MWh
John Day Pool		C-2	N/A	Klickitat PUD	WA	Pumped storage	Columbia	1,000.000	15,000.0
Swan Lake		C-2	N/A	EDF Renewable Energy	OR	Pumped storage	Klamath	600.000	10,000.0
Banks Lake		SR	2019	*Grand Coulee Hydroelectric Power Agency (GCHPA)	WA	Pumped storage	Columbia	1,040.000	8,084.0
PUMPED STORAGE PROJECTS								2,640.000	33,084.0

SR: Survey

Table A

Tidal and Wave Energy

Potential Hydropower

November 2014

Anticipated 2015-2035

No identified projects at this time

General Assessments

	FERC No	Study #	Date Opr.	Developer	State	Project Information	River	Capacity MW	Generation MWh
Identified in Survey and FERC Applications									
Various canal or small reservoir		E-3	N/A	Various irrigation districts	OR	30 Conduit exemptions	Oregon Rivers	20.630	5,852.0
Oak Springs		SR	N/A	Oregon Dept. Fish/Wildlife	OR	Exemption at existing diversion	Deschutes	0.085	15.0
Unidentified Location		SR	N/A	Portland General Electric	OR	New traditional project	Clackamas	2.800	22,210.0
Identified in FERC Applications only									
Go with the Flow	P-14538	FERC	N/A	Go with the Flow Hydropower	OR	Traditional hydro exemption	Umatilla	1.200	
Weiser-Galloway	P14608	FERC	N/A	Idaho Water Resources Board	ID	Traditional hydro project	Weiser	60.000	365,000.0
Two Girls Creek	P-14626	FERC	N/A	Green Volt Hydro Inc.	OR	Traditional hydro	Two Girls Creek	5.000	36,870.0
GENERAL ASSESSMENTS							35 Projects:	89.7	429,947.0

Upgrades

	FERC No	Study #	Date Opr.	Developer	State	Project Information	River	Capacity MW	Generation MWh
These projects were identified in the survey:									
Blind report as requested		SR	2020	Unidentified utility	WA	Add equipment	NW	7.000	N/A
Box Canyon Dam	P-2042	SR	2017	Pend Oreille PUD	WA	Add equipment	Pend Oreille	30.000	1,300,000.0
North Wasco PUD Plant	P-7076	OR	2018	North Wasco PUD	OR	Add capacity at Dalles Dam	Columbia	5.000	3,800.0
Shoshone Falls	P-2778	ID	2022	Idaho Power Company	ID	Add capacity	Snake	52.000	N/A
Blind report as requested		SR	2015	Unidentified utility	WA	Add energy	NW	0.000	2,000.0
Grand Coulee Dam		SR	2018+	Bureau of Reclamation	WA	Add units 19-21	Columbia	200.000	N/A
Boundary Dam		SR	2015-2035	Seattle City Light	WA	Add equipment	Pend Oreille	40.000	100,000.0
Packwood Lake Hydro		SR	2015	Energy Northwest	WA	Add energy	Cowlitz	0.000	5,808.0
Black Canyon Dam		SR	2018	Bureau of Reclamation	ID	Add third unit	Payette	12.000	N/A
Hungry Horse Dam		SR	2019+	Bureau of Reclamation	MT	Replace turbines/efficiency	Flathead	0.000	N/A
Lower Baker		SR	N/A	Puget Sound Energy	WA	New powerhouse		30.000	N/A
Little Falls		SR	2015-2018	Avista Corporation	WA	4 new units	Spokane	4.000	17,520.0
Nine Mile		SR	2015	Avista Corporation	WA	Upgrade	Spokane	8.000	35,040.0
Palisades Dam		SR	2016	Bureau of Reclamation	ID	Replace turbines +7.5 efficiency	Snake	0.000	N/A
							14 Projects:	388.000	1,464,168.0

TOTAL OF ALL PROJECTS OF EACH TECHNOLOGY:	3,238.56	2,301,555.10

SR: Survey

Explanations for Table A

Non-Powered Dams
The non-powered dams listed are those that were identified in the NWHA survey or as one of the priority projects in studies A-1, A-2 or A-3 (Chapter 1). In addition, all of these projects are active in the FERC application process and have the potential to be completed within the next 5 to 10 year period. Some of the projects result in agreements with the Bureau of Reclamation under an agreed upon Lease of Power Privilege (LOPP) which allows private development at a federal facility. Other projects on the list of non-powered dams at page 1-2 in Chapter 1 are not on FERC application lists or were not advised to be moving forward in the near future by a survey respondent.

Potential: 10 Projects 57.159 MW Capacity 148,248.3 MWhs Energy

Conduit Exemptions and Hydrokinetic Projects
Projects on the Potential Hydropower List were identified by study developers as viable sites with a higher potential for a positive cost/benefit ratio. These are all projects within canal systems with minimal environmental impacts. Some projects are underway now and will be completed in 2015. Others could be easily completed within 5 years or less, depending upon power sales agreement pricing that supports financing. Some of the projects have or are completed LOPP agreements with the Bureau of Reclamation. These projects are moving forward as they are able to often secure green credits from federally funded state water quality revolving funds for green projects or other incentives. The previously developed conduit projects in Oregon have resulted in reducing the districts' water rights and placing that amount of water back into the river system as an instream water right with an early priority date in exchange for support of funds to purchase pipe and replace open canals with a closed delivery system. See Chapter 2 for tables identifying the projects and the FERC tables in Chapter 8 (Tables 1 and 2).

Potential: 143 Projects 63.697 MW Capacity 226,107.8 MWhs Energy

Pumped Storage Projects
While there are 8 pumped storage projects with FERC applications, only 3 of the projects have made significant process in moving forward with studies and review, as depicted in Table A and Chapter 3. Two are to complete their draft license application in 2015 (John Day Pool and Swan Lake); the Banks project is anticipated to be completed and on line by 2024. Completion of the projects will be determined upon the basis of achievable power sales agreements that support financing, or with the provision of other incentives. The energy total from the projects is reduced to net energy, based on the need to use some energy for reverse pumping operation.

Potential: 3 Projects 2,640 MW Capacity 33,084.0 MWhs Energy

Tidal and Wave Energy Projects
There appear to be no current FERC applications that have not been withdrawn for tidal or wave energy projects in the Northwest. There is a potential demo project that may move forward, discussed in Chapter 4. The technology for tidal and wave energy projects is developing and there may be a number of projects within the next 20 year period. Currently there is not enough information to identify those projects.

General Assessments
It is difficult to determine the amount of power available from the general assessments in Chapter 5 because specific projects sites are often not identified. NWHA has requested a map that will show where the protected areas overlap the stream reaches identified but more information will be required to determine the amount of the power potentially available from studies E-1, E-2, E-5, E-6 and E-7. All of the Oregon small irrigation district projects identified in E-3 are included as they have little impact and can be developed with green incentives in the near future. Study E-4 is a review of water rights that could eventually lead to project identification but only calculates potentially available water rights within investor-owned utility service areas.

Potential: ***35 Projects*** ***89.7 MW Capacity*** ***429,947 MWhs Energy***

Upgrades to Existing Projects
The listed upgrades in Table A were reported by the utility or entity owner. Not all of the respondents advised the amount of energy that would be added from the upgrades so the number represented below is lower than it would be with the additional information.

Table 8 in Appendix C lists tax credits for upgrade projects that have been awarded to Northwest dam owners. The information does not contain dates when construction will or has taken place and although the chart is dated August 31, 2014, some of these tax credits go back to 2005 and may have already been applied to projects completed as well as being applicable to future projects. With more investigation, additional generation might be identified.

Potential: ***14 Projects*** ***388.0 MW Capacity*** ***1,464.168.0+ MWhs Energy***

TOTAL POTENTIAL FROM ALL HYDROPOWER TECHNOLOGIES AS REPRESENTED ON THE CHART:

Potential: ***3,238.56 MW Capacity*** ***2,301,555.10 MWhs Energy***

*Where projects were duplicated within more than one study or more than one FERC application list, they were counted only one time in the above numbers.

CHAPTER 1

NON-POWERED DAMS

There are more than 80,000 non-powered dams (NPDs) in the United States, dams constructed in the past without the inclusion of energy generating equipment. In contrast, 2,500 powered dams provide 100 GW (gigawatts) of power: 78 GWs of conventional hydropower and 22 GWs of pumped-storage hydropower. [1] As many of the environmental impacts and capital costs of construction have already been addressed in building these facilities, adding hydropower provides an opportunity to produce additional power at a lower installed cost, with more limited environmental impacts and business risks, and within a more expedited time frame.

The following studies were reviewed in addressing potential in the Northwest[2] for adding generation to the non-powered dams, as identified in Appendices A and B:

- A-1
  "*Hydropower Resource Assessment at Non-Powered USACE Sites*"
  U.S. Army Corps of Engineers
  July 2013
  Prepared by the Hydropower Analysis Center of USACE

- A-2
  "*An Assessment of Energy Potential at Non-Powered Dams in the United States*"
  U.S. Department of Energy, Wind and Water Power Program
  April 2012
  Prepared by Oak Ridge National Laboratory

- A-3
  "*Hydropower Resource Assessment at Existing Reclamation Facilities*"
  U.S. Bureau of Reclamation
  March 2011
  Prepared by Power Resources Office, Bureau of Reclamation, Department of the Interior

The three studies identified the following potential hydropower capacity at NPDs in the Pacific Northwest[3]:

Study A-1	116.13	MWs of capacity	168,778.39 MWhs
Study A-2	225.00	MWs of capacity	871,000.00 MWhs
Study A-3	27.656	MWs of capacity	106,448.00 MWhs

[1] Study A-2
[2] For the purpose of this report, all of the state of Montana is included in the Pacific Northwest, even though the BPA service area includes only western Montana; many of the studies in this report present analysis on a state basis.

Total potential identified:

The capacity identified includes these specific projects:

Study	Project Name	State	Capacity (MWs)	Generation (MWhs)
A-1	Blue River	OR	20.63	32,565.26
A-1	Cottage Grove	OR	8.41	12,048.79
A-1	Fern Ridge	OR	10.08	11,832.67
A-1	Hiram M. Chittenden Locks & Dam	WA	11.43	16,755.29
A-1	Howard A. Hanson Dam*	WA	65.58	95,576.38
A-2	Howard A. Hanson Dam (not included in total)*	WA	[26.3]	[101.62]
A-3	Arthur R. Bowman Dam	OR	3.293	18,282.00
A-3	Easton Diversion Dam	OR	1.057	7,400.00
A-3	Sunnyside Dam	WA	1.362	10,182.00
A-3	Scootney Wasteway	WA	2.276	11,238.00
A-3	Emigrant Dam	OR	.733	2,619.00
A-3	Wickiup Dam	OR	3.950	15,650.00
A-3	Cle Elum Dam	WA	7.249	14,911.00
A-3	Ririe Dam	ID	.993	3,778.00
A-3	Scoggins Dam	OR	.955	3,683.00
A-3	McKay Dam	OR	1.362	4,344.00
A-3	Keechelus Dam	WA	2.394	6,746.00
A-3	Haystack Dam	OR	.805	3,738.00
A-3	Kachess Dam	WA	1.227	3,877.00
	TOTAL		**143.786**	**275,226.39**

(*Apparent discrepancy in capacity between studies A-1 and A-2 on Howard A. Hanson Dam)

The above chart does not include the 225 MWs in study A-2 which are broken down only by state for capacity: Idaho – 12 MW; Montana – 88 MW; Oregon 116 MW; and Washington, 85 MW.

Study A-1

This July 2013 study addresses adding generation to the non-powered US Army Corps dams. The study employed the 2012 Oak Ridge National Laboratory (ORNL) study of over 54,000 dams (Study A-2). A total of 419 of the sites identified in the study were USACD dams. The USACE reduced the feasible number of dams by applying additional screening criteria: a) generation of 1 MW or more of potential capacity; b) no current Federal Energy Regulatory Commission (FERC) license; and c) no obvious hindrances in developing hydropower, which resulted in 223 feasible sites.

Economic benefits, such as energy value and federal and state incentives were considered, as well as cost estimations for construction, non-construction development and annual operating and maintenance costs defined by the Idaho National Engineering and Environmental Laboratory's (INEEL) 2003 study (study E-8 in this document) and from the Bureau of Reclamation's 2011 assessment (study A-3 in this document). To determine economic feasibility the study employed use of a benefit-cost ratio and an internal rate of return, comparing the net present value over a 50-year period of analysis. Using those factors, the 12 projects in the Northwestern Division equated to 348.74 MWs of potential capacity, but upon review, reduced to 50.63 MWs as feasible capacity.

The maximum power value is used in calculating a site's potential capacity. Site specific restrictions such as water quality and other environmental impacts were not calculated. Energy prices reflected by the Energy Information Administration (EIA) were applied to the sites. Five sites were considered feasible in the Northwest Region, which covers the Corps' Portland (Figure 1) and Seattle (Figure 2) Districts, the majority of the four northwestern states.

This is one of the few studies that takes into consideration the benefit of reduction in greenhouse gas emissions, using a specific identifying factor for each region, taking into account 26 differing sub-regions. A chart included in the study details the northwest region output emission rates from three sources. The five northwest projects would have the capability of avoiding 203.78 million tons of GHG emissions.

This study uses one of the broadest numbers of parameters in analyzing projects for both benefits and costs, providing the formulas for analysis.

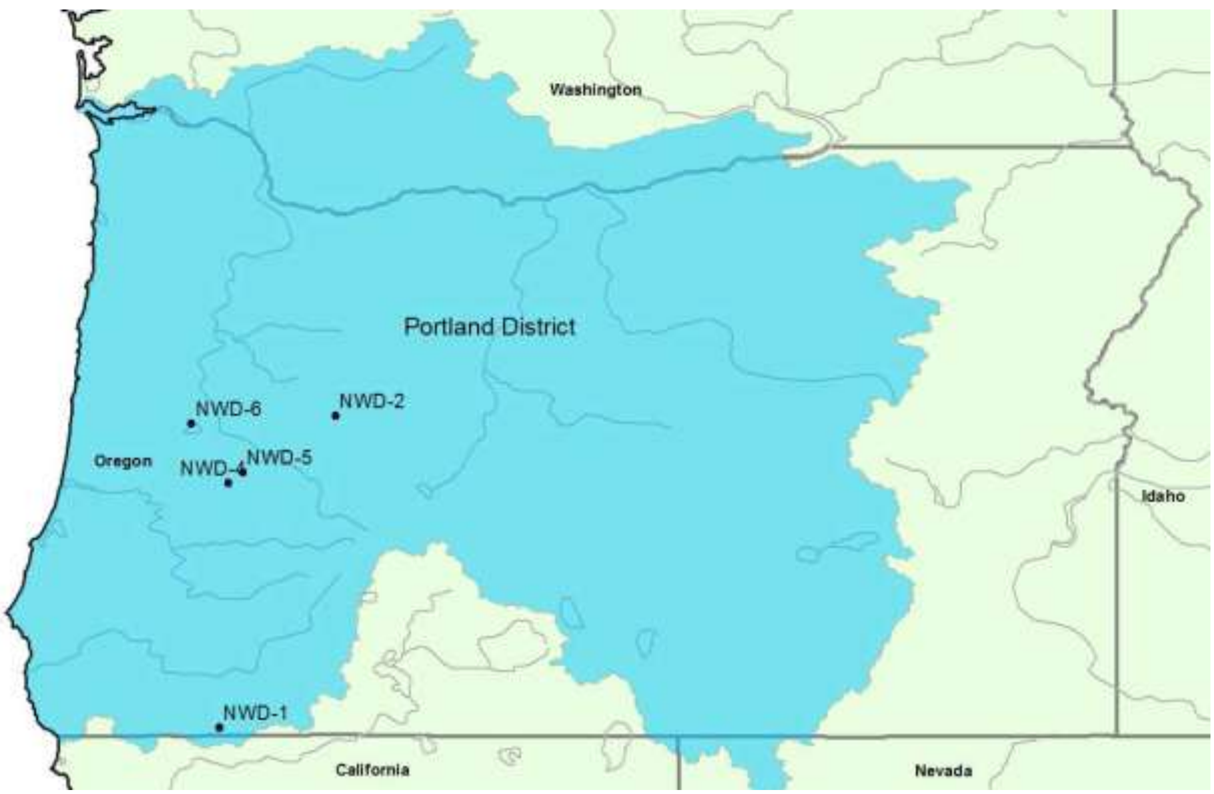


Figure 1 Sites of Oregon Projects – Portland District US Army Corps Study A-1

Figure 2 Sites of Washington Projects – Seattle District US Army Corps, Study A-1

The Protected Areas designation of the Northwest Power and Conservation Council's Fish and Wildlife Plan does not apply as these sites are at existing diversions.

Study A-2

Oak Ridge National Laboratory (ORNL) analyzed 54,391 of the potential 80,000 NPDs nationwide, with input from the Idaho National Laboratory. Dams excluded from the study were those under 5' in height and those without adequate flow and other pertinent information. Dam sites include federal facilities, both US Army Corps of Engineers and Bureau of Reclamation facilities, as well as other dams from the National Inventory of Dams. Project sites were assessed on the basis that all existing flow through dams and runoff potential within the basin were included in determining flow available for generation and assuming a constant hydraulic head. The capacity factor was based on Energy Information Administration (EIA) generation for an 8 year period ending in 2008 for all generation in the US, with an additional regional factor.

The study is based on energy production only as other mitigation factors, such as environmental impacts, are assumed to have been addressed during original construction. The analysis did not take into consideration economic feasibility nor regulatory review factors.

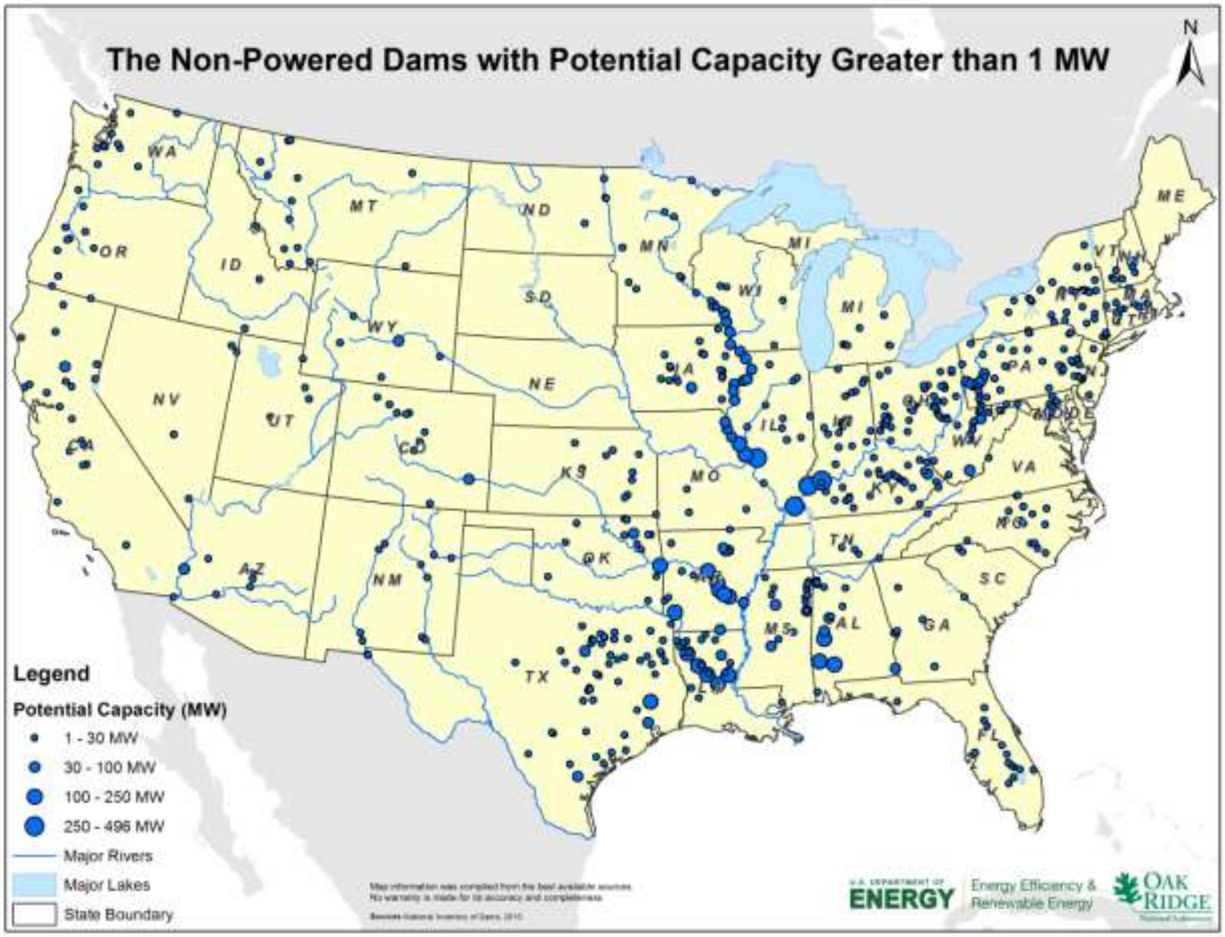


Figure 3

The addition of power to non-powered dams has the potential of adding up to 12 GWs or 12,000 MWs of renewable capacity. Of that capacity, 225 MWs are identified within the Pacific Northwest region. Figure 3 shows sites of non-powered dams with the potential of capacity greater than 1 MW. Individual projects are not called out in the study unless they are among the top 100 sites. There is one such site identified in the table above.

Some sites in the Pacific Northwest are not included in the study as they are already approved by FERC and under construction.[4]

The National Hydropower Assessment Program (NHAAP) baseline database and other national data systems were used as the basis for the study.

The Protected Areas designation of the Northwest Power and Conservation Council's Fish and Wildlife Plan does not apply as these sites are at existing diversions.

[4] See Chapter I – FERC applications pending and recently approved.

Study A-3
The third study on non-powered dams was developed by the Power Resources Office of the U.S. Bureau of Reclamation, Department of the Interior, March 2011. Reclamation assessed 530 sites in the west, determining that 191 sites appear to have potential for further evaluation. An earlier 2005 study addressed the same sites; this assessment provides additional and updated information.

The Hydropower Assessment Tool was used to estimate potential hydropower capacity and generation, as well as economic benefits. Reclamation's assessment tool computes generation; cost estimates for construction, equipment, preliminary transmission access, permitting and mitigation; as well as economic benefits. Current and forecast energy prices are used for the revenue stream. Green incentives from federal and state incentives are considered in the analysis. The benefit cost ration and internal return on revenue are based on a 50 year period. An interested developer can input data into the Excel spreadsheet model with embedded macro functions, providing the developer with a preliminary evaluation tool for a potential site. Various assumptions may be changed—equipment, interest rate, flow exceedance, or cost variables, among other factors.

The Resource Assessment also evaluated potential regulatory constraints including, but not limited to, fish and wildlife considerations and effects on Native American resources, recreation, water supply and quality and potential mitigation costs for those variables.

Of the 530 sites reviewed, 105 sites were in the Pacific Northwest Region. A total of 28 of those sites were specified as having high confidence for potential development, 7 as medium confidence and the remaining 48 as low confidence.

This study develops costs per kW of capacity. Thirteen Pacific Northwest sites have a benefit cost ration greater than 0.75 and are included in the chart on page 1-2. These 13 sites would produce 27.656 MWs of capacity and 106,248 MWhs of energy. The average price per kW installed with all costs estimated ranges from $1,889 to $5,075.

The chart on page 2 shows the dam sites with a benefit cost ratio, with green incentives, greater than .75 with medium and high confidence data.

Figure 4 chart shows all non-powered dams reviewed in the Pacific Northwest, including those with a higher level of feasibility shown on page 1-2.

The Protected Areas designation of the Northwest Power and Conservation Council's Fish and Wildlife Plan does not apply as these sites are at existing diversions.

5.3.1 Economic Evaluation

Table 5-22 summarizes the economic evaluation of hydropower development at sites in the Pacific Northwest region. Except for Washington, the other states in the Pacific Northwest region (sites are primarily in Oregon and Idaho) can receive the Federal green incentive for hydropower development. On average, for the sites analyzed, the green incentives only resulted in an increase in the benefit cost ratio of about 0.04. Some sites in the Pacific Northwest region had very high cost per installed capacity, low benefit cost ratios, and low IRRs, indicating they would not be economical to develop.

Table 5-22 Economic Evaluation Summary for Sites in Pacific Northwest Region

Site ID	Site Name	Total Construction Cost (1,000 $)	Annual O&M Cost (1,000 $)	Cost per Installed Capacity ($/kW)	Benefit Cost Ratio	IRR	Benefit Cost Ratio	IRR
					With Green Incentives		Without Green Incentives	
PN-1	Agate Dam	$821.5	$41.8	$9,267	0.24	< 0	0.22	< 0
PN-2	Agency Valley	$11,353.3	$283.6	$9,626	0.33	< 0	0.31	< 0
PN-6	Arthur R. Bowman Dam	$8,994.9	$285.6	$2,732	1.9	11.2%	1.79	10.0%
PN-9	Bully Creek	$8,062.9	$189.1	$25,773	0.13	< 0	0.12	< 0
PN-10	Bumping Lake	$11,275.7	$253.9	$21,650	0.2	< 0	0.19	< 0
PN-12	Cle Elum Dam	$13,692.3	$491.1	$1,889	0.94	3.8%	0.89	3.3%
PN-15	Cold Springs Dam	$1,308.8	$48.9	$19,942	0.09	< 0	0.08	< 0
PN-20	Crane Prairie	$7,751.3	$183.6	$25,317	0.25	< 0	0.23	< 0
PN-24	Deadwood Dam	$19,510.1	$428.5	$22,402	0.2	< 0	0.19	< 0
PN-31	Easton Diversion Dam	$4,006.9	$143.0	$3,792	1.68	9.9%	1.58	8.8%
PN-34	Emigrant Dam	$2,209.7	$95.0	$3,013	0.99	4.3%	0.93	3.7%
PN-37	Fish Lake	$1,176.0	$48.3	$11,555	0.18	< 0	0.17	< 0
PN-41	Golden Gate Canal	$3,991.6	$121.5	$7,771	0.56	< 0	0.53	< 0
PN-43	Harper Dam	$5,901.2	$152.4	$13,606	0.31	< 0	0.29	< 0
PN-44	Haystack	$3,916.4	$131.4	$4,866	0.85	2.9%	0.8	2.4%
PN-48	Kachess Dam	$4,335.9	$154.6	$3,535	0.77	1.9%	0.72	1.5%
PN-49	Keechelus Dam	$6,774.2	$224.0	$2,830	0.87	3.0%	0.81	2.5%
PN-52	Little Wood River Dam	$17,931.2	$419.3	$12,013	0.29	< 0	0.27	< 0
PN-53	Lytle Creek	$1,603.2	$54.4	$32,368	0.19	< 0	0.18	< 0
PN-56	Mann Creek	$3,554.4	$112.0	$7,174	0.56	< 0	0.52	< 0
PN-57	Mason Dam	$7,276.4	$220.2	$4,414	0.72	1.5%	0.68	1.1%
PN-58	Maxwell Dam	$2,075.4	$66.9	$17,766	0.3	< 0	0.28	< 0
PN-59	McKay Dam	$4,274.0	$155.7	$3,138	0.88	3.2%	0.83	2.7%
PN-65	Ochoco Dam	$1,286.3	$49.5	$18,532	0.16	< 0	0.15	< 0
PN-78	Reservoir "A"	$1,262.2	$47.4	$27,968	0.12	< 0	0.11	< 0
PN-80	Ririe Dam	$3,636.9	$131.5	$3,661	0.94	3.8%	0.89	3.3%
PN-87	Scoggins Dam	$3,665.4	$130.6	$3,838	0.92	3.6%	0.86	3.1%
PN-88	Scootney Wasteway	$8,014.4	$258.3	$3,521	1.26	6.6%	1.18	5.9%
PN-95	Sunnyside Dam	$6,912.0	$205.4	$5,075	1.43	7.8%	1.35	7.0%
PN-97	Thief Valley Dam	$2,601.0	$87.2	$7,050	0.64	0.1%	0.6	< 0
PN-100	Unity Dam	$9,462.0	$213.5	$30,808	0.14	< 0	0.13	< 0

Figure 4

CHAPTER 2

CONDUIT AND HYDROKINETIC PROJECTS

Projects that add generation equipment to existing conduits (pipelines, canals or other conveyance systems beyond an existing diversion) are considered by the Federal Energy Regulatory Commission (FERC) as “conduit exemption” projects. Conduit exemption projects are exempt from FERC licensing. There is still a review by FERC, but at a lower level that consists of filing a “Notice of Declaration” showing a site map and minimal project information. The projects are generally approved in 6 months or less when a complete application is filed. There is a public notice and the ability for comment.

Conduit exemption project experience in the Northwest has occurred mainly within irrigation delivery systems, but there are now projects being installed within municipal water system pipelines. There is the potential to install projects within wastewater and other water delivery systems as well.

In addition to adding generation equipment to conduits, there are also new equipment technologies that allow for equipment to be suspended within a conduit, or in some cases within a river or stream. Those hydropower projects are referred to as “hydrokinetic” energy projects. At this time the kinetic technologies are in the demonstration stage. While there are some prototypes currently installed, the technology is quite new.

Council staff comment: The Protected Areas provisions of the Northwest Power and Conservation Council’s Fish and Wildlife Program call for the protection of designated stream reaches from hydroelectric development. Exempt from this policy is the addition of hydroelectric generation to an existing non-hydroelectric dam or diversion structure, even if in a protected area. Thus any proposal to add hydroelectric generation to an existing conduit is exempt from the Protected Areas policy, whether that project uses conventional or hydrokinetic technology. New hydroelectric development directly in a stream is not exempt, and there is no distinction in the policy as to whether the project uses conventional or hydrokinetic technology. The Council adopted the protected areas policy in 1988, and has confirmed it in all fish and wildlife programs and power plans since. The Council has never formally considered the issue of new hydrokinetic technologies in this regard.

The following studies were reviewed for conduit and hydrokinetic project potential:

- B-1
  “Technical & Economic Feasibility of Small Hydropower Development in the Deschutes River Basin”
  U.S. Department of Energy
  June 2013
  Prepared by Oak Ridge National Laboratory

- B-2
  “The Integrated Basin-Scale Opportunity Assessment Initiative, FY 2011 Year-End Report: Deschutes Basin Preliminary Hydropower Opportunity Assessment”
  U.S. Department of Energy

September 2011
Prepared by Pacific Northwest National Laboratory, Battelle

- B-3
  "Feasibility Study on Five Potential Hydroelectric Power Generation Locations in the North Unit Irrigation District"
  Energy Trust of Oregon
  August 2009
  Prepared by Blackrock Consulting
- B-4
  "Power Extraction from Irrigation Laterals and Canals in the Columbia Basin Project"
  University of Washington
  2009
  Prepared by Jessica M. Theilmann

- B-5
  "Site Inventory and Hydropower Energy Assessment of Reclamation Owned Conduits"
  U.S. Bureau of Reclamation
  March 2012
  Prepared by Power Resources Office, Bureau of Reclamation, Department of the Interior

- B-6
  "Bureau of Reclamation Renewable Energy Update"
  U.S. Bureau of Reclamation
  July 2014
  Fiscal Year 2014, Q3
  Prepared by Bureau of Reclamation, Department of the Interior

- B-7
  Scoping Study of Hydropower Potential in Wallowa County, Oregon
  Energy Trust of Oregon
  November 2010
  Prepared by Renewable Energy Solutions, LLC

The seven studies identified

Study	Project Name	Capacity (MWs)	Generation (MWhs)
B-1	Wickiup Dam	7.118	29,010
B-1	Bowman Dam	5.959	19,587
B-1	North Canal Dam	1.135	5,145
B-1	Ochoco Dam	.366	2,992
B-1	Mile 45 conduit site	2.700	12,565
B-1	Haystack canal site	1.730	8,078
B-1	Lateral 58-11 canal site	.137	560
B-1	Lateral 58-9 canal site	.750	305

B-3	Brinson Boulevard canal site	.969	4,214
B-3	Smith Rock Drop canal site	.610	1,958
B-5	Pacific NW Regional canal sites	34.000	116,597
B-6	18 Reclamation Facilities	50.750	91,243
B-7	22 conduit sites	1.02	3,391
	TOTAL	**92.616**	**295,645**

Table 1

Study B-1

The purpose of the study was to identify and assess opportunities for new small hydropower development in the Deschutes Basin, in Central Oregon, along with the technology needed to develop selected sites and the economic feasibility. The focus was to narrow the investigation to projects at existing diversions: non-powered dams, irrigation canals or other diversion structures.

A 2010 Memorandum of Understanding among the U.S. Department of Energy (DOE), the U.S. Department of the Interior (DOI) and the U.S. Department of the Army (USACE) encouraged the Bureau of Reclamation, as one of the agencies affected by the agreement, to support optimization of energy at existing federal and non-federal projects. Section B of the agreement entails “Integrated Basin-Scale Opportunity Assessments.” This study reflects one of the basin assessments envisioned. The Deschutes Basin was selected as the first pilot basin.

Criteria for addressing projects in the basin included:

- new generation at non-powered dams (NPDs) and diversion structures;
- new generation within existing irrigation canals and conduits; and
- increased generation at existing hydropower facilities; and
- projects considered to be “small hydro” (110 kW to 10 MW capacity).

Because the potential projects are all at existing diversions, they are exempt from the restrictions of the Protected Areas of the Northwest Power Planning and Conservation Council.

The study used the Oak Ridge National Laboratory (ORNL) “Hydropower Energy and Economic Assessment” (HEEA) tool under development. The tool uses site-specific information and hydrological data from multiple sources to:

- generate flow and power duration curves;
- determine turbine design flow, net head and technology type;
- calculate monthly and annual power generation and determine design power capacity;
- estimate project cost (installation cost and levelized cost of energy); and
- perform benefits and economic evaluations.

The economic analysis considered:

- energy value derived from monthly generation data adjusted seasonally;
- capacity value reflecting avoided cost by utilities; and
- green incentives: tax credits, renewable energy credits (RECs)

The study assessed the following potential projects with sufficient historical flow data:

- 14 non-powered dams
- 15 irrigation canal/conduit sites.

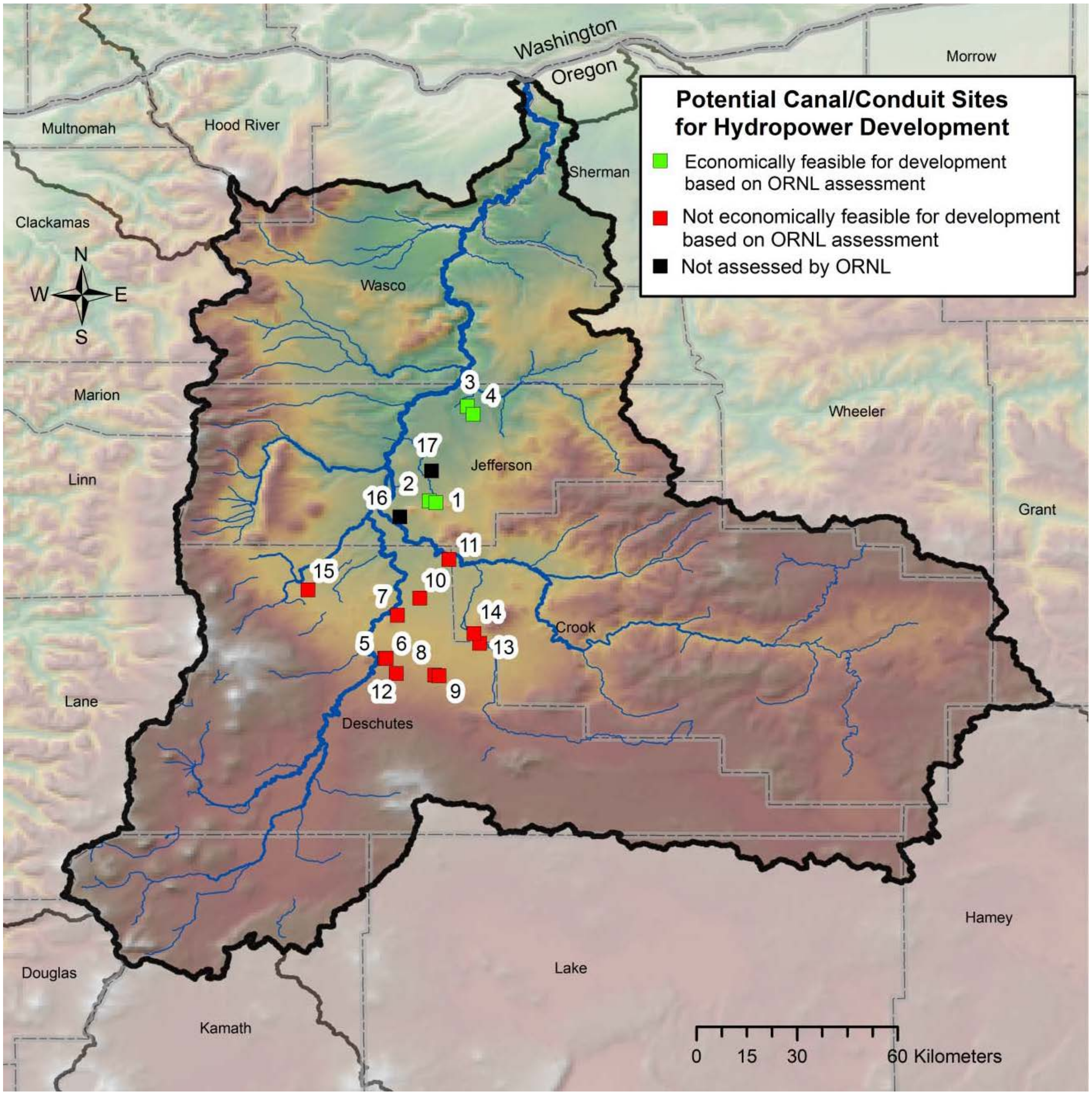
Of the 29 sites reviewed, 8 were considered to be economically viable using the HEEA tool. Those sites would add about 19 MW of hydroelectric capacity in the basin while generating over 78 gigawatt hours (GWh) of renewable energy annually. The result would be the powering of about 6,000 homes year-round and avoiding about 29,000 tons of greenhouse gas emissions.

These are the 8 projected determined to be economically viable at this time:

Project Name	Project No. on Map	Capacity (MWs)	Generation (MWhs)
Wickiup Dam		7.118	29,010
Bowman Dam		5.959	19,587
North Canal Dam		1.135	5,145
Ochoco Dam		.366	2,992
Mile 45 conduit site	1	2.700	12,556
Haystack canal site	2	1.730	8,078
Lateral 58-11 site	3	.137	560
Lateral 58-9 site	4	.075	305
TOTAL		**19.895**	**78,242**

Table 2

Figure 1: Map of conduit/canal projects (including #1-4 in Table 2)



(*Source:* Study B-1)

Study B-2

The September 2011 study of the Deschutes Basin is a document reporting on the first-year progress of the Integrated Basin-Scale Opportunity Assessment Initiative, preceding study B-1 referenced on the preceding pages. These activities occurred between March 2010 and September 2011 of a two year pilot project period. The study represents an in-depth technical process report of the work developed in study B-1.

Study B-3

The North Unit Irrigation District in and around Madras, Oregon, has a delivery system encompassing 300 miles of canals and laterals. A private consultant, Black Rock Consulting, performed a review of canal sites that might lend themselves to potentially feasible generation sites. Three of the sites reviewed are the same as those in study B-1; study B-1 acknowledges this review as one of the source documents for the work accomplished.

The review results were based on field survey data, canal and lateral design specifications, and flow information using district gauging stations. A cost estimate was defined for each of the five projects and current power sales rates were used in the revenue calculations. The project costs and revenues were based upon first year benefit versus cost of revenue versus amortized loan and simple payback periods.

The Brinson Boulevard site ranked higher in this study than lateral 58-9 did in study B-1 and is added to the chart of available projects in the basin on page 2-2 due to its priority in this study. In addition, the fifth site in this study, Smith Rock Drop, was added due to its feasibility.

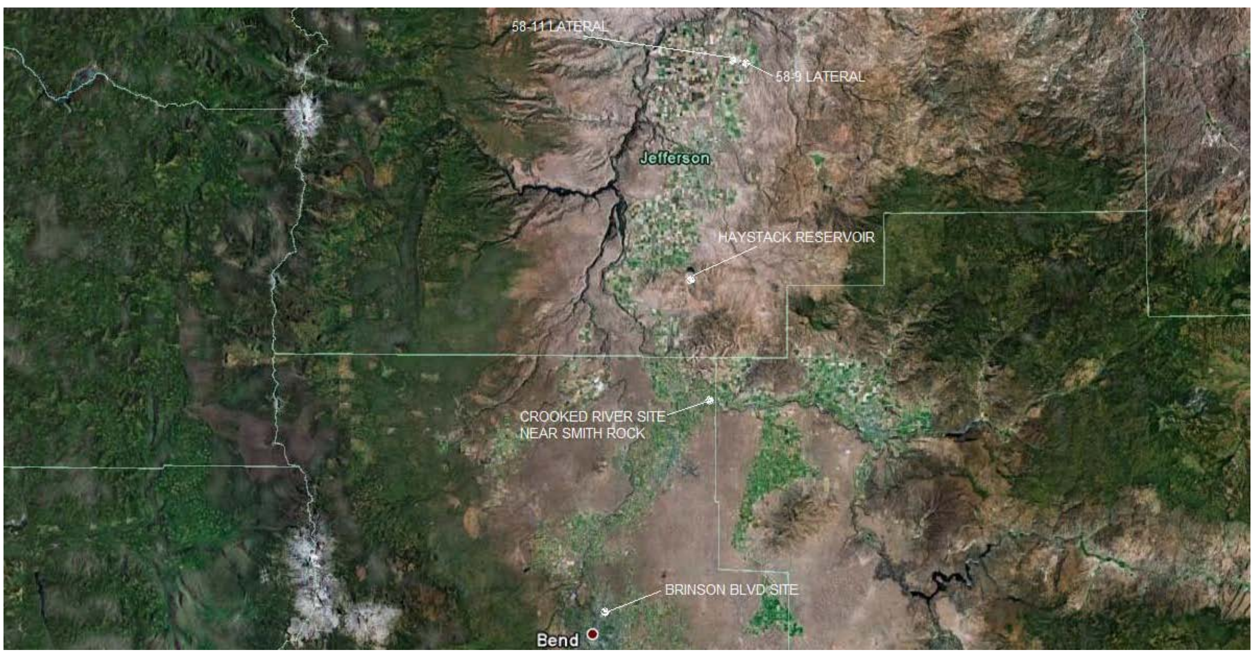


Figure 2: Map of 5 North Unit Irrigation District Sites from Study B-3

- Brinson Boulevard Site .969 MW Capacity 4,214.095
- Smith Rock Drop .610 MW Capacity 1,958.217

Study B-4

This study is the result of a thesis for the Master of Science program in Mechanical Engineering at the University of Washington, submitted in 2009. Ms. Theilmann did field studies and worked with Grant County PUD and staff of the Columbia Basin Project. The study area, the Columbia Basin Project, is located in central Washington State, across six counties; the Project serves 671,000 acres of irrigation. Grant County PUD sought to demonstrate hydrokinetic turbines in some of the Project laterals. While the Project canals would provide greater generation capability, the hydrokinetic devices would interfere with irrigation water delivery. As a result the hydrokinetic units were to be instead provided in the smaller lateral conveyance areas of the system. Three lateral sites were chosen to be reviewed for hydrokinetic potential.

Hydrokinetic power harnesses the energy of water flow within water bodies, which could be a canal, stream or river. There is no impoundment of water required for hydrokinetic units to be placed within a water body. Most hydrokinetic turbines are in prototype status. This study refers to the unit engineered by New Energy Corporation in Canada, but since 2009 a number of other units have been installed. A current unit supplied by Instream Energy Technologies has been installed in the Roza Irrigation District near Yakima, Washington. At the time of this study the units ranged in size from 5 kW to 250kW at a cost of approximately $4,000 per installed kW. Today the range of sizes is broader and a larger variety of designs is available. At the time of the study, Solar energy cost $8,000 per kW, traditional hydropower $2,000 and small wind turbines about $2,500, by comparison. The hydrokinetic design must be tailored to the size of the lateral. For example a 25 kW hydrokinetic turbine in 2009 required a cross-sectional area of 12.22 feet, a water depth of 5.58 feet and a required channel width of 11.15 feet. These turbines are most effective in a high velocity situation.

For the purpose of this study, the only costs considered were the equipment, its installation and appurtenant civil works. The study sought to compare the cost of traditional hydropower at lateral site diversions versus the cost of hydrokinetic installation. The conclusion of the study was that traditional hydropower within the Columbia Basin Project system was not only somewhat cheaper per kW but that traditional installations would also produce considerably more power than the hydrokinetic turbines. But the capital outlay for the conventional hydro systems is much larger because of the greater power generation output. The limitations on hydrokinetic power are a result of channel design and the flow relation to its critical point.

An example in point is comparison of a hydrokinetic design for Check 2 on the lateral system with a 25 kW rated turbine in a 13' wide channel. In that configuration, 18 kW of electrical power would be generated at a unit capital cost of nearly $7,000 per kW. A conventional hydropower turbine at the same site would generate 700 kW at about $5,000 per installed kW. The design would replace the current check structure (diversion) and down channel baffle blocks.

Given the new designs and prototypes since 2009, an updated study would be required to determine if the same comparison values still apply.

Study B-5

This March 2012 study is a supplement to the “Hydropower Resource Assessment at Existing Reclamation Facilities Report” of March 2011 (see chapter 1 – non-powered dams). Of the 530 sites identified, 191 were determined to have some level of hydropower potential. If all 191 sites were developed, 268 MWs in capacity would be available and 1.2 million MWh of energy produced. If all the sites with a benefit cost ratio greater than .75 were developed, that would provide 225 MW and 1.0 million MWh of energy.

An earlier report did not capture the specific drops and listed the head differential along the entire stretch of a canal, which could be over ten miles long, rather than capturing the energy potential at drops along the canal. Unlike the earlier study, this supplement included site visits. This study also identifies proximity to distribution/transmission lines and provides site maps for the identified sites. It does not include an economic benefit cost analysis.

As with any non-federal development of hydropower on Reclamation facilities, existing project water deliveries cannot be negatively impacted by any proposed hydropower project envisioned. The project must be designed to protect continued water delivery even in the event of a powerplant outage. Project operators, such as irrigation districts, should be contacted to involve them as stakeholders in any project. Reclamation has a process for allowing development on federal facilities, the "Lease of Power Privilege" (LOPP); or the Federal Energy Regulatory Commission (FERC) may provide oversight through FERC's licensing process in accordance with the Memorandum of Understanding between FERC and Reclamation.

Reclamation owns 47,336 miles of canals, laterals, drains, pipelines and tunnels, many with little head or flow. In discussion with equipment manufacturers, developers and others, Reclamation determined that a reasonable minimum head for a technically feasible micro-hydro project had to be at least 5 feet. Sites must have the capability of operating at least 4 months out of the year seasonally and produce 50 kW of capacity or more based on gross head and flow capacity of the canal would be identified in the report.

The study uses the Hydropower Assessment Tool designed to size a power plant, but cut the flow exceedance to 15%, in discussions with Idaho National Laboratory, to account for the fact that canals operate seasonally. The majority of canal systems in the Pacific Northwest region operate 6-7 months annually.

Outcome: Energy and Capacity

STATE	CANAL SITES	POTENTIAL INSTALLED CAPACITY MW	POTENTIAL ANNUAL ENERGY MWH
ID	9	2.77	11,451.81
MT	32	9.88	26,316.56
OR	68	20.40	75,943.04
WA	2	1.05	2,885.36
TOTAL	**111**	**34.00**	**116,596.77**

Table 3

Study B-6
This is a July 2014 update of renewable energy projects that includes planned facilities or projects in progress. Projects on Reclamation facilities proposed to be developed by others will be developed under Reclamation's Lease of Power Privilege agreement process.

FERC and LOPP Non-Federal Hydroelectric Projects
Planned on Reclamation Infrastructure in the Pacific Northwest as of July 2014

State	Type	Facility Type	Status	Type	Project Name	FERC	Operating Entity	Capacity (kW)	Pump Generation Capacity (kW)	Estimated Annual Generation (kWh)	Project Initiation	Preliminary Permit/ Lease Date
WA	FERC	Conduit	Preliminary	Conventional	16.4 Wasteway	14349	Grand Coulee Project H. Authority	1,750			7/29/2011	3/26/2013
OR	FERC	Conduit	Exemption	Conventional	45-Mile	13817	Earth by Design (Exemption: 12/17/2010)	5,000			7/16/2010	
WA	FERC	Conduit	Preliminary	Conventional	46A Wasteway	14351	Grand Coulee Project H. Authority	1,600			7/29/2011	3/26/2013
WA	FERC	Dam	Preliminary	Pump Storage	Banks Lake Pumped Storage Project	14329	Grand Coulee Project H. Authority		1,000,000	2,263,000,000	11/30/2011	8/22/2013
OR	FERC	Dam	Preliminary	Pump Storage	Bryant Mountain Pumped Storage	13680	Bryant Mountain LLC	-	1,250,000	2,409,000,000	3/1/2010	9/24/2010
MT	FERC	Conduit	Exemption	Conventional	Mary Taylor Drop	14294	Turnbull Hydro, LLC (Exemption: 6/28/2012)	890		1,840,000	9/23/2011	
WA	FERC	Dam	Preliminary	Conventional	McKay Dam	14546	Houtama Hydropower, LLC	2,300			8/13/2013	2/6/2014
OR	FERC	Conduit	Preliminary	Conventional	Monroe Drop	14430	Natel	300		1,733,511	7/2/2012	3/28/2013
WA	FERC	Conduit	Preliminary	Conventional	PEC 1973 Drop	14316	Grand Coulee Project H. Authority	2,200			11/8/2011	3/26/2013
WA	FERC	Dam	Preliminary	Conventional	Pinto Dam	14380	Grand Coulee Project H. Authority	3,400			4/4/2012	10/10/2012
WA	FERC	Conduit	Preliminary	Conventional	Rocky Coulee Wasteway	14372	Grand Coulee Project H. Authority	12,000			3/13/2012	7/11/2012
WA	FERC	Conduit	Preliminary	Conventional	Scooteney Outlet Drop	14317	Grand Coulee Project H. Authority	1,300			5/31/2011	3/26/2013
WA	FERC	Conduit	Preliminary	Conventional	Scooteney Wasteway	14352	Grand Coulee Project H. Authority	1,110			7/28/2011	3/26/2013
WA	FERC	Conduit	Preliminary	Conventional	Scootney Inlet Drop	14318	Grand Coulee Project H. Authority	1,700			5/31/2011	3/26/2013
OR	FERC	Dam	Preliminary	Conventional	Unity Dams/Warm Springs Hydro	14576	Warm Springs Hydro, LLC	800		3,400,000	1/13/2014	6/16/2014
MT	LOPP	Conduit	Request	Conventional	A Drop	n/a	Turnbull Hydro, LLC	1,000		2,500,000	6/1/2014	
MT	LOPP	Dam	Request	Conventional	Helena Valley Pumping Plant	n/a	Helena Valley Irrigation District	4,800		9,608,000	9/13/2013	
MT	LOPP	Conduit	Request	Conventional	Johnson Drop	n/a	Turnbull Hydro, LLC	700		1,700,000	6/1/2014	
MT	LOPP	Conduit	Request	Conventional	Woods Drop	n/a	Turnbull Hydro, LLC	900		2,200,000	6/1/2014	
MT	LOPP	Dam	Request	Conventional	Yellowtail Afterbay	n/a	Crow Tribe	9,000		68,261,000	1/11/2012	

Table 4

Total Potential Capacity: 50.75 MW Conduits

Tot l Potential Capacity: Pumped Storage: 2,250.00 MW

Annual Energy Potential: 91,242.511 MWh
Pumped Storage: 4,672,000 MWh

In addition to the 18 traditional or conduit exemption projects identified in the chart on the prior page, the chart also includes two pumped storage projects. One of them is already listed in another study in Chapter 3, the Banks Lake Project.

There are two other projects in the Pacific Northwest that are not included in the chart as Reclamation's input was grant funding through the Water Smart Program, outside of the Lease of Power Privilege Program.

Three Sisters Irrigation District - Sisters, Oregon
Reclamation partially funded, under the Water Smart grant program, a .950kW hydropower project that resulted from piping an open canal in the Three Sisters Irrigation District. This project came on line in September 2014. It will provide 3.1 million kWh of energy annually between April and October. In addition to the generation project, the pipeline will provide pressurized water to 4,000 acres of agricultural lands within the district.

Roza Canal Hydrokinetic Pilot Project - Sunnyside, Washington
Instream Energy is developing a hydrokinetic pilot project on a canal in the Roza Irrigation District in Washington. The project has a capacity of 10 kW.

Study B-7
Renewable Energy Solutions, during the 2010 irrigation season, examined hydroelectric potential and conveyance efficiency at 22 canal sites in Wallowa County, Oregon. The sites total 1.02 MW capacity with the potential of 3,300 MWhs of annual energy potential. See Table 5 following.

The study included field review of existing irrigation infrastructure, transmission distances, water right information, technical detail and energy and water use efficiency.

When determining the cost, the consultant received cost quotations on pipe, valves, generation equipment; and estimated powerhouse, construction and transmission cost, permitting and engineering. The energy value was determined by utility standard pricing in place at the time of the study and was not specific to projects.

Site Name	HEAD (feet)	Flow max (cfs)	Kilowatt Max	Kilowatt-hour	Energy Value
Alder Slope D. 1	100	2.50	12.7	41,118	$ 2,961
Allen Canyon D. 1	304	7.00	108.0	349,998	25,200
Arrowhead Pipeline	374	0.47	8.9	28,781	2,072
Arrowhead Pipeline	462	1.15	27.1	87,696	6,314
Chamberlain D. 1	36	13.11	24.0	108,674	7,825
Clearwater D. 1	76	3.92	15.1	49,012	3,529
Clearwater D. 3	46	3.38	7.9	25,572	1,841
Creighton D. 1	40	3.00	6.1	19,737	1,421
Cross Country Canal	16	30	24.4	78,947	5,684
Kinney Lake D. 1	186	7.75	73.2	237,087	17,070
Kinney Lake D. 2	49	17.5	43.5	141,035	10,155
Kinney Lake D. 3	25	17.5	22.2	71,957	5,181
Kinney Lake D. 4	33	17.5	29.3	94,983	6,839
McCully Creek 1	128	1.98	12.9	41,684	3,001
Moonshine D. 1	239	3.762	45.6	147,802	10,642
Prairie Creek. 1	319	7.75	125.5	406,617	29,276
Sheep Creek D. 1	220	35.00	390.9	1,266,439	91,184
Sheep Ridge D. 1	222	0.45	5.0	16,270	1,171
Sheep Ridge D. 2	152	0.84	6.5	21,000	1,512
West Side D. 1	201	1.01	10.3	33,390	2,404
West Side D. 2	92	2.00	9.3	51,447	3,704
West Side D. 3	197	1.3	13.0	71,606	5,156

Table 5

CHAPTER 3

PUMPED STORAGE

Pumped storage hydroelectric projects provide significant benefits to our energy supply system including storage, load balancing, frequency control, and reserve generation capacity. During off-peak hours or low demand periods, water is pumped from a lower reservoir into an upper reservoir where it is stored in the upper reservoir until released through generating units during peak demand. Pumped storage projects are able to absorb excess load at times of high output and low demand (i.e. over generation), while providing additional peak capacity to meet energy needs [figure 1].

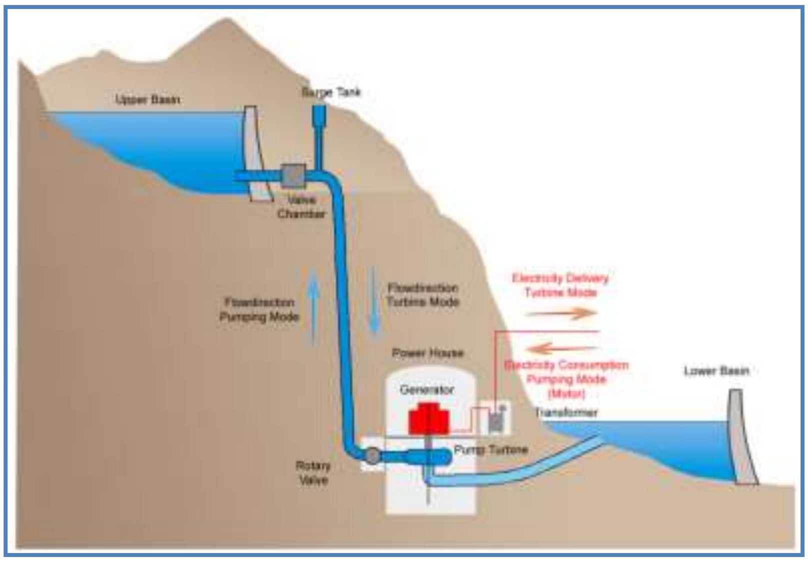


Figure 1 - Typical Pumped Storage Plant/System

This type of storage and generation may be applied to firm the variability of non-dispatchable renewable power sources, such as wind and solar power energy. Several pumped storage assessments have been conducted in the Northwest and throughout the United States, looking at candidate sites and energy storage needs for the region. It is also widely recognized that the storage reservoirs associated with pumped storage may be designed to provide multiple regional benefits including agriculture, domestic/commercial water usage, flow augmentation, and recreational enhancements.

Pumped storage hydroelectric projects have been providing storage capacity and transmission grid ancillary benefits in the U.S. and Europe since the 1920s. Today, there are 40 pumped storage projects operating in the U.S. that provide more than 20 GW, or nearly 2 percent, of the capacity for our nation’s energy supply system (Energy Information Admin, 2007). Figure 2 indicates the distribution of existing pumped storage projects in the U.S. Pumped storage and conventional hydroelectric plants combined account for approximately 77 percent of the nation’s renewable energy capacity, with pumped storage alone accounting for an estimated 16 percent of U.S. renewable capacity (Energy Information Admin., 2007).

Figure 2 – Existing Pumped Storage Projects in the United States

<u>Studies Reviewed</u>

The following studies were reviewed in addressing the potential in the Northwest for adding pumped storage, as identified in Appendix A:

- C-1
  "Assessment of Opportunities for New US Pumped Storage Hydroelectric Plants Using Existing Water Features as Auxiliary Reservoirs"
  Department of Energy, Idaho National Lab
  March 2014

- C-2
  "Technical Analysis of Pumped Storage and Integration with Wind Power in the Pacific Northwest"
  MWH for US Army Corps of Engineers
  August 2009

- C-3
  "Appraisal Evaluation of Columbia River Mainstem Off-Channel Storage Options
  CH2MHill for US Bureau of Reclamation
  May 2007

- C-4
  "Hydroelectric Pumped Storage for Enabling Variable Energy Resources within Federal Columbia Power System"
  HDR for Bonneville Power Administration
  September 2010

From these reports, Table 1.0 provides a summary of the capacity potential of the more promising set of pumped storage projects that have been identified in the Northwest.

Table 1: Summary of Capacity Identified in Studies C-1 through C-4

Study	Project Name	State	Capacity (MW)
C-1	See Report, Large Number of Studies Nationwide	N/A	-----
C-2	John Day Pool	WA	1300
C-2	Swan Lake	OR	600
C-3	Crab Creek (varies by size)	WA	69-392
C-3	Sand Hollow Creek	WA	285
C-3	Hawk Creek (varies by size)	WA	237-1136
C-3	Foster Creek	WA	300-1100
C-4	John Day Pool (duplicate, also cited in C-2)	WA	-----
C-4	Swan Lake North	OR	600
C-4	Brown's Canyon	WA	1000
C-4	Banks Lake Pumped Storage – North Banks Lake	WA	1000
C-4	Banks Lake Pumped Storage – South Banks Lake	WA	1040
C-4	Lorella (Klamath County)	OR	1000
C-4	Gordon Butte	Mt	400
C-4	Yale-Merwin	WA	255

Study C-1

This study provides a general assessment of opportunities for pumped storage in the lower 48 states that used an existing water body for either the lower or upper reservoir, but in most cases identified locations where two existing reservoirs could be hydraulically connected for use in pumped storage. The study identifies sites that met basic plant characteristic screening criteria and that were not located in an exclusion zone or environmentally sensitive area. The authors utilized some of the design elements of the 40 existing pumped storage projects in operation for their selection criteria, and based on the criteria used for this study, 2,505 sites were identified. The evaluation criteria included a base plant capacity of 10 MW minimum, area of upper reservoir surface area of 100 acres or greater, maximum distance between base plant and upper reservoir of 2 miles, and minimum elevation difference between reservoirs of 20 ft. By relaxing the minimum capacity to 1 MW, an additional 1,893 sites were identified. The report goes on to state that the number of sites would likely be reduced significantly upon further evaluation.

The following items were identified as issues that impact the usefulness of this report in the evaluation of pumped storage potential in the Northwest.

- The authors used existing pumped storage projects to ascertain the screening characteristics but unfortunately did not look at energy density in more rigor. If the report had determined that the minimum head requirement been greater than 300', the results would have been much more applicable.

- The report ignores the basics of water conveyance length (L) versus total gross head (H) ratio to be a metric for the screening study. There are established rules of thumb for L/H ration to apply to screening studies to identify possible sites for further evaluation (Pumped-Storage Planning and Evaluation Guide EPRI GS-6669 (January 1990).

- There are several projects that would have qualified as potential sites within the scope of this study: Turlock Irrigation's Red Mountain Bar site, Duke Energy's Coley Creek, site, and Grand Coulee Hydroelectric Power Authority's Banks Lake site, however, none of these sites are identified in the report.

- The report loses some credibility early on when three of the projects listed on the existing pumped storage data set do not in fact exist.

- The report identifies potential sites at existing pumped storage projects: Bear Swamp, Northfield, Castaic, Raccoon Mountain and Hyatt.

- More applicable to the Pacific Northwest, the authors did not considered closed loop pumped storage sites at all, and did not identify any of the sites outlined in previous studies of the Columbia River system off-stream storage, for example, or adjacent to Banks Lake.

- The configuration/capacity of an existing hydro station seems to influence the potential for reasons that are unknown or not relevant to pumped storage potential as demonstrated by the statement "the potential base plant should have a capacity or a capacity potential of at least 10 MW."

- Lastly, it does not appear that any of the 60+ existing FERC preliminary permits or applications for permits were reviewed by the authors to apply a more modern methodology to this effort nor to provide any ground-truthing to the results.

Due to the reasons listed above, the INEL report is limited in its usefulness to identify specific sites with pumped storage potential in the Pacific Northwest. Since this report covers the entire U.S. and the criteria used were significantly different than the other studies reviewed, specifics such as the MW potential of pumped storage in the Northwest from this report are not cited in this review.

Study C-2

This report provides a summary of projects in the Northwest that have FERC preliminary permits. The list of projects with FERC permits were reviewed in this study, and the sites with the most potential are cited in **Table 2.0.**

The study notes that permitting, designing, procuring equipment and constructing a pumped storage project is a long term process requiring at least 6 to 7 years and 10 to 12 years to completing construction is more likely. To date, a large scale pumped storage project has never been developed by a private developer; however, new innovative Public-Private-Partnerships and permitting process are recommended for sites where environmental issues are considered to be limited.

Table 2.0 Pumped Storage Projects with FERC permits

FERC Docket Number	Project Name	Licensee/Permit Holder/Applicant	State	Capacity (MW)	Closed Loop?	L/H Ratio	Estimated Energy Storage (MWh)
13333	John Day Pool	PUD No.1 of Klickitat County	WA	1000	Yes	4.58	15000
13318	Swan Lake North	Swan Lake North Hydro, LLC	OR	600	Yes	4.98	10000
2753	Brown’s Canyon	Douglas County PUD	WA	1000	No	0.00	37000
14329	Banks Lake Pumped Storage (Alternative 1 – North Banks Lake)	Grand Coulee Hydro Authority	WA	1000	No	28.29	8000
14329	Banks Lake Pumped Storage (Alternative 2 – South Banks Lake)	Grand Coulee Hydro Authority	WA	1040	No	3.18	8084
14416	Lorella (Klamath County)	FFP Project 111, LLC	OR	1000	Yes	4.81	15625
13642	Gordon Butte	GB Energy Park, LLC	MT	400	Yes	3.88	3422
--------	Yale-Merwin	PacifiCorp	WA	255	No	N/A	2550

Study C-3

This report provides an appraisal study for four potential storage sites in Washington State. The primary needs for storage in this evaluation included agriculture, flow augmentation, domestic/commercial/ municipal/industrial (DCM&I) and climate change response. The secondary purposes included recreation and power.

The 2007 Appraisal Evaluation builds on the work contained in the Pre-Appraisal Report, which was completed in December 2005. The objective of the Appraisal Evaluation is to determine which off-channel storage sites warrant further investigation, if a Feasibility Study is conducted. From the array of 11 potential off-channel storage options identified in the Pre-Appraisal Report, Reclamation and Ecology have determined that four off-channel storage alternatives warrant being carried forward into the Appraisal Evaluation.

The four sites are referenced as Hawk Creek, Crab Creek, Sand Hollow Creek and Foster Creek. During the evaluation process, Foster Creek was eliminated from consideration due to geotechnical reasons.

Appraisal-level designs for the dam and appurtenant structures, which include intake structures, inlet/outlet conveyance facilities, pumping/power plants, and transmission lines, were developed to support evaluation of the suitability of each project. The criteria/methodology used to develop appraisal-level designs, cost estimates, and the evaluation/ screening criteria used to compare the sites. Water balance modeling was used during the evaluation process. To provide an objective comparison of the sites, a decision support model was used in the evaluation. Through this process, Crab Creek was recommended as the project that should be evaluated in future studies.

The Hawk Creek site, southwest of Spokane, would utilize Lake Roosevelt as its lower reservoir and has the most promise from an energy density/pumped storage perspective due to its higher head of approximately 780'.

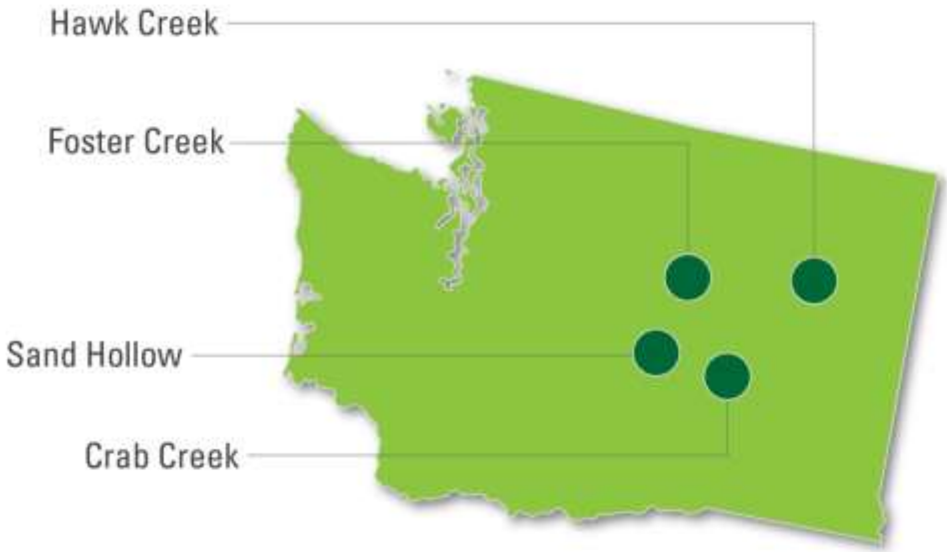


Figure 2 – Site Map for C-3 Studies

Study C-4
In 2010 HDR completed a study on behalf of BPA to help identify various strategies for combing wind integration and pumped storage technologies. This study assessed the operational flexibility of Reclamation's Keys pumped storage project and also did an evaluation of two closed loop projects adjacent to the main stem of the Columbia River – Klickitat PUD's JD Pool site, and the previously mentioned Hawk Creek site upstream of Grand Coulee.

The objective of the report was focused on how pumped storage could be another tool in BPA's toolbox for providing reserves for wind integration and potentially returning flexibility to the FCRPS. Identifying new sites across the BPA footprint was not within the scope of the study.

The report is useful as an educational document on how grids in Europe utilize both conventional hydropower storage and new pumped storage for integrating variable energy resources. The study also demonstrated how much flexibility and system reserves could be provided by Reclamation's Keys pumped storage project for ten months of the year when water supply demands for irrigation did not trump all other project uses.

Additionally, this report provides an assessment of the proposed projects in the U.S. that have been granted and/or filed for a FERC Preliminary Permit Application, as illustrated in Figure 3. This report concludes that one of the most promising sites in the Pacific NW for new, closed loop pumped storage is Klickitat PUD's JD Pool site. This is a high head site with relatively shorter tunnels, has outstanding transmission access, and has water rights available with no new water intake infrastructure required from the main-stem of the Columbia River.

Northwest Pumped Storage Sites and Costs
In addition to the studies reviewed a team of experienced consultants (see resumes, Appendix D) provided a brief review of the projects available in the Pacific Northwest and projected cost information. Figure 3 shows the existing FERC permits for pumped storage projects. A total of 17 of these projects are located within the Northwest service area of Bonneville Power Administration.

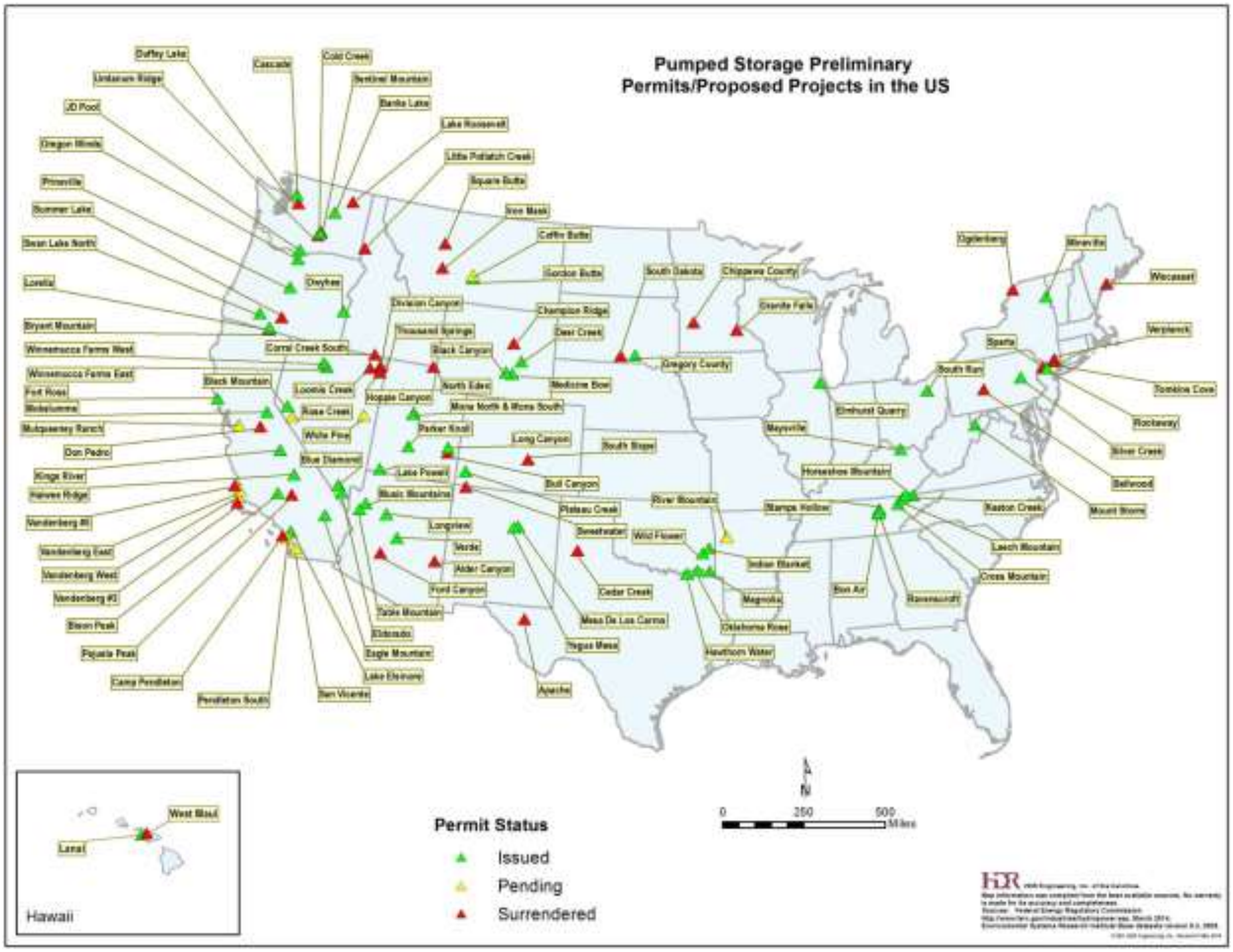


Figure 3 – Preliminary Proposed Pumped Storage Projects as of April, 2014

Because of the timeline for new pumped storage projects, short term measures will be required. Notably, the one and only pumped storage site in the Northwest is the Bureau of Reclamation's John W. Keys III Pump-Generating Plant utilizing Banks Lake at Grand Coulee Dam with an installed pumped storage capacity of 314-MW. There are several pumped storage projects in active development such as Électricité de France Renewable Energy's (EDF-RE) Swan Lake North Pumped Storage Project and Public Utility District No. 1 of Klickitat County, Washington's (KPUD) John Day Pool (JD Pool) Pumped Storage Project (Figure 4).

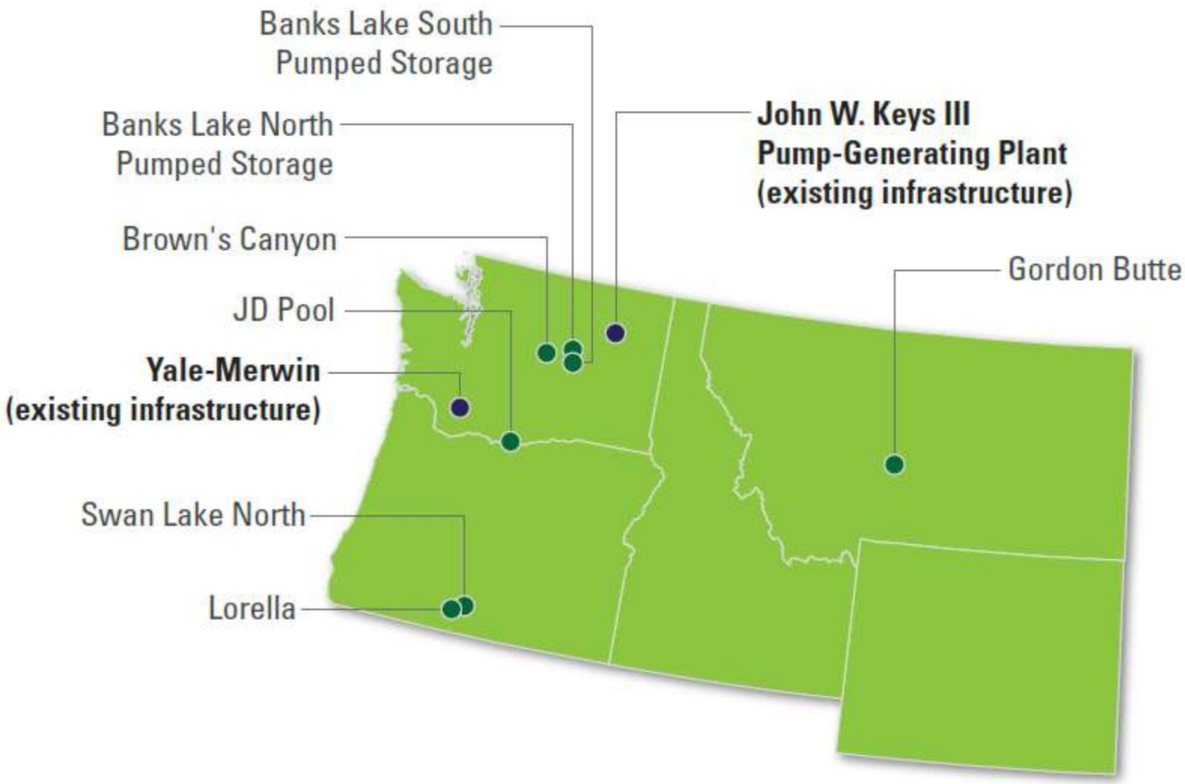


Figure 4 – Map of existing and proposed technically attractive pumped storage projects in the Northwest

Costs

The projected costs for pumped storage range from \$1800/kW to \$3500/kW of installed capacity. This range is driven by

- tunnel lengths,
- the overall head (the higher the head the smaller the machine dimensions and thus lower costs),
- the amount of above ground civil infrastructure required (such as an upper and lower reservoir), and
- variable speed technology for the pump/turbines.

Refining the published costs for new, greenfield pumped storage is not practical at this time since engineering is in the preliminary stage for the Northwest projects.

The potential of new pumped storage in the Pacific Northwest is very different than estimating conventional hydropower. It is not a matter of implementing a typical site on a navigable river or stream where economics are based upon head and flow, but rather what the market needs for grid balancing services and the valuation of those products provided from a pumped storage plant. For example, providing load following (flexible ramping capability) and regulation up and regulation down is not compensated; there is not a revenue stream that can help in the financing of a pumped storage project for that service. But those are precisely the services that a pumped storage project can provide and the need to better integrate variable energy supply.

Protected Areas
It appears that the proposed sites are outside the Council's protected areas designation, which can be affirmed once the coordination between the StreamNet map and the Oak Ridge National Laboratory map can be rectified this fall.

CHAPTER 4

TIDAL AND WAVE ENERGY PROJECTS

Tidal and wave energy technologies are new on the horizon and only a few projects have been developed or planned. The Pacific Northwest is uniquely situated to capture the energy of the Pacific Ocean. Wave energy is more stable than wind energy because wave energy is driven by the gravitational forces and is therefore more predictable. While current projects are more expensive than traditional hydropower, once more experience develops and research and development funds are committed, the wave and tidal technologies should follow a decrease in cost.

Wave energy resources seem best between 30 and 60 degrees latitude and the potential seems to be greater on western coasts. Wave energy along the nation's coastlines is equal to 2,100 terawatt hours each year. Just one quarter of this potential would produce as much energy as the entire U.S. hydropower system. Oregon and Washington have the strongest resource in the lower 48 states.

There are three types of wave energy technologies:

- floats, buoys or other pitching devices to generate electricity, driving hydraulic pumps by using the rise and fall of the ocean's swells;
- oscillating water column (OWC) devices to generate near the shore using the rise and fall of water in a cylindrical shaft; and an
- overtopping device or tapered channel, which may be used either near the shore or offshore.

While these devices do not produce pollutant emissions or greenhouse gases, there is concern for impacts on marine ecosystems and fishery resources. Oregon, for example, has established an ocean floor mapping process with technical support from NOAA's Office of Coast Survey and Oregon State University. Using latest technologies the team completed the mapping in 2012, measuring depth, searching for navigational hazards and recording the natural features of coastal seabeds and fragile aquatic life. The intent is to develop similar mapping for the three Pacific states by 2020. The work will be helpful in modeling wave energy, marine reserves and tsunami modeling.

The following studies appear to be among the most current reports involved the potential for tidal and wave energy resources:

- D-1
  "Assessment of Energy Production Potential from Tidal Streams in the United States"
  Funded by the Wind and Water Program, Office of Energy Efficiency and Renewable Energy,
  U.S. Department of Commerce
  June 29, 2011
  Prepared by Georgia Tech Research Corporation

- D-2
  "Mapping and Assessment of the United States Ocean Wave Energy Resource"
  2011 Technical Report
  Electric Power Research Institute (EPRI)

- D-3
  "Assessment and Mapping of the Riverine Hydrokinetic Resource in the Continental United States"
  2012 Technical Report
  Electric Power Research Institute (EPRI)

No specific projects were identified in any of the studies.

Study D-1

The George Tech Research Corporation created a national database of tidal stream energy potential and a GIS tool usable by industry to support tidal energy technology development. The tidal currents were numerically modeled with the Regional Ocean Modeling System (ROMS) and calibrated with the available measurements of tidal current speed and water level surface.

The states of Oregon and Washington were shown to have among the highest potential with Oregon having the potential of 48 MW in capacity and Washington, 683 MW. The study website provides mapping and other tools for determining project potential.

Study D-2

EPRI identified that there was an estimated 440 TWh/yr (terawatt hours annually) along the West Coast (Washington, Oregon and California) with an estimate of 590 TWh/yr potential estimate on the outer shelf. A terawatt hour is one million megawatt hours or one trillion kilowatt hours.

- Washington 72 TWh/yr Inner Shelf 116 TWh/yr Outer Shelf
- Oregon 143 TWh/yr Inner Shelf 179 TWh/yr Outer Shelf

The project used a 51-month Wavewatch III hindcast database developed by NOAA's National Centers for Environmental Prediction to calculate available wave power density.

Study D-3

EPRI's 2012 technical report details assessment of the hydrokinetic resource in the 48 contiguous states, derived from spatially-explicit data contained in the NHDPlus, a GIS-based database containing river segment-specific information on discharge characteristics and channel slope A total of 72,398 river segments having a mean annual flow greater than 1,000 cubic feet per second (cfs) mean discharge were included in the assessment. River segments with hydroelectric dams were excluded.

The Pacific Northwest was determined to have 296.7 terrawatt hours per year in theoretical power with a technically recoverable power annually of 11 terrawatt hours. The technically recoverable instream hydrokinetic resource can be broadly defined as the amount of power that could be recovered given existing technologies. The Pacific Northwest has 9.2% of the total energy potential. The practically recoverable resource remains an unknown.

While the studies identified net potential resources, no specific projects were identified.

There are projects underway in the Pacific Northwest, however. Snohomish PUD in Washington has identified two projects:

- Admiralty Inlet, east of Port Townsend
  FERC P-12690 for 29.3 to 75.3 average megawatts
  License issued March 2014 for 10-year pilot project

- Deception Pass, North Whidbey Island
  FERC P-12687 for 3 average megawatts

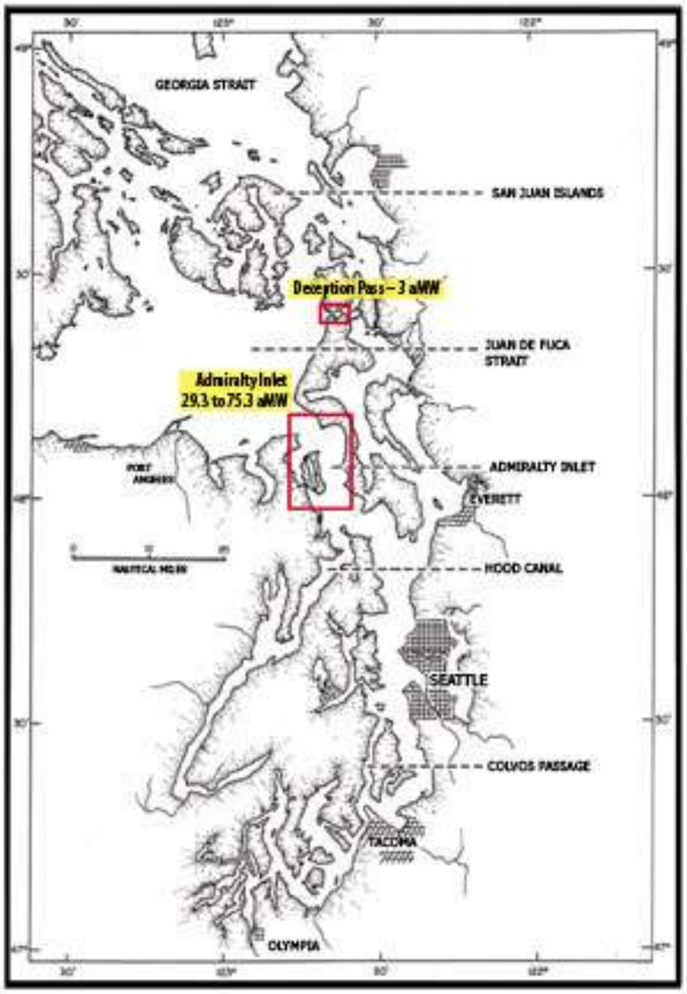


Figure 1

Snohomish PUD recently scrapped its Admiralty project, according to a September 30, 2014, press release. The projected cost had almost doubled from the earlier estimates and further funds for research and development from the U.S. Department of Energy didn't appear to be forthcoming to continue the attempt to develop the project.

A demo project in Oregon is currently underway:

- M3 Wave Company, Salem, Oregon, is testing a new device with a one-fifth scale prototype; a full scale 100-foot device could produce 150 kWs of power. The device was partially funded by U.S. DOE, the Oregon Wave Energy Trust and Oregon BEST.

In May of 2014 Ocean Power Technologies surrendered its 35-year FERC license issued in 2012 for the initial 1.5 MW phase of a planned 50 MW project (FERC 12713) at Reedsport, Oregon, the OPT Wave Park Project. The company is seeking approval to decommission and remove equipment installed in 2013 when installation of the first of 10 Power Buoys were placed.

U.S. DOE has funded the Northwest National Marine Renewable Energy Center (NMERC) as a collaboration of Oregon State University and the University of Washington, to provide device testing. FERC issued an alternative license (FERC 14616) for an up to 20 MW test site for utility scale wave energy conversion devices near Newport, Oregon on the Outer Continental Shelf.

FERC has currently licensed five marine and hydrokinetic projects, for both tidal energy and wave energy technologies. Preliminary permits have been issued for six additional projects.

CHAPTER 5

GENERAL GENERATION PROJECT ASSESSMENTS

In addition to studies developed specific to certain hydropower technologies there have been some broader studies which include varying technologies, generally conventional hydropower technology.

This chapter will review the following studies:

- E-1
  New Stream-reach Development: A Comprehensive Assessment of Hydropower Energy Potential in the United States
  U.S. Department of Energy, Energy Efficiency and Renewable Energy, Wind and Water Power Technologies Office
  April 2014
  Prepared by: Oak Ridge National Laboratories

- E-2
  Assessment of Natural Stream Sites for Hydroelectric Dams in the Pacific Northwest Region
  Idaho National Laboratory
  March 2012

- E-3
  Hydropower Potential and Energy Savings Evaluation – Irrigation Water Providers of Oregon
  Energy Trust of Oregon
  2011
  Prepared by Black Rock Consulting

- E-4
  Small Hydropower Technology and Market Assessment
  Energy Trust of Oregon
  January 2009
  Prepared by Summit Blue Consulting LLC

- E-5
  Assessment of Waterpower Potential and Development Needs
  March 2007
  Electric Power Research Institute (EPRI)

- E-6
  Feasibility Assessment of the Water Energy Resources of the United States for New Low Power and Small Hydro Classes of Hydroelectric Plants
  U.S. Department of Energy, Energy Efficiency and Renewable Energy, Wind and Water Power Technologies Office
  January 2006
  Prepared by Idaho National Laboratory

- E-7
  Estimation of Economic Parameters of U.S. Hydropower Resources
  Idaho National Engineering and Environmental Laboratory
  June 2003

Potential for the Northwest identified from studies:

Study	Project Name	Capacity (MWs)	Generation
E-1	Northwest Projects < 1 MW	15,997.00	96,756,000 MWh
E-1	Northwest Projects > 1 MW	9,228.00	52,244,000 MWh
E-2	Northwest Projects (5,439 sites)	15,021.00	n/a
E-3	Irrigation Projects (30 sites)	20.61	5,823 MWh
E-6	Northwest Projects	n/a	9,969 MWa

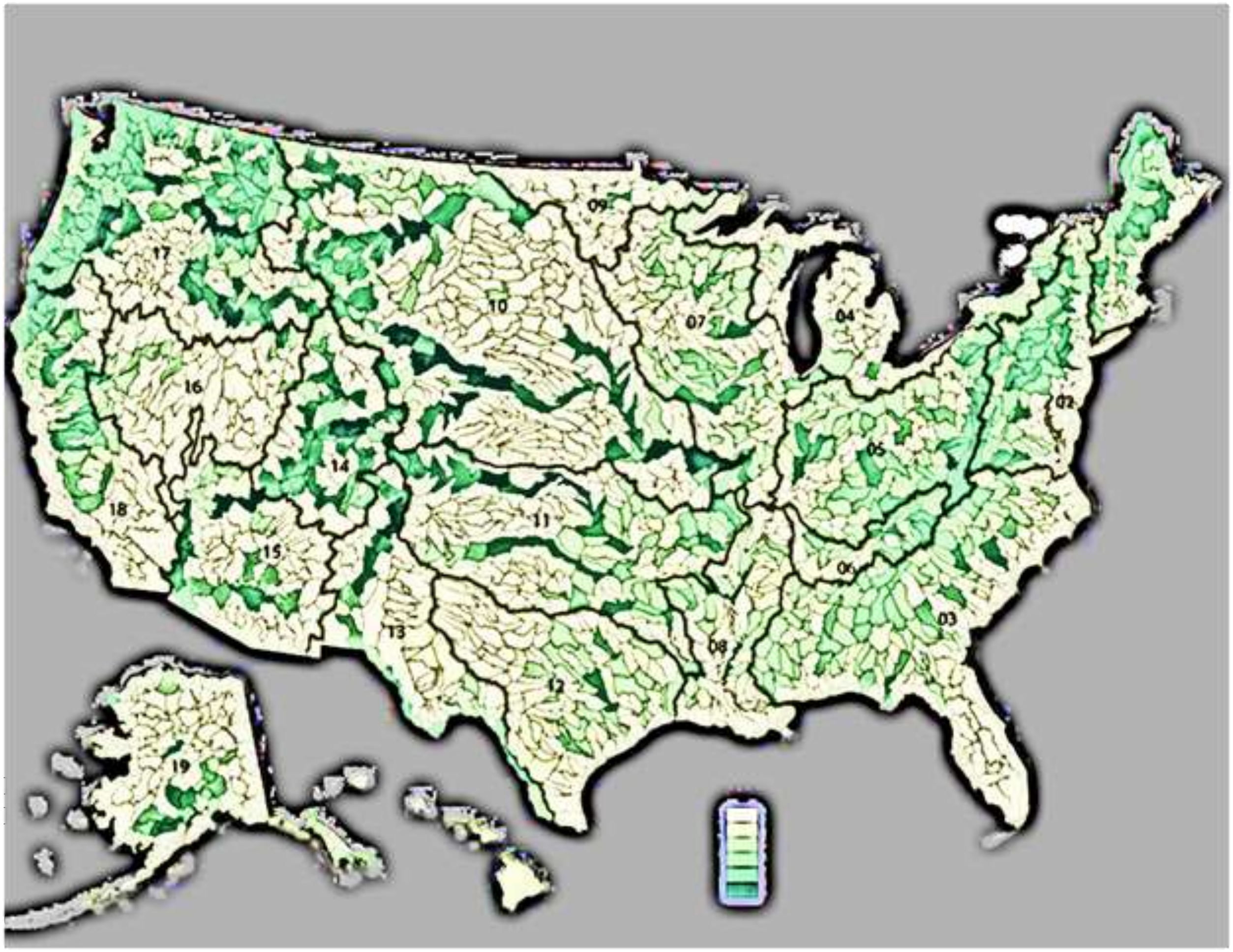
Table 1

Study E-1

This study focuses on new run-of-the-river projects. The projects would likely be run-of-the-river projects as the assessment is based upon stream reaches. A total of 3,793 stream reaches of high energy density (with estimated potential capacity > 1 MW per stream reach) were identified. The highest potential among the 18 national regions is in the Pacific Northwest, Region 17, which has 32% of all future capacity. Within the Pacific Northwest region, the Lower Snake River subregion has the most potential, then the Middle Columbia subregion, with the highest potential found predominantly in the Deschutes River Basin.

Oak Ridge National Laboratory followed the NSD methodology (Hadjerious et al., 2013) to determine the total undeveloped capacity of 25.23 GW (gigawatts) for the Pacific Northwest. This number equates to 76% of the capacity of existing hydropower in the region. In terms of energy, the undeveloped generation is 149.00 TWh/year (terawatt hours annually), which is 118% of energy from existing hydropower projects in the Northwest. A terawatt is one million megawatt hours or one trillion kilowatt hours. NSD stream reaches have higher capacity factors compared with other larger-storage peaking-operation projects in the region that now exist. The capacity figure for the Pacific Northwest was rated at 67%.

Figure 1



Potential new hydropower capacity in the United States (higher-energy-density stream-reaches with >1 MW per reach, aggregated to HUC08 subbasins for illustration).

State	Capacity (MW)	Energy (MWhs/year)
Idaho	7,018	41,015,000
Montana	4,763	28,201,000
Oregon	8,920	53,353,000
Washington	7,381	43,788,000
TOTAL	**28,082**	**166,357,000**

Table 2

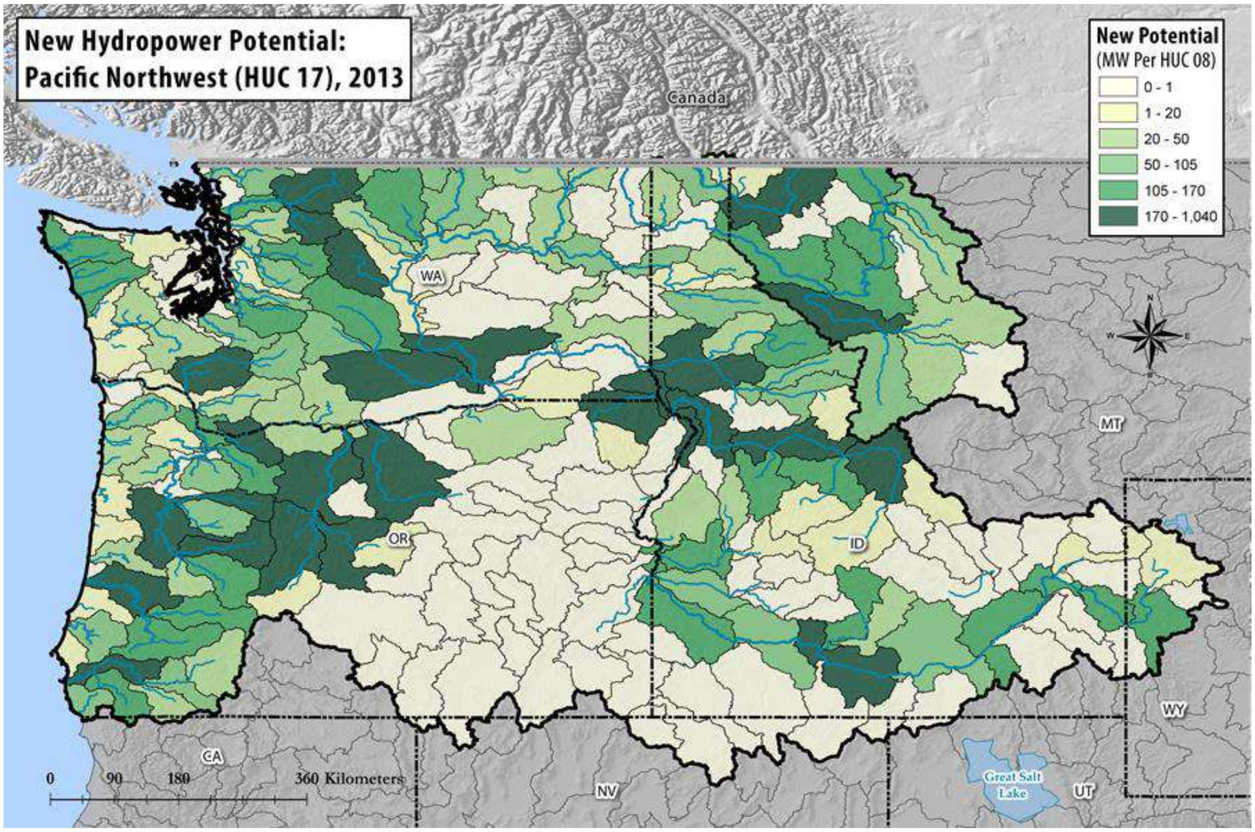
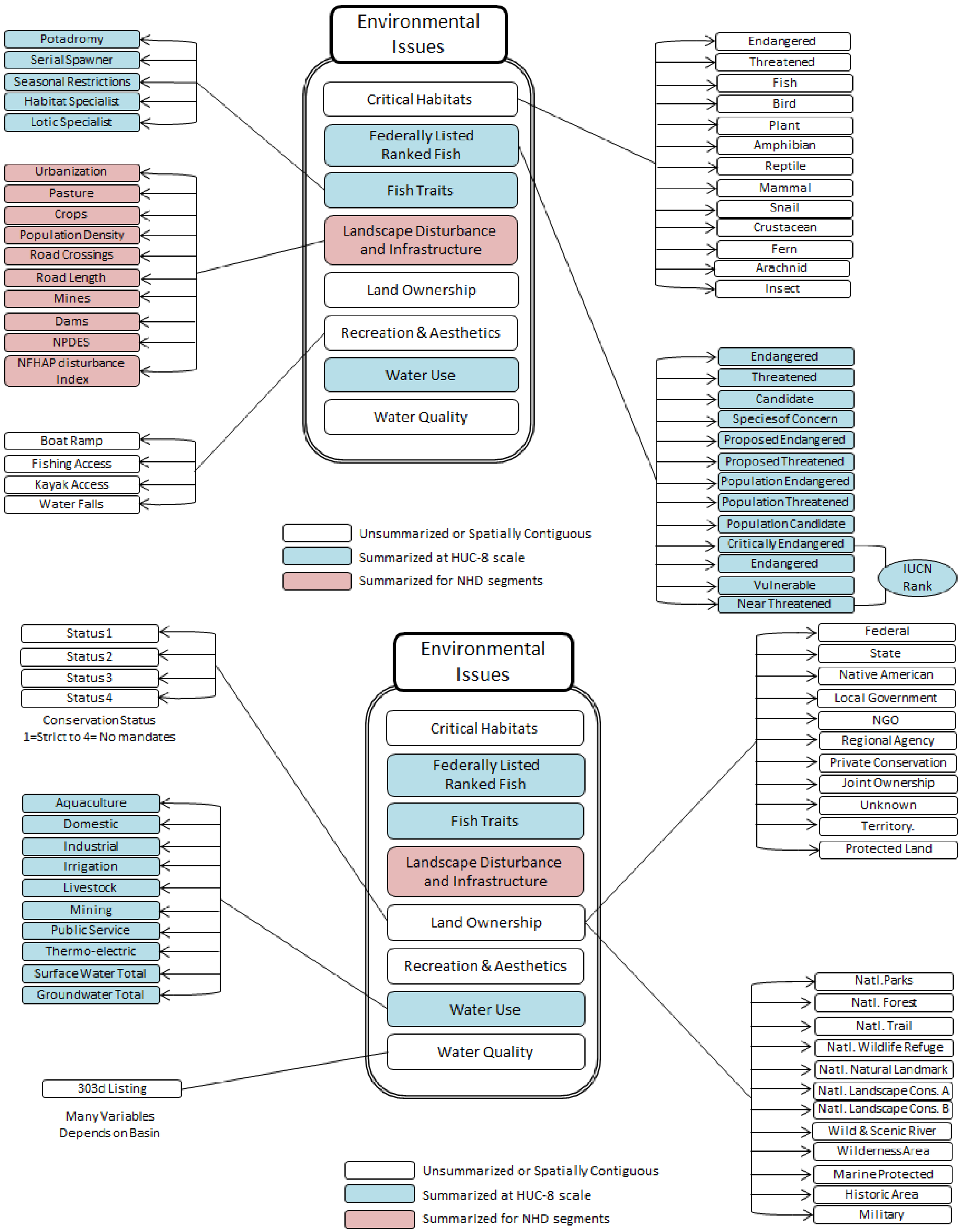


Figure 2: New Hydropower Potential in the Pacific Northwest

The study is designed to accommodate the whole of more than 3 million U.S. streams so it is targeted at a higher reconnaissance level. The methodology considers only the physical characteristics of each stream and landscape and does not consider the economic feasibility of issues arising from environmental impacts, cost or benefits. The methodology allows for the identification of stream reaches using a range of technical, socio-economic and environmental characteristics, but it does not produce estimates of capacity, production, cost or impacts of sufficient accuracy to determine absolute economic feasibility but identifies reaches that have projects that could be review on a more detailed site specific process.

The Northwest region has 70 native fish species; 16 of the species are identified in the study as fully or partially within ESA (Endangered Species Act) designations. Critical habitat for certain protect wildlife species was also considered. In addition, there are over 110 million acres of protected lands in the region or 57% of the total land area, 83% federally owned. Other factors considered were water quality, recreation, Wild and Scenic Rivers, fishing access and water use.

Figure 3: Environmental Constraints



Because the study is based on new run-of-the-river projects, there is going to be considerable concern about which areas fall under the protected area designations identified in the Northwest Power and Conservation Council's (Council) Fish and Wildlife Program as hydropower projects not currently sited at existing diversions require a special exception process review.   NWHA is working with Oak Ridge National Laboratory and the Pacific Marine Salmon Fisheries Commission staff to develop a map that matches the protected area designations to the mapping of the stream reaches in this study to determine the overlap between the protected areas and the reaches. The map is anticipated in November. The map from the study that depicts fishery resources on the identified streams may be helpful in the interim to display protected fishery resources:

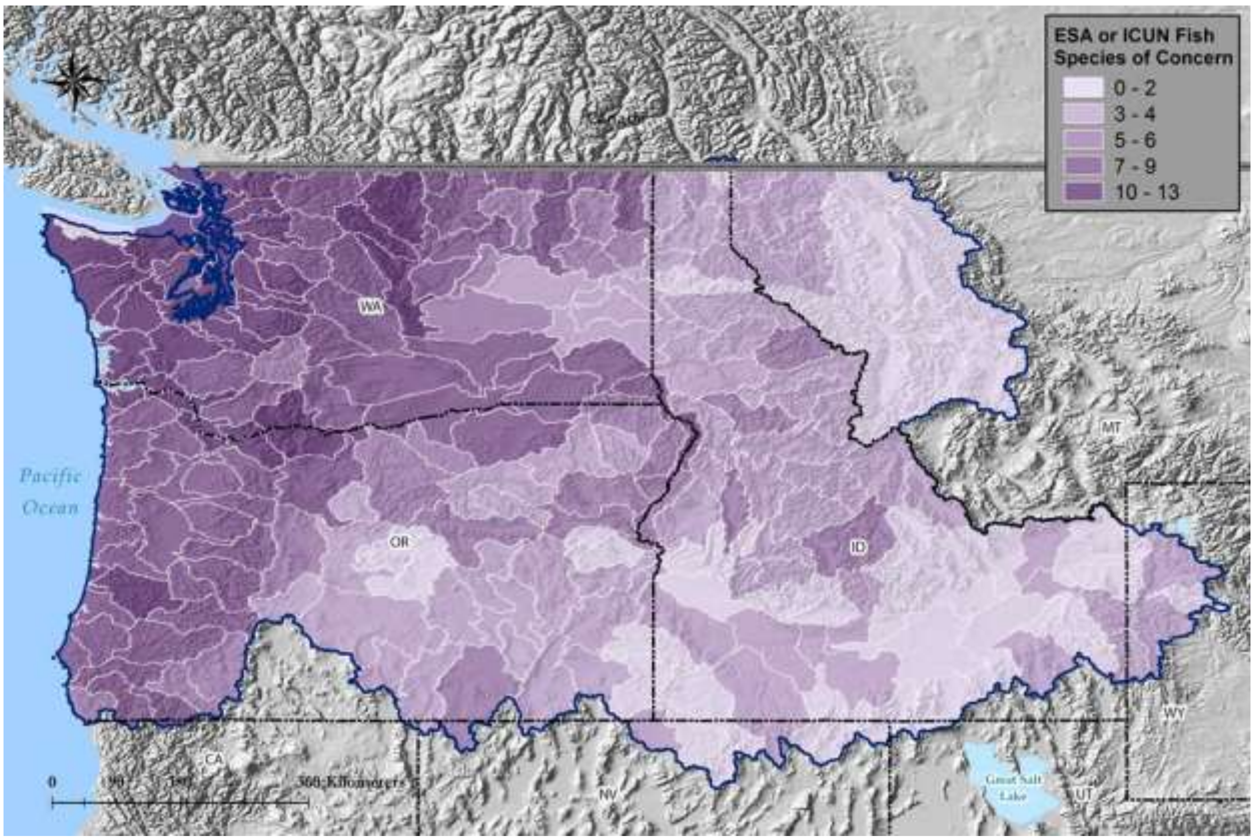


Figure 4: Fish species of concern (number per HUC08 subbasin) in Region 17

Study E-2
This study also defines the Pacific Northwest region as Region 17, similar to study E-1, but in this case Region 17 does not include Montana. The study focused on Region 17 as a pilot project. Each stream reach in the region is considered to be a potential development site where a dam or other structure could be developed to impound water at the downstream end of the reach to capture the entire reach hydraulic head. The focus is on small hydropower projects to eliminate unrealistic project site reaches that were part of a larger river system. For the purposes of this study, a small hydro project is designated as 2 to 60 MWs in capacity and energy potential of less than 1 MWa up to 30 MWa annual power potential.

The Idaho National Laboratory also used the NHD database for this study, as used in study E-1. The study addressed 231,747 regions in the region. Stream reaches with existing dam were excluded from the study (5,032 reaches).

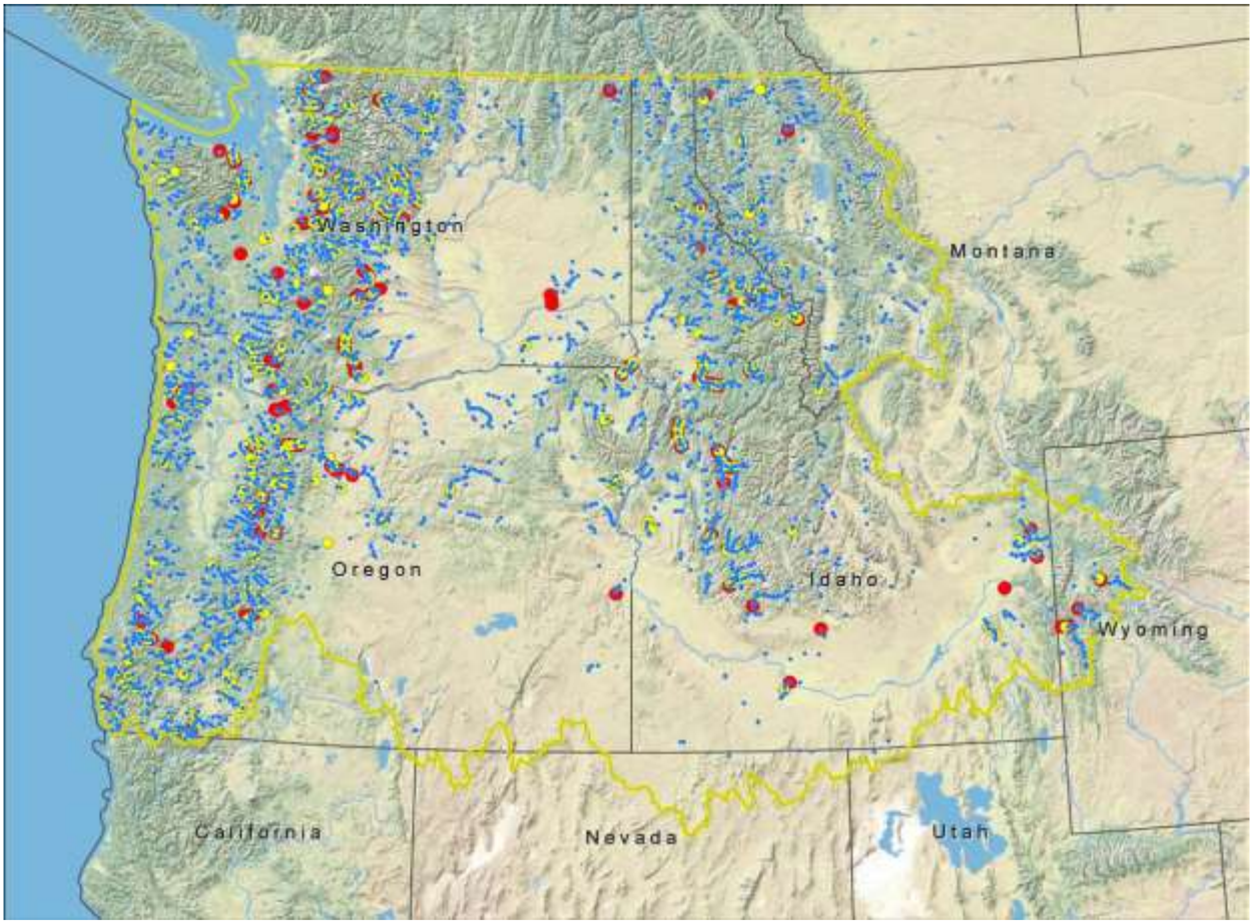


Figure 5: Locations of candidate small hydropower sites in Hydrologic Region 17

Stream reaches identified with potential projects:

Reaches	Number of Reaches	Capacity (MWs)
All reaches	231,747	211,666
Capacity potential less than 1 MW	29,580	185,485
Small hydropower reaches: 2 MW – 60 MW	24,489	73,934
Available small hydropower reaches	15,676	42,835
Candidate reach sites for further assessment	**5,439**	**15,021**

Table 3

The study took into consideration protected lands and some environmental exclusions, but does not list specifics. An earlier study a number of years prior using the same reaches defined reaches that would be excluded from development and removed them from the total defined.

For the 24,489 sites considered "small hydro", the following exclusions were made to arrive at that number of reaches with sites from the total reaches, leaving 64% of the sites as potential for development, or 15,676 sites:

- Existing dams .4 %
- Federal exclusions 29.0 %
- Environmental exclusions 7.0 %

Study E-3

The 2010 study reviewed potential sites within Oregon's irrigation districts and considered both sites at existing dams as well as in conduits and canals. Only a subset, 14 of the 45 Oregon irrigation districts, could be included in the study as other feasibility studies were in progress with Energy Trust. A 2008 assessment (see study E-5) identified the irrigation districts as one of the state's largest resources for development of untapped hydropower potential.

Analysis involved reviewing the water rights of 108 irrigation water suppliers (districts, ditch companies, and other forms of agricultural water delivery entities) and then providing a self-survey to 29 suppliers representing 30 different sites.

Costs included current prices for piping open canals to create pressurized conduits, interconnection costs, generation equipment design and permitting, and powerhouse construction. No mitigation costs were included unless a fishscreen was not already in place and needed to be provided as required by Oregon law. Energy prices were based on revenue for standard power sales agreements as established by rule of the Oregon Public Utility Commission.

The identified projects are exempt from the Protected Areas designation of the Council because all of these projects are at or beyond existing diversions. Oregon irrigation districts may use their existing water right for irrigation to also provide energy as a secondary use, so long as the water right is not enlarged, defined as using the right used beyond the existing term or season of use, or expansion in the quantity or delivery rate. A streamlined process through the Oregon Water Resources Department is available to establish hydropower as a secondary use for conduit or exempt projects approved by FERC. One of the constraints discovered in the review of these irrigation district projects was inconsistency in land use siting from one county to another. In some counties the conduit exemptions were an outright use; in others a conditional use permit was required; and in some a zone change was required.

Total Capacity from the 30 Sites:

20.63 MW Capacity 5,852 MWh Annually*

*These are season projects that generally operate 6 months a year, during irrigation season.

Study E-4
The scope of work involved reviewing Oregon's water rights to determine the location of the larger water rights used by water delivery entities to assess potential hydropower by reuse of the same water right for energy purposes. The Oregon Water Resources Department WRIS (Water Rights Information System) was used for the analysis. The water right locations, for the purpose of the study, had to be located within an Oregon investor-owned utility (IOU) service area: Portland General Electric or PacifiCorp's systems. If funds from Energy Trust of Oregon (ETO) were to be used for future feasibility sites of projects, the projects would have to be in the IOU systems as under state law the IOUs fund ETO.

The analysis found the following number of water rights of 5,000 acre feet or more in the two IOU service areas with a priority date of 1980 or older:

Type of Water Right	PacifiCorp	PGE
Surface Water	44	20
Groundwater	4	2
Stored Water	7	1
Total	**55**	**23**

Table 4

The study addressed capital costs, operations and maintenance, incentives and other costs and benefits on a general basis, but not by project. In addition to reviewing water rights to determine generation potential, the study consultant addressed federal and state requirements and environmental constraints.

A survey was sent to the holders of the 78 water rights detailed in the chart above. An appendix in the study lists the water right holders subject to the referenced numbers. No calculations were made as to project capacity or energy potential.

Study E-5
EPRI's (Electric Power Research Institute) study of 2006 estimated 23,000 MW capacity could be added to the generation system by the year 2025: 2,700 from new small hydro projects of less than 30 MW each; 2300 MW capacity additions to existing plants; 5,000 new MW at existing non-powered dams; 10,000 MW from ocean energy technologies; and 3,000 MW from hydrokinetic technologies. The overall resource potential was estimated to be 85,000 to 95,000 MW.

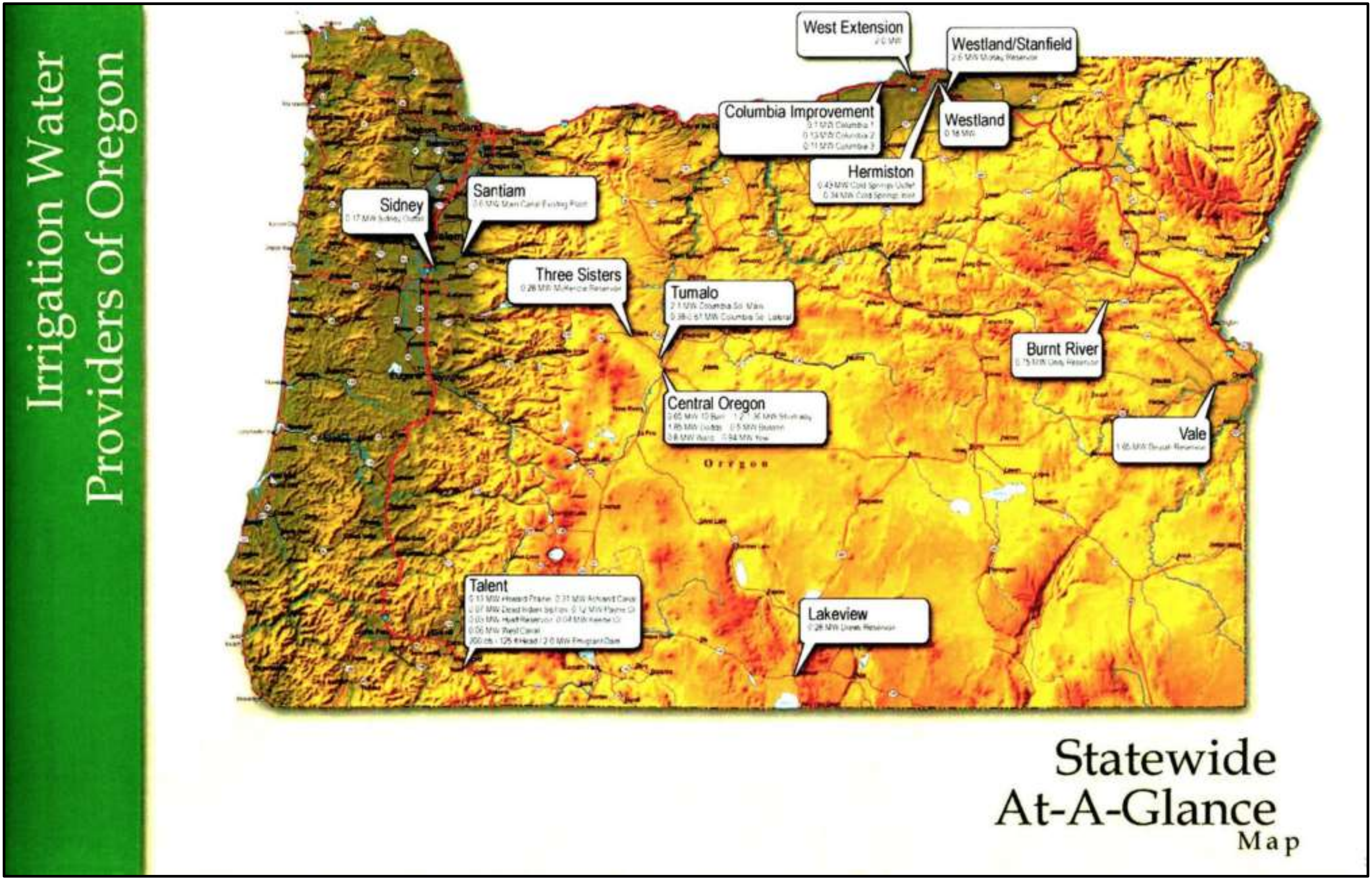
The numbers identified were derived from the evaluation of existing studies and documents. A survey of generation providers also provided information. EPRI reported that to accomplish the potential suggested, there would need to be an investment of $377 million through 2015 for research and development in hydropower technology and an extension of the federal Production Tax Credit (PTC) and Clean Renewable Energy Bond (CREB) programs. Additionally, regulatory revisions to streamline and expedite permitting would be required. The report provides a thorough discussion of the available incentives.

There are no regional figures presented and no specific projects addressed in this study.

Irrigation Water Providers of Oregon

Site	Location	Utility	Net Head (ft)	Avg. Flow Rate (cfs)	Peak Power (MW)	Annual Power (MWh)	Conceptual Cost
Western Oregon							
Sidney Irrigation District							
Sidney	Jefferson	Pacificorp	30	70	0.17	575	
Santiam Water Control District							
Santiam	Stayton	Pacificorp	10	780	0.60	Pending	
Southern Oregon							
Lakeview Water Users, Inc.							
Drews Reservoir	Lakeview	Surprise Valley Electric Coop	46-27	75	0.28	850	
Talent Irrigation District							
Howard Prairie Outlet Works	Talent	Pacificorp	40	23-52	0.13	732	
Ashland Canal	Talent	Pacificorp	130	15. 40	0.31	1.752	
Dead Indian Siphon	Talent	Pacificorp	118	10	0.07	304	
Payne Creek	Talent	Pacificorp	100	20	0.12	521	
Hyatt Reservoir Outlet Works	Talent	Pacificorp	30	3-19	0.03	122	
Keene Creek Reservoir	Talent	Pacificorp	14	28-50	0.04	139	
West Canal	Talent	Pacificorp	245	4	0.06	255	
Emigrant Dam	Talent	Pacificorp	125	200	2.0	6.318	
Central Oregon							
Central Oregon Irrigation District							
Ward	Redmond	Central Oregon Coop/Pacificorp	25	330	0.80	2.480	
Brinson	Redmond	Pacificorp	17	370	0.50	2.000	
10 Barr	Redmond	Central Oregon Coop	27	260	0.65	2.100	
Dodds	Redmond	Central Oregon Coop	79	245	1.85	5.800	
Shumway	Redmond	Central Oregon Coop	79-89	150	1.20-1.36	3.650-4.000	
Yew	Redmond	Pacificorp	45	190	0.94	2.600	
Three Sisters Irrigation District							
McKenzie	Sisters/Redmond	Central Oregon Coop	96	30	0.28	907	
Tumalo Irrigation District							
Columbia Southern Main	Bend	Central Oregon Coop	1.005	30	2.10	9,040	
Columbia Southern Lateral	Bend	Central Oregon Coop	68-111	65	0.38-0.61	1.325-2.160	
Northeast Oregon							
Columbia Improvement District							
Columbia 1	Boardman	Umatilla Electric Coop	5	180	0.10	260	
Columbia 2	Boardman	Umatilla Electric Coop	9.5	115	0.13	320	
Columbia 3	Boardman	Umatilla Electric Coop	15	64	0.11	280	
West Extension Irrigation District							
West Extension	Irrigon	Pacificorp	95	250	2.00	4.000	
Westland Irrigation District							
Westland	Hermiston	Umatilla Electric Coop	44	45	0.18	590	
Hermiston Irrigation District							
Cold Springs Outlet	Hermiston	Umatilla Electric Coop	42-4	129	0.43	1,010	
Cold Springs Inlet	Hermiston	Umatilla Electric Coop	33-2	174	0.34	360	
Westland/Stanfield Irrigation Districts							
McKay Reservoir	Hermiston/Stanfield	Pacificorp	130-40	150	2.6	4.500	
Eastern Oregon							
Burnt River Irrigation District							
Unity Reservoir	Hereford	Idaho Power	48-18	78	0.75	1.170	
Vale Oregon Irrigation District							
Beulah Reservoir	Vale	Idaho Power	60-18	310	1.65	3.688	

Statewide
At-A-Glance
Data


Irrigation Water
Providers of Oregon
West Extension
Westland/Stanfield
Columbia Improvement
Westland
Hermiston
Santiam
Sidney
Three Sisters
Tumalo
Burnt River
Central Oregon
Vale
Oregon
Talent
Lakeview
Statewide
At-A-Glance
Map

Study E-6
The U.S. Department of Energy study of 2006 updates an earlier study by the Idaho National Laboratory in 2004, using previously identified sites. The earlier study addressed every natural stream reach in the U.S. This study applies feasibility criteria to those earlier sites: site accessibility, load or transmission proximity, land use and environmental sensitivities. A development model, not using a dam, was applied to the stream reaches. It was assumed that either a low power (less than 1 MW) or a small hydro (1 MW to 30 MW) project would be installed at the site, whichever was less. The working flow was restricted to half the streamflow rate or sufficient flow to produce 30 MWa, whichever was less.

As a result there were over 500,000 sites with a collective gross power potential of about 300,000 MWa. In further addressing feasibility criteria, the number of sites was reduced to 130,000 with about 100,000 MWa energy potential. When the development model was used with a limited penstock length, the energy potential was reduced to 30,000 MWa. This number equates to the total existing electrical energy load supplied by existing hydropower plants. A further reduction, after all criteria was applied, reduced the total sites to 5,400 with an energy output of 18,000 MWa, a greater than 50% increase in the existing hydropower fleet. Additional requirements included having a site within one mile of a road and within one mile of transmission access.

The four Northwest states, along with California and Alaska, had the most identified sites. The Pacific Northwest is identified as Region 17 in the study. The Pacific Northwest potential was broken down by states:

STATE	**ENERGY: MWa**
Idaho	2,122
Montana	2,669
Oregon	2,072
Washington	3,106
Total	**9,969**

Table 5

Study E-7
The June 2003 study by Idaho National Laboratory does not define project sites, but instead provides estimating tools. Due to the age of the study and updates that have more recently occurred, the costs provided may no longer be relevant. At that time one-half of the proposed 43,036 MW of capacity were identified as being able to be developed for $1,600 per kW@ or less. Developing power at non-powered dams was identified at $1,200 per kW and $700 per kW, depending on the size capacity.

CHAPTER 6

TOOLS FOR ASSESSING HYDROPOWER POTENTIAL

There are a number of tools that have been developed to apply to potential hydropower projects to determine feasibility.

- F-1
  Northwest Subbasin Databrowser
  Developed by GIS Support Division and Environment, Fish and Wildlife Group,
  Bonneville Power Administration
  2014

- F-2
  National Inventory of Dams
  Maintained by the U.S. Army Corps
  May 2013 Update

- F-3
  Hydropower Energy and Economic Analysis Tool
  U.S. Bureau of Reclamation
  2014

- F-4
  Virtual Hydropower Prospector
  Idaho National Laboratory
  2011

- F-5
  Tidal Stream Interactive Map
  Georgia Tech Institute
  June 2011

- F-6
  National Hydropower Asset Assessment Program
  Oak Ridge National Laboratory

Tool F-1
The new model of the Subbasin Data Browser provides access to environmental information for hydroelectric project sites in correlation with the Pacific Northwest Hydropower Database and Analysis System. A map viewer and data sets in a customizable environment allow users or user groups to create and share content as well. Data sets unique to the northwest, such as the protected areas map of the Northwest Power and Conservation Council's Fish and Wildlife Plan, are included in the components that can be addressed in ArcGIS format.

Tool F-2
The 2013 National Inventory of Dams database was collected from state and federal agencies that regulate dams in the United States. It provides maps and charts the majority of regulated dams and rates the facilities by degree of risk or hazard.

Example: Oregon dams

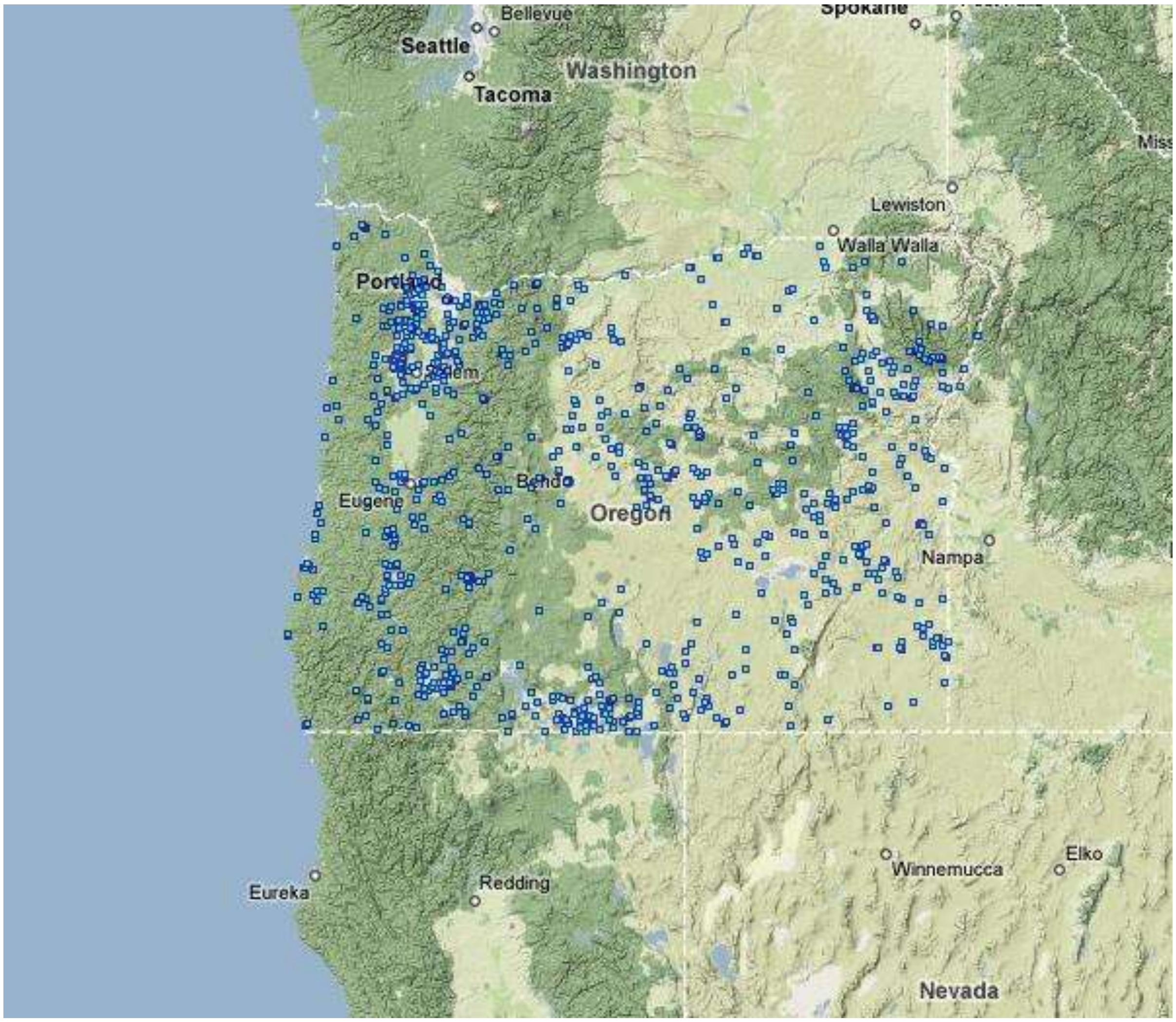


Figure 1

Tool F-3
The Hydropower Energy and Economic Analysis Tool is part of the recent studies conducted by Reclamation (Studies A-3 and B-5). This tool is a model that allows interested parties to conduct reconnaissance level hydropower assessments with minimal data inputs (location, flow and head). Then the Excel spreadsheet allows choices of equipment and other input to arrive at projected monthly production and it allows factoring in green incentives and other parameters.

Bureau of Reclamation - Hydropower Assessment Tool - Version 2.0

Date of Analysis		
Facility Name		
Agency		
Analysis Performed by		
Project Location (State):*		

***If Other is selected for project location- state-specific information must be input in "Other State" Tab**

Latitude		
Longitude		
Data Set		yrs
Max Head		ft
Min Head		ft
Max Flow		cfs
Min Flow		cfs

Data Analysis:

Turbine Selection Input/Analysis:

Turbine Design Head		ft
Turbine Maximum Flow		cfs
Turbine Type		
Generator Speed		rpm
Max Generating Head Limit		ft
Min Generating Head Limit		ft
Max Generating Flow Limit		cfs
Min Generating Flow Limit		cfs

indicates the default/model recommended value; Value can be overridden by user

Powerplant Cost Estimate Input:

Transmission Voltage		kV
T-Line Length		miles
Fish and Wildlife Mitigation		
Recreation Mitigation		
Historical & Archaeological		
Water Quality Monitoring		
Fish Passage Required		

Figure 2

Tool F-4
The Virtual Hydropower Prospector is a geographic information system (GIS) tool designed to assist a user in locating and assessing natural stream water energy resources nationally. Pop ups shows the locations of potential projects determined using a set of feasibility criteria. Features such as roads, power infrastructure, land use, cities, etc., are visible to the user in a series of layers. This is a preliminary assessment tool that will define a level of feasibility, but actual field review of the site would be required to complete necessary feasibility information.

The methods used for this tool are described in “Water Energy Resources of the United States with Emphasis on Low Head/Low Power Resources” as produced by the U.S. Department of Energy, April 2004. Methods to determine power potential originates from “Feasibility Assessment of the Water Resources of the United States for Low Power and Small Hydroelectric Plants” as developed by the U.S. Department of Energy, January 2006 (Study E-6). Resource assessment data from the “Hydropower Resource Assessment at Existing Reclamation Facilities”, March 2011 (Study A-3) was also used in development of the tool. The interactive maps link to various resource data. There are query tools to select specific features.

Tool F-5
The Tidal Stream Interactive Map system, developed by Georgia Tech Institute, is a companion to the study developed by Georgia Tech (Study D-1). The user can look at a series of data layers, such as mean current speed, mean kinetic power density and water depth as well as geographic mapping. Data can be selected and exported.

Tool F-6
The NHAAP GIS team at Oak Ridge National Laboratory (ORNL) developed this interactive mapping site to work from a database of studies produced by ORNL and others. A navigation system provides access to data and map products for:

- existing hydropower assets,
- non-powered dams,
- new stream-reach development,
- environmental attribution,
- ecological research,
- stream classification.


U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy
THE NATIONAL HYDROPOWER MAP
Drainage Characteristics
Hydropower Assets
OAK RIDGE

Figure 3

CHAPTER 7

LEGISLATIVE AND REGULATORY ENVIRONMENT

CONGRESSIONAL LEGISLATION

Major Congressional legislation and federal rulemaking will have an impact on the ability to move forward with hydropower projects in the near term. Two pieces of significant legislation were enacted by the U.S. Congress in 2013 that provided streamlining of hydropower applications.

Hydropower Regulatory Efficiency Act of 2013

Public Law 113-23 (H.R. 267) was enacted August 9, 2013
House vote 422-0; Senate unanimous consent
http://www.gpo.gov/fdsys/pkg/PLAW-113publ23/pdf/PLAW-113publ23.pdf

Findings - *Section 2*: Congress finds that the hydropower industry currently employs approximately 300,00 workers across the United States; hydropower is the largest source of clean, renewable electricity in the United States; as of the date of enactment of this Act, hydropower resources, including pumped storage facilities, provide nearly 7% of the electricity generated in the United States; and approximately 100,000 megawatts of electric capacity in the United States; only 3% of the 80,000 dams in the United States generate electricity, so there is a substantial potential for adding hydropower generation to non-powered dams; and according to one study, by utilizing currently untapped resources, the United States could add approximately 60,00 megawatts of new hydropower capacity by 2025, which could create 700,000 new jobs over the next 13 years.

Components of the legislation

Exemption Capacity – Section 3

Section 3 of the Act amended section 405 of the PURPA (Public Utility Regulatory Policies Act of 1978) by increasing the maximum capacity of a project exempt from the full licensing process described under the Federal Power Act, as regulated by FERC, from 5 MW to 10 MW. An exemption is still regulated by the Federal Energy Regulatory Commission (FERC), even though not licensed, but the process is less onerous. A project would qualify for an exemption if it is at an existing diversion.

Conduit Exemption – Section 4

This section provides that conduit hydropower facilities with an installed capacity not exceeding 5 MW which meets other qualifying criteria set by FERC are not required to be licensed under the Federal Power Act. However, a "notice of intent" must be filed with FERC to determine if the project meets the qualifying criteria. If the facility does meet the criteria, FERC will make an initial determination within 15 days of the notice and then issue a public notice period for 45 days. A letter approving the facility will then be provided unless FERC receives comments contesting the action. Conduit projects have been moving through the process in 60-75 days, generally with no contesting comments. There is a template for the notice of intent posted on FERC's website.

Section 4 also increases the maximum installed capacity from 15 MW to 40 MW for a privately developed hydropower facility that qualifies for a conduit exemption. Previously the 40 MW capacity only applied to municipal projects.

A qualifying conduit hydropower facility must meet the following provisions:

1) A conduit is any tunnel, canal pipeline, aqueduct, flume, ditch or similar manmade water conveyance that is operated for the distribution of water for agricultural, municipal, or industrial consumption, and is not primarily for the generation of electricity.

2) The facility generates electric power using only the hydroelectric potential of a non-federally owned conduit.*

3) The facility has an installed capacity that does not exceed 5 megawatts (5 MW).

4) The facility was not licensed or exempted from the licensing requirements of Part I of the Federal Power Act on or before August 9, 2013.

*If it is a federally owned conduit, then the Bureau of Reclamation would oversee the process through The LOPP process (Lease of Power Privilege).

Figure 1: conduit project under construction

<u>Extension of Preliminary Permit</u> – Section 5

FERC is granted the authority to extend preliminary permits for up to 2 additional years beyond the 3 years previously allowed under Section 5 of the Federal Power Act to study a project before applying for the final license. Any permittee wishing to extend the preliminary permit term must file an application with FERC at least 30 days prior to the expiration date of the permit specifying the term of extension and how reasonable diligence has been carried out to meet the activities required under the permit.

Two-year Licensing Process – Section 6
Section 6 requires FERC to investigate the feasibility of a 2-year licensing process for hydropower development at non-powered dams and closed-loop pumped storage projects.

On August 5, 2014 FERC approved a pilot project to test the two-year licensing process, Free Flow Power's Project 92 proposed 5 MW project located at the Kentucky River Authority's existing Lock & Dam No. 11 on the Kentucky River.

Legislative Background
It is instructive to look at the Congressional votes for the streamlining legislation in this Act as passage was near unanimous prior to the President's signature. A coalition of interests, from federal agencies to hydropower developers and environmental organizations, such as America Rivers, supported the final legislation as enacted.

Bureau of Reclamation Small Conduit Hydropower Development and Rural Jobs Act
Public Law 113-24 (H.R. 678) was enacted August 9, 2013
House vote 416-7; Senate unanimous consent
http://www.gpo.gov/fdsys/pkg/PLAW-113publ24/pdf/PLAW-113publ24.pdf

Overview
The legislation amends the Reclamation Project Act of 1939 [43 U.S.C. 485h(c)] by

- authorizing lease of power privileges in addition to and alternative to any authority in existing laws related to particular projects, including small conduit hydropower development; and
- first offering the lease of power privilege to an irrigation district or water users association operating the applicable transferred conduit, or to the irrigation district or water users association receiving water from the applicable reserved conduit; and
- using Reclamation's categorical exclusion process under the National Environmental Policy Act (NEPA) to small conduit hydropower development, excluding siting of associated transmission facilities on Federal lands.

The Secretary of the Department of Interior will determine a reasonable time frame for the irrigation district or water users association to accept or reject a lease of power privilege offer for a small conduit hydropower project and if the entity does not elect to pursue the offer, the Secretary shall offer the lease of power privilege to other parties.

For the purposes of this Act, "small conduit hydropower" means a facility capable of producing 5 MW or less of electric capacity.

The Power Resources Office of Reclamation shall be the lead office of small conduit hydropower policy and procedure-setting activities under this Act.

If an application was already provided to FERC prior to this Act, then it stands.

Lease of Power Privilege

A Lease of Power Privilege agreement is a contractual right given to a non-federal entity used when Reclamation chooses to lease its right to develop hydropower at one of its facilities if that development does not interfere with other authorized project purposes. To implement Public Law 113-24, Reclamation revised its policy on the Lease of Power Privilege process that allows private developers, irrigation districts and others to implement projects on Reclamation facilities. A temporary process has been established (see: http://www.usbr.gov/recman/temporary_releases/factrmr-61.pdf) while the Reclamation manual is being updated, due to be completed in February 2015.

CURRENT RULEMAKING

EPA RULE III(d)

On June 2, 2014, the U.S. Environmental Protection Agency, under President Obama's "Climate Action Plan", proposed a plan to cut carbon pollution from existing power plants. See the proposed rules at https://www.federalregister.gov/articles/2014/06/18/2014-13726/carbon-pollution-emission-guidelines-for-existing-stationary-sources-electric-utility-generating (RIN 2060-AR 33). Public listening sessions were held nationwide at 11 sessions, including a session in Seattle in the Pacific Northwest region. The comment period has been extended to December 1, 2014 and a final rule is anticipated in June 2015.

The proposal sets $C0_2$ standards for each state to be met by 2030 based on lowering carbon emissions by 30% below 2005 levels by 2030. The formula proposed for the state goals is the rate of C02 emissions from fossil fuel-powered plants in pounds divided by state electricity generation from fossil-fuel powered plants and certain low- or zero-emitting power sources in megawatt hours (MWh). Each state must come up with a plan to meet the standard or form regional groups to do so. EPA is encouraging regional solutions as power plants are part of a large and complex interstate system. The state plans are due in June of 2016 with the potential of extensions available through June of 2018. The goal for the Pacific Northwest is about 60% reduction over all.

Table 1: Proposed EPA Targets for Existing Power Plants

State	2012 Emissions (lbs/MWh)	2030 Emissions (lbs/MWh)	Percent Reduction
Idaho	339	228	33%
Montana	2,246	1,771	21%
Oregon	717	372	48%
Washington	756	215	72%
Total	4,058	2,586	

Northwest electricity generation has half the carbon emissions as the rest of the nation, due to the region's massive hydroelectric system[1]. While states like Washington and Oregon have some of the lowest emission rates in the country due to large hydroelectric resources, they have some of the steepest emission reductions by percentage under EPA's proposal. Washington, for example, would be required to have a 72% decrease in emissions.

A number of factors and assumptions in the rules appear to drive some inequity in hydro rich states. For example, the base year for determining pollution decreases in the proposed rule is 2012. That was a year when the Pacific Northwest had an abundance of hydropower and displaced much of its generation from thermal facilities, giving the Northwest a very low carbon emission level of record. Discussions have centered on providing an alternative of a range of years to account for the differences among dry and wet years to provide more equity.

The Northwest is unique in that the four states already participate in regional planning as the result of the federal Pacific Northwest Electric Power Planning and Conservation Act of 1980, administered by the Northwest Power and Conservation Council representing the four states. Hydropower represents 60% of the power generation mix in the Northwest[2] as compared to about 21% in the rest of the U.S. A number of programs are already reducing carbon emissions in the Northwest, including energy efficiency programs, retirement of coal plants, and the adoption of states' renewable portfolio standards and other state incentives.

The impact on the Northwest from the proposed rule is somewhat unclear at this time. The proposed rule could change significantly following the receipt of comments and revisions made by EPA. One of the largest concerns is that no credit for all of the region's prior actions to reduce emissions is taken into consideration in setting the goal.

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[1] EIA (U.S. Energy Information Administration) Egrid data, 2009-2013 average.
[2] ibid

REGIONAL HYDROPOWER POTENTIAL SCOPING STUDY

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Appendix A: PACIFIC NORTHWEST HYDROPOWER POTENTIAL SCOPING STUDY - LIST OF STUDIES

STUDIES AND ASSESSMENTS

	PROJECTS AT EXISTING UNPOWERED DAMS	Author	Prepared For	Date	Link	National	PNW Region
A-1	Hydropower Resource Assessment at Non-Powered USACE Sites	Hydropower Analysis Center	US ACE	July 2013	http://www.hydro.org/wp-content/uploads/2014/01/Army-Corps-NPD-Assessment.pdf	X	X
A-2	An Assessment of Energy Potential at Non-Powered Dams in the United States	Oak Ridge National Lab	U.S. Department of Energy	April 2012	http://www1.eere.energy.gov/water/pdfs/npd_report.pdf	X	X
A-3	Hydropower Resource Assessment at Existing Reclamation Facilities	Power Resources Office	Bureau of Reclamation	March 2011	http://www.usbr.gov/power/AssessmentReport/USBRHydroAssessmentFinalReportMarch2011.pdf	X	X

	CONDUIT AND KINETIC PROJECTS	Author	Prepared For	Date	Link	National	PNW Region
B-1	Technical & Economic Feasibility Assessment of Small Hydropower Development in Deschutes River Basin	Oak Ridge National Lab	U.S. Department of Energy	February 2013	http://info.ornl.gov/sites/publications/files/Pub44168.pdf		X
B-2	Integrated Basin-Scale Opportunity Assessment Initiative, FY 2011 Year-End Report: Deschutes Basin Preliminary Hydropower Opportunity Assessment	Pacific NW Laboratory	U.S. Department of Energy	September 2011	http://basin.pnnl.gov/Content/reports/BasinScaleFinalReport2011_PNNL-20802.pdf		X
B-3	Feasibility Study on Five Potential Hydroelectric Power Generation Locations, North Unit Irrigation District	Black Rock Consulting	North Unit Irrigation District	August 2009	http://www.oregon.gov/energy/renew/docs/creff/northunitirrigationdistrict.pdf		X
B-4	Power Extraction from Irrigation Laterals and Canals in the Columbia Basin Project	University of Washington	Grant County PUD	January 2009	http://depts.washington.edu/nnmrec/docs/20090115_TheilmannJ_thesis_Irrigation.pdf		X
B-5	Site Inventory and Hydropower Energy Assessment of Reclamation Owned Conduits	Power Resources Office	Bureau of Reclamation	March 2012	http://www.usbr.gov/power/canalreport/finalreportMarch2012.pdf	X	X
B-6	Bureau of Reclamation Renewable Energy Update	Bureau of Reclamation	Department of the Interior	July 2014	http://www.usbr.gov/power/FY%202014%20Q1%20Renewable%20Update.pdf	X	X
B-7	Scoping Study of Hydropower Potential in Wallowa County, Oregon	Renewable Energy Solutions, LLC	Energy Trust of Oregon	November 2010	http://energytrust.org/library/reports/101120_Wallowa_Mapping2.pdf		X

	PUMPED STORAGE/ENERGY STORAGE PROJECTS	Author	Prepared For	Date	Link	National	PNW Region
C-1	Assessment of Opportunities for New US Pumped Storage Hydroelectric Plants Using Existing Water Features as Auxiliary Reservoirs	Idaho National Lab	U.S. Department of Energy	March 2014	http://hydropower.inel.gov/resourceassessment/d/pumped-storage-hydro-assessment-report-published-version-20mar14.pdf	X	X
C-2	Appraisal Evaluation of Columbia River Mainstem Off-Channel Storage Options	CH2M HILL	Bureau of Reclamation	May 2007	http://www.ecy.wa.gov/programs/wr/cwp/images/pdf/appraisal_rpt/VolumeI.pdf		X
C-3	Hydroelectric Pumped Storage for Enabling Variable Energy Resources within the Federal Columbia River Power System	HDR Engineering	Bonneville Power Administration	September 2010	http://www.hydro.org/wp-content/uploads/2011/07/BPA-Proof-of-Concept-Final-Sep30.pdf		
C-4	Technical Analysis of Pumped Storage and Integration with Wind Power in the Pacific Northwest	MWH	US Army Corp of Engineers	August 2009	http://www.hydro.org/wp-content/uploads/2011/07/PS-Wind-Integration-Final-Report-without-Exhibits-MWH-3.pdf		X

	TIDAL AND WAVE ENERGY PROJECTS	Author	Prepared For	Date	Link	National	PNW Region
D-1	Assessment of Energy Production Potential for Tidal Streams in the US	Georgia Tech Institute	U.S. Department of Energy	June 2011	http://www.tidalstreampower.gatech.edu/Final_Report_tidal_v2.pdf	X	X
D-2	Mapping and Assessment of the US Ocean Wave Energy Resources	Electric Power Research Institute	EPRI	2011	http://energy.gov/sites/prod/files/2013/12/f5/mappingandassessment.pdf	X	X
D-3	Assessment/Mapping of Riverine Hydroknetic Resource in the Contintental US	Electric Power Research Institute	EPRI	2012	http://energy.gov/sites/prod/files/2013/12/f5/riverine_hydrokinetic_resource_assessment_and_mapping.pdf	x	x

	GENERAL GENERATION PROJECT ASSESSMENTS:	Author	Prepared For	Date	Link	National	PNW Region
E-1	New Stream-reach Development: Comprehensive Assessment of Hydropower Energy Potential in the US	Oak Ridge National Lab	U.S. Department of Energy	April 2014	http://nhaap.ornl.gov/sites/default/files/ORNL_NSD_FY14_Final_Report.pdf	X	X
E-2	Assessment of Natural Stream Sites for Hydroelectric Dams in the PNW Region	Idaho National Lab	U.S. Department of Energy	March 2012	http://hydropower.inel.gov/resourceassessment/pdfs/hydro-assessment2012.pdf		X
E-3	Irrigation Water Providers of Oregon: Hydropower Potential and Energy Savings Evaluation	Black Rock Consulting	Energy Trust of Oregon	November 2009	http://energytrust.org/library/reports/100916_HydropowerPotential.pdf		X
E-4	Small Hydropower Technology and Market Assessment	Summit Blue Consulting	Energy Trust of Oregon	January 2009	http://energytrust.org/library/reports/090126_small_hydropower.pdf	X	X
E-5	Assessment of Waterpower Potential and Development Needs	Electric Power Research Institute	EPRI	December 2006	http://www.epri.com/search/Pages/results.aspx?k=hydropower%20potential	X	X
E-6	Feasibility Assessment of the Water Energy Resources for the US for New Low Power & Small Hydro Classes	Idaho National Lab	U.S. Department of Energy	January 2006	http://www1.eere.energy.gov/water/pdfs/doewater-11263.pdf	X	X
E-7	Estimation of Economic Parameters of US Hydropower Resources	INEEL	U.S. Department of Energy	June 2003	http://www1.eere.energy.gov/water/pdfs/doewater-00662.pdf		

	MODELS/DATABASES/TOOLS	Author	Prepared For	Date	Link	National	PNW Region
F-1	Northwest Hydrosite Database	BPA/Council		Ongoing	http://gis.bpa.gov/NPCC/default.htm		X
F-2	National Inventory of Dams	US Army Corp of Engineers			http://geo.usace.army.mil/pgis/f?p=397:1:0	X	X
F-3	Hydropower Energy and Economic Analysis Tool	Oak Ridge National Laboratory	U.S. Department of Energy		http://www.usbr.gov/power/AssessmentReport/USBRHydroAssessmentToolVersion2.0.xlsm	X	X
F-4	Virtual Prospector Tool	Idaho National Lab			http://hydropower.inel.gov/prospector/index.shtml	X	X
F-5	Tidal Stream Interactive Map	Georgia Tech Institute	U.S. Department of Energy	Jun-11	http://www.tidalstreampower.gatech.edu	X	X
F-6	National Hydropower Asset Assessment Program (database)	Oak Ridge National Laboratory	U.S. Department of Energy		http://nhaap.ornl.gov/NHAAP-GIS-Data-and-Maps	X	X

	LEGISLATION AND RULEMAKING	Author	Prepared For	Date	Link	National	PNW Region
G-1	Bureau of Reclamation Small Conduit Hydropower Development and Rural Jobs Act	US Congress	Public Law 113-24	Enrolled Aug. 2013	http://www.gpo.gov/fdsys/pkg/PLAW-113publ24/pdf/PLAW-113publ24.pdf	X	X
G-2	Hydropower Regulatory Efficiency Act of 2013	US Congress	Public Law 113-23	Enrolled Aug. 2013	http://www.gpo.gov/fdsys/pkg/PLAW-113publ23/pdf/PLAW-113publ23.pdf	X	X
G-3	EPA Rulemaking - Existing Power Plant Emissions	Evnironmental Protection Agency	Rulemaking	14-Jun-14	http://www.reginfo.gov/public/do/eAgendaViewRule?pubId=201310&RIN=2060-AR33	X	X

Appendix B

PARAMETERS OF STUDIES REVIEWED

STUDIES AND ASSESSMENTS

The study number correlates with the list of studies identified in Attachment A.

PROJECTS AT EXISTING UNPOWERED DAMS

A-1) Hydropower Resource Assessment at Non-Powered USACE Sites

Objective:
Assess the potential and economic feasibility of adding hydroelectric power to non-powered dams at USACE facilities

Model:
NHAAP (National Hydropower Asset Baseline Database); uses data and process from study #2

Approach: Of the 419 USACE non-powered dams of the USACE, 223 sites were reviewed:
a) based on capacity (1 MW or larger), no current FERC license and no obvious hindrances in developing hydropower at these sites;
b) using review of daily hydraulic head and flow values from 3 years of full data to determine seasonality and yearly hydrological variation and the relationship between hydraulic head and flow in conjunction and review of daily flows;
c) base data from Oak Ridge National Laboratory when information not available from District offices

Parameters:
a) use of the maximum power value as a site's potential capacity;
b) use of cost numbers from the Idaho National Engineering and Environmental Laboratory's (INEEL) 2003 study (study #21, attachment A) and the Bureau of Reclamation study of 2011 (study #3, attachment A);
c) calculation of monetary benefits (energy value of generation, federal incentives); and non-monetary benefits (avoided emissions of non-fossil fuel based resource)
d) determination by two metrics: benefit-cost ration and internal rate of return, comparing the net present value of cost over 50 years;
e) site specific restrictions were not considered: environmental impacts, water quality, etc.; and
f) energy prices based on EIA (Energy Information Administration) projected data by USACE District.

Pacific NW Potential:
a) Portland District: 3 projects deemed feasible with a total capacity of 39.12 MWs and generation of 56,446.62 MWh, avoiding 75.66 millions of tons of emissions from GHG (greenhouse gasses); Applegate and Dorena were exempted from the analysis as they have existing FERC licenses although not developed yet.
b) Seattle District: 2 projects reviewed, but only one deemed feasible with a total capacity of 65.58 MWs and generation of 95,576.38 MWhs, avoiding 128.12 millions of tons of GHG emissions.

When determining the estimated potential for the Pacific NW, it will be necessary to add back USACE facilities that are in the FERC process and not yet generating which were removed from the study due to having an existing permit or license from FERC, which can occur in the NWHA team's analysis of FERC applications.

Protected Areas Impact:
Existing diversions are exempt from protected area restrictions.

A-2) <u>An Assessment of Energy Potential at Non-Powered Dams in the United States</u>

Objective:
Identify non-powered dams (NPDs) to assess energy potential nationally

Model:
NHAAP (National Hydropower Asset Baseline Database); uses data and process from study #2

Approach:
a) analysis of 54,391 sites of 80,000 available national; capacity potential of 12,000 MWs
b) does not include sites under construction (get info from FERC analysis)
c) assumes all existing flows through dams for capacity calculation and basin runoff potential
d) only dams 5' or higher analyzed

Parameters:
Assesses only energy production as other mitigation factors considered to be addressed during original construction; no cost or regulatory review

Pacific NW Potential:
225 MWs

Only one site is named in the PNW because the study just shows the top 100 sites by name, which includes Howard A. Hanson Dam in Washington. The rest of the 225 MWs is not identified by site.

<u>A-3) Hydropower Resource Assessment at Existing Reclamation Facilities</u>

Objective:
Identify and assess generation on existing Reclamation facilities

Model:
Reclamation Hydropower Assessment Tool

Approach:
Assessed 503 sites in the west based on flow records and other data already available; 191 dams and 52 canal systems nationally determined to have potential for further evaluation

Parameters:
Cost, economic benefits, transmission, equipment, green incentives, mitigation costs

Pacific NW Potential:
a) feasible sites in the PNW: 38.1 MW potential
b) of 105 sites reviewed, only 34 with potential

CONDUIT AND KINETIC PROJECTS (with some non-powered dams)

B-1) Technical & Economic Feasibility Assessment of Small Hydropower Development in Deschutes River Basin

Objective:
Identify and assess opportunities for new small hydro in the Deschutes Basin

Model:
HEEA (Hydropower Energy and Economic Analysis Tool) of the Oak Ridge National Laboratory

Approach:
Assess ability to add new generation at non-powered dams and existing canals/conduits, implementing a new basin scale approach

Parameters:
Costs, inclusion of green incentives

Pacific NW Potential:
Potential of 27 MWs, considering 14 NPDs and 15 irrigation canal conduits; 19.89 MWs deemed viable with 78,242 MWhs of energy generation.

B-2) Integrated Basin-Scale Opportunity Assessment Initiative, FY 2011 Year-End Report: Deschutes Basin Preliminary Hydropower Opportunity Assessment

Objective:
Determine if a comprehensive basin analysis can result in increased hydropower generation while maintaining ancillary benefits such as water quality while maintaining other water uses (irrigation, instream flows, municipal)

Model:
a) BSOA (Basin Scale Opportunity Assessment Toolbox); and
b) VIC (Variable Infiltration Capacity)

Approach:
a) Assess potential generation if objectives described above are met
b) Uses base data from Study #2

Parameters:
Environmental, passage, economic benefit, transmission, flows, protected areas

Pacific NW Potential:
Does not breakdown potential; this is a draft; there may be a later version, which will be researched.

B-3) Feasibility Study on Five Potential Hydroelectric Power Generation Locations, North Unit Irrigation District

Objective:

Identify and assess potential generation sites within the North Unit Irrigation District (vicinity of Madras, OR)

Model:
General field review; no specific model

Approach:
a) Field survey data review
b) Flow data review from irrigation district records
c) Economic information from other projects recently constructed in the Deschutes Basin

Parameters:
Flow, transmission, economics, revenue, incentives

Pacific NW Potential:
1.579 MWs with potential energy generation of 6,172.312 MWhs.

B-4) <u>Power Extraction from Irrigation Laterals and Canals in the Columbia Basin Project</u>

Objective:
Graduate thesis detailing how to define and select hydrokinetic and conventional hydropower projects in the Columbia Basin Project irrigation districts

Model:
None

Approach:
a) Details new hydrokinetic equipment and potential for generation
b) Explores costs of various use of equipment with comparisons

Parameters:
Cost, equipment; no analysis of impacts

Pacific NW Potential:
Cites 3 potential projects that would equate to 3.2 MW capacity in the system. Given the large Columbia Basin Project system, there are likely many more projects within that system as well as other NW irrigation districts with substantial kinetic energy potential. This study addresses developing a model.

B-5) <u>Site Inventory and Hydropower Energy Assessment of Reclamation Owned Conduits</u>

Objective:
Supplemental assessment to study #3, adding a substantial number of canal facilities that could provide generation as conduit projects on Reclamation facilities and an update of the 2007 study "Potential Hydropower Development at Existing Federal Facilities

Model:
Hydropower Assessment Tool

Approach:
Reclamation staff
a) researched project drawings of existing facilities
b) conducted physical field tours
c) reviewed aerial imagery
d) evaluated flow exceedance minimums for sizing generation capacity
e) garnered local experiential data from facility operators

Parameters:
Flow, proximity to transmission (not addressed in earlier studies), site maps, seasonal analysis

Pacific NW Potential:
Total western potential 373 sites, 104 MWs
Pacific Northwest: 111 canal sites with 34.0 MWs capacity and 116,596.77 MWhs generation.

B-6) <u>Bureau of Reclamation Renewable Energy Update</u>

Objective:
In July of 2014 Reclamation provided an updated document detailing new hydropower projects that have come on line or were in development at that time. Some were provided funds from Reclamation's Water Smart program and some projects are being developed under Reclamation's Lease of Power Privilege program.

Model:
These are not modeled results, but results based on studies conducted.

Approach:
Listing of in development projects.

Parameters:
These are projects more likely to move forward. They are either at existing dams or on conduits so they would be exempt from the Protect Areas prohibition.

Pacific NW Potential:
Conventional and conduit projects: 18 projects totaling 50.75 MWs and 91,243 MWhs of energy production. The update also includes 2,250 MWs of pumped storage at 2 projects with 4,672,000,000 MWhs of generation.

B-7) <u>Scoping Study of Hydropower Potential in Wallowa County, Oregon</u>

Objective:
The study seeks to identify viable conduit exemption projects in Wallowa County (northeastern) Oregon related to irrigation infrastructure.

Model:
These are not modeled results, but results based on field studies conducted.

Approach:
The consultant conducted field studies of the project and calculated capacity, production, available flows based on water right, water availability based on state agency records, and project development costs.

Parameters:
These are projects on existing irrigation infrastructure and are not new diversions, therefore they are exempt from the Protect Areas prohibition.

Pacific NW Potential:
A total of 22 conduit sites were identified, providing 1.02 MWs of capacity and 3,391 MWhs of generation production.

PUMPED STORAGE/ENERGY STORAGE PROJECTS

C-1) Assessment of Opportunities for New US Pumped Storage Hydroelectric Plants Using Existing Water Features as Auxiliary Reservoirs

Objective:
Assesses pumped storage potential nationally using existing water features as reservoirs

Model:
None

Approach:
a) Used GIS capabilities to research
b) Developed applicable criteria to define 4 different types of sites (see PNW potential below)
c) Identified surface water bodies with more than 100 acres and applied criteria

Parameters:
Technical review of sites based on physical properties; does not include cost or environmental impacts

Pacific NW Potential:
a) Pumped storage at existing hydropower facilities (dam/reservoir)
OR - 135 MW; WA – 19 MW
b) Pumped storage at non-powered dams, 1 MW or greater – 0
c) Pumped storage at greenfield sites of 10 MW or greater
ID – 10 MW; MT – 22 MW; OR – 131 MW; WA – 272 MW

C-2) <u>Technical Analysis of Pumped Storage and Integration with Wind Power in the Pacific Northwest</u>

Objective:
Describes various aspects of pumped storage development and integration with wind power in the NW

Model:
None

Approach:

Details all the aspects of developing pumped storage from a technology point of view and how the technology could be addressed in the PNW.

Parameters:
Physical attributes

Pacific NW Potential:
Potential new projects not identified specifically, but provides a list of projects that were in the FERC process in 2009:
a) NW pump storage projects with a FERC issued preliminary permit in 2009 13,421 MW capacity
b) NW pumped storage projects with a FERC preliminary permit pending in 2009 2,032 MW capacity

C-3) <u>Appraisal Evaluation of Columbia River Mainstem Off-Channel Storage Options</u>

Objective:
Analyze and compare four off-channel reservoir sites on the Columbia River mainstem in WA state

Model:
None

Approach:
Development of sizing options comparing sites using a range of criteria, identifying power generation as a secondary benefit

Parameters:
Transmission lines, internal project pumping electrical needs, flow analysis, other water uses, cultural and environmental impacts, geology, socioencomics

Pacific NW Potential:
Of the sites considered, one of which may be selected, the power capacity varies from 69 MWs to 1,136 MWs, which will eventually be determined by the height of the dam, which facility is chosen (if any), the size of the reservoir and the scheduling of flows for power generation.

C-4) <u>Technical Analysis of Pumped Storage and Integration with Wind Power in the Pacific Northwest</u>

Objective:
The study was conducted for the Bonneville Power Administration to identify strategies for combining wind integration and pumped storage technologies, with the potential of returning flexibility to the Federal Columbia River Power System (FCRPS).

Model:
A specific model was not used for the overall review, but “Microfin” was used to determine plant costs for estimated revenues derived in the study to show recovery of BPA costs associated with providing wind balancing reserves from the identified pumped storage alternatives for high levels of wind penetration.

Approach/Parameters:
The consultant reviewed how grids in Europe utilize both conventional hydropower storage and new pumped storage for integrating variable energy resources. The study also demonstrated how much flexibility and system reserves could be provided by Reclamation's Keys Pumped Storage Project. The study also addressed proposed projects in the U.S. that have been granted and/or filed for a FERC preliminary permit.

Pacific NW Potential:
Identifying new sites was not within the scope of the study, but some existing sites were referenced in the Pacific NW totaling 5,295 MWs of capacity. (See page 3, chapter 3.)

TIDAL AND WAVE ENERGY PROJECTS

D-1) Assessment of Energy Production Potential for Tidal Streams in the US

Objective:
Development of national database for tidal stream and current flow energy generation potential and development of a GIS tool and mapping feature to accelerate the market for tidal energy (see also study item #27 mapping tool)

Model:
Regional Ocean Modeling System

Approach:
a) Use of minimal grid resolution tool
b) Use of bathymetric data interpolated onto model grid
c) Determination of harmonic constituents for tidal current
d) Use of kinetic readings of 2700 readings of NOAA tidal current stations

Parameters:
a) Velocity and flow rate
b) Seabed geology and depth
c) Environmental impacts
d) Electric grid connection and energy
e) Competing costs of other electricity sources

Pacific NW Potential:
Total theoretical power available along the coast of Pacific Northwest states:
OR - 48 MW
WA – 683 MW

D-2) <u>Mapping and Assessment of the US Ocean Wave Energy Resources</u>

Objective:
Assessment and mapping of US ocean wave energy resources to determine potential generation and to provide a third party validation by NREL

Model:

Use of Wavewatch III hindcast database developed by NOAA

Approach:
a) Determine cumulative development through probability distribution analysis
b) Use of three capacity packing densities as input
c) Quantitative analysis of coastal and marine spatial planning
d) Formula derivation for developer project lease areas required
e) Definition of accommodating different wave climates

Parameters:
Physical parameters only; does not consider Oregon's mapped development areas for tidal resources.

Pacific NW Potential:
WA – 188 TWh/yr: 72 TWh/yr Inner Shelf; 116 TWh/yr Outer Shelf
OR – 322 TWh/yr: 143 TWh/yr Inner Shelf; 179 TWh/yr Outer Shelf

D-3) <u>Assessment/Mapping of Riverine Hydrokinetic Resource in the Continental U.S.</u>

Objective:
The Electric Power Research Institute (EPRI) assessed hydrokinetic resources in the 48 contiguous state to determine potential power that might be generated by hydrokinetic project development.

Model:
The spatially-explicit data contained in the NHDPlus, a GIS-based database containing river segment-specific information on discharge characteristics and channel slope was used in the assessment.   (Details: pages 5-1 through 5-8 of the study)

Approach:
A total of 73,298 river segments having a mean annual flow greater than 1,000 cubic feet per second (cfs) mean discharge were included in the assessment. River segments with existing hydroelectric dams were excluded.

Parameters:
The studied used hydrologic and physical components but does not take into account environmental impacts or costs.

Pacific NW Potential:
While the studies identified net potential resources, no specific projects were identified.

GENERAL GENERATION PROJECT ASSESSMENTS:

E-1) New Stream-reach Development: Comprehensive Assessment of Hydropower Energy Potential in the US

Objective:
Reconnaissance level analysis of undeveloped stream reaches considering the technical resource that could be available for development

Model:
NHAAP (National Hydropower Asset Assessment Project)

Approach:
a) Analysis of 3 million US stream reaches w/high energy density potential
b) Use of topographical tools to determine surface inundation and reservoir storage area
c) Environmental attribution to spatially join energy potential of reaches with natural ecological systems, social and cultural settings, policies, management and legal constraints

Parameters:
Review of fish habitat, recreational use, natural ecological systems, sensitive species, social and cultural importance and regulatory constraints.

Pacific NW Potential:
PNW has 32% of national potential of 25,266 MWs and 148,999,000 MWh/yr at 67% capacity.

	Capacity/MW	MWhs/yr
ID	7,018	41,015,000
MT	4,763	28,201,000
OR	8,920	53,353,000
WA	7,381	43,788,000
Total	28,082	166,357,000

E-2) Assessment of Natural Stream Sites for Hydroelectric Dams in the PNW Region

Objective:
Obtain total and site specific hydro potential and information about the physical characteristics and impacts of using a ;dam as a hydro development at greenfield sites, building on earlier INEL studies using Region 17 (OR/ID/WA) as a pilot project

Model:

Approach:
a) Each stream reach considered a potential development site
b) Considers dimensions of constructed impoundment boundary for dam and extent of inundated area produced by reservoir
c) Focus on small hydro projects to eliminate unrealistic project site reaches that were part of a large river

Parameters:
a) Federal exclusion applied – federal land use designations
b) Environmental exclusions – environmentally sensitive areas
c) Definition of small hydro for purposes of this study: 2 to 60 MWs of capacity; energy component of less than 1 MWa up to 30 MWa of average annual power potential

Pacific NW Potential:

ID/OR/WA:

	No. Reaches	Capacity MW
All reaches:	231,747	211,666
Capacity potential less than 1 MW:	29,580	185,485
Small hydropower reaches:	24,489	73,934
Available small hydropower reaches:	15,676	42,835
Candidate small hydropower sites: selected for further assessment	**5,439**	**15,021**

(Montana not included in Region 17 and only Region 17 included in pilot)

E-3) Irrigation Water Providers of Oregon: Hydropower Potential and Energy Savings Evaluation

Objective:
Assessment of project potential in certain Oregon irrigation districts and to identify potential energy upgrade projects within delivery systems or end user equipment such as pumps

Model:
None

Approach:
a) Analysis of water rights of 108 irrigation water suppliers in Oregon
b) Secondary review through survey of 29 suppliers with potential projects of .5 MW or larger
c) Physical analysis of sites resulting in feasibility review of 14 suppliers representing 30 sites

Parameters:
Flow rate, seasonality and stability of water right
Interconnection cost and issues
Equipment configuration and estimated costs
Permitting and regulatory issues
Review of protected areas
Environmental parameters: protected species, water quality, wild and scenic rivers, passage
Power sales revenue
Land use siting
Incentives

Pacific NW Potential:
OR 58,523 kwhs energy
20.61 MW

E-4) Small Hydropower Technology and Market Assessment

Objective:
Develop an understanding of hydro technologies, project types, configurations and associated cost for hydropower in Oregon, as well as reviewing institutional constraints and incentives

Model:
None

Approach:
a) Database analysis of 41,500 water rights in Oregon within PGE and PacifiCorp service areas, addressing the largest water users
b) Develop a map of water right holders by region
c) Segment large water users into 5 groups: municipal, irrigation, industrial/manufacturing, storage and agriculture
d) Survey large water right holders w/water rights of 10,000 acre feet or more with a priority of 1980 or earlier.

Parameters:
Regulatory and permitting issues
Water right size and priority, seasonality and stability
Incentives
Projects with existing diversions
Capital and operation and maintenance costs
Transmission access
Market assessment

Pacific NW Potential:
The report did not determine the capacity and energy components, only the size of water rights.

E-5) <u>Assessment of Waterpower Potential and Development Needs</u>

Objective:
Assess waterpower potential and development needs in support of US DOE's Renewable Research Programs such as R&D, incentive tax credits, etc.

Model:
None

Approach:
a) Identification and review of pertinent literature evaluating existing data sources
b) Consultation with industry personnel and project owners with relevant knowledge
c) Identification of need to extend incentives such as the production tax credit and Clean Renewable Energy Bonds (CREBs) to 2015
d) Identification of regulatory process enhancements

Parameters:

Pacific NW Potential:
Only identified national numbers: 23,000 MW by 2025
(10,000 MW from conventional hydro; 3,000 from new hydro kinetic projects; and 10,000 ocean tidal energy devices

E-6) Feasibility Assessment of the Water Energy Resources for the US for New Low Power & Small Hydro Classes

Objective:
Updates 2004 study with new feasibility criteria

Model:
None
See also Virtual Hydropower Prospector Database and Mapping (#26) which coordinates with this study

Approach:
a) Review feasibility of earlier study by assuming a development model not requiring a dam but instead a penstock running parallel to the stream and returning water to the stream at the end of the penstock
b) Assume only small or micro hydro development
c) Limit flow for project to no more than half of the live streamflow or to produce 30 MWa, whichever is less

Parameters:
Site accessibility
Load or transmission proximity
Land use and environmental sensitivities

Site within 1 mile of road
Site within 1 mile of transmission or power infrastructure

Pacific NW Potential:
Reviewed 500,000 sites nationally, reducing to 5400 sites with 18,000 MWa as viable

ID 2,122 MWa
MT 1,669 MWa
OR 2,072 MWa
WA 3,106 MWa

E-7) Estimation of Economic Parameters of US Hydropower Resources

Objective:
Develop tools for estimating the cost of project development, operation, maintenance and upgrading of hydroelectric plants and estimating generation potential

Model:
Use of Hydropower Evaluation Software (HES)

Approach:
a) Develop separate tools for costs and 5 types of environmental mitigation
b) Develop median costs for capacity development
c) Apply tools to previously identified hydropower resources identified in 1989-1998 by earlier studies
d) Assume that capacity is within the range of 1 MW or more, but no more than 1300 MW capacity;

does not include pumped storage

Parameters:
Fish and wildlife mitigation
Recreation mitigation
Cultural resources evaluation
Water quality monitoring
Fish passage

Pacific NW Potential
Does not provide assessment of potential projects

MODELS/DATABASES/TOOLS

The following databases have specific detail of projects which are referred to within the above studies. We will be using those tools to assist in estimating future potential in the final report.

F-1) Northwest Hydro site Database

F-2) National Inventory of Dams

F-3) Hydropower Energy and Economic Analysis Tool

F-4) Virtual Prospector Tool

F-5) Tidal Stream Interactive Map

F-6) National Hydropower Asset Assessment Program (database)

LEGISLATION AND RULEMAKING

G-1) Bureau of Reclamation Small Conduit Hydropower Development and Rural Jobs Act

G-2) Hydropower Regulatory Efficiency Act of 2013

The final report will describe current legislation and rulemaking.

APPENDIX C

Appendix C includes a summary of the following documents:

- Federal Energy Regulatory (FERC) Tables
  Identifying applications in process
    - Issued exemptions
    - Pending conventional preliminary permits
    - Licensed marine projects
    - Issued preliminary permits for pumped storage
    - Issued preliminary permits for conventional hydropower
    - Tax Credits Issued

- Survey Results from NWHA
  Survey conducted September 2014
    - Survey questions
    - Compilation of survey forms from respondents
    - Lease of Power Privilege and other projects – U.S. Bureau of Reclamation

- Project Potential Identified in Review of Studies by Technology Type
  Compilation of charts from Chapters 1-5

The most reliable information comes from the FERC applications and survey responses as action has been taken to pursue projects by the entities responding to the survey and by applicants who have filed their intentions with FERC to study and pursue the listed projects. Some of the studies have less specific information and represent potential without significant feasibility analysis.

FERC TABLES

Federal Energy Regulatory (FERC) Tables *Identification of applications in process*

PROJECT TYPE	TABLE	NO. OF PROJECTS	STATUS	CAPACITY (MW)	ENERGY (MWh)
Conduit Exemptions	1	9	Issued	3.099	10,837
Conduit Exemptions	2	11	Issued	6.258	4,000
Licensed Marine	3	2	Issued	2.500	299,500
Conventional Hydro - Permits	4	2	Pending	65.000	401,870
Conventional Hydro - Permits	5	22	Issued	125.270	498,436
Conventional Hydro - Licenses	6	9	Pending	46.525	95,952
Pumped Storage - Permits	7	9	Pending	7,294.000	15,123,686
TOTAL		**64**		**7,542.652**	**16,434281**

- Issued Conduit Exemptions
  Projects approved by FERC and project development can be underway

  Applications filed before the new legislation (chapter 7) requiring exemption permit (Table 1)
  Applications filed after the legislation was enacted requiring only a notice of intent (Table 2)

(must be 5 MW or less capacity to file a notice of intent; conduit exemptions more than 5 MW and up to 40 MW must file an exemption permit)

Conduit exemption projects are those with generation equipment within or at the end of canals, pipelines, ditches and other man-made conveyance facilities that as their primary purpose supply water to agriculture, municipal or industrial purposes.

- Permits (Tables 4, 5)
  A preliminary permit allows a 3 year study period for project planning purposes; potential extensions are available under approved circumstances for up to 4 years.

- Licenses (Tables 3, 6)
  Licenses are awarded after necessary studies and public process are completed, generally after the permit stage, although it is possible to start at the license level without applying for a pre-liminary permit. Once a license is awarded, then construction can begin.

- Table of Tax Credits Issue (Table 7)
  FERC record of tax credits issued on upgrade projects

SURVEY RESPONSES

Table B represents the responses received during the survey conducted in September 2014 by NWHA to ascertain projects planned or underway by generators, both utility and non-utility generators. In addition some state and federal agencies provided information that represents filings made in the public record.

NORTHWEST HYDROELECTRIC ASSOCIATION

Pacific Northwest Hydropower Potential Scoping Study

Introduction

The Northwest Power and Conservation Council has awarded a contract to the Northwest Hydroelectric Association (NWHA) to complete the Pacific Northwest Hydropower Potential Scoping Study. The NWHA is compiling information from various studies that have been conducted over the past ten years at both the regional and national level. These studies identify significant potential in the Pacific Northwest, but are often missing key elements of analysis necessary for determining realistic potential – for example, environmental protected areas and cost effectiveness. NWHA will be providing information that will help the Council determine as part of its power planning if a realistic potential can be drawn from existing studies or if further steps need to be taken.

As part of this hydropower potential scoping study, and in recognition of the current refurbishment of many existing regional hydropower facilities, NWHA is conducting a voluntary survey of current and future hydropower development in the Pacific Northwest. We are collecting information about specific hydropower projects that may be either in progress or on the drawing board that are anticipated to be developed within the next 20 year period. Projects may be new development, or may be efficiency and capacity improvements to existing projects. We will separate the responses into two time periods:

1) projects potentially available in the 5 year period beginning 2015-2019; and
2) projects potentially available for the rest of the 20 year period 2015-2034.

NWHA and the Council greatly appreciate your participation in this voluntary survey. Responses are due by September 22nd in order for the NWHA to include it in the final deliverable to the Council. If you have any specific questions or concerns as you complete the survey, please feel free to call or email Jan Lee at NWHA or Gillian Charles at the Council.

Thank you.

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Pacific Northwest Hydropower Potential Scoping Study

Survey

Please provide information on each project anticipated that will include the following parameters and also feel free to add detail at the end of the survey if you wish.

1. Company Name

Company Name

2. Project Name/Identifier *(including FERC project number and EIA plant code, if known)*

Project Name/Identifier*(including FERC project number and EIA plant code, if known)*

3. Type of NEW Project:

Type of**NEW**Project:

Please provide a brief description of new project here: (e.g., “New in-stream diversion structure, 1.5 mi. canal, penstock and powerhouse with one 2.5 MW turbine-generator.”)

4. Type of Incremental Power Addition:

Type of Incremental Power **Addition**:

Please provide details of upgrade(s) here:

5. Estimated beginning generation date:

Estimated beginning generation date: Month:

Year:

Current Status:

6. Planned New/Additional Capacity *(in Megawatts or portion of a MW)*:

Planned New/Additional Capacity*(in Megawatts or portion of a MW)*: MW

KW

7. Estimated energy production (*MWa*):

Estimated energy production (*MWa*):

8. Estimated Cost (if available): ***(Please explain what kind of cost you are providing.)***

Estimated Cost (if available):*(Please explain what kind of cost you are providing.)*

9. Stream Location: ***(Please include specific information, such as stream mile, if possible.)***

Stream Location:*(Please include specific information, such as stream mile, if possible.)*

10. Additional Comments:

Additional Comments:

11. Would you please provide your name and email address so that we can get back to you if we have questions about your responses?

Would you please provide your name and email address so that we can get back to you if we have questions about your responses?

Click "Done" to submit information. Review prior to clicking if you'd like to verify or change information.

Previous Done

PROJECTS IDENTIFIED IN STUDIES

Each chapter identifies project sites or stream reaches in the Pacific Northwest that may provide future hydropower potential. The following table represents the totals from each chapter.

TYPE OF PROJECT	NO. OF PROJECTS	CAPACITY (MW)	ENERGY (MWh)
Chapter 1: Non-powered Dams	19	143.786	275,226.39
Chapter 2: Conduit and Hydrokinetic	51	92.616	295,645.00
Chapter 3: Pumped Storage	8	6,295.000	99,681.00
Chapter 4: Tidal and Wave Energy	-	731.000	-
Chapter 5: General/Multiple Type Assessments	-	40,266.610	164,792,000.00

For chapters 1 and 2, projects were identified specifically enough to calculate the capacity and energy shown in the chart. The figures for those projects are probably in the middle range for the region's potential. There are significant opportunities for conduit and hydrokinetic projects which do not require a new diversion, even more than the projects identified in the studies in these chapters as these projects are a newer technology to the region and have only begun being developed in the last 10 years. The studies developed by the Bureau of Reclamation (A-3, B-5 and B-6) are more specific and viable in noting projects and also provide current tools for addressing feasibility that could be applied to other projects.

For chapter 3 the overall studies showed some very high totals for the region, but the authors of chapter 3 were able to address the studies and select the most viable projects and estimate the potential from the list shown in that chapter so that this number is more refined. In addition, the energy total reflects reserved energy instead of gross energy; the FERC numbers on that chart are gross energy and overestimate what will be available from the project.

The tidal and wave energy total from chapter 4 was taken from the Georgia Tech study, which was the only one to show total capacity by state. The other studies were a reflection of the total ocean potential along the coastline. The Georgia Tech study did not indicate the energy component for the capacity they identified. This technology is very new and most of the projects proposed in the region are pilots to determine feasibility and demonstrate new equipment models.

The general assessments include all types of projects and stream reaches as well as particular projects so those numbers would be at the very high range of what can be developed. The 2014 study developed by Oak Ridge National Laboratory for the U.S. Department of Energy is the newest analysis of general project data. Overlaying this study with the protected areas map (in development) will be critical to determine how viable projects on the enumerated stream reaches may be.

The ranges from the charts in this section typify what may be available in the region with the level of information currently available. Some projects are most likely cited in multiple sources, while other projects might not have been identified in the sources. The lower end represents the survey data, FERC applications and the pumped storage chart from chapter 3 as the more readily available projects. The higher end represents the total from studies.

The Council asked if there is enough information in the studies to determine the power potential in the Pacific Northwest over the next 20 years period of the Seventh Power Plan. The answer is no, from NWHA's perspective. Most of the study information is not specific enough at this time. However, we do feel that the information from the survey and from the FERC applications provides a good basis, as well as the carefully analyzed pumped storage information. The information from the survey was self-reported and email and phone communications attempted to firm it up, but in the short period of time it was not possible to achieve a broader set of responses. Follow up calls with known entities on a grander scale would, we believe, note a higher potential.

The studies reviewed and summarized in this report were developed over the last decade by a wide variety of entities ranging from national laboratories to consulting firms working for government and private entities. The criteria used, the hydrologic data and the topographic information available to predict new and upgraded hydropower capacity varies between the studies. As a result, general ranges of future hydropower potential are provided in this summary report. The hydropower potential estimates could be improved in future studies by interviewing authors of the various reports and by further analyses of the specific criteria used in development of the estimates.

However, there are new tools being developed in studies ongoing at this time. The Hydro Research Foundation has developed a small hydropower study that will be released next month and the foundation has developed a series of technical tools both for estimating and implementing hydropower projects (www.hydrofoundation.org) Members of this project team are participating in the ongoing Department of Energy's Hydropower Visioning Project that is intended to develop a 2025 vision for the future of hydropower in the U.S. to accomplish this particular task.

SURVEY RESULTS: September 2014

FUTURE HYDROPOWER FACILITIES

ID Code	Reporter	Developer	Project Name	FERC No.	Project Type	Type of Upgrade	Project Generation Date	Estimated New Capacity MWs	Estimated Energy Annual MWh	Cost	Stream	Name	Email	Protected	Water Right	LOPP Pending		Notes	
1	Blind report	Blind report	Not determined	N/A	Upgrade	Add equipment	2020	7.0	N/A	< $30,000,000	N/A	Blind Report	Blind report	Protected					
2	Montana Dept. Natural Resources	Montana Dept. Natl. Resources	Tongue River Dam	P-14602	Non-powered dam	Add capacity	N/A	2.2	7,344	11,000,000	Ruby River	Dustin de Yong	ddeyong@mt.gov	No					
3	Klickitat PUD	Klickitat PUD	John Day Pool	P-1333	Pumped storage	New closed loop	N/A	1,500.0	4,121,000		John Day Pool	Randy Knowles	mmo@gorge. Net	No					
4	Pend Oreille PUD	Pend Oreille PUD	Box Canyon Dam	P-2042	Upgrade	Add equipment	2011	30.0	N/A		Pend Oreille River	Mark Cauchy	mcauchy@popud.org	No					
5	Montana Dept. Natural Resources	Absaroka Energy	Gordon Butte	P-13642	Pumped storage	New project	2020	400.0	1,300,000	$800,000	Musselshell Drainage	R. Hurless	rhurless@absarokaenergy.com	No					
6	State of Montana	Tollhouse Energy/Greenfield ID	Gibson Dam Hydro	P-12478	Non-powered dam	New project	2016	15.0	43,217	$30-40 million	Sun River	Dustin de Yong	ddeyong@mt.gov	No					
7	Instream Energy Systems	Instream Energy Systems	demo stage in canal		New	Hydrokinetic	N/A	1.0	N/A	N/A	Central Washington	Brett Hawse	brett.hawse@gmail.com	No					
8	North Wasco PUD	North Wasco PUD	Hydro Project	P-7076	Upgrade	Add capacity	2018	5.0	3,800	$55/MWh levelized	The Dalles Dam	Kurt Conger	kurt-conger@nwasco.com	No					
9	Flathead Electric Coop	Flathead Electric Coop	Hydro Project		Non-powered dam	New project	N/A	360.0	N/A	N/A	Flowercreek	Russ Schneider	r.schneider@flathead.coop	No					
11	Idaho Power Companey	Idaho Power Company	Shoshone Falls	P-2778	Upgrade	Add capacity	2022	52.0	N/A	$110,000,000	Snake River	Lewis Wardle	lwardle@idahopower.com	No					
12	Bureau of Reclamation	Klamath Irrigation District	Canal Drop C			New project	2012	0.9			Canal from Klamath R	C Bishop	cbishop@usbr.gov	No					
13	Bureau of Reclamation	Crow Tribe	Yellowtail Afterbay Dam		Non-powered dam	New project	N/A	9.0	N/A		Bighorn River	C Bishop	cbishop@usbr.gov	No		X			
14	Bureau of Reclamation	Helena Valley Irrig. Distr.	Helena Valley Pump Plant		Non-powered dam	New project	N/A	4.8	N/A		Missouri River, MT	C Bishop	cbishop@usbr.gov	No		X			
15	Bureau of Reclamation	Turnbull Hydro, LLC	Johnson, Wood & A-Drop		Conduit exemption	New project	N/A	2.6	N/A		Canal/Greenfields ID	C Bishop	cbishop@usbr.gov	No		X			
16	Three Sisters Irrigation District	Three Sisters Irrigation Distr	Watson Hydro Facility	P-14364	Conduit exemption	New project	2014	0.7	3,100		Canal from Wychus Cr	Marc Thalacker	manager@tsidweb.org.	No					
17	Blind report	Blind Report	Blind Report	N/A	Upgrade	Add energy	2015	0.0	2,000		Protected	Blind Report	Blind report	Protected					
18	State of Oregon	Oregon Dept. Fish/Wildlife	Oak Springs		Exempt	New project	N/A	0.085			Trib. Deschutes River	Oregon WRD	Mary.S.GRAINEY@state.or.us	No	PC 893				
19	State of Oregon	North Unit Irrigation Distr.	Monroe Drop		Conduit exemption	New project	2015	0.3	1,004		Deschutes/Crooked R.	Oregon WRD	Mary.S.GRAINEY@state.or.us	No	Certif.				
20	State of Oregon	Swan Lake North Hydro LLC	Swan Lake Pump Storage	P-13318	Pumped storage	New project	N/A	1,000.0	3,340,000		Klamath River	Oregon WRD	Mary.s.GRAINEY@state.or.us	No	HE 609				
21	State of Oregon	Baker County	Existing dam	P-12686	Non-powered dam	New project	N/A	3.4	8,100		Powder River	Oregon WRD	Mary.S.GRAINEY@state.or.us	No	HE 605				
22	State of Oregon	Roaring Springs Ranch	Roarding Springs Hydro	CD14-21	Conduit exemption	New project	N/A	0.048	410		Three Mile Creek	Oregon WRD	Mary.S.GRAINEY@state.or.us	No					
23	State of Oregon	City of Corvallis	Treatment Plant Conduit	CD14-19	Conduit exemption	New project	N/A	0.028	305		Marys River	Oregon WRD	Mary.S.GRAINEY@state.or.us	No	Certif.				
24	State of Oregon	City of Gresham	Treatment Plant Conduit	P-13466	Conduit exemption	New Project	N/A	0.05	413		Columbia River	Oregon WRD	Mary.S.GRAINEY@state.or.us	No	S 54627				
25	State of Oregon	City of Astoria	Conduit from reservoir	CD13-6	Conduit exemption	New project	N/A	0.06	475		Bear Creek	Oregon WRD	Mary.S.GRAINEY@state.or.us	No	Certif.				
26	State of Oregon	North Unit Irrigation Distr.	45-Mile Hydro Project		Conduit exemption	New project	2015	5.0			Deschutes/Crooked R.	Oregon WRD	Mary.S.GRAINEY@state.or.us	No	Certif.				
27	State of Oregon	City of Hillsboro	Hydro Project	P-14371	Conduit exemption	New project	N/A	0.094	404		Tualatin River	Oregon WRD	Mary.S.GRAINEY@state.or.us	No	PC 896				
28	State of Oregon	Portland General Electric	N/A	N/A	N/A	New project	N/A	2.8	N/A		Clackamas River	Oregon WRD	Mary.S.GRAINEY@state.or.us	No	Certif.				
29	State of Oregon	Warmsprings Irrigation Distr.	Warm Springs Dam Hydro	P-13570	Non-powered dam	New project	N/A	7.15	22,210		Malheur River	Oregon WRD	Mary.S.GRAINEY@state.or.us	No	PC 900				
30	State of Oregon	Corbett Water District	Treatment Plan		Conduit exemption	New project	2014	0.01	0.7		Gordon Creek	Oregon WRD	Mary.S.GRAINEY@state.or.us	No	PC 894				
31	Grand Coulee Project Hydro Authority	GCPHA	Pinto Dam	P-14380	Non-powered dam	New project	by 2019	2.929	9,700		Columbia River	Tim Culbertson	tculbertson@gcpha.org	No					
32	Grand Coulee Project Hydro Authority	GCPHA	Rocky Coulee Wasteway	P-14372	Conduit exemption	New project	by 2019	2.709	5,100		Columbia River	Tim Culbertson	tculbertson@gcpha.org	No					
33	Grand Coulee Project Hydro Authority	GCPHA	PE Scooteney Wasteway	P-14352	Conduit exemption	New project	by 2019	0.501	2,200		Columbia River	Tim Culbertson	tculbertson@gcpha.org	No					
34	Grand Coulee Project Hydro Authority	GCPHA	Scooteney Inlet Drop	P-14318	Conduit exemption	New project	by 2019	2,372	7,000		Columbia River	Tim Culbertson	tculbertson@gcpha.org	No					
35	Grand Coulee Project Hydro Authority	GCPHA	Scooteney Outlet Drop	P-14317	Conduit exemption	New project	by 2019	1.635	2,600		Columbia River	Tim Culbertson	tculbertson@gcpha.org	No					
36	Grand Coulee Project Hydro Authority	GCPHA	PEWC Drop - Mesa Check	P-14316	Conduit exemption	New project	by 2019	1.805	5,500		Columbia River	Tim Culbertson	tculbertson@gcpha.org	No					
37	Grand Coulee Project Hydro Authority	GCPHA	PE 46A Wasteway	P-14351	Conduit exemption	New project	by 2019	0.637	3,000		Columbia River	Tim Culbertson	tculbertson@gcpha.org	No					
38	Grand Coulee Project Hydro Authority	GCPHA	PE 16.4 Wasteway	P-14349	Conduit exemption	New project	by 2019	1.378	8,900		Columbia River	Tim Culbertson	tculbertson@gcpha.org	No					
39	Grand Coulee Project Hydro Authority	GCPHA	Banks Lake	P-14329	Pumped storage	New Project	by 2024	1,000.0	22,630		Columbia River	Tim Culbertson	tculbertson@gcpha.org	No					
40	Bureau of Reclamation	Bureau of Reclamation	Grand Coulee		G-19-21 addition	Upgrade	2018 start	200.0	?		Columbia River	Clark Bishop	cbishop@usbr.gov	No		Potential upgrade in planning			
41	Blind report	Blind report	Blind report	N/A	Run-of-River	New Project	2017	6.0	22,100	$29,000,000	Blind Report	Blind report	Blind report	Protected					
42	Blind report	Blind report	Blind report	N/A	Run-of-River	New Project	2016	6.0	20,700	$24,000,000	Blind Report	Blind report	Blind report	Protected					
43	Blind report	Blind report	Blind report	N/A	Run-of-River	New Project	2020-2024	30.0	123,900	$133,000,000	Blind Report	Blind report	Blind report	Protected					
44	Seattle City Light	Seattle City Light	Boundary	Upgrade	Upgrade	Add equipment	2015-2035	40.0	100,000		Pond Oreille	Mike Haynes	mike.haynes@seattle.gov	No					
45	Energy Northwest	Energy Northwwest	Packwood Lake Hydro	Upgrade	Upgrades	Upgrade	2015	0.0	5,808		Cowlitz River	Dan Ross	dlross@energy-northwest.com	No					
46	State of Oregon	City of Portland Water Bureau	Mt. Tabor Reservoir	P-13732	Conduit Exemption	New Project	2014	0.79			Mt. Tabor Reservoir	Oregon WRD	Mary.S.Grainey@state.or.us	No	S 54647				
47	Bureau of Reclamation	Bureau of Reclamation	Palisades Dam	Upgrade	Upgrades	Replace turbines	2016	add 7.5% eff.	?		Snake River	Clark Bishop	cbishop@usbr.gov	No		Replace 4 turbines; eff. Increase			
48	Bureau of Reclamation	Bureau of Reclamation	Black Canyon Dam	Upgrade	Upgrades	Third Unit	2018	12.5	?		Payette River	Clark Bishop	cbishop@usbr.gov	No		Efficiency upgrade			
49	Bureau of Reclamation	Bureau of Reclamation	Hungry Horse Dam	Upgrade	Upgrade	Replace turbines	2019 start	add efficiency	?		Flathead River	Clark Bishop	cbishop@usbr.gov	No		Overhaul of units			
50	Avista Corporation	Avista Corporation	Little Falls	Upgrade	Upgrade	4 new units/upgr	2015-2018*	4.0	17,520		Spokane River	Michele Drake	michele.drake@avistacorp.com	No		*on upgrade per yr. at 4,380 MWh			
51	Avista Corporation	Avista Corporation	Nine Mile	Upgrade	Upgrade	Upgrade	2015	8.0	35,040		Spokane River	Michele Drake	michele.drake@avistacorp.com	No					
52	Puget Sound Energy	Puget Sound Energy	Lower Baker	Upgrade	Upgrade	New powerhouse		30	N/A										
								7130.1	**9,245,481**										
		TABLE B																	

Issued Exemptions

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Docket Number	Project Name	Energy (MWh)	Issue Date	Authorized Capcity (MW)	Licensee	Waterway	ST	Description
P- 14364	THREE SISTERS IRRIGATION	3,400	04/12/12	0.700	THREE SISTERS IRRIGATION DIST	THREE SISTERS IRRIGATION MAIN CANAL	OR	Exemption - Conduit
P- 14259	EIGHTMILE	1,120	04/26/12	0.460	JORDAN WHITTAKER	BIG EIGHTMILE CREEK	ID	Exemption - Conduit
P- 14294	MARY TAYLOR	1,840	06/28/12	0.890	TURNBULL HYDRO, LLC.	SUN RIVER	MT	Exemption - Conduit
P- 14371	WILL CRANDALL RESERVOIR/PUMP STA	60	11/14/12	0.094	CITY OF HILLSBORO, OR	WILL CRANDALL RESERVOIR	OR	Exemption - Conduit
P- 14407	ENERY RECOVERY PHASE 1	700	11/15/12	0.161	CITY OF PENDLETON, OR	UMATILLA RIVER	OR	Exemption - Conduit
P- 14440	ENERGY RECOVERY PHASE II	1,013	11/16/12	0.234	CITY OF PENDLETON, OR	UMATILLA	OR	Exemption - Conduit
P- 14448	P COULEE POWER PLANT	500	12/17/12	0.060	JAY A. MOYLE	ROCK CREEK	ID	Exemption - Conduit
P- 14498	CONDUIT 3	1,200	06/03/13	0.200	LUCID ENERGY, INC	CONDUIT 3 PIPELINE	OR	Exemption - Conduit
P- 14430	MONROE DROP	1,004	08/01/14	0.300	MONROE HYDRO, LLC	MAIN CANAL	OR	Exemption - Conduit
		10,837		**3.099**				

Table 1

Notices of Intent to Construct Qualifying Conduit Hydropower Facilities

(Status as of September 3, 2014)

Docket Number	Project Name	Applicant	County/Cou	State	Capacity (kW)	Notice of Intent Filed	Energy	Determination Issued	Determination
CD13-1/ DI13-7	Little Sand Creek Project	City of Sandpoint, Idaho	Bonner	ID	65	8/15/2013		10/9/2013	Qualifies
CD14-1	U Canal Hydro #2 Project	North Side Canal Company, Ltd.	Jerome	ID	4,800	10/3/2013		12/4/2013	Qualifies
CD14-10	Head of U Canal Hydro	North Side Canal Company, Ltd.	Jerome	ID	1,200	11/5/2013		1/8/2014	Qualifies
CD13-5	Corbett Hydroelectric Project	Corbett Water District	Multnomah	OR	10	9/23/2013		11/21/2013	Qualifies
CD13-6	Bear Creek Watershed Hydroelectric Project	City of Astoria, Oregon	Clatsop	OR	60	9/24/2013		11/21/2013	Qualifies
CD14-17*	Roaring Springs Hydropower Project	Roaring Springs Ranch	Harney	OR	37	4/9/2014		4/21/2014	Rejected
CD14-18*	Three Mile Spring Hydropower Project	Roaring Springs Ranch	Harney	OR	10.5	4/9/2014		4/21/2014	Rejected
CD14-19	City of Corvallis Rock Water Treatment Plan	City of Corvallis, Oregon	Benton	OR	28	4/24/2014		7/3/2014	Qualifies
CD14-21*	Three Mile Hydropower Project	Roaring Springs Ranch	Harney	OR	10.5	6/23/2014		8/25/2014	Qualifies
CD14-22*	Roaring Springs Headquarters Hydropower Project	Roaring Springs Ranch	Harney	OR	37	6/23/2014		8/25/2014	Qualifies
CD14-24	Lemelson Residence Project	Karuna Property, LLC	Josephine	OR	0.36	8/14/2014		8/29/2014	Rejected
					6258.36				

6.25836
MW

Table 2

The new "notice of intent" process for conduit facilities
does not require energy calculation so
that is not included in this summary.

Licensed Marine Projects - September 2014

Project Number	Project Name	Expiration Date	Issue Date	Energy (MWh)	Authorized Capacity (MW)	Licensee	Waterway	ST	Description
P- 12713	Reedsport OPT Wave Park	07/31/47	08/13/12	153,300	1.5	Reedsport Opt Wave Park, LLC	Pacific Ocean	OR	HydroKinetic-Wave
P- 12690	Admiralty Inlet	02/28/24	03/20/14	146,200	1.0	Public Utility District No. 1 of Snohomish County, WA	Admiralty Inlet, Puget Sound	WA	HydroKinetic-Tidal
				299,500	**2.5**				

Table 3

Pending Conventional Hydropower Preliminary Permits

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please email Customer@ferc.gov or call 202-502-6088; Toll-free: 1-866-208-3372; 202-502-8659 TTY.

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Docket No.	Permit Name[1]	Waterway[2]	ST	Applicant Name	Proposed Capacity (MW)	Energy (MWh)	Filing Date	Type
P- 14608	Weiser-Galloway	Weiser River	ID	Idaho Water Resources Board	60.000	365,000	03/21/14	Conventional
P- 14626	Two Girls Creek	Two Girls Creek	OR	GreenVolt Hydro, LLC	5.000	36,870	06/20/14	Conventional
					65.000	**401,870**		

Table 4

[1](PS&CON) = pumped storage and conventional project
[2]Preliminary determination of waterway based on preliminary

Issued Preliminary Permits for Conventional Hydropower

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please email Customer@ferc.gov or call 202-502-6088; Toll-free: 1-866-208-3372; 202-502-8659 TTY.

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Docket Number	Project Name[1]	Expiration Date	Issue Date	Energy (MWh)	Authorized Capacity (MW)	Licensee	Waterway[2]	ST	Description
P- 14355	EAST FORK DITCH	03/31/15	04/18/12	4,000	1.35	JOHN B. CROCKETT	EAST FORK DITCH	ID	Conventional Permit
P- 14443	CONSOLIDATED IRRG. - GLENDALE	09/30/16	10/03/13	2,526	0.5	CONSOLIDATED IRRIGATION COMPANY	MINK CREEK	ID	Conventional Permit
P- 14513	COUNTY LINE ROAD	09/30/16	10/09/13	18,300	2.5	IDAHO IRRIGATION DISTRICT	SNAKE RIVER	ID	Conventional Permit
P- 14492	RUBY RIVER RESERVOIR	08/30/16	09/16/13	10,000	2.3	HYDRODYNAMICS, INC (MT	RUBY RIVER	MT	Conventional Permit
P- 14602	TONGUE RIVER POWER	06/30/17	07/30/14	7,340	2.016	MONTANA DEPT-NATURAL RESOURCES (MT)	TONGUE RIVER	MT	Conventional Permit
P- 14205	MCKAY DAM	10/31/14	11/23/11	7,400	3.0	MCKAY DAM HYDROPOWER, LLC	MCKAY DAM	OR	Conventional Permit
P- 14381	BLUE RIVER DAM	06/30/15	07/11/12	50,000	20.0	QUALIFIED HYDRO 15, LLC	BLUE RIVER	OR	Conventional Permit
P- 14383	WHITEWATER CREEK	10/31/15	11/05/12	95,040	11.0	WHITEWATER GREEN ENERGY, LLC	WHITEWATER AND RUSSELL CREEKS	OR	Conventional Permit
P- 14538	GO WITH THE FLOW	12/31/16	01/28/14	3,000	1.2	GO WITH THE FLOW HYDRO POWER, LLC	UMATILLA RIVER	OR	Conventional Permit
P- 14546	MCKAY DAM	01/31/17	02/06/14	5,000	2.3	HOUTAMA HYDROPOWER, LLC	MCKAY DAM	OR	Conventional Permit
P- 13951	BEAR CREEK	04/30/15	05/06/11	1,200	0.85	BEAR CREEK HYDRO ASSOCIATES, LLC	BEAR CREEK	WA	Conventional Permit
P- 14110	BLACK CANYON	09/30/14	10/14/11	90,000	25.0	BLACK CANYON HYDRO, LLC	SNOQUALMIE RIVER	WA	Conventional Permit
P- 14295	SUNSET FALLS	02/28/15	03/02/12	120,000	30.0	PUD NO 1 OF SNOHOMISH COUNTY (WA)	SOUTH FORK SKYKOMISH RIVER	WA	Conventional Permit
P- 14372	ROCKY COULEE WASTEWAY	06/30/15	07/11/12	16,900	5.2	GRAND COULEE HYDRO AUTHORITY	ROCKY COULEE WASTEWAY	WA	Conventional Permit
P- 14380	PINTO DAM	09/30/15	10/10/12	8,100	3.4	GRAND COULEE HYDRO AUTHORITY	PINTO DAM	WA	Conventional Permit
P- 14352	P.E. SCOOTENEY WASTEWAY	02/28/16	03/26/13	1,480	1.1	GRAND COULEE HYDRO AUTHORITY	SCOOTENEY WASTEWAY	WA	Conventional Permit
P- 14316	PEC 1973 DROP	02/28/16	03/26/13	6,100	2.2	GRAND COULEE HYDRO AUTHORITY	POTHOLES EAST CANAL	WA	Conventional Permit
P- 14351	P.E. 46A WASTEWAY	02/28/16	03/26/13	6,750	1.6	GRAND COULEE HYDRO AUTHORITY	46A WASTEWAY	WA	Conventional Permit
P- 14349	P.E. 16.4 WASTEWAY	02/28/16	03/26/13	10,000	1.75	GRAND COULEE HYDRO AUTHORITY	16.4 WASTEWAY	WA	Conventional Permit
P- 14318	SCOOTENEY INLET DROP	02/28/16	03/26/13	5,200	1.7	GRAND COULEE HYDRO AUTHORITY	POTHOLES EAST CANAL	WA	Conventional Permit
P- 14317	SCOOTNEY OUTLET DROP	02/28/16	03/26/13	4,100	1.3	GRAND COULEE HYDRO AUTHORITY	POTHOLES EAST CANAL	WA	Conventional Permit
P- 14594	HASON	06/30/17	07/30/14	26,000	5.0	HOWARD A. HANSON POWER, LLC.	HANSON RESERVOIR	WA	Conventional Permit
				498,436	**125.27**				

Table 5

Pending Conventional Licenses

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Docket Number	Project Name[1]	Licensee	State	File Date	Application Type	Energy (MWh)	Proposed Capacity (MW)
P- 13629	Coleman	Coleman Hydro, LLC	ID	04/22/11	Original License	3,325	0.075
p- 12486	Bear River Narrows	Twin Lakes Canal Company	ID	11/27/13	Original License	5,100	10.000
P- 12788	Fall Creek Dam	Fall Creek Hydro, LLC	OR	02/28/11	Original License	5,000	10.000
P- 12965	Wickiup Dam	Symbiotics, LLC	OR	03/25/11	Original License	22,210	7.150
P- 13570	Warmsprings Dam	Warmsprings Irrigation District's	OR	04/15/13	Original License	6,600	2.700
P- 12686	Mason Dam	Baker County Oregon	OR	04/30/13	Original License	8,100	3.400
P- 13948	Calligan Creek	Snohomish County PUD No. 1	WA	08/01/13	Original License	20,717	6.000
P- 13994	Hancock Creek	Snohomish County PUD No. 1	WA	08/01/13	Original License	21,900	6.000
					Total	**92,952**	**45.325**

P- 14538	Go with the Flow	Go with the Flow Hydro Power, LLC	OR	05/05/14	5-MW Exemption	3,000	1.200
					Total	**3,000**	**1200.000**

[1](PS&CON) = pumped storage and conventional project

Table 6

PTC ORDERS ISSUED				
FERC NO.	PROJECT NAME	ISSUE DATE	STATE	GENERATION INCREASE (MWh)
2082	Klamath	5/30/2006	OR	8,343
5	Kerr	12/10/2007	MT	35,519
7194	Birch Creek	1/3/2008	ID	2,411.78
2188	Missouri-Madison	1/27/2010	MT	1,580
2301	Mystic Lake	6/2/2010	MT	6,442
2150	Baker River Hydro	12/16/2010	WA	109,575
3503	Elk Creek	12/22/2010	ID	152.89
2493	Snoqualmie Falls	2/9/2011	WA	22,030
4885	Twin Falls Hydro	3/9/2011	WA	1,256.59
2058	Cabinet Gorge	4/27/2011	WA	17,958
2058	Cabinet Gorge	4/27/2011	WA	3,943
2058	Cabinet Gorge	4/27/2011	WA	21,409
2058	Cabinet Gorge	10/11/2011	WA	9,549
2188	Missouri-Madison	4/25/2012	MT	135,155
2058	Cabinet Gorge	8/1/2012	WA	9,548
	TOTAL INCREASED GENERATION:			384,872

PTC: Production Tax Credits
Issued 8/5/05 - 9/30/14

Table 7