Exploring the Possibilities of Small Hydropower Development Utilizing NRCS-Assisted Flood Control Dams

A report prepared by the National Watershed Coalition
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Introduction

This report and topical agenda for training is provided as an agreement deliverable for NRCS Contribution Agreement No. 68-3A75-10-117, Item IV-A. 1d:

"In cooperation with NRCS identify hydropower community and agency contacts to collect information applicable to hydropower technology for watershed program structures. Also design a pilot introductory retrofitting workshop for sponsors and NRCS water resources program staff on Watershed program hydropower applications."

In addition to the summary report of background information and workshop topical agenda a list references and resources follows.

There are many variables involved in determining suitability and achieving success in producing environmentally clean and financially sound hydropower. There are a variety of challenges not limited to the well-documented regulatory, financial, environmental issues that must be considered for planning a hydropower project. Each issue has its own scope and scale directly related to the actual scope and scale of the project itself. All need to be explored and carefully evaluated as each watershed project partner considers investing its specific resources and a long-term commitment to a Watershed Structure/Hydropower project.

Hydro Background

According to the US Department of Energy hydropower projects currently provide 81% of the United States renewable electricity generation. This represents about 10% of the nation's total electricity. The National Hydropower Association (NHA) estimates that hydro generation currently produces enough electricity to power almost 38 million homes. The majority of this production comes from large-scale projects that generate more than 30 megawatts (MW). One megawatt roughly equates to enough electricity to power 1000 homes.

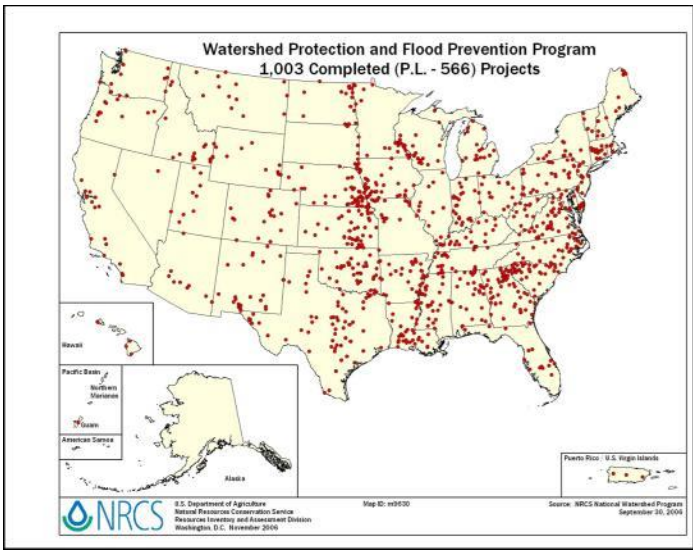
A quick review of the literature related to smaller hydro potential yields several points of interest. The NHA notes that only 3% of the nation's 80,000 dams currently generate electricity. The current interest in clean energy, reducing carbon emissions and a green economy has also spurred interest in tapping the unused potential that is represented in the inventory of existing dams in the US. Maximizing existing infrastructure has potential appeal to a variety of stakeholders.

Studies cited by the NHA indicate that the introduction of 60,000MW of electricity generation equipment/capacity has the potential to create 1.4 million cumulative jobs by the year 2025. With an estimated 10,000 MW of the total coming from converting non-powered dams, 233,333 of those jobs could be attributed to hydropower developed on existing non-powered dams.

A look at the regulatory framework for hydropower managed by the Federal Energy Regulatory Commission reveals several attempts through policy and programs to encourage small hydro development. These incentives range from special exemptions for projects no larger than 5MW to streamlining application processes and the creation of more small hydro friendly customer service models to assist developers/applicants.

While interest is high and the stage appears to be set, success still requires the right combination of physical location, water yield/flow, finance, environmental/regulatory compliance and end user/market availability.

Watershed Program Background



There are 11,000 NRCS-assisted flood control dams constructed in over 1,700 watershed projects in 47 states. The majority of these dams were constructed in rural areas for flood control on agricultural lands, although there are dams that are in or near urban areas and sometimes have multiple added uses such as water supply and recreation. Projects are required to have benefits that are directly related to agriculture, including rural communities that are at least 20 percent of the total benefits of the project. Watershed plans involving federal contributions in excess of $5,000,000 for contribution, or construction of any single structure having a capacity in excess of 2,500 acre feet, require Congressional approval.

All works of improvement, including floodwater retarding dams and reservoirs, are operated and/or owned by sponsoring local organizations and participating individuals. Sponsors for the watershed projects are local units of government, such as conservation or special purpose districts, municipal and county governments.

The concept of flood control through use of the USDA Watershed Program is to construct a series of small flood control dams in a watershed of 250,000 or less acres. These dams impound rainfall during heavy storms and slowly release the water over a period of days or weeks, thus reducing the flooding downstream along major streams or rivers. This concept of a series of small dams means that many of the dams only impound 5 to 25 surface acres of water.

The majority of the dams are located on private lands where landowners have granted easements for their construction. Water rights for the impounded water most often have been assigned to landowners . In some cases other individuals or entities may have claimed rights for other uses such as irrigation, municipal/industrial supply or recreation.

Within the USDA Watershed Program and its authorizing legislation the NRCS currently administers an active, yet underfunded structural rehabilitation program. Under this authority the NRCS structural rehabilitation effort lends itself to value added or repurposing efforts to be incorporated with the rehabilitation of aging flood control dams. Retrofitting for value added benefits through hydro generation is both an important and appealing consideration.

The following information is provided as background for those considering the possibility of utilizing/retrofitting existing flood control dams built under the USDA-NRCS Watershed Program for small hydropower.

Small Hydropower

Hydropower is created by running water from a stream or reservoir through a device which converts the power of flowing water to mechanical energy that is used to power the generation of electrical energy. One definition of small hydropower is the development of hydroelectric power on a scale serving a small community or industrial plant. The generating capacity of up to 5 megawatts (MW) is generally accepted as the upper limit of what can be termed small hydro. A 10-kilowatt micro -hydropower system generally can provide enough power for a large home, a small factory, or a small farm.

There are two basic types of small hydro generation. In small hydro literature the two are referenced as pump back and unrecovered flow. Pump back systems recirculate/recycle water through the generation equipment using power and storing the excess electricity generated. During periods of low demand excess or stored power is used to pump previously used and captured water back to a point above the point of generation so that it may be rereleased and circulated through the system again and again as needed. Unrecovered flow systems require a dependable volume of almost constant or predictable flow to be guided through the generation equipment to be released into a downstream flow where the water continues on downstream available for other use or perhaps flows out of the watershed.

Many smaller dams / reservoirs would appear better suited to a pump back system development.

The literature reveals there are several advantages to small hydropower systems, among those: They are reliable sources of electricity; require little maintenance; produces high quality, predictable electricity; have a low environmental impact; and can be incorporated into existing systems.

Disadvantages are also noted. They include a number of issues, among those: power production contingent upon head and flow; capital cost variability depending on permitting requirements (local and federal), fluctuations in labor and materials costs; location in relation to need and grid access and a constant supply of water is required.

In considering the use of small dams in creating small hydropower development several issues would require attention: Identifying dams that can provide an adequate and constant supply of water; the impact of hydro modifications on flood control function and storage capacity; the impact on hazard classification for the dam; design and cost for creating the capacity/facility for capture and pump back systems; location of dam in relationship to the end user of electricity; the cost/benefit ratio of a project; assigned water rights for other uses; the need/market for additional electricity in an area; permit requirements; new environmental issues created by the addition of hydro generation capacity/operation; and any increased liability and responsibility for project sponsors.

Financing Projects/ Financial incentives Large and Small

A review of current literature leads to the conclusion that for profit hydro generation is a complex issue requiring significant finance skill and investment. Analysis also indicates that most small hydro projects, whether the power is used in front or behind the meter, require some type or level of financial incentive or subsidization to be sustained in the current market. Incentives or subsidies are found in many forms including tax credits or exemptions, policy favorable to development, special loan or grant programs or participation in emerging carbon credit markets. The scope and scale of incentives and subsidized capital investments vary widely based on size, location and market.

Payout/return on investment estimates also vary widely with 20 years being the most common referenced. Many environmental and clean or green energy benefits are mentioned as results of hydropower development. In today's economic and political climate measuring return on investment where public funds are involved may quickly be reduced to dollars over seemingly ephemeral environmental benefits. For an initiative to be viable, solid economic and environmental data will be required on the front end. This aspect of a retrofitting project is critical for sustainability and it requires additional development if any national retrofitting initiative were to proceed.

Using and Selling Power

Power generated can be used on site "behind the meter" or connected to the grid and used or sold "in front of the meter". Selling electricity comes with its own set of policies, procedures and *safety* concerns. Most small hydro generation projects use a portion of the electricity produced and sell excess power to others through a system of metering and billing techniques that exceed the scope of this background paper. A brief explanation of metering and billing is found in the DOE publication "Small Hydropower Systems" referenced below.

Behind the meter use may contribute to a reduction in energy purchase costs for farm use, residential use or commercial use immediately located and associated with the selected watershed dam.

Watershed Project Sponsors-Benefits and Concerns

For local sponsors /owners or operators of Watershed Program Project dams hydropower development represents significant opportunity for some and challenges for all. Many sponsors would welcome the value added aspect of hydropower as they advocate for their project.

For those sponsors who actually hold title to land as well as own the water rights for the reservoir associated with their dam, hydro may present an opportunity for attracting investment and producing income. It may also add opportunity through additional environmental benefits for the project.

Hydro could open the door to carbon credits, mitigation banking credits, air quality improvement emission credits and other innovative, marketable environmental credits for project sponsors.

Hydro development would offer sponsors opportunity to partner with a new set of stakeholders. The skills and resources brought to the table by the hydro community should create additional support for the resource management efforts of the local sponsor. For sponsors faced with limited human and financial resources new partnerships may provide opportunities for addressing such issues.

With the actual volume and value of the end product unknown it is difficult to say what costs and services the outside investment or end profits in retrofit ting may cover. Maintaining NRCS expertise that can be brought to bear on processes related to permits, approvals, environmental assessments and regulations related to project modifications is an essential component for many sponsors to affordably participate in an initial retrofitting effort.

Project sponsors remain concerned about the reduced availability of NRCS Watershed Program TA and a perceived decline the technical expertise required for basic Watershed Program delivery. If a hydropower retrofitting initiative is to be developed and promoted by the Agency this issue would need to be addressed early in the process.

The challenges presented by a new and additional layer of dam safety regulation will also require a robust Sponsor/ NRCS partnership to act in concert as they work to insure compliance. Sponsors believe NRCS participation in both program management and engineering and planning decisions is both desirable and essential to maintain some level of consistency in both quality and policy across the country.

Retrofitting an NRCS Watershed Program dam to meet the FERC 5MW Exemption Criteria

Familiarity with NRCS assisted Watershed Program dams and their sponsors moves the primary target for development of successful projects toward those projects that would qualify for the 5MW exemption that is offered through the Federal Energy Regulatory Commission.

According to the FERC website **"a small hydroelectric project of 5 MW or less may be eligible for an exemption. *The applicant must propose to install or add capacity to a project located at a non federal, pre 2005 dam*, or at a natural water feature. The project can be located on federal lands but cannot be located on a federal dam. *The applicant must have all the real property interests or an option to obtain the interests in any non federal lands."*** *(Emphasis added.)*

Reducing complexity on the regulatory licensing side of the project is a significant step toward actual installation and operation. The State of Colorado has developed a criterion checklist to guide small hydro projects toward qualification for the FERC 5MW exemption. The list is a good starting point for guidance in development of projects using NRCS project dams.

Projects will:

- Be located within an existing water delivery system
- Use existing infrastructure, including points of diversion and discharge
- Have no increased stream diversions
- Be entirely contained by existing waterway structures
- The primary purpose of the infrastructure will remain, e.g., most commonly municipal water supply and irrigation *(Editor's note: Flood Control)*
- Be no significant change in operation of the infrastructure
- The water delivery system has all necessary water ri ghts, permits, licenses or other approvals required by any local, state, or federal authority
- Not adversely affect water quality
- Not adversely affect fish passage
- Not adversely affect a threatened or endangered species
- Not adversely affect a cultural resource
- Not adversely affect a recreational resource
- Meet all of the other requirements of either a conduit or a 5MW exemption *(FERC/State of Colorado MOU-2010)*

Other watershed dam retrofitting project development considerations also need to be considered in advance. Those may include site assessments, NRCS engineering development and/or review and approval of structural modifications required for hydropower generation.

A preliminary draft list of NRCS engineering concerns was developed in conjunction with this effort for use in developing a topical agenda as well as presentation development for an introductory workshop on retrofitting NRCS assisted dams for hydropower. NRCS hydrology expertise would also be a valuable resource in assessing water yield and flow duration information during the site suitability assessment process.

In many settings a method of water capture for pump back would be required for an existing dam to lend itself to hydro retrofitting. While NRCS may have a role in design criteria, design standards as well as the actual design, they most certainly would have a role in determining suitability of location relative to the existing dam. At a minimum enumeration of NRCS silting concerns to the developer in advance of capture basin/system development would be necessary.

Historically USDA-Agricultural Research Service (ARS) has also played an important research role in the USDA Watershed Program. ARS expertise may also be of value in assuring that modifications required in order to meet the conveyance and hydraulic requirements of power generation are met in a manner which is suitable and safe within the constraints of a constructed earthen/vegetated embankment typical of NRCS assisted Watershed Program dams. Additional research questions may reside in principal spillway modification and Roller Compacted Concrete (RCC) auxiliary spillway/hydro generation modifications for both dam safety and environmental compliance requirements.

Dam Safety

Hydropower development comes with its own set of dam safety considerations, which will require compliance by dam owners and developers. These regulations are implemented in addition to any other NRCS/Federal requirements as well as state dam safety program regulations. As regulations sometimes vary between levels of government and entities involved a thorough analysis of the dam safety requirements of each regulatory entity is required to insure compliance. Conflicts in regulatory policy should be addressed and resolved prior to initiation of modifications. A summary of FERC dam Safety regulations and activities is found on the FERC website and should serve as a starting point for review, analysis and resolution of potential inter regulatory conflicts.

Conclusion

The information gathered in this effort is starting point for further discussion and action.

Retrofitting for hydropower presents both opportunity and challenge. There is significant interest in the inventory of non-powered dams across the country. NRCS Assisted Flood Control dams are part of that inventory. While a preliminary inquiry by NRCS to the states resulted in a list of potential candidate sites, a more detailed criteria based assessment or sifting process is needed to focus limited resources on the viable opportunities for success. An estimated 33% of the NRCS-assisted inventory would be potential candidates for developing small hydropower systems

Due to site specific barriers to efficient retrofitting and distribution of power there would be dams that would have little possibility for efficient, viable development. Many dams may offer opportunity for small systems that would produce all or supplement electricity for individual homes, farms or small businesses.

Further assessment of the NRCS dams inventory is needed to determine existing dams that have the potential to attract commercial for profit hydropower development. The feasibility of these projects would be dependent on individual site specific conditions.

Discussion between NRCS, FERC and DOE beyond the current arena of dam safety is needed. There is significant information available from DOE, FERC and NHA on small hydropower. There is a major lack of information and understanding by those entities concerning NRCS and its Watershed Program activities and portfolio of federally assisted dams. Dialog is required to determine if there is a fit worthy of investing in an initiative to retrofit suitable NRCS assisted flood control dams.

A retrofitting initiative could yield value added benefits to the Watershed Program dams as well as contribute to a number of NRCS environmental goals for reducing carbon emissions and improving air and water quality. The scope and scale of the benefits would be directly proportional to the number of NRCS assisted dams found to be suitable for inclusion in a retrofitting initiative.

The level of investment required will require NRCS to play a role in attracting, retaining and interacting with public and private sector finance and for profit energy developers.

The Conservation Innovation Grant (CIG) program administered by USDA NRCS is one opportunity for NRCS to address and answer questions concerning the potential for a meaningful hydropower retrofitting initiative for dams created under their Small Watershed Program.

Through research and pilot projects the engineering, economic and program expertise of NRCS could be brought to bear on many of the issues identified in this preliminary examination of hydropower potential. The CIG program provides an avenue for implementation followed by evaluation for potential technology transfer. Success would require a significant long-term commitment by NRCS of focus, technical and financial resources to a small hydro initiative.

TOPICAL AGENDA
Introductory Hydropower Workshop
Length: 2 1/2 Days

> New Opportunities for NRCS Assisted Watershed Projects: Hydropower

> The Partners---Roles and Relationships New and Old
- DOE
- FERC
- NRCS
- Sponsors
- Dam Owner/Water Rights Owner
- Hydro Contractor
- Aggregator/Marketer or End User

> Hydropower Basics
- What is Small Low Head Hydro
- How Hydropower Works---Flow and Pump Back Systems
- Benefits of Small Hydropower
- Barriers to Small Hydropower
- Scale and Scope---Right Sizing Projects

> Financing Hydro Project Costs
- Finance Options
- Commercial Viability
- Incentives and Subsidization

> Site Selection/Suitability
- Location for Access to Grid or On Site Point of use
- Pre and Post Hazard Classification
- Drainage Area Water Yield and Seasonable Availability
- Land Rights/Access Considerations

Watershed Structure Engineering Basics and Hydropower Opportunities
- Conveyance of Water
- Minimum Criteria for Suitability
- Environmental and Engineering Concerns

> Dam Safety and Small Low Head Hydropower Development
- FERC's Dam Safety Program
- NRCS Dam Safety Concerns
- State Dam Safety Concerns

> Developing Retrofitting Small Watershed Hydropower Projects
- NRCS's Role
- Sponsor's Role
- Developer's Role
- FERC's Role

> Hydro Hardware and Installation

- Off the Shelf
- Shop Made
- Contractor/Developer Supplied

> Pre and Post Regulatory and Licensing Procedures

- License
- 5---Megawatt Exemption and NRCS Assisted Watershed Structures
- Conduit Exemption

> FERC Assistance and the Licensing Process

- Pre---filing Consultation and Initial Project Review
- Application Processing
- Expedited Process and Factors to Reduce Time and Cost

> On or Off the Grid?

- Producing Power
- Aggregating Production
- Which Side of the Meter?
- Customers and Clients – Marketing and Sales

> Small Hydro Case Study

- Elephant Butte Irrigation District
- Others

> Retrofitting Concerns for Watershed Project Sponsors

- Clear definition of Liability/Responsibility related to changes or modifications
- New Dam Safety Regulations
- New O&M Issues related to Modifications
- Flood Storage Capacity and Flood Event Operation

Web Site References:

The web based references listed below reflect both the pros and cons of small hydropower as well as considerations for potential project development. The links, pdf files and references included provide a gateway for a more in depth review and analysis by the reader. They are provided solely as a source of further reading and an opportunity for hydropower background education. The references are not presented as a reflection the opinions or policies of the National Watershed Coalition or its individual members.

http://hydro.org/tech---and---policy/developing---hydro/small---hydro/

http://hydro.org/wp---content/uploads/2010/12/Converting4.pdf

http://hydro.org/

http://www.ferc.gov/industries/hydropower/gen---info/licensing/small---low---impact.asp

http://hydropower.inel.gov/environmental/pdfs/ornltm---11673.pdf

https://inlportal.inl.gov/portal/server.pt?open=514&objID=1269&mode=2&featurestory=DA 62292

http://hydropower.inl.gov/prospector/index.shtml

http://hydropower.inl.gov/techtransfer/index.shtml

http://www1.eere.energy.gov/water/hydropower resources.html

http://www.nrel.gov/docs/fy01osti/29065.pdf

http://www.smallhydropower.com/manual3.htm

http://www.wvu.edu/~exten/infores/pubs/ageng/epp13.pdf

http://www.dnr.state.mn.us/waters/surfacewater section/stream hydro/cranking.html