U.S. DEPARTMENT OF ENERGY

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Pacific Northwest National Laboratory
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The Integrated Basin-Scale Opportunity Assessment Initiative: Phase 1 Methodology and Preliminary Scoping Assessments for the Connecticut River and Roanoke River Basins

Annual Report 2013

Pacific Northwest National Laboratory
Oak Ridge National Laboratory

September 2013 (revised November 2013)

OAK RIDGE National Laboratory

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GE Johnson, MS Bevelhimer[1], KB Larson, JD Tagestad, JW Saulsbury[1], RA McManamay[1], CA Duberstein, CR DeRolph[1], SL Hetrick[1], BT Smith[1], and SH Geerlofs

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Preface

The study reported herein was conducted in support of the U.S. Department of Energy (DOE) Water Power Program's Basin-Scale Opportunity Assessment (BSOA) initiative. The goal of the BSOA initiative is to develop and implement an integrative approach for the assessment of hydropower and environmental opportunities at a river-basin scale. The BSOA initiative commenced in fiscal year 2010 (FY10) and is scheduled to be completed in FY14. During FY11-12, research was focused on a pilot study in the Deschutes River basin in central Oregon. Based on that experience, a three-phased, sequential assessment strategy for a given basin was recommended for future work: Phase 1 Scoping Assessment, Phase 2 Stakeholder Engagement, and Phase 3 Technical Analysis. FY13 research objectives concerned development of a technical approach and quantitative, geospatial methodology for Phase 1 Scoping Assessments in two river basins in the contiguous United States: the Connecticut River and Roanoke River basins. The DOE and the U.S. Bureau of Reclamation identified a third basin, the Big Horn/Powder River basin, and scheduled a Phase 1 Scoping Assessment for it in FY14. Objectives proposed for FY14 are to refine the Phase 1 methodology, complete the three Phase 1 Scoping Assessments, obtain technical peer review, and conduct outreach regionally and nationally.

The FY13 research was performed through a collaboration of the Pacific Northwest National Laboratory (PNNL) and Oak Ridge National Laboratory (ORNL), with active participation from DOE. DOE's managers for the project were Hoyt Battey and Thomas Heibel. Simon Geerlofs (PNNL) was the project manager and he worked closely with Brennan Smith (ORNL) as co-laboratory leads to coordinate teams and integrate work between PNNL and ORNL. The PNNL/ORNL team responded to oversight and guidance from the DOE and the BSOA national steering committee, including the federal signatories of the Hydropower Memorandum of Understanding (DOE, Bureau of Reclamation [BOR], and U.S. Army Corps of Engineers). The research was organized so that it was integrated vertically (within a basin) and horizontally (across basins). A philosophy of the project team was that there be co-thought leadership among DOE, ORNL, and PNNL.

This FY13 annual report documents a technical approach and methodology for Phase 1 Scoping Assessments and *preliminary* assessments for the Connecticut River and Roanoke River basins. The assessments are preliminary because 1) the methods and findings have not yet been reviewed by the BSOA national steering committee, expert scientists and engineers, or basin stakeholders, and 2) there may be important data sets that should be included but are not at this time. Such peer review and outreach is scheduled to occur in FY14, when the Connecticut and Roanoke assessments are scheduled to be finalized and published as standalone documents. To be clear, the contents of this report are not intended for use in any manner in the hydropower relicensing proceedings of the Federal Energy Regulatory Commission.

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Acknowledgments

We thank Hoyt Battey and Thomas Heibel (DOE); members of the BSOA national steering committee, including Linda Church-Ciocci (National Hydropower Association), Julie Keil (Portland General Electric), Jeff Leahy (National Hydropower Association), Kerry McCalman (BOR), Lisa Morales and Kamau Sadiki (U.S. Army Corps of Engineers), Jeff Opperman (The Nature Conservancy [TNC]), Mike Pulskamp (BOR), Richard Roos-Collins (Water and Power Law Group), and John Seebach (Low Impact Hydropower Institute). We also are grateful to assistance from Mike Sale (BCS, Inc.); Melanie Harris, Fritz Rohde, Bill McDavitt, and Sean McDermott (National Marine Fisheries Service); Kurt Imhoff and Chris Vernon (PNNL); Kim Lutz and Chuck Peoples (TNC); John Ragonese (TransCanada); Chris Hatfield and Frank Yelverton (USACE); and Mark Tedesco (U.S. Environmental Protection Agency).

Synopsis

The ongoing Basin-Scale Opportunity Assessment (BSOA) initiative, led by the U.S. Department of Energy's (DOE's) Water Power Program, is establishing an integrative approach for the assessment of combined hydropower-environmental opportunities for selected river basins. Under the BSOA initiative, Phase 1 Scoping Assessments are intended to provide initial identification, classification, screening, and integration of possible hydropower and environmental opportunities in a given basin for DOE and basin stakeholders to consider carrying forward as appropriate. The fiscal year 2013 (FY13) study reported herein developed a technical approach and methodology for BSOA Phase 1 assessments and performed preliminary assessments in the Connecticut River and Roanoke River basins.

Opportunities are defined in this process as possible actions for hydropower development or environmental improvement. An environmental "opportunity" is defined as a situation in which an existing environmental issue can be improved, either directly or indirectly, as a result of or in conjunction with a hydropower action. Other environmental opportunities independent of a hydropower action, such as ecosystem restoration, water management, and wetland rehabilitation, are possible, but were not considered at this time because focus was on combined hydropower-environmental opportunities, i.e., opportunities for hydropower development that have associated environmental improvements.

The technical approach has 10 steps. It begins with planning/organization, basin selection, and key stakeholder identification. Next, information is compiled from national databases and literature sources on basin-specific hydropower opportunities and key environmental issues that may either be improved by or offset hydropower development. Hydropower opportunities are identified, which can involve powering non-powered dams, new stream-reach development (i.e., constructing a new hydropower dam), increasing generation at existing hydropower facilities, installing hydrokinetic devices in streams and rivers, and powering of non-powered water conveyance systems, such as canals and pipes. Next, environmental issues are identified, such as fish interactions, water quality, aquatic habitat loss/ degradation, hydrologic modification, and other water resource concerns. The hydropower and environmental information is then integrated in a geospatially derived data model that was developed specifically to assess interactions between hydropower opportunities and environmental issues to identify combined hydropower-environmental opportunities. The approach ends with stakeholder outreach/feedback and finalization of the assessment.

For the preliminary assessments in the Connecticut and Roanoke basins, we focused on hydropower opportunities for powering non-powered dams or new stream-reach development, because relevant data were readily available from the National Hydropower Asset Assessment Program database. Similarly, comparable environmental issues were assessed in each basin: impaired water quality (DO, temperature, sediment, turbidity); high hydrologic disturbance; impaired fish passage; and poor access to non-motorized boat recreation (whitewater and paddling). Dam removal, based on The Nature Conservancy's Northeast Aquatic Connectivity Tool, was included as an environmental opportunity if the particular dam was in catchments intersected by the reservoir or tailwater of the prospective hydropower development site. The following combined hydropower-environmental opportunities were investigated in the preliminary Phase 1 Scoping Assessments.

Powering non-powered dams (NPD) or new stream-reach development (NSD) may:

- Increase dissolved oxygen in downstream reaches exhibiting dissolved oxygen impairment, assuming aeration is incorporated into new development.
- Provide better flow management in downstream reaches containing excessive sedimentation or turbidity impairment.
- Provide improved thermal control in downstream reaches exhibiting temperature impairment.
- Provide better flow management in downstream reaches exhibiting high hydrologic disturbance.
- Provide better flow management conducive for whitewater paddling.
- Result in improvements to fish passage, including dam removal or facility modifications, assuming the hydropower development is contingent on fish passage improvements.
- Provide access to increase recreational trout fishing opportunities.
- Provide access to improve reservoir recreational fishing opportunities.

The results of the preliminary Phase 1 Scoping Assessment of combined hydropower-environmental opportunities for the Connecticut River and Roanoke River basins are summarized as follows by the total number and megawatts (MW) of NPD and NSD hydropower sites that were linked to at least one potential environmental opportunity.

River Basin	Non-Powered Dams		New Stream-Reach Development	
	Number	MW	Number	MW
Connecticut	17	20.7	20	35.2
Roanoke	9	4.8	27	97.6

In conclusion, it is important to realize that these are only *preliminary* FY13 assessment results, because an important next step scheduled for FY14 is to reach out to key stakeholders in each basin to request review and feedback on the approach, methodology, and results.

Acronyms and Abbreviations

BOR	Bureau of Reclamation
BSOA	basin-scale opportunity assessment
cfs	cubic (foot) feet per second
DOE	Department of Energy
EPA	U.S. Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
ft	foot (feet)
FY	fiscal year
GAP	Gap Analysis Program
GIS	geographic information system
HUC	hydrologic unit code
km	kilometer(s)
km^2	square kilometer(s)
MOU	Memorandum of Understanding
MW	megawatt(s)
NABD	National Anthropogenic Barrier Data set
NCAT	Northeast Aquatic Connectivity Tool
NFHAP	National Fish Habitat Action Plan
NHD	National Hydrography Data set
NHAAP	National Hydropower Asset Assessment Program
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service
NPD	non-powered dam
NPS	National Park Service
NSD	New Stream-reach Development
NPD	non-powered dams
NWSR	National Wild and Scenic River
ORNL	Oak Ridge National Laboratory
PAD	protected area database
PD	powered dam (existing)
PNNL	Pacific Northwest National Laboratory
RRBA	Roanoke River Basin Association
T&E	threatened and endangered
TNC	The Nature Conservancy
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

USFS	U.S. Forest Service
USGS	U.S. Geological Survey

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1.0 Introduction

The study reported herein was conducted for the U.S. Department of Energy (DOE) by researchers at the Pacific Northwest National Laboratory (PNNL) and the Oak Ridge National Laboratory (ORNL). The study responded to the Basin-Scale Opportunity Assessment (BSOA) initiative being led by DOE. The PNNL/ORNL team developed an approach and methodology for BSOA Phase 1 Scoping Assessments and performed preliminary assessments in the Connecticut and Roanoke river basins. The purpose of a Phase 1 Scoping Assessment is to identify combined hydropower-environmental opportunities[1] in a given basin for DOE, basin stakeholders, and others to consider pursuing as appropriate.

1.1 Background

The BSOA initiative originated as an action item in the 2010 Memorandum of Understanding (MOU) for Hydropower among the DOE (Office of Energy Efficiency and Renewable Energy), Interior (Bureau of Reclamation; BOR), and Army (U.S. Army Corps of Engineers [USACE]). The purpose of the Hydropower MOU (DOE et al. 2010) is to "…help meet the Nation's needs for reliable, affordable, and environmentally sustainable hydropower by building a long-term working relationship, prioritizing similar goals, and aligning ongoing and future renewable energy development efforts…" among the three signatory federal agencies. The MOU agencies, while recognizing that hydropower is the largest source of renewable energy in the nation, emphasized that efforts to increase hydropower generation must avoid, mitigate, or improve environmental conditions in our nation's rivers and watersheds. Accordingly, the goal of the BSOA initiative is to develop and implement an integrative approach for the assessment of hydropower and environmental opportunities at a basin scale.

The BSOA initiative emphasizes sustainable, low-impact, or small hydropower, and related renewable energies, while simultaneously identifying opportunities for associated environmental improvements in a given basin. By exploring specific pathways through which integrated hydropower and environmental opportunities might be feasible, the BSOA initiative complements other DOE assessments of hydropower, such as small hydropower (Hall et al. 2006), powering non-powered dams (Hadjerioua et al. 2012), and new stream-reach development (i.e., constructing a new hydropower dam; Kao and Smith 2013). The BSOA initiative provides a framework with nationally deployable applicability to identify, investigate, synthesize, and visualize "win-win" hydropower and environmental opportunities at the basin scale. By shifting focus from the site to the basin, system-scale opportunities that benefit both hydropower and environmental conditions can be assessed. Expanding the scale of analysis enables identification of commonality among the sometimes disparate goals of regional stakeholders and increases the possibility that development can proceed with fewer conflicts. Federal, state, and local agencies; the hydropower industry; the environmental community; and other stakeholders in a basin could benefit from the identification and development of "win-win" opportunities resulting in the generation of more energy and improvement of environmental conditions. Information from basin-scale opportunity assessments is intended to encourage subsequent dialog among regional stakeholders about feasible actions that can be taken at the basin scale to increase hydropower generation while protecting and improving environmental values, within the context of existing uses.

[1] By definition, a combined hydropower-environmental opportunity is an opportunity for hydropower development that has possible direct or indirect environmental improvements associated with it.

The MOU agencies established a national steering committee to serve in an advisory capacity to research team members from the Pacific Northwest and Oak Ridge national laboratories during implementation of the BSOA initiative. The national steering committee consists of representatives of the MOU agencies, hydropower industry, the environmental community, and other key stakeholders. During fiscal year 2010 (FY10), the national steering committee selected the Deschutes River basin in central Oregon for a pilot study. Since then, researchers have developed a multidisciplinary toolbox to conduct opportunity assessments using geographic information system (GIS) models, hydrology modeling, water management operational modeling, hydropower technology evaluation, data visualization, and stakeholder engagement (Geerlofs et al. 2011). Based on experience from the pilot study, a three-phased, sequential assessment approach for a given basin was identified to improve the cost effectiveness, research efficiency, and impact of the BSOA initiative. The phases are as follows:

- Phase 1 Scoping Assessment − rapid (approximately 6 months), initial classification, screening, and identification of potential combined hydropower-environmental opportunities;
- Phase 2 Stakeholder Engagement − stakeholder-driven opportunity identification, prioritization, and scenario building;
- Phase 3 Technical Analysis − detailed analysis of interactions and tradeoffs between hydropower and environmental opportunities in the context of other water uses.

Progression from one phase to the next requires a conscious go/no go decision on the part of DOE and the national steering committee. Specifically, the intent of a Phase 1 Scoping Assessment for a given basin is to identify the stakeholder and hydrologic context, list and map possible hydropower opportunities and environmental issues in the basin, and perform geospatial analysis to identify potential combined hydropower-environmental opportunities.

1.2 Objectives and Report Contents

The objectives of the FY13 BSOA research were to 1) develop a stepwise technical approach and quantitative, geospatially driven methodology for Phase 1 Scoping Assessments, and 2) conduct preliminary assessments for the Connecticut River and Roanoke River basins. The technical approach and methodology for a Phase 1 Scoping Assessment is described in Section 2.0. The preliminary Phase 1 Scoping Assessments for the Connecticut and Roanoke basins are contained in Sections 3.0 and 4.0, respectively. Section 5.0 contains discussion and Section 6.0 lists the references. Appendices A and B contain supporting materials for the Connecticut and Roanoke assessments, respectively.

2.0 Technical Approach

The PNNL/ORNL team developed a stepwise technical approach[1] to Phase 1 Scoping Assessments. The approach (Figure 2.1) started with planning/organization and basin selection (Steps 1−2). The core of the assessment process consisted of five main steps (Steps 3−7). The major technological advance derived from this research was new quantitative geospatially driven methods of identifying and assessing combined hydropower-environmental opportunities[2] (Step 7). The approach closed with outreach/feedback and finalization (Steps 9−10). General methodologies for Steps 2−7 are described in this section.

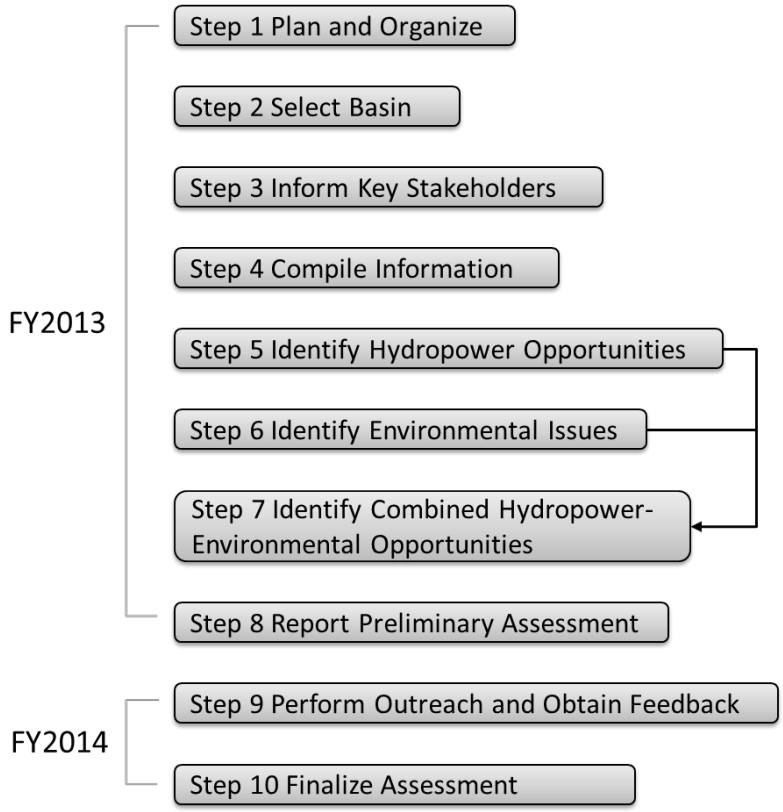

Figure 2.1. Stepwise technical approach for Phase 1 Scoping Assessments for a given basin. The fiscal years denote scheduling for the preliminary and final assessments for the Connecticut and Roanoke river basins. The connection lines between hydropower opportunities and environmental issues to combined hydropower-environmental opportunities highlight this fundamental aspect of the BSOA initiative.

[1] We make a distinction between "approach" and "methodology"—approach means the overall composition and relationships among the steps, whereas methodology refers to data manipulation and analytical procedures specific to a given step in the approach.

[2] By definition, opportunities are possible actions and issues are problems. An environmental "opportunity" is defined as a situation where an existing environmental issue can be alleviated as a result of a hydropower action. Other environmental opportunities independent of a hydropower action, such as ecosystem restoration, water management, and wetland rehabilitation, are possible, but were not considered at this time because the focus was on combined hydropower-environmental opportunities.

2.1 Select Basins

To select basins for Phase 1 Scoping Assessments, we developed selection criteria to score prospective basins for applicability, and coordinated decision-making discussions among DOE, the national steering committee, and the PNNL/ORNL team. In addition to the selection criteria used in FY10[1] for the BSOA pilot study, we assessed the potential for significant environmental and hydropower improvements, existing stakeholder engagement mechanisms, and coverage of different regions across the contiguous United States. Information from Internet searches and the National Hydropower Asset Assessment Program[2] (NHAAP; http://nhaap.ornl.gov/) database was used to score and rank every basin in the United States (defined by the six-digit hydrologic unit code; HUC 6) based on three categories: hydropower opportunities, environmental issues, and stakeholder involvement. For purposes of ranking, scores were standardized to values between 0 and 1 for each of the three categories. A grand total score was computed for each basin with a higher cumulative score being an indicator of greater potential for basin-scale opportunity assessment. The metrics for each category are listed in Table 2.1.

Table 2.1. Metrics used as indicators of favorable conditions for a basin-scale assessment solely for the purpose of selecting basins for further evaluation.

Metric	Metric Strength Favorable to Basin-Scale Opportunity Assessment
Hydropower Opportunity	
Number of existing powered dams	High
Capacity of existing powered dams (megawatts[MW])	High
Number of existing USACE and BOR dams	High
Number of non-powered dams (NPDs)	High
Capacity of NPD potential USACE (MW)	High
Capacity of NPD potential BOR (MW)	High
Capacity of new site potential (MW)	High
Capacity of new site potential (MW/acre)	High
Environmental Opportunity	
Fish habitat degradation based on Habitat Condition Index scores from U.S. Fish and Wildlife Service National Fish Habitat Action Plan database	High
Water-quality degradation based on EPA's Clean Water Act 303d list of impaired waters	High
Total number of dams	High
Number of threatened or endangered fishes, snails, crustaceans, or clams	High
Number of major migratory fish species present	High
Stakeholder Involvement	
Number of Federal Energy Regulatory Commission (FERC) licenses expiring in next 10 years	High
Capacity (MW) of FERC licenses expiring in next 10 years	High
Number of boat ramps	High

[1] During FY10, selection criteria for the basin for the BSOA pilot study included known potential hydropower and environmental opportunities, potential for effective basin coordination or leadership, opportunity for learning, opportunities to address other water uses, potential to integrate renewable energy sources, and stakeholder interest.
[2] The National Hydropower Asset Assessment Program conducted by ORNL has produced a geospatial database of hydropower assets and corresponding environmental attributes for the entire United States.

Table 2.1. (contd)

Metric	Metric Strength Favorable to Basin-Scale Opportunity Assessment
Amount of recreational whitewater (km)	Low
Ratio of surface water use to annual precipitation	Low
Area of protected lands per total HUC area	Low
Number of federal landowners/agencies	Low

We applied the selection criteria to identify candidate basins, which were then presented to the national steering committee. The top 25 basins identified in this process are listed in Table 2.2. (The entire data set is available from M. Bevelhimer, ORNL.) To facilitate the selection process, a conference call with DOE, the national steering committee, and the PNNL/ORNL team was held on March 22, 2013 to discuss basin selection in general, the selection data set, and possible candidate basins. After this call, S. Geerlofs (BSOA Project Manager) pursued follow-up conversations with DOE and national steering committee members to select two basins—the Connecticut River and Roanoke River basins. The rationales for selecting the Connecticut and Roanoke basins are contained in the introductory material for each Phase 1 Scoping Assessment (Sections 3.0 and 4.0, respectively). The PNNL/ORNL team understood that both basins have active regulatory proceedings under way that must not be affected or jeopardized by a Phase 1 Scoping Assessment.

Finally, a third basin was selected to fulfill the DOE's and national steering committee's desire for the BSOA initiative to include Phase 1 Scoping Assessments for three basins in the contiguous United States. After consulting with the BOR, and because of the desire to include a western U.S. basin to complement the two eastern basins, a third basin (Big Horn/Powder) was added in June 2013 for Phase 1 Scoping Assessment during FY14.

Table 2.2. Rank of the top 25 river basins in United States based on scores for hydropower opportunity (HO), environmental opportunity (EO), and stakeholder interest (SI). HO, EO, and SI scores are standardized (0-1). The total score range is 0-3. The Connecticut River and Roanoke River basins are highlighted.

Rank	Region (HUC2)	Subregion (HUC4)	Basin (HUC6)	HO	EO	SI	Total
1	New England Region	Androscoggin	Androscoggin	0.86	0.80	0.87	2.5
2	South Atlantic-Gulf Region	Alabama	Alabama	0.89	0.71	0.86	2.5
3	New England Region	Saco	Saco	0.79	0.90	0.76	2.4
4	New England Region	Merrimack	Merrimack	0.86	0.87	0.71	2.4
5	New England Region	Connecticut	Lower Connecticut	0.91	0.84	0.69	2.4
6	Arkansas-White-Red Region	Lower Arkansas	Robert S. Kerr Reservoir	0.89	0.87	0.68	2.4
7	Mid Atlantic Region	Upper Hudson	Upper Hudson	0.84	0.79	0.75	2.4
8	South Atlantic-Gulf Region	Chowan-Roanoke	Roanoke	0.77	0.85	0.76	2.4
9	Missouri Region	Chariton-Grand	Grand	0.48	0.86	1.00	2.3
10	Ohio Region	Scioto	Scioto	0.76	0.84	0.73	2.3

Table 2.2. (contd)

Rank	Region (HUC2)	Subregion (HUC4)	Basin (HUC6)	HO	EO	SI	Total
11	New England Region	Connecticut Coastal	Connecticut Coastal	0.79	0.86	0.67	2.3
12	South Atlantic-Gulf Region	Edisto-Santee	Santee	0.79	0.79	0.74	2.3
13	Arkansas-White-Red Region	Arkansas-Keystone	Arkansas-Keystone	0.62	0.82	0.86	2.3
14	Lower Mississippi Region	Lower Red-Ouachita	Upper Ouachita	1.00	0.60	0.69	2.3
15	Mid Atlantic Region	Delaware-Mid Atlantic Coastal	Upper Delaware	0.88	0.76	0.65	2.3
16	Mid Atlantic Region	Susquehanna	Lower Susquehanna	0.71	0.79	0.79	2.3
17	Arkansas-White-Red Region	Lower Canadian	Lower Canadian	0.68	0.76	0.85	2.3
18	New England Region	Connecticut	Upper Connecticut	0.81	0.67	0.80	2.3
19	South Atlantic-Gulf Region	Alabama	Coosa-Tallapoosa	0.87	0.63	0.76	2.3
20	Arkansas-White-Red Region	North Canadian	Lower North Canadian	0.55	0.86	0.84	2.2
21	Ohio Region	Upper Ohio	Upper Ohio-Little Kanawha	0.68	0.77	0.79	2.2
22	New England Region	Massachusetts-Rhode Island Coastal	Massachusetts-Rhode Island Coastal	0.65	0.96	0.62	2.2
23	South Atlantic-Gulf Region	Pearl	Pearl	0.56	0.79	0.87	2.2
24	South Atlantic-Gulf Region	Cape Fear	Cape Fear	0.65	0.83	0.73	2.2
25	Arkansas-White-Red Region	Lower Arkansas	Lower Arkansas-Fourche La Fave	0.82	0.71	0.67	2.2

2.2 Inform Key Stakeholders

The purpose of this step in the Phase 1 process was coordination. For the Connecticut and Roanoke basins, we worked with the BSOA national steering committee to identify a small number of "key" strategic stakeholder groups, their interests, and points of contact. The key stakeholders necessarily have expert knowledge of the basin. We contacted stakeholders, such as hydropower operators, federal agencies, and leading environmental organizations, and informed them of the Phase 1 assessment. By design, stakeholder interaction during Phase 1 was minimal; the focus was on informing stakeholders (FY13) and obtaining feedback (FY14) on the preliminary assessment. For Phase 1, we identified representatives of stakeholder groups rather than individual stakeholders; individuals can be identified as appropriate in the more extensive stakeholder outreach to be conducted during Phase 2, if the decision is made to proceed to the next phase. Basin-specific methods and contact information for key stakeholders are included in the preliminary Phase 1 Scoping Assessments for Connecticut and Roanoke basins (Sections 3.0 and 4.0 of this report, respectively).

2.3 Compile Information

This step involved obtaining and reviewing key information resources for each basin, including reports, planning documents, and publically-available data sets. The PNMNL/ORNL team examined general information about hydropower opportunities (e.g., powering non-powered dams, pumped storage projects, in-conduit or constructed waterways, and instream hydrokinetics). A broad list of environmental issues pertaining to water resources (e.g., fish passage, water quality, aquatic habitats, watershed condition, instream flow, recreation) was developed to guide research on potential environmental opportunities (Table 2.3). To obtain information, we also 1) reviewed the Federal Energy Regulatory Commission (FERC) eLibrary website; 2) reviewed the list of watershed organizations listed in the U.S. Environmental Protection Agency (EPA) web site "Surf Your Watershed" (EPA 2013); and 3) conducted a general Internet search. When applicable, information gathered was documented in a bibliographic database.

Table 2.3. General list of common environmental issue categories and subcategories applicable to Phase 1 Scoping Assessments. See Table 2.4 (Section 2.5) for descriptions and data sets for many of the environmental issues listed here.

Issue	Subcategory	Issue	Subcategory
Fish Interactions	Injury	Water Quality	Temperature
	Barriers		Dissolved gases
	Entrainment		Pollution
	Harvest		Turbidity/erosion
	Competition/predation		pH/acidification
	Population augmentation		Bacteria
	Other		DOM/nutrients
Aquatic Habitat Loss/Degradation	Life cycle habitat		Salinity
	T&E species habitat		Other
	Critical habitat	Hydrology & Hydraulics	Surface, sub-surface input
	Sensitive habitat		Hydraulic modification
	Riparian condition		Morphological changes
	Inundation or dewatering		Sediment/nutrient export
	Habitat condition		Land cover changes
	Other		Precipitation changes
Socio-Concerns	Wild and scenic river		Other
	Protected areas		
	Recreational importance		
	Cultural importance		
	Aesthetic preservation		

2.4 Identify Hydropower Opportunities

Information from the NHAAP database was used to identify hydropower development opportunities at existing powered dams, non-powered dams, and potential new stream-reach development sites. Non-powered dams (NPDs) were evaluated for the potential to install turbines and generate power. New stream-reach development (NSD) sites were evaluated for suitability of dam installation within the context of the hydrologic and environmental screening methodology presented herein. Opportunities for improving efficiency at existing powered dams were examined but not included in the assessment of

combined hydropower-environmental opportunities, because of analytical limitations at this time. In FY14, however, existing powered dams are scheduled to be evaluated for the potential to increase capacity, improve efficiency of operations, increase head, and replace existing turbines with fish-friendly turbine designs, such as the Alden turbine. Other hydropower development opportunities, such as powering of non-powered water conveyance systems (canals and pipes) and instream hydrokinetics, were considered, but not included because they apparently are not being realized at this time in the Connecticut and Roanoke basins.

The PNNL/ORNL team derived reservoir (where applicable) and tailwater data sets for each hydropower opportunity to allow for subsequent analysis of spatial interactions between the hydropower opportunities and environmental issues (Figure 2.1; Step 7). The reservoir data set included water bodies (i.e., reservoirs/lakes/ponds) from the high-resolution National Hydrography Data set (NHD) that are greater than 0.1 km^2 in size and are located within a maximum distance of 300 ft from the associated dam. The tailwaters data set included medium resolution NHD stream flow lines that extend approximately 10 miles downstream of each dam site.

Spatial representations of the dams and their associated tailwaters and reservoirs were loaded into the GIS database supporting the BSOA data model (described below). Descriptive information about each hydropower opportunity was also loaded into this database to allow for hierarchical viewing and analysis of hydropower spatial data.

2.5 Identify Environmental Issues

The purpose of this step was to identify and map key environmental issues in the basin that may present challenges for or potentially be improved by potential hydropower development opportunities. Key environmental issues were ascertained from publicly-available resources such as watershed planning documents, stakeholder reports, environmental impact statements, water-quality certifications, regulatory filings for hydropower projects, and nationally available environmental data (e.g., EPA's Clean Water Act 303d list of impaired waters [EPA 2013], National Fish Habitat Assessment Program, and NatureServe). Spatial representations of environmental issues were derived from existing geospatial data or manually georeferenced from information in literature sources and loaded into the geodatabase supporting the BSOA data model (see Step 7; Figure 2.1). Environmental data were categorized in the geodatabase based on the issue categories developed in Step 4 (Table 2.3) to allow for hierarchical viewing and analysis of combined hydropower-environmental opportunities (Step 7). A customized tool was developed within the GIS to facilitate and standardize data entry in the geodatabase.

Environmental opportunities were defined as issues related to environmental degradation in the basin that could be mitigated or improved by one of the following actions: 1) adding a turbine to an existing NPD, 2) increasing the efficiency or change of operations at existing hydropower facilities, and 3) new stream-reach development (i.e., constructing a new hydropower facility). In addition, ecological, cultural, or aesthetic issues representing potential public resistance to or negative impact caused by hydropower development were also identified and used to filter the hydropower opportunities. Key environmental issues were identified using public data sources, including watershed planning documents, stakeholder reports, environmental impact statements, water-quality certifications, and records of decision for existing and proposed hydropower projects. Once key environmental issues were identified, they were categorized (Table 2.3). Geospatial coverage of environmental issues were compiled in three main ways:

1) by accessing the NHAAP environmental database, 2) by extracting and geo-referencing data from literature, and 3) by creating previously unavailable data sets through geoprocessing. Data from literature were compiled by extracting environmental issues from text and mapping each issue by location reference (e.g., the confluence of Beaver and Granite Creeks to Highway 314). All geospatial data were input to a GIS and intersected with networked hydrologic catchments, which served as a common map unit for cataloging environmental issues with disparate spatial representations (point, line, or area) and extents. The map of environmental issues provided the basis for environmental opportunity identification based on the interaction of potential hydropower developments and potential management changes.

Brief descriptions and data sets used for the Connecticut and Roanoke assessments are provided in Table 2.4. We describe issue subcategories and associated data in detail in the ensuing narrative.

Table 2.4. Descriptions and data sets used for the Connecticut and Roanoke assessments. Data sets obtained or created to address each issue are noted. Asterisks (*) indicate data that were obtained from the NHAAP environmental database.

Issue Category Sub-Category	Description	Data Set(s)
Fish Interactions		
Barriers	Physical barriers (i.e. dams, weirs, culverts) preventing migratory movements of fish	NCAT Tool (TNC); NABD
Injury/ Entrainment	Injuries or morality resulting from entrainment through dam, turbine strike, and associated hydropower operations	FERC orders; USACE NID; NABD
Water Quality		
Temperature	Abnormal temperatures (too low or too high)	EPA 303d Listed Waterbodies*
Dissolved gases	Low dissolved oxygen	EPA 303d Listed Waterbodies*
Pollution	High pollution or contaminant levels	EPA 303d Listed Waterbodies*
Turbidity/ erosion	High erosion and turbidity levels	EPA 303d Listed Waterbodies*
pH/ acidification	Low pH	EPA 303d Listed Waterbodies*
Bacteria	Elevated pathogen and bacteria concentrations	EPA 303d Listed Waterbodies*
DOM/ nutrients	Elevated nutrients and DOM (dissolved organic matter)	EPA 303d Listed Waterbodies*
Salinity	Increased total dissolved solids and salinity	EPA 303d Listed Waterbodies*
Aquatic Habitat Loss/Degradation		
T&E species habitat	Areas containing state or federally listed species excluded from critical habitat designations	NatureServe
Critical Habitat	Critical habitat designation areas for federally listed endangered and threatened species	USFWS Critical Habitats*
Sensitive habitats	Areas designated by federal or state as having high biodiversity or conservation value (e.g., wetlands, diverse habitats)	State-specific conservation data sets
Habitat condition	Degree of anthropogenic disturbance (e.g. urbanization, upstream dams) in watershed or stream segments	NFHAP*
Hydrology & Hydraulics		
Hydraulic modification	Degree of hydrologic alteration of stream flows. Presence of infrastructure, such as canals and penstocks, known to modify natural hydrologic processes.	NHD 1:24,000 scale canals, penstocks, pipelines; USGS stream gages*; NFHAP*

Table 2.4. (contd)

Issue Category Sub-Category	Description	Data Set(s)
Other Water Resource Issues		
Wild and Scenic River	Rivers protected under the Wild and Scenic River Act	Digitized NWSR lines - Rivers.gov*
Protected Areas	Areas owned and protected for conservation, recreation, or aesthetic purposes	PAD US Database*
Recreational Importance	Areas of known recreational value, such as fishing or boating.	DeLorme fish and boat access*; American Whitewater Rafting runs*
Aesthetic preservation	Areas of aesthetic value, such as waterfalls, geologic formations, or landmarks.	Waterfall point locations*

2.5.1 Fish Interactions

Fish interactions involve barriers to migration and related injuries and entrainment.

- *Barriers.* Barriers, primarily dams, represented obstacles to fish migration that could provide an environmental opportunity if mitigated through barrier removal or fish passage creation. Specific locations where fish passage is considered important for anadromous fish restoration in the basin were derived from The Nature Conservancy's (TNC's) Northeast Aquatic Connectivity Tool (NCAT), which evaluates the potential ecological value of improving fish passage at a particular dam, either through dam removal of or improvements to passage facilities (Martin and Apse 2011). Results from the NCAT analysis were grouped into percentile-based tiers. Dams that ranked in the top two tiers (i.e., top 10 %) were used to represent potential opportunities for improving fish passage in the combined opportunity assessment because these dams may represent bottlenecks to the restoration of anadromous species. NCAT was completed for the entire Connecticut basin and the Virginia portion of the Roanoke basin. For the Roanoke basin, dams falling on stream networks were identified using the National Anthropogenic Barrier data set (NABD) (Ostroff et al. 2013). Dams intersecting anadromous fish habitats (see Section 2.5.3 Aquatic Habitat Loss/Degradation) were identified as barriers.
- *Injury/Entrainment.* Injury resulting from entrainment at hydropower facilities was determined by reviewing FERC documents or reports for each basin. Occurrences of fish injury or entrainment were georeferenced.

2.5.2 Water Quality

Water-quality issues were considered if they could be mitigated by modifying dam operations by 1) adding a new turbine, intake, or gate, or 2) trapping pollutants, toxics, or contaminants within reservoirs. Spatial information about water-quality issues was obtained from the EPA's Impaired Water NHD Indexed Data set for 303d listed waters (EPA 2013) and by manually georeferencing information from literature sources. The EPA impaired waters website provided point, line, and polygon coverage of 303d-listed water bodies. All water-quality issues present in a basin may not be captured by 303d listing. Thus, records of water-quality issues mentioned in reports, journals, or websites were georeferenced and included as issues. Water-quality issues that were deemed most relevant for the integrated opportunity

assessment included water temperature, low dissolved oxygen (DO), excessive sedimentation, and high turbidity.

2.5.3 Aquatic Habitat Loss/Degradation

Degradation may affect threatened and endangered (T&E) species habitats as well as critical and sensitive habitats; remaining aware of habitat conditions relative to anthropogenic disturbance offers opportunities for habitat restoration or mitigation.

- *T&E species habitat*: Locations of federally and state-listed endangered and threatened species were obtained from literature or online sources and georeferenced. In addition, state-specific natural heritage data containing geospatial point locations of federally/state-listed species were compiled and included in analysis. Areas of sensitive habitat may pose constraints on hydropower opportunities.
- *Critical habitats*: Polygon and line coverage of T&E species were obtained from the U.S. Fish and Wildlife Service (USFWS). All federally-listed species do not have associated critical habitat designations. Again, critical habitats may be an indication of negative impact from hydropower.
- *Sensitive habitats*: State department websites provide geographic coverage of various areas considered sensitive to development or of high conservation value. Because of jurisdictional boundaries, these data sets vary from state to state. However, these data were combined to provide consistent seamless coverage for the entire basin. Anadromous fish habitats were created using historic and current fish distributions from NatureServe at the HUC 8 basin resolution. NHD (1:100,000 scale) stream lines were filtered to only include stream reaches with an average flow $\geq$20 cfs. NHD stream lines falling within the current distribution of anadromous fish were considered potential habitat.
- *Habitat condition:* Aquatic habitats displaying high levels of anthropogenic disturbance may be an environmental opportunity for habitat restoration or mitigation. The National Fish Habitat Action Plan (NFHAP) developed a disturbance index for each NHD (1:100,000 scale) catchment in the United States. Disturbance indices were accompanied by summarized anthropogenic disturbance information including land use (e.g., urbanization), roads, dams, mines, and point-source pollution sites for each local watershed and the total upstream cumulative watershed.

2.5.4 Hydrologic Modification

Similar to habitat condition, high levels of hydrologic modification may present an environmental opportunity because altered stream flows could be mitigated by hydropower dam operation. Two sources of information were used as surrogates of hydrologic modification. First, canals, penstocks, and pipelines were available at line events in the NHD (1:24,000 scale). The presence of this infrastructure suggests changes in natural hydrology. Secondly, a predictive model of hydrologic alteration was constructed using discharge from reference-condition and disturbed U.S. Geological Survey (USGS) stream gages. All USGS gages were selected within a 50-km radius around each basin. Hydrologic statistics were calculated that summarized the discharge from each stream gage. All gages were placed in a hydrologic class, i.e., group of streams sharing similar hydrology. Based on class membership, hydrologic statistics from disturbed gages were compared to reference gages to calculate a hydrologic disturbance index (HDI). Geospatial information (urbanization, dams, water use) was summarized within NHD stream reaches and was used to develop a statistical model to predict an HDI for every stream reach in the basin.

2.5.5 Other Water Resource Issues

Additional issues related to water resources include Wild and Scenic River designations, protected areas, recreational importance, and waterfalls.

- *Wild and Scenic River*. The greatest protective measure placed on a river is the Wild and Scenic River designation, which specifically prohibits new dam construction. Line coverage of Wild and Scenic Rivers is provided by the National Wild and Scenic Rivers System (www.rivers.gov).
- *Protected Areas*. Protected areas typically represent areas owned and managed for conservation, recreation, and aesthetic purposes. The owner and designation for each parcel, however, will determine the likely positive or negative impact on hydropower opportunities. The Protected Area Database (PAD US) was developed as a comprehensive coverage of protected areas in the United States. PAD US developed the Gap Analysis Program (GAP)-status[1] as a system of ranking protective measures for protected lands with Status 1 and 2 lands being managed more strictly for conservation purposes than Status 3 and 4 lands managed for variable purposes, including recreation and extractive uses. Status 1 and 2 lands were considered areas where hydropower development of any kind is highly unlikely.
- *Recreational Importance*. Areas known for recreational value may represent public resistance to hydropower development if recreation is compromised by development. However, the absence of recreation or potential for recreational improvement may create an opportunity because hydropower licensing typically involves the creation of public access areas. Boat ramps, fishing access areas, and American Whitewater boating runs were compiled from the NHAAP database. Spatial information about non-motorized boating locations was derived from American Whitewater's National Whitewater Inventory (http://www.americanwhitewater.org/content/River/view/) and manually georeferenced from literature sources (CRJC 2008a,b,c).
- *Waterfalls*. Waterfalls represent areas of aesthetic importance. Waterfall locations were compiled from the NHAAP database.

2.6 Identify Combined Hydropower-Environmental Opportunities

In this step, potential hydropower opportunities were evaluated in the context of existing environmental issues to identify where combined opportunities or potential conflicts might occur. Recall, an environmental "opportunity" was defined as a situation where an existing environmental issue can be alleviated as a result of or in conjunction with a hydropower action, although other environmental opportunities, such as ecosystem restoration, are possible but were not considered at this time because focus was on combined hydropower-environmental opportunities. Environmental opportunities can result *directly*, e.g., installing a turbine at an NPD provides opportunity for aerating downstream reaches that have low DO issues; or *indirectly* from a hydropower action, e.g., creating fish passage at or removal of a

[1] From the USGS page: http://gapanalysis.usgs.gov/. USGS Gap Analysis Program (GAP). GAP Status 1: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, intensity, and legacy) are allowed to proceed without interference or are mimicked through management. GAP Status 2: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance.

nearby low-head dam as part of development elsewhere. Environmental opportunities for dam removal were considered in association with NPD and NSD development opportunities (as described in Section 2.5.1).

For the FY13 assessment, we focused on evaluating direct opportunities based on spatially explicit interactions between hydropower opportunities and environmental issues. Development of methods to assess indirect opportunities is scheduled for FY14. In this section, we explain the data model, geospatial database, and the process for identifying combined hydropower-environmental opportunities.

2.6.1 Data Model

We developed a geospatially driven data model to examine spatially explicit interactions between hydropower opportunities and environmental issues to identify possible "win-win" scenarios, i.e., combined hydropower-environmental opportunities (Figure 2.2). The data model enabled a rapid, flexible, and robust process for assessing interactions between data elements that are spatially disparate but functionally linked. The BSOA data model included core *data elements*, *relationships* between data elements, and *rules* by which interactions were explored and opportunities revealed. Core data elements of the BSOA data model include hydropower opportunities, environmental issues, and hydrologic catchments.

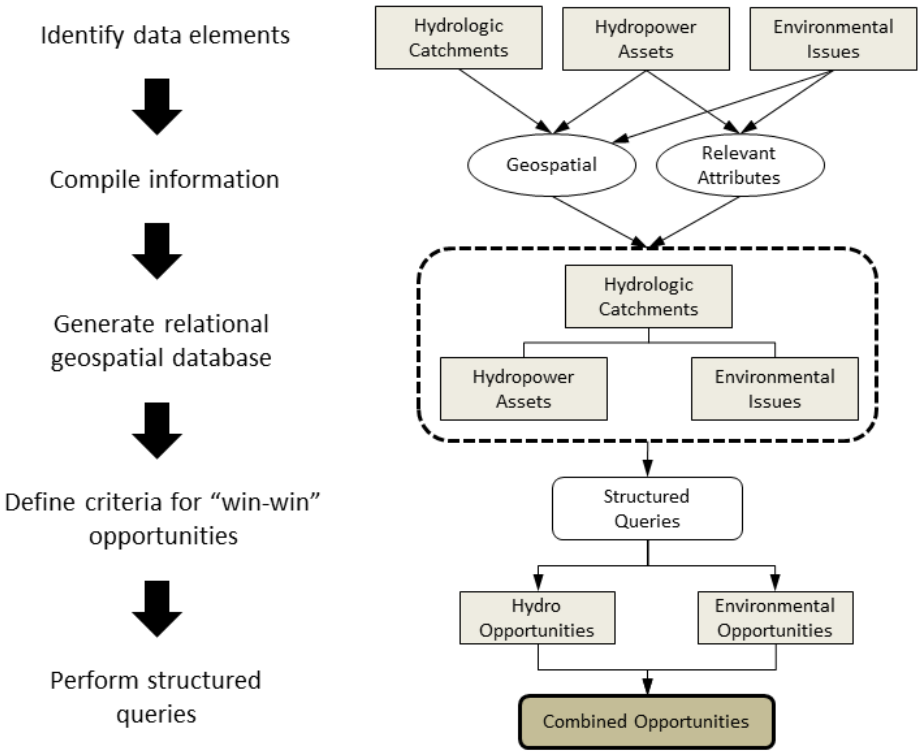

Figure 2.2. BSOA data model and process flow for identifying combined hydropower-environmental opportunities in Phase 1 Scoping Assessments.

2.6.2 Geospatial Database

Relationships between data elements were realized in a geospatial database, which standardized storage of the elements in a GIS format and facilitated implementation of the data model. A key function of the geodatabase was to maintain the spatial relationships among the data elements. The geodatabase also maintained non-spatial relationships among data elements and tables containing descriptive attributes for each element that were used to examine interactions in greater detail. By using this type of relational structure, the geodatabase allowed for considerable flexibility in examining interactions between hydropower opportunities and environmental issues under a variety of scenarios.

2.6.3 Process for Identifying Combined Hydropower-Environmental Opportunities

The BSOA Phase 1 Scoping Assessment included a sequential six-step process for identifying combined hydropower-environmental opportunities (Figure 2.3). A key aspect of this process was development of *criteria* for structuring queries of the geospatial database that would reveal combined hydropower-environmental opportunities. Descriptions of the six steps follow.

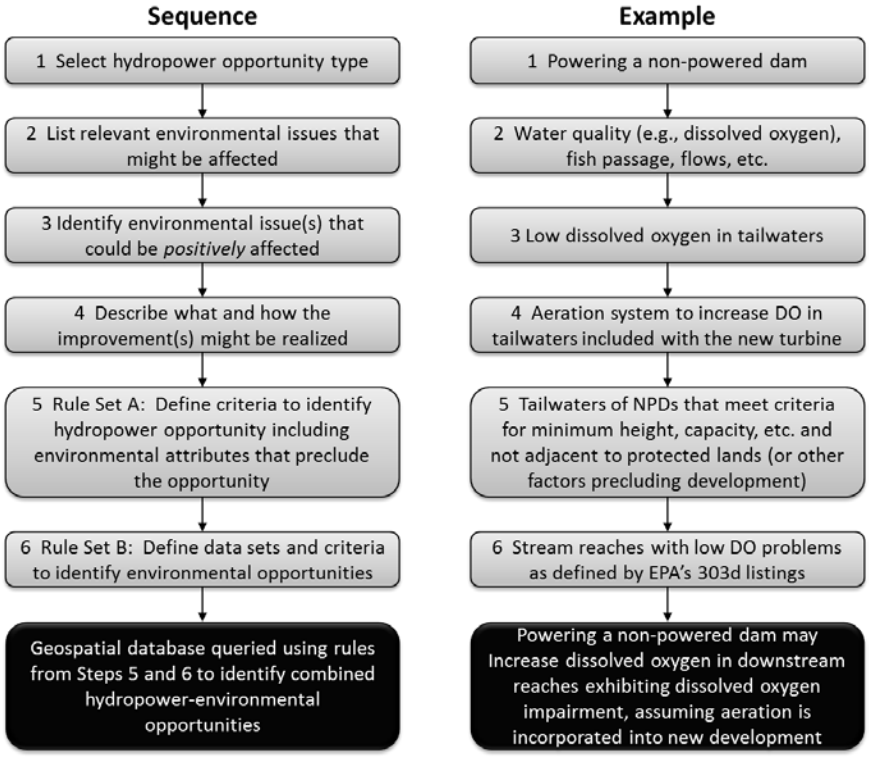

Figure 2.3. Sequential process with example for identifying combined hydropower-environmental opportunities.

1. Select a hydropower opportunity type. Hydropower opportunity types or categories considered in the Connecticut and Roanoke basins were powering an NPD and NSD. Other types of hydropower opportunities that could be included in future assessments are modifying an existing site, powering a water conduit, or developing hydrokinetic energy

2. List relevant environmental issues that might be affected by the selected hydropower opportunity. This list necessarily should include more than what might be considered opportunities for environmental improvement to create a broad characterization of possible effects from which opportunities can be identified.
3. Identify environmental issue(s) that could be affected in a positive manner if hydropower development was conducted in a particular fashion; an example is the environmental issue of low DO.
4. Describe what and how the environmental improvements could be realized during hydropower development. For example, installing a turbine at an NPD could be done in a way (e.g., with aerating turbines) that increases DO levels in a downstream reach that has low DO issues.
5. Define criteria (Rule Set A) for structuring queries of the geospatial database to identify sites where the selected hydropower opportunity may create a mutual environmental opportunity. Hydropower opportunity criteria developed in the fifth step define those sites (non-powered, existing, or new) where the opportunity of interest might be realized. Step 5 rules also included attributes or issues (environmental and other) that we deemed would almost certainly preclude development at a particular location (Table 2.5).
6. Define data sets and criteria (Rule Set B) to identify environmental opportunities. This is to determine the spatial extent in which the combined hydropower-environmental opportunity of interest may be realized. This extent was determined by the nature of the interaction (i.e., upstream or downstream) and area in which it is expected to occur (i.e., tailwater or reservoir, as defined by the analyst). In the example presented above and included in Figure 2.3, the opportunity to improve low DO is downstream of the dam within a 10-mile reach defined as its tailwater.

The rules established in Steps 5 and 6 above were applied to the geospatial database to identify locations where the hydropower opportunities and environmental issues of interest interact. For the purposes of our assessments in FY13, we focused on developing rules that pertained to key environmental issues in the Roanoke and Connecticut basins (Table 2.6). Additional rules for other environmental issues are planned for FY14 to create comprehensive set of rules that can be broadly applied. Furthermore, methods to prioritize combined hydropower-environmental opportunities should be considered in FY14.

Table 2.5. Criteria for environmental and hydropower attributes that may preclude a hydropower opportunity. Key: "X" indicates applicability and "---" indicates no applicability.

	Hydropower Opportunity Type	
Attribute	Non-Powered Dams	New Stream-Reach Developments
Generating capacity[(a)]	X	X
GAP status = 1 or 2[(b)]	X	X
Other protected areas	X	X
Wild and Scenic River	X	X
NSD between lowest dam and ocean	---	X
Presence of threatened/endangered species habitat[(c)]	X	X

(a) Capacity thresholds were 0.1 MW for NPD and 1 MW for NSD.
(b) Lands classified by the USGS National Gap Analysis Program as having permanent protection from conversion of natural land cover. For more information refer to http://gapanalysis.usgs.gov/.
(c) This criterion may not always preclude development in some cases, but was important for consideration for preliminary assessments in the Connecticut and Roanoke basins.

Table 2.6. Generic structure and example environmental opportunities and associated criteria for classifying interactions between environmental issues and hydropower opportunity types. For a given basin and hydropower opportunity type, determinations would be made regarding the applicability the environmental opportunity in dam tailwater (TW), reservoir (RES), or both.

Environmental Criteria	Example Environmental Opportunity	Hydro Opportunity Type	
		A	B
Does not meet EPA criteria for dissolved oxygen (DO)	Aeration from new development/adding a turbine could increase DO in downstream reaches with DO impairment.	TW or RES or both	TW or RES or both
Does not meet EPA criteria for sedimentation/siltation or turbidity	New development/adding turbine could provide better flow management in downstream reaches with excessive sedimentation or turbidity impairments.	"	"
Does not meet EPA criteria for temperature	New development/adding a turbine could provide better flow management in downstream reaches with temperature impairments.	"	"
High level of hydrologic disturbance	New development/adding a turbine could provide better flow management in downstream reaches with high hydrologic disturbance.	"	"
Presence of American Whitewater boat runs & "Other" important paddling waters	Adding a turbine could provide better flow management in existing whitewater/paddling reaches below the dam.	"	"
Presence of a dam that is ecologically important for anadromous fish restoration	Assume improvements to fish passage can be made as part of project development, either through facility modification or dam removal.	"	"
Trout are present but management (e.g., stock enhancement) is lacking.	Trout fishery can be enhanced (e.g., by stocking or flow modification) to provide more opportunity for public utilization.	"	"
No whitewater boating at present although slope and flow meet criteria for whitewater opportunity	Where there exists sufficient slope and flow and whitewater boating is not present, conditions could be created in conjunction with new development to provide whitewater recreation.	"	"
Existing or potential reservoirs above minimum size and without present fishing access	Public access could be provided to reservoirs of sufficient size and presently limited access.	"	"

Caveat: There is inherent uncertainty about how a given opportunity would be realized. For example, for the opportunities strongly tied to flow management, it is assumed that powering a NPD or building an NSD would provide some mechanism(s) for managing flows to better meet environmental objectives like improving water quality or recreation. Ultimately, the exact mechanism or manner in which a hydropower opportunity addresses a specific environmental issue depends on a suite of factors whose description is beyond the scope of a Phase 1 Scoping Assessment.

3.0 Connecticut River Basin – Preliminary Phase 1 Scoping Assessment

The purpose of the Phase 1 Scoping Assessment for the Connecticut River basin was to identify combined hydropower-environmental opportunities. The BSOA national steering committee selected the Connecticut basin for a Phase 1 Scoping Assessment because the basin has good potential for powering NPDs, opportunities to improve habitat connectivity, and challenging environmental issues. The Connecticut basin is characterized by high summer water temperatures and other water-quality issues associated with dams that could provide opportunities for environmental improvements. In addition, strong stakeholder and community engagement has resulted in solid foundational science and high data richness.

The following elements and associated tasks composed the *preliminary* Phase 1 Scoping Assessment for the Connecticut basin:

- Stakeholders: Identify and contact key stakeholders to inform them of the Phase 1 Scoping Assessment.
- Information: Compile general information regarding hydropower opportunities and environmental issues in the basin.
- Hydropower Opportunities: Perform an initial screening of potential increases in hydropower power assets.
- Environmental Issues: Perform an initial screening of environmental issues that may be improved by actions associated with hydropower opportunities.
- Combined Hydropower-Environmental Opportunities: Assess interactions between hydropower opportunities and environmental issues to identify potential combined opportunities.

3.1 Key Stakeholders

The PNNL/ORNL team identified and contacted a set of key stakeholders in the Connecticut basin to inform them of the Phase 1 Scoping Assessment. The team worked with the BSOA national steering committee during a conference call on March 22, 2013, to identify a small number of "key" strategic stakeholder groups, including major utilities and leading environmental organizations. We also solicited input from the Long Island Sound National Estuary Program (Mark Tedesco, Director, EPA Long Island Sound Office), whose watershed includes the Connecticut basin. Key stakeholders and contacts were listed and contacted by email and phone. The stakeholder list was not meant to be exhaustive.

The key stakeholders in the Connecticut basin who were contacted during FY13 for the BSOA Phase 1 Scoping Assessment included four environmental groups or regulatory agencies, one utility, and one federal Hydropower MOU agency (Table 3.1). Communications with Connecticut stakeholders are summarized in Table 3.2. An annotated list of stakeholders in the Connecticut basin is provided in Appendix A.

Table 3.1. Contact information for key stakeholders for the BSOA Phase 1 Scoping Assessment in the Connecticut basin. (This list is a draft; it will be updated after review by regional parties in FY14.)

Name	Affiliation	Phone	Email
Fisk, Andy	The Connecticut River Watershed Council	413.772.2020 ext. 208	afisk@ctriver.org
French, Andrew	USFWS Silvio Conte Wildlife Refuge	413.548.8002 ext. 111	andrew_french@ fws.gov
Hatfield, Chris	USACE, New England District	978.318.8520	christopher.l.hatfield@ usace.army.mil
Lutz, Kim	The Nature Conservancy	413.584.1016	klutz@tnc.org
McDermott, Sean	NMFS Habitat Conservation Division	978.281.9113	sean.mcdermott@ noaa.gov
Ragonese, John	TransCanada	603.498.2851	john_ragonese@ transcanada.com

Table 3.2. Communications with key stakeholders for the BSOA Phase 1 Scoping Assessment in the Connecticut basin.

Date	From	To	Vehicle	Description	Notes
5/31/13	Johnson	French, Lutz, McDermott, Ragonese	Email	Informed the recipients about the assessment	None
6/5/13	Johnson	Fisk	Email	Ibid	None
6/5/13	Johnson	Fisk, French, Lutz, McDermott	Phone calls	Called to touch base; left messages for folks to call Johnson with questions or concerns	None
6/5/13	Johnson	Ragonese	Phone call	Discussed the assessment	Concerned that the assessment in no way impacts ongoing FERC relicensing efforts
6/14/13	Morales (USACE HQ)	Hatfield	Phone call	Informed him about the assessment	None
6/14/13	McDermott and McDavitt (NMFS)	Johnson	Email	Provided suggestions for data sets to include in the assessment	More detailed than needed for current work on Phase 1
6/20/13	Johnson	McDermott and McDavitt	Email	Expressed appreciation for the work	None
9/5/13	Johnson	All	Email	Status report on the Phase 1 Scoping Assessment for the Connecticut basin	Well under way; delivery to DOE by 9/30/13; outreach and peer review commencing some time in fall 2013
9/19/13	Johnson and Geerlofs	Lutz and Hatfield	Conf call	Discussed the status and schedule for the assessment	Key stakeholder outreach and review will occur in FY14

3.2 Information Compilation

The Connecticut River basin stretches 280 miles from its headwaters in Quebec, Canada, to the Connecticut State coast where it empties into Long Island Sound of the Atlantic Ocean (Figure 3.1). The basin encompasses approximately 11,250 square miles, of which 13% are in Connecticut, 24% in Massachusetts, 27% in New Hampshire, 35% in Vermont, and 1% in Canada (information source: http://www.nae.usace.army.mil/Missions/CivilWorks/RiverBasins/Connecticut.aspx.). The Connecticut basin is in the Piedmont Plateau/New England Physiographic Region; the central and southern basin is in the New England Uplands section and the northern basin in the White Mountain section (http://tapestry.usgs.gov/physiogr/physio.html). Major tributaries include the Ashuelet, Chicopee, Deerfield, Farmington, Millers, Passumpsic, Sugar, West, Westfield, and White rivers.

The hydrology of the Connecticut River and its tributaries is linked closely to the geology and physiography of the basin. Rivers draining the upper portion of the basin tend to have non-alluvial channels that are underlain by bedrock and sediments that resist erosion, and therefore tend to have more variable flows. Rivers in the lower portion of the basin tend to have alluvial channels that are more dynamic with respect to channel morphology due to erosion and sedimentation. Thus, the effects of altered flow regimes may vary between portions of the basin or among rivers within each portion.

There are numerous non-powered and powered dams in the Connecticut basin (see Figure 3.1 for locations of the powered dams). FERC has issued licenses for many hydropower projects in the Connecticut River. The USACE does not operate any hydropower dams in the Connecticut basin, although it owns eight flood-control dams whereas non-federal interests own and operate hydropower plants. Dams and impoundments are considered a primary cause of flow alteration in the Connecticut basin.[1] There are 65 dams on the main stem of the Connecticut River and its tributaries that are capable of storing at least 10% of mean annual runoff at their locations. Most of these dams are located in tributaries. At least 17 of 44 major tributaries, most of which are located in the southern half of the Connecticut basin, are likely to experience moderate to severe hydrologic alteration. Flood-control dams have significantly affected hydrology in the basin by decreasing the frequency and magnitude of high-flow events, decreasing the frequency of extreme low-flow periods, and increasing the magnitude of low flows and duration of low-flow pulses. Hydropower dams also influence hydrology in the Connecticut system by altering the frequency and magnitude of hourly flow fluctuations.

Dams are not the only cause of hydrologic alteration in the Connecticut River basin. Withdrawals for water supply, irrigation, and snow-making are also thought to significantly alter hydrology in the basin. Of the authorized water withdrawals in Massachusetts and Connecticut, only 5.4 and 15 %, respectively, are subject to state permitting processes. The rest are grandfathered and not subject to environmental review. The transformation of the New England landscape from virgin forests to croplands and grazing lands has affected the hydrology and geomorphology of streams and rivers in the basin.

[1] TNC (date unknown). Hydrologic Alteration in the Connecticut River Watershed. Draft report. Available at: http://www.mass.gov/eea/docs/eea/water/swm/framework/ct-river-watershed-doc-b.pdf.

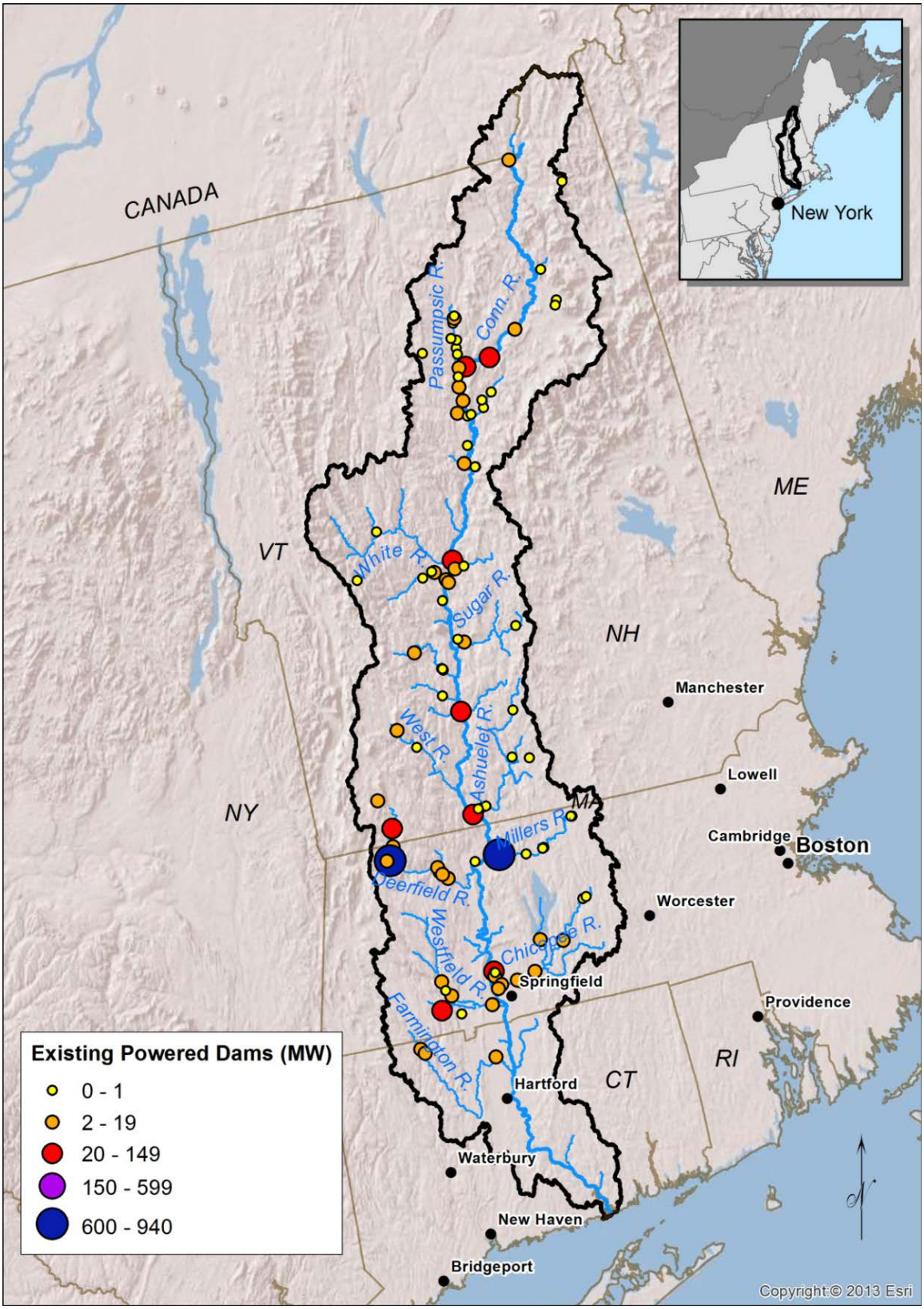

Figure 3.1. Map of the Connecticut River basin, including locations of existing hydropower facilities.

3.3 Hydropower Opportunities

We considered the following hydropower opportunities for the Connecticut basin because relevant data were readily available in the NHAAP database: increasing efficiencies at existing hydropower plants, powering NPDs, and NSDs. Other hydropower opportunities may be considered in future assessments, although we found no indication that hydrokinetic development and powering of non-powered water conveyance systems are being considered for development in the Connecticut basin.

There are 104 existing hydropower dams in the basin representing a total installed capacity of 2,198.5 MW. Hydropower production at these sites might be increased through increasing capacity, improved efficiency, or changes in operations, but these types of opportunities are difficult to determine through analysis of individual project information contained in NHAAP database or readily available elsewhere. Developing algorithms for identifying opportunities at existing projects is a task for FY14.

The assessment of potential hydropower capacity that could be obtained by powering NPDs conducted as part of ORNL's NHAAP identified 86 of 692 NPDs in the Connecticut basin that have a potential capacity of ≥0.1 MW each and a combined capacity of 80.7 MW. Of the 86 NPDs with a potential capacity of 0.1 MW or greater, 66 meet the criteria for a potential opportunity to power an existing NPD and represent a total capacity of 69.5 MW (Figure 3.2).

The NSD task of the NHAAP identified 238.8 MW of potential capacity in the basin distributed among 60 possible locations. It is impractical to develop all of these sites, but each site presents a possible opportunity that is evaluated further in this analysis. Of the 60 NSD locations, 27 meet the criteria for a potential opportunity for new stream-reach development and represent a total capacity of 46.1 MW (Figure 3.3).

The potential hydropower opportunities for 66 NPDs and 27 NSDs were evaluated further to identify combined hydropower- environmental opportunities (Section 3.5).

3.4 Environmental Issues

Impaired water quality emerged in our information assessment (Step 4) as a prominent environmental issue in the Connecticut basin. Prevalent water-quality issues include bacteria, pollution, water temperature, DO, sedimentation, and turbidity. Water quality in the Connecticut basin is affected by many factors, although soil chemistry, water management, land use, and non-point pollution are commonly cited factors. Figure 3.4 illustrates catchments in the Connecticut basin that contain at least one of these water-quality issues.

Other important environmental issues in the Connecticut basin include barriers to fish movement, presence of T&E species, hydrologic alteration, and a shortage of non-motorized boat recreation areas. Dam construction and operations have resulted in fish passage issues throughout the basin; fish passage is a priority issue for restoring anadromous fish such as American shad (*Alosa sapidissima*), American eel (*Anguilla rostrata*), Atlantic salmon (*Salmo salar*), blueback herring (*Alosa aestivalis*), and shortnose sturgeon (*Acipenser brevirostrum*). Figure 3.4 illustrates catchments that contain at least one dam that was ranked by the NCAT tool as a top-two tier dam (i.e., top 10%) for improving fish passage.

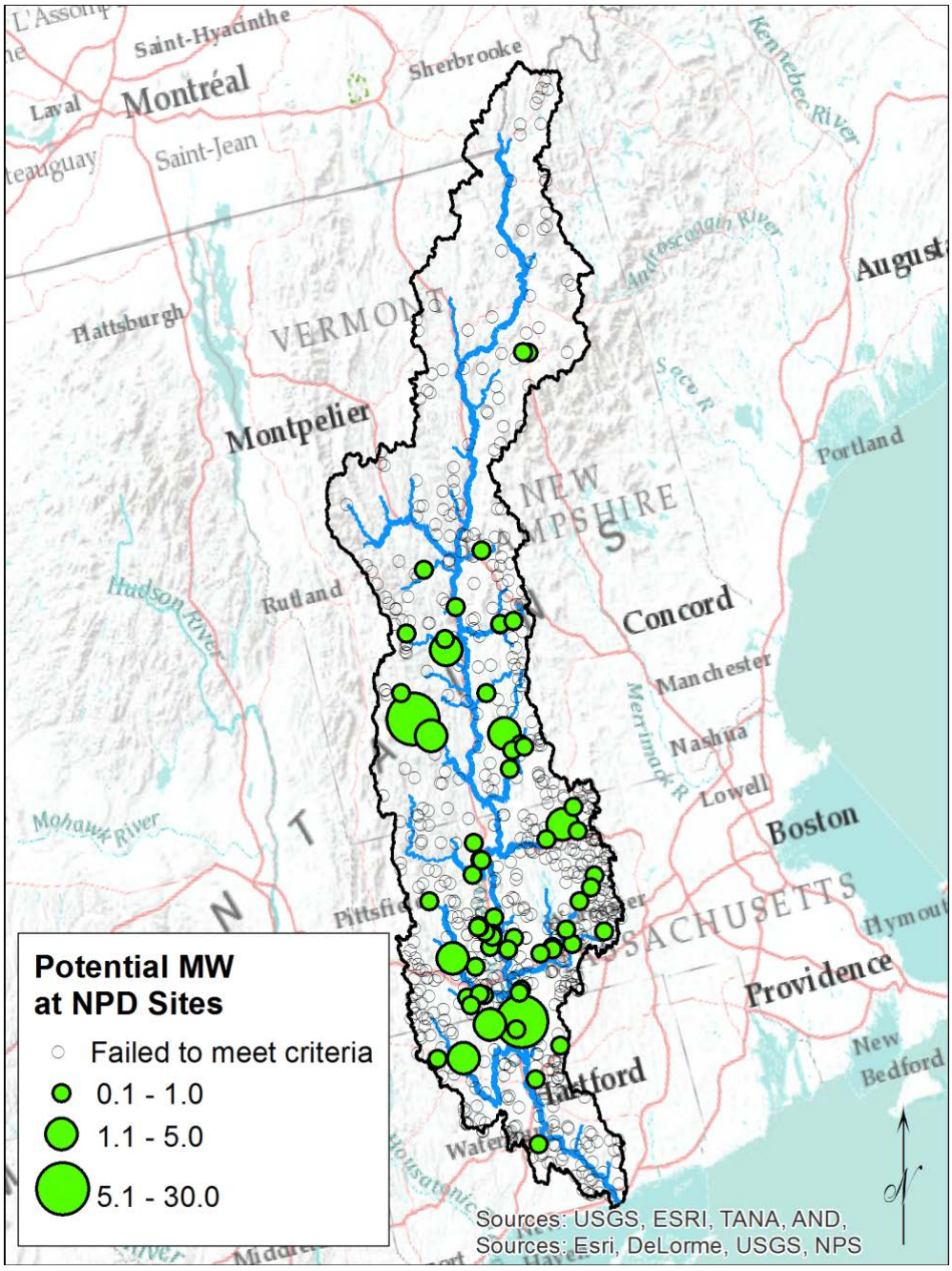

Figure 3.2. Non-powered dam sites in the Connecticut basin that meet screening criteria for potential development opportunities. Sites that do not meet the criteria are also shown for reference.

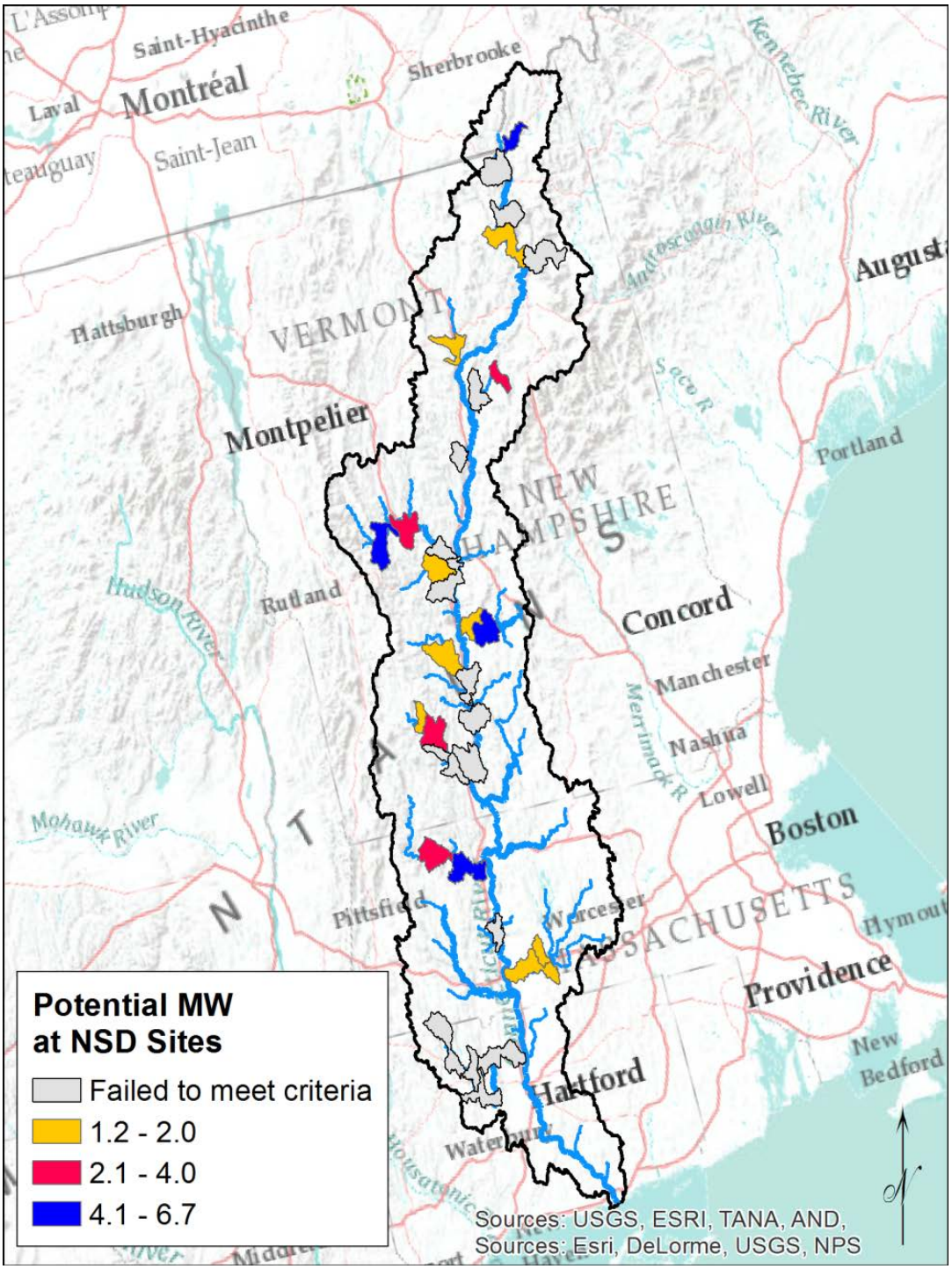

Figure 3.3. New stream-reach development sites in the Connecticut basin that meet the criteria for potential development opportunities. Sites that do not meet the criteria are shown for reference.

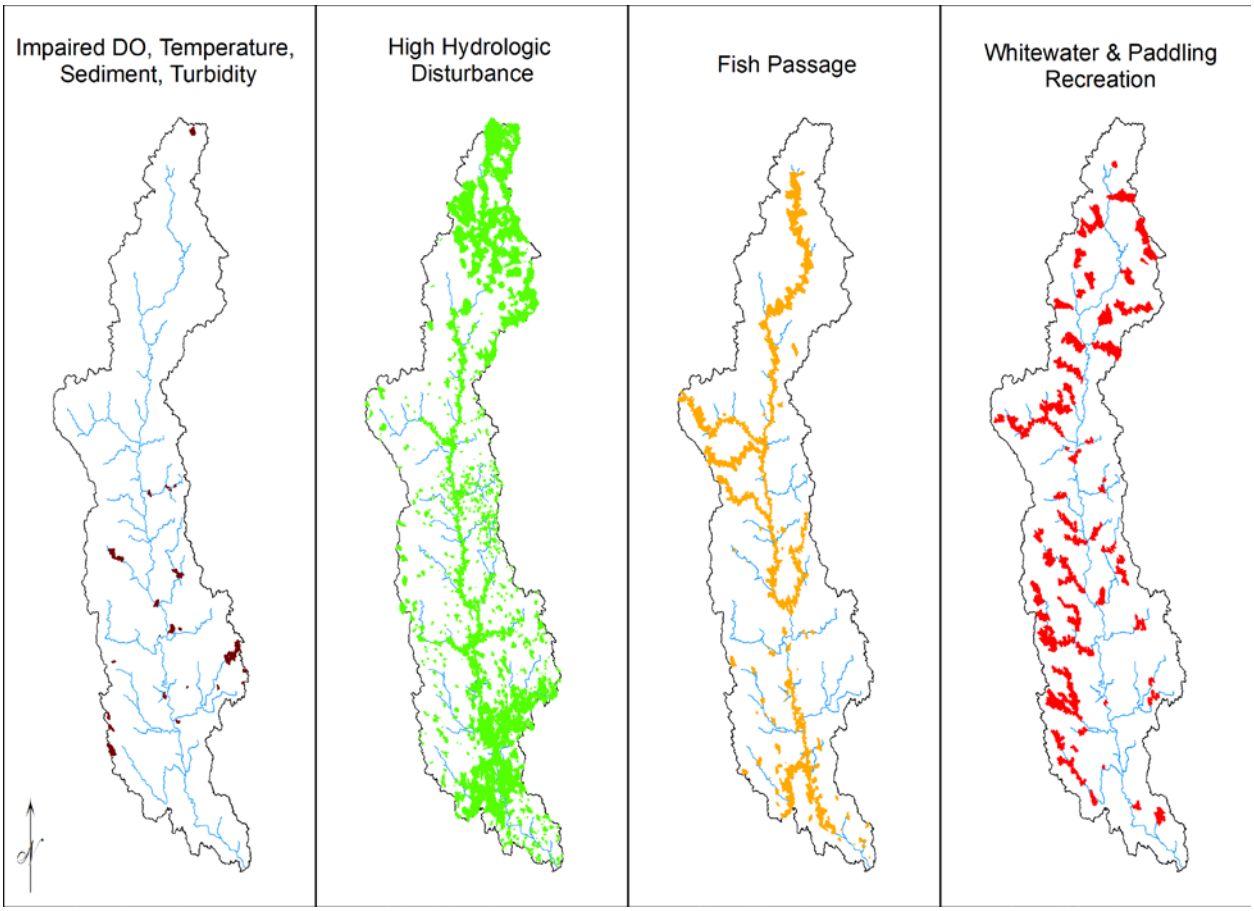

Figure 3.4. Catchments in the Connecticut basin showing key environmental issues that were examined for potential combined hydropower-environmental opportunities.

Dams, especially those operated for flood control, are cited as a primary cause of flow alteration in the Connecticut basin. Other factors contributing to flow alteration in the basin include withdrawals for water supply, irrigation, land conversion, and snow-making. Flow alteration is thought to be a significant factor affecting the distribution and abundance of the dwarf wedge mussel (*Alasmidonta heterdon*), a federal endangered species found in the basin. Figure 3.4 illustrates catchments that were classified as having a high level of hydrologic disturbance (HDI ≥9).

Maintaining non-motorized recreational boating opportunities is also a significant issue in the basin. Figure 3.4 illustrates catchments that contain stream reaches that are important non-motorized boat recreation areas.

3.5 Combined Hydropower-Environmental Opportunities

By evaluating spatially-explicit, direct interactions between hydropower opportunities and environmental issues (explained in Section 2.6), the PNNL/ORNL team identified combined hydropower-environmental opportunities for two types of hydropower development in the Connecticut basin: powering NPDs and NSDs (Table 3.3). Of the 66 NPD opportunities, 17 provided a potential improvement to at least one of the environmental issues included in the combined opportunity analysis

(Table 3.4; Figure 3.5). These 17 combined NPD environmental opportunities represent an estimated total capacity of 20.7 MW. The most common environmental opportunities associated with NPDs included opportunities to decrease hydrologic disturbance, improve fish passage, and increase access to non-motorized boat recreation. Of the 27 NSD opportunities assessed in the Connecticut basin, 20 provided a potential improvement to at least one of the environmental issues included in the combined opportunity analysis (Table 3.4; Figure 3.6). These 20 combined NSD environmental opportunities represent an estimated total capacity of 35.2 MW. The most common environmental opportunities associated with new site developments included opportunities to diminish hydrologic disturbance and improve fish passage, either through facility modifications or dam removal elsewhere in the associated catchments. Combined opportunities for improving sedimentation and turbidity were not realized for any of the NPD or NSD opportunities.

Table 3.3. Criteria for classifying interactions between environmental issues and hydropower opportunities that may result in an environmental benefit in the Connecticut basin (CT). Key TW = tailwater, RES = reservoir, and "---" indicates no applicability.

		Hydro Opportunity Type	
Environmental Criteria	Environmental Opportunity	Non-Powered Dams	New Stream-Reach Developments
Does not meet EPA criteria for dissolved oxygen (DO)	Aeration from new development/adding a turbine could increase DO in downstream reaches with DO impairment.	TW	---
Does not meet EPA criteria for sedimentation/siltation or turbidity	New development/adding turbine could provide better flow management in downstream reaches with excessive sedimentation or turbidity impairments.	TW	---
Does not meet EPA criteria for temperature	New development/adding a turbine could provide better flow management in downstream reaches with temperature impairments.	TW	---
High level of hydrologic disturbance	New development/adding a turbine could provide better flow management in downstream reaches with high hydrologic disturbance.	TW	---
Presence of American Whitewater boat runs & "Other" important paddling waters	Adding a turbine could provide better flow management in existing whitewater/paddling reaches below the dam.	TW	---
Presence of a dam that is ecologically important for anadromous fish restoration	Assume improvements to fish passage can be made as part of project development, either through facility modification or dam removal.	TW&RES	TW&RES

Caveat: There is inherent uncertainty about how a given opportunity would be realized. For example, for the opportunities strongly tied to flow management, it is assumed that powering a NPD or building an NSD would provide some mechanism(s) for managing flows to better meet environmental objectives like improving water quality or recreation. Ultimately, the exact mechanism or manner in which a hydropower opportunity addresses a specific environmental issue depends on a suite of factors whose description is beyond the scope of a Phase 1 Scoping Assessment.

Table 3.4. Summary of the number and capacity of non-powered dams and potential new stream-reach development sites that have associated opportunities for environmental improvement in the Connecticut basin. This assessment of potential new hydropower capacity is conservative because it does not include other hydropower opportunity types nor does it include potential system-level benefits.

Environmental Opportunity	Non-Powered Dams		New Stream-Reach Developments	
	Number	MW	Number	MW
Aeration from new development/adding a turbine could increase DO in downstream reaches with DO impairment.	0	0	1	1.66
New development/adding a turbine could provide better flow management in downstream reaches with sedimentation or turbidity impairments.	0	0	0	0
New development/adding a turbine could provide better flow management in downstream reaches with temperature impairment.	2	9.1	1	1.2
New development/adding a turbine could provide better flow management in downstream reaches with high hydrologic disturbance.	7	6.4	17	30.4
Adding a turbine could provide better flow management in existing whitewater/paddling reaches below dam.	8	12.3	NA	NA
Assume improvements to fish passage can be made as part of project development, either through facility modification or dam removal.	11	16.0	8	15.5
Total number and megawatts of sites that have at least one potential environmental opportunity	17	20.7	20	35.2

NA = not applicable.

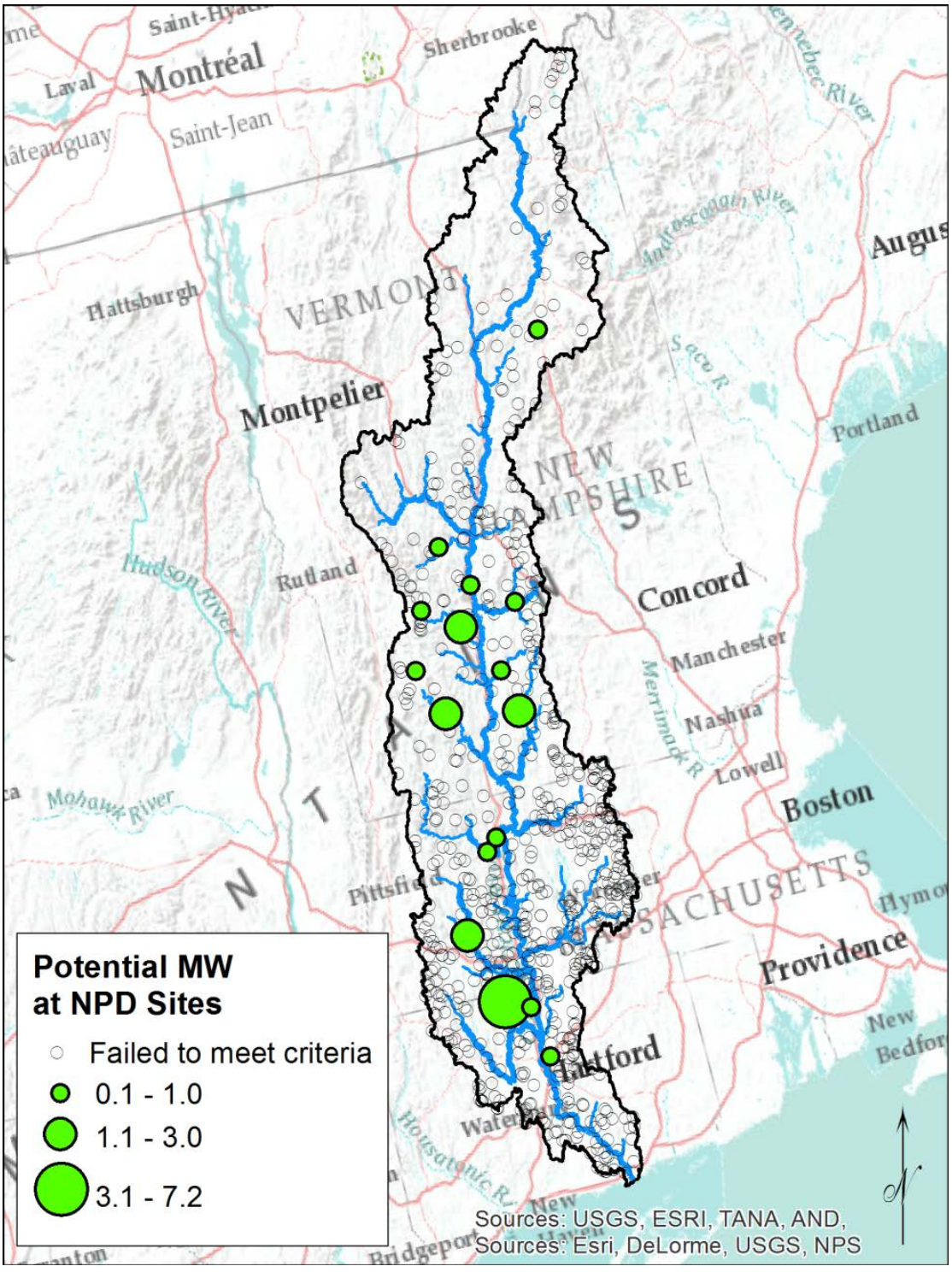

Figure 3.5. Non-powered dam sites in the Connecticut River basin that meet screening criteria for combined hydropower-environmental opportunities. Sites that do not meet the criteria are also shown for reference.

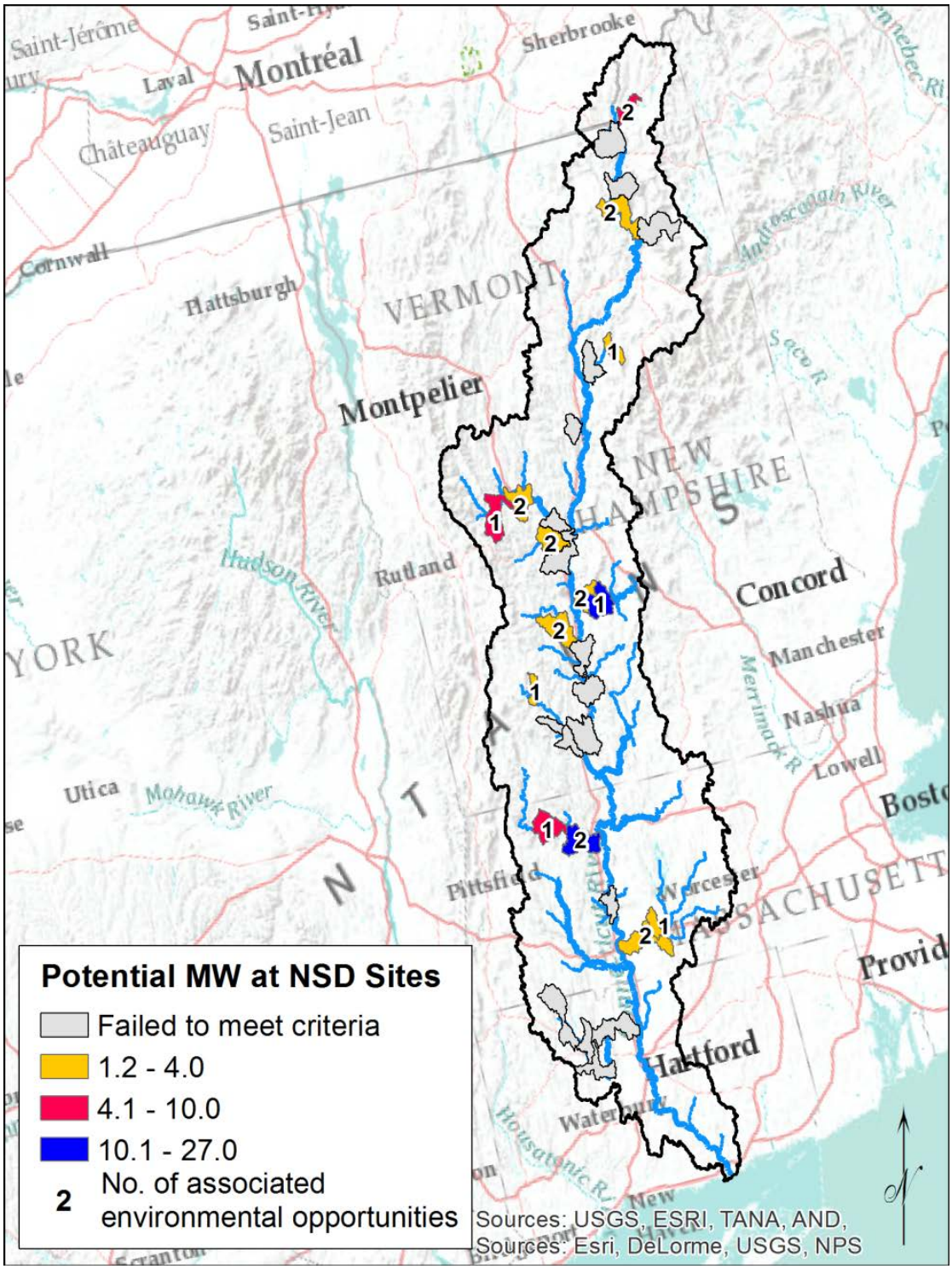

Figure 3.6. New stream-reach development sites in the Connecticut River basin that meet screening criteria for combined hydropower and environmental opportunities. Sites that do not meet the criteria are also shown for reference.

3.6 Summary

Combined hydropower-environmental opportunities were assessed for two types of hydropower opportunities in the Connecticut River basin: powering NPDs and NSDs.

3.6.1 Non-Powered Dams

Of the 692 NPD sites evaluated, only 17 met the screening criteria for a potential hydropower opportunity that may benefit at least one environmental issue (i.e., combined hydropower-environmental opportunity). Estimated capacities of these 17 combined opportunities ranged from 0.1 to 7.2 MW, representing a total capacity of 20.7 MW. Most (88%) NPD sites were not considered practical opportunities because they had an estimated capacity less than 0.1 MW. However, 284 sites (not mutually exclusive from those with capacities less than 0.1 MW) were also deemed impractical because they intersected catchments containing protected lands (GAP Status 1 or 2 or Wild and Scenic Rivers) or habitat of the dwarf wedgemussel, a T&E species.

Environmental opportunities associated with potentially suitable NPD sites included opportunities to diminish hydrologic disturbance and improve temperature, non-motorized boat recreation, and fish passage. Powering an NPD may provide opportunities for decreasing hydrologic disturbance, improving water temperature, and increasing non-motorized boat recreation by improving the ability to better manage flows at NPD sites.

In addition, powering an NPD may provide opportunities for improving fish passage by adding or improving fish passage facilities at the site or at an adjacent site as part of the FERC licensing process. Opportunities for dam removal were also considered as part of an NPD opportunity. Existing sites that were considered opportunities for improving fish passage in the Connecticut basin included dams that were ranked highly (top 10%) by TNC's NCAT tool as being ecologically important for anadromous fish restoration (Martin and Apse 2011). NCAT results were useful because they provided an ecologically appealing and rapid means to conduct an initial screening of opportunities. However, it is important to acknowledge that similar opportunities may exist at other dams despite their NCAT rankings. Additional input from key stakeholders in FY14 may help to identify other locations in the basin that are of interest for improving fish passage.

3.6.2 New Stream Development

Of the 60 NSD sites evaluated, 20 met the screening criteria for a potential hydropower opportunity that may benefit at least one environmental issue. Estimated capacities of these 20 combined hydropower-environmental opportunities ranged from 1.2 to 3.8 MW, representing a total capacity of 35.2 MW. The other 33 NSD sites were deemed impractical because they intersected catchments containing protected lands (GAP Status 1 or 2 or Wild and Scenic Rivers) or dwarf wedgemussel habitat.

Environmental opportunities associated with potentially suitable NSD sites included improvements in DO levels, water temperature, degree of hydrologic disturbance, and fish passage. NSDs may provide opportunities for improving the first three issues by improving the ability to better manage flows. However, these opportunities may be contingent on the proximity of other dams and current flow management practices in those reaches. For example, opportunities for improving flow management may

be greater in reaches with older dams that have no or limited ability for manually controlling flow. Conversely, an NSD may not provide added value for improving environmental flow in reaches with modern flow management measures and best management practices. These situations were not evaluated in this assessment because of a lack of information about existing dams and flow management practices. Even so, they would be difficult to evaluate in a Phase 1 Scoping Assessment because of the multiple contingencies at each site; if necessary, such work might be possible under BSOA Phase 3, Technical Analysis, should it be undertaken.

NSDs may also provide opportunities for improving fish passage by adding or improving fish passage facilities at existing sites or by dam removal elsewhere in the catchment(s). Existing sites that were considered opportunities for improving fish passage in the Connecticut basin included dams that were ranked highly (top 10%) by TNC's NCAT tool as being ecologically important for anadromous fish restoration (Martin and Apse 2011). Again, NCAT results were useful because they provided an ecologically appealing and rapid means of conducting an initial screening of opportunities. However, as with NPDs, it is important to acknowledge that similar opportunities for fish passage improvements may exist at other dams despite their NCAT rankings.

3.6.3 Conclusion

Additional input from key stakeholders in FY14 or Phase 2 (should it be undertaken) may help to identify other locations in the basin that are of interest for improving fish passage. It is important to note that these results are preliminary and subject to change as more information is gleaned, methodologies are refined, and stakeholder feedback is obtained.

4.0 Roanoke River Basin – Preliminary Phase 1 Scoping Assessment

The purpose of the Phase 1 Scoping Assessment for the Roanoke River basin was to identify combined hydropower-environmental opportunities. The BSOA national steering committee selected the Roanoke basin for a Phase 1 Scoping Assessment because of USACE's interest and the basin's relatively manageable size, rich data sources, and various possible hydropower and environmental opportunities. The basin has strong existing hydropower capacity in the upper basin and perceived potential for new site development in the lower basin. It scored well in the selection process because of environmental opportunities, which include degraded migratory fish species habitat, reduced riparian function, and poor existing water quality. Furthermore, the USACE and TNC (national steering committee members) are collaborating in the Roanoke River under the Sustainable Rivers Initiative, providing an avenue for collaboration and coordination for a Phase 1 Scoping Assessment.

The following elements and associated tasks compose the *preliminary* Phase 1 Scoping Assessment for the Roanoke basin:

- Stakeholders: Identify and contact key stakeholders to inform them of the Phase 1 Scoping Assessment.
- Information: Compile general information regarding hydropower and environmental opportunities in the basin.
- Hydropower Opportunities: Perform an initial screening of potential increases in hydropower power assets.
- Environmental Issues: Perform an initial screening of environmental issues that may be improved by actions associated with hydropower opportunities.
- Combined Hydropower-Environmental Opportunities: Assess interactions between hydropower opportunities and environmental issues to identify potential combined opportunities.

4.1 Key Stakeholders

The PNNL/ORNL team identified and contacted a set of key stakeholders in the Roanoke basin to inform them of the Phase 1 Scoping Assessment. We worked with the BSOA national steering committee during a conference call on March 22, 2013, to identify a small number of key strategic stakeholder groups, including major hydropower operators, federal agencies, and leading environmental organizations. We continued the process of identifying key stakeholder groups in the Roanoke basin by 1) reviewing a list of landowners along the Roanoke River compiled for the NSD project; 2) reviewing the FERC License Orders for the Smith Mountain, Niagara, and Gaston/Roanoke Rapids hydropower projects; 3) reviewing the list of watershed organizations for each Roanoke basin watershed listed in the EPA web site "Surf Your Watershed" (EPA 2013); and 4) conducting a general Internet search.

Next, we contacted representatives of two organizations on the BSOA national steering committee that have strong interests in the Roanoke basin: the USACE and TNC. Lisa Morales (USACE) and Jeff Opperman (TNC) provided names and contact information for their organizations' representatives in the

Roanoke basin. Lisa Morales recommended Frank Yelverton of the USACE Wilmington District. Jeff Opperman and Andy Warner (TNC) recommended Chuck Peoples, the Northeast North Carolina Program Director in TNC's Roanoke River Field Office. In addition, Melanie Harris, the BSOA national steering committee representative from the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS), recommended Fritz Rohde, the NMFS North Carolina Hydropower Program Coordinator.

We conducted telephone interviews with Frank Yelverton (USACE), Chuck Peoples (TNC), and Fritz Rohde (NOAA/NMFS) to get information about other key stakeholder groups in the Roanoke basin. All three contacts provided background documents and contact information for other stakeholder organizations.

Lisa Morales and Kamau Sadiki (USACE) invited the PNNL/ORNL team to participate in a site visit at the USACE John H. Kerr and Philpott hydropower projects in August 2013. The team met with several USACE staff during the visit, including Frank Yelverton, Craig "Rocky" Rockwell, Steve Jones, Michael Womack, and Michael Young. The USACE staff provided additional information about stakeholder groups as well as potential hydropower and environmental opportunities in the basin.

In summary, the key stakeholders contacted for the BSOA Phase 1 Scoping Assessment in the Roanoke basin included one environmental group, one federal resource agency, and one federal Hydropower MOU agency (Table 4.1). Communications with key Roanoke stakeholders are summarized in Table 4.2. An annotated list of stakeholders in the Roanoke basin is provided in Appendix B.

Table 4.1. Contact information for key stakeholders for the BSOA Phase 1 Scoping Assessment in the Roanoke basin. (This list is a draft; it will be updated after review by regional parties in FY14.)

Name	Affiliation	Phone	Email
Peoples, Chuck	The Nature Conservancy, Roanoke River Field Office	252.583.0007	cpeoples@tnc.org
Rohde, Fritz	NOAA/NMFS, North Carolina Hydropower Program	252.838.0828	fritz.rohde@noaa.gov
Yelverton, Frank	USACE, Wilmington District	910.251.4640	Frank.Yelverton@usace.army.mil

4.2 Information Compilation

The Roanoke River basin extends from the Blue Ridge Mountains in southwestern Virginia to Albemarle Sound in eastern North Carolina, covering about 9,580 square miles and including more than 400 miles of rivers (RRBA 2013) (Figure 4.1). The Roanoke basin includes the Roanoke River, its tributaries, the Dan, Smith, and Staunton rivers, and numerous other smaller tributary rivers and streams.

Table 4.2. Communications with key stakeholders for the BSOA Phase 1 Scoping Assessment in the Roanoke basin.

Date	From	To	Vehicle	Description
4/17/13	Saulsbury	Jeff Opperman (TNC)	Emails	Discussed assessment with Jeff and requested TNC contact in the basin.
4/17/13	Saulsbury	Andy Warner (TNC)	Emails	Discussed assessment with Andy and requested TNC contact in the basin.
4/17-23/13	Saulsbury	Chuck Peoples (TNC)	Emails	Informed Chuck of assessment, provided BSOA background information, and requested telephone interview.
4/19/13	Saulsbury	Lisa Morales (USACE)	Emails	Discussed assessment with Lisa and requested USACE contact in the basin.
4/26/13	Saulsbury	Chuck Peoples (TNC)	Phone call and Emails	Conducted telephone interview with Chuck; he provided some background information via email.
6/19/13	Lisa Morales (USACE)	Saulsbury	Emails	Provided USACE contact in the basin.
6/20/13	Saulsbury	Fritz Rohde (NOAA/NMFS)	Emails	Informed Fritz of assessment, provided BSOA background information, and requested telephone interview.
6/20/13	Saulsbury	Frank Yelverton (USACE)	Emails	Informed Frank of assessment, provided BSOA background information, and requested telephone interview.
7/01/13	Saulsbury	Frank Yelverton (USACE)	Phone call and Emails	Conducted telephone interview with Frank; he provided some background information via email.
7/03/13	Saulsbury	Fritz Rohde (NOAA/NMFS)	Phone call and Emails	Conducted telephone interview with Fritz; he provided some background information via email.
8/27-28/13	Saulsbury and Bevelhimer	USACE staff from HQ, Wilmington District, and Kerr and Philpott projects	Site Visit	Site visit and meetings at USACE Kerr and Philpott projects.

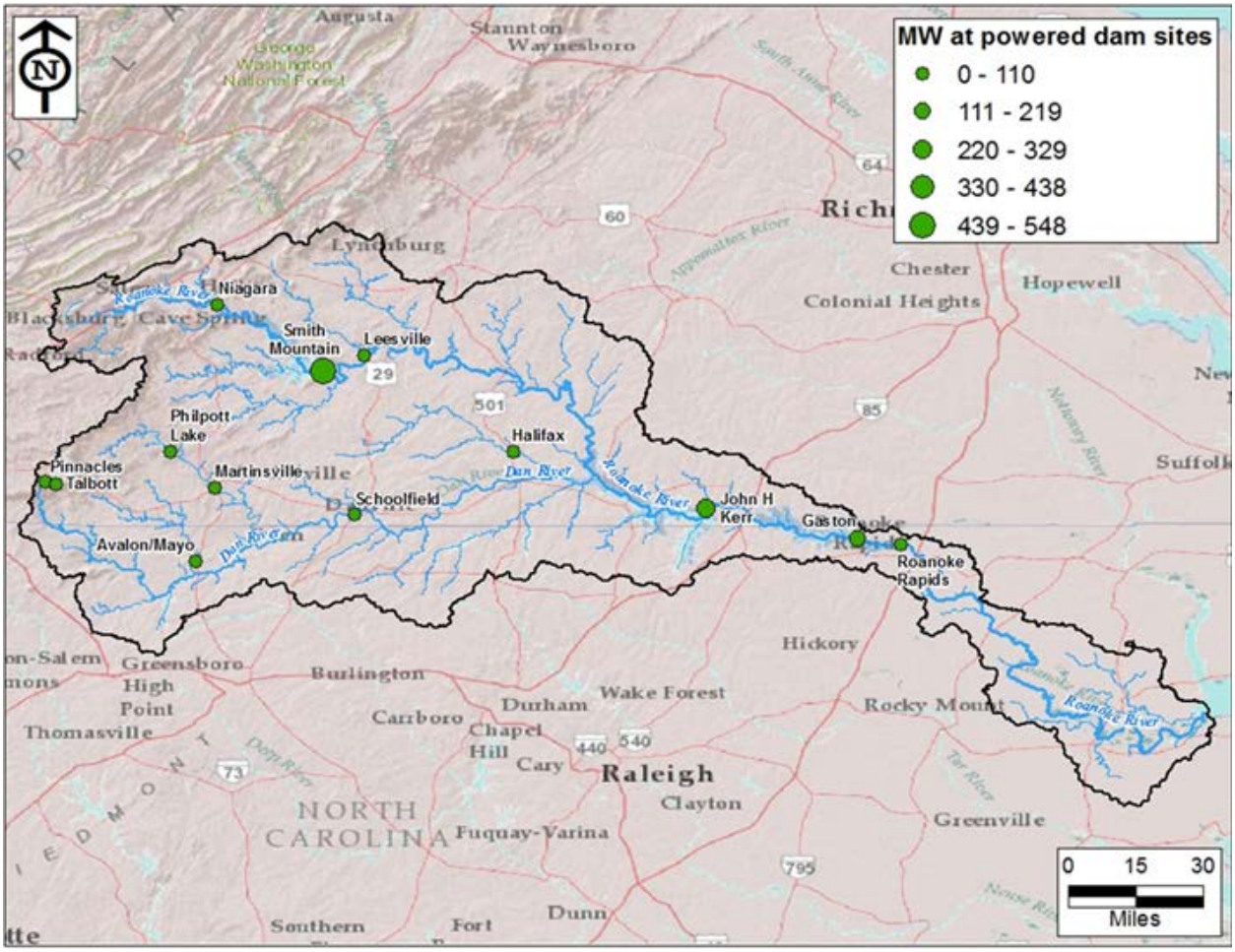

Figure 4.1. The Roanoke River basin showing existing powered dams.

There are 13 existing hydropower projects in the Roanoke River basin. Appalachian Power owns and operates the two most upstream hydropower projects on the Roanoke River. The larger of the two Appalachian Power projects is the 636-MW Smith Mountain Project (FERC No. 2210), a combination pumped storage and conventional hydropower project with two developments. The upstream, pumped storage part of the project is the Smith Mountain Development, which has a generating capacity of 586 MW and a 20,260-acre reservoir known as Smith Mountain Lake. The downstream, conventional hydropower part of the project is the Leesville Development, which has a generating capacity of 50 MW and a 3,260-acre reservoir known as Leesville Lake. The smaller, more downstream of the two Appalachian Power projects on the Roanoke River is the Niagara Project (FERC No. 2466), which has a generating capacity of 2.4 MW and a 62-acre reservoir.

The USACE (Wilmington District) also owns and operates two hydropower projects in the Roanoke basin. The larger of the two USACE projects is the 206-MW John H. Kerr Project, which is located on the Roanoke River and has a 48,900-acre reservoir. The smaller of the two USACE projects is the 14-MW Philpott Project, which is located on the Smith River and has a 2,880-acre reservoir. The USACE coordinates water management and hydropower production between the Kerr and Philpott projects.

Dominion Power owns and operates the 329-MW Roanoke Rapids and Gaston Project (FERC No. 2009), which is located on the Roanoke River immediately downstream from the USACE John H. Kerr Project. The Gaston Development has a generating capacity of 225 MW and a 20,300-acre reservoir (Lake Gaston). The Gaston Development occupies about 252 acres of federal land administered by the USACE. The Roanoke Rapids Development has a generating capacity of 104 MW and a 4,600-acre reservoir (Roanoke Rapids Lake). Dominion Power and the USACE coordinate water management and hydropower production among the Kerr, Gaston, and Roanoke Rapids facilities.

4.3 Hydropower Opportunities

Hydropower opportunities for the Roanoke River basin include powering NPDs, NSDs, and increasing hydropower generation at existing facilities. We found no indication that hydrokinetic development and powering of non-powered water conveyance systems are being considered for development in the Roanoke basin. The assessment of potential hydropower capacity that could be obtained by powering NPDs conducted as part of ORNL's NHAAP identified 19 dams in the Roanoke basin having a potential capacity of >0.1 MW each and a combined capacity of 7.8 MW (Figure 4.2). Similarly, the NSD task of the NHAAP identified 97.6 MW of potential capacity throughout the basin distributed among 27 possible locations (Figure 4.3). It is impractical to develop all of these sites, but each site presents a possible opportunity that is evaluated further in this analysis. Thirteen existing hydropower dams (PDs) in the basin have an installed capacity of 1200 MW. Hydropower production at these sites might be increased through increasing capacity, improved efficiency, or changes in operations, but these types of opportunities are difficult to determine through analysis of individual project information contained in NHAAP database or readily available elsewhere and, therefore, were not included in the assessment of combined hydropower-environmental opportunities at this time.

No NPD or NSD site is contiguous with any of the criteria that would preclude its development, i.e., Wild and Scenic River designation or GAP Status 1 or 2 lands. Therefore, all of these NPD and NSD sites were considered as candidates for development in conjunction with an environmental opportunity if it exists and thereby included in the assessment of combined hydropower-environmental opportunities for the Roanoke River basin (Section 4.5).

A look at the relative generation capacity of these two types of hydropower opportunities indicates that the development potential at existing NPDs is much less than at NSDs (Figure 4.4). However, existing NPDs probably have an advantage in terms of construction cost and regulatory requirements, thereby making it difficult to conclude that one opportunity type is better than the other. As an aside, it is difficult to predict how much increased capacity might be available at existing PDs through modifications to project infrastructure or operations; it is likely to be only a fraction of the existing capacity, which would probably put potential development at existing PDs on par with NPD development.

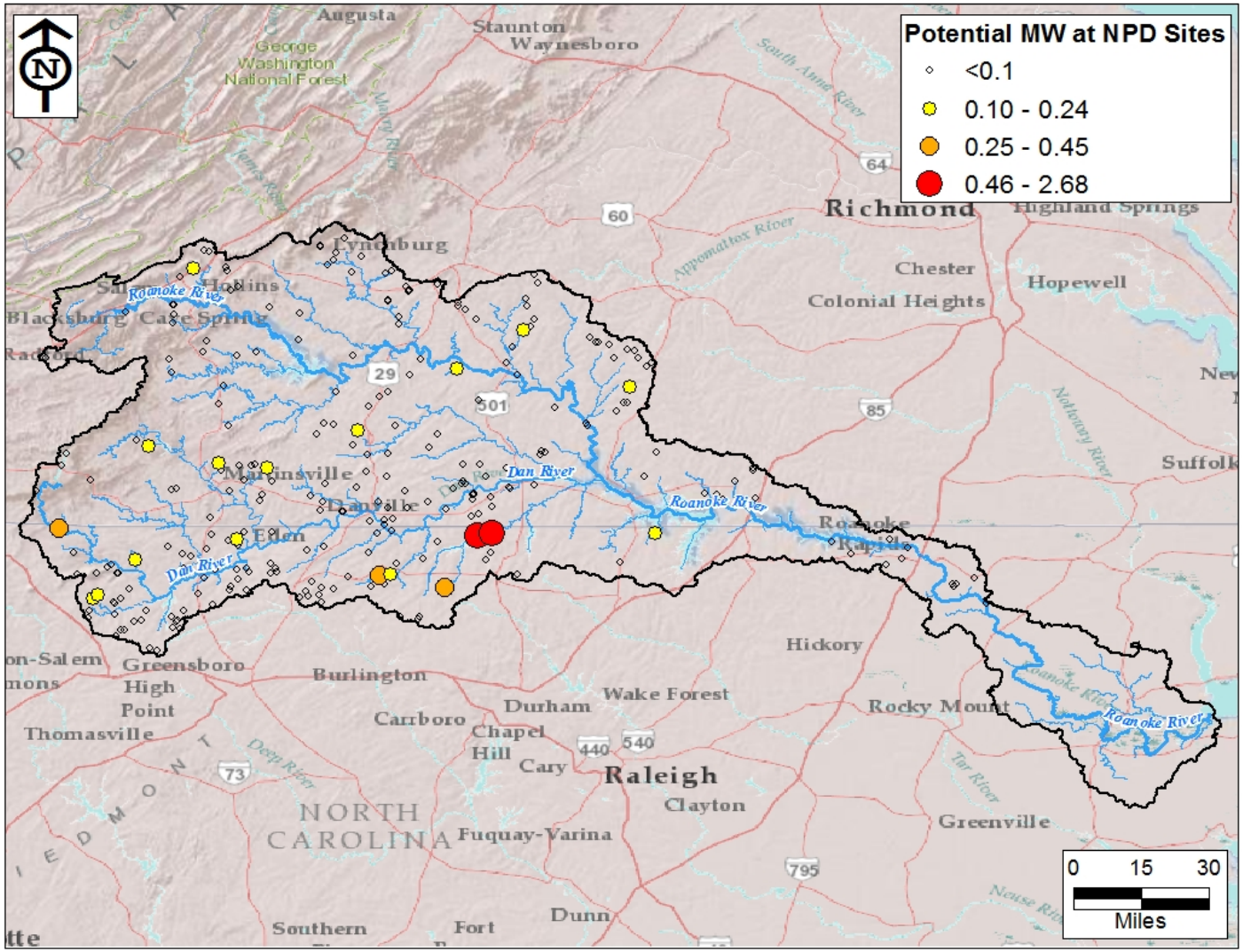

Figure 4.2. Location and potential capacity (megawatts) of existing non-powered dams in the Roanoke basin that meet the criteria imposed to identify reasonable hydropower opportunities.

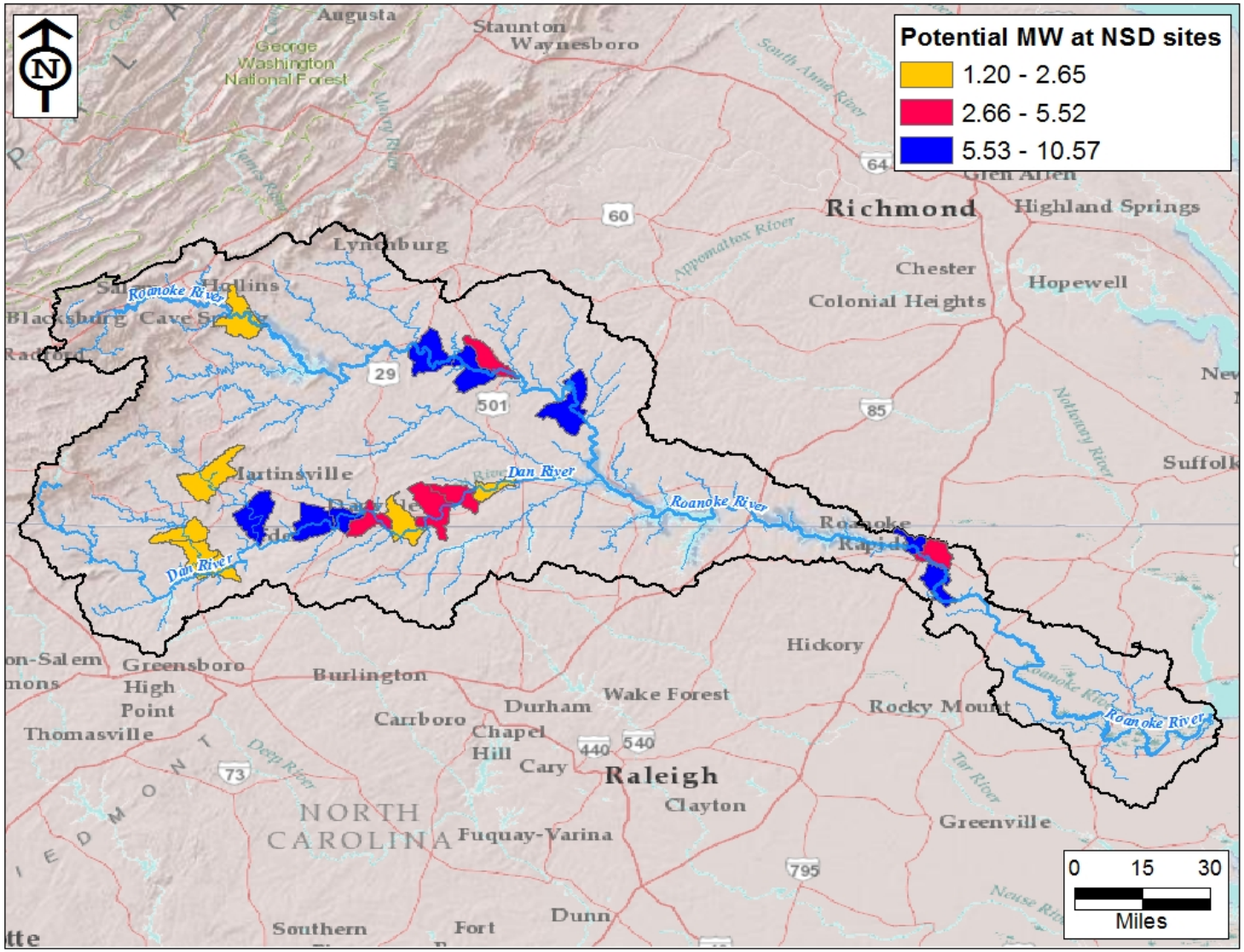

Figure 4.3. General location and potential capacity (megawatts) of potential new hydropower sites in the Roanoke basin that were identified during the NHAAP new stream-reach development process and meet the criteria to identify reasonable hydropower opportunities.

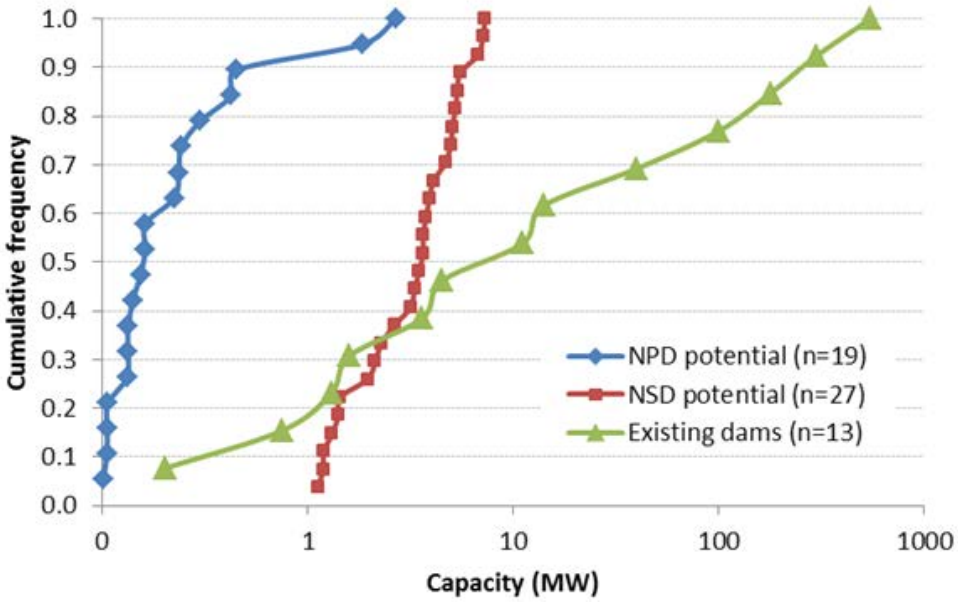

Figure 4.4. The relative generation capacity of non-powered dams (potential megawatts), new site development (potential megawatts), and existing (present megawatts) of sites where hydropower development opportunities might exist. Cumulative frequency refers to the proportion of the total number of sites for a given capacity for a given hydropower opportunity type. Since the data are not cumulative MW, the capacity at a cumulative frequency of 1.0 will *not* equal the total potential capacities of 7.8 MW for NPD and 97.6 MW for NSD mentioned in text above.

4.4 Environmental Issues

Many environmental issues in the Roanoke River (Figure 4.5) occur in the lower Roanoke River, which is the last free-flowing stretch of the river between Roanoke Rapids Dam and Albemarle Sound (Figure 4.1). This section of the river has received a great deal of conservation effort focused on fish passage, hydrology, and floodplain habitats. Roanoke Rapids Dam is the farthest downstream barrier to migrations by anadromous fish, including federally endangered short-nosed sturgeon, federal species of concern blueback herring and Alewife (*Alosa pseudoharengus*), and high-profile species such as American shad, striped bass (*Morone saxatillis*), and American eel. There are no structural fish passage facilities at Roanoke Rapids Dam; however, feasibility assessments of trap-and-transfer programs have been attempted for American shad and American eel with little success for American shad (Harris and Hightower 2011) and unknown success for American eel (FERC 2004). The Lower Roanoke also provides habitat for two other federally listed species, the American Alligator (*Alligator mississippiensis*) and Bald Eagle (*Haliaeetus leucocephalus*). Besides fish passage, changes in dam operations at Roanoke Rapids to improve hydrology have been a major focus of multiple stakeholder groups to support better spawning and juvenile rearing habitat for striped bass and other migratory fish. Attempting to naturalize flood-inundation flows to conserve many of the bottomland hardwoods in the floodplain has been another major conservation focus.

Several fish species of concern occur farther upstream in the basin, including the federally endangered Roanoke logperch (*Percina rex*), state-listed Carolina darter (*Etheostoma collis*) and

orangefin madtom (*Noturus gilberti*), and species of concern including rustyside sucker (*Thoburnia hamiltoni*) and Roanoke bass (*Amplobtes cavifrons*).

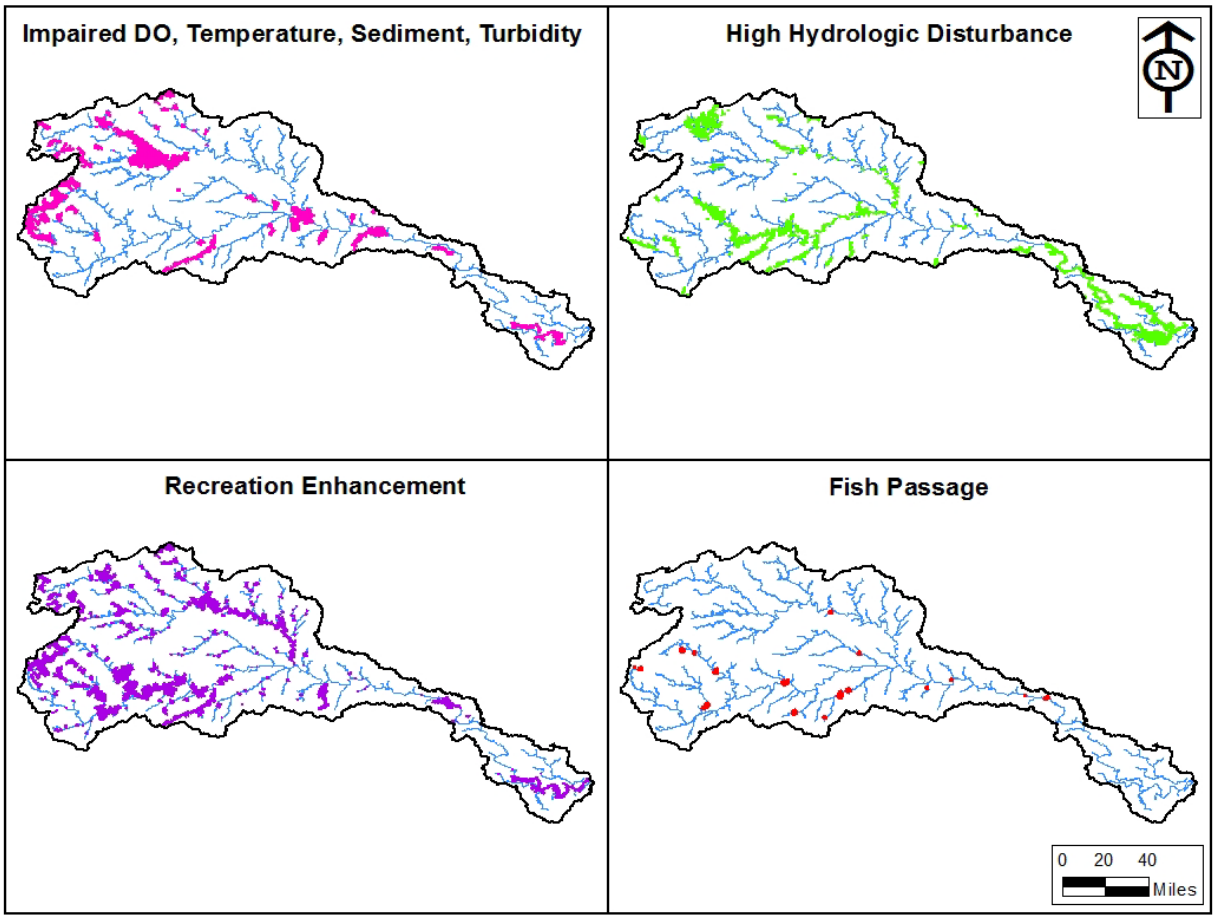

Figure 4.5. Catchments in the Roanoke basin showing key environmental issues that were examined for potential combined hydropower-environmental opportunities.

Water-quality concerns and degraded aquatic habitat were predominant environmental issues in the basin. The majority of water-quality concerns included E. coli contamination, elevated mercury levels in fish tissue, low DO levels, polychlorinated biphenyls in fish tissue, and fecal coliform pollution. Aquatic weeds were also documented as a nuisance in Roanoke Rapids Lake. Temperature was documented as a water-quality concern mostly in the upper sections of the basin. Water quality can be modified by dam operations to benefit downstream aquatic communities. For example, modified flow releases were attempted below Philpott Dam (USACE, Smith River) to increase temperatures to benefit a quality brown trout (*Salmo trutta*) fishery (too cold for optimal growth) (Krause et al. 2005). However, without more dramatic changes in infrastructure, temperatures could only be influenced minimally by alternative flows.

The majority of the Roanoke Basin is highly regulated by impoundments, starting in the headwaters of the main stem and its tributaries (Smith and Dan Rivers). Much of the main stem and large tributaries show evidence of intense hydrologic alteration (hydrologic disturbance indices greater than the 95th percentile value). Altered hydrologic conditions below Roanoke Rapids Dam and their implications on riverine and floodplain communities have also been a major interest in the basin. According to the

NFHAP, most of the hydrologic catchments are categorized as “moderate” watershed disturbances, which are associated with intense urbanization and development. Canals are prevalent in the basin (335 total) with the highest numbers occurring in the vicinity of Albemarle Sound. Water-transfer connectors and pipelines are found throughout the basin but are less common than canals.

Protected lands are generally patchily distributed throughout the Roanoke basin, although protected land coverage is consolidated and dense in the Lower Roanoke as it approaches Albemarle Sound. The U.S. Forest Service (USFS) owns most of the protected lands in the basin. The USACE is second largest land-owning entity in the Roanoke basin. USACE-owned facilities and associated lands include Philpott and John H. Kerr dams and reservoirs. Approximately 75% of protected lands in the basin are classified as GAP Status 3 (50%) and 4 (25%)—classifications that are indicative of supporting a wider spectrum of uses.

Recreation is prevalent throughout the basin with more than 100 boat ramps and 42 fishing access locations. Recreational boating (primarily whitewater) is more common in the eastern half of the basin; 33 different boating runs are found within the mountains and piedmont. Similarly, 24 different public trout waters occur in the mountains and piedmont. However, many opportunities exist to provide recreational boating, boat ramp, and fishing access in areas where they are absent.

4.5 Combined Hydropower-Environmental Opportunities

By evaluating spatially-explicit, direct interactions between hydropower opportunities and environmental issues (explained in Section 2.6), combined hydropower-environmental opportunities were assessed for two hydropower opportunity types in the Roanoke River basin: powering NPDs and NSDs (Table 4.3). Of the 273 NPD opportunities assessed in the Roanoke River basin, 19 were of a size (>0.1 MW) that could provide a reasonable opportunity for hydropower development. All of these met criteria that would preclude development, such as being included in or bordering a protected land entity (e.g., a GAP Status of 1 or 2, or within a federally designated Wild and Scenic River). These 19 sites were evaluated for association with indicators of opportunity for environmental improvement to produce combined hydropower-environmental opportunities.

The screening level analysis identified nine NPD sites that had associated environmental improvement opportunities representing a total of 4.8 MW of potential capacity (Table 4.4; Figure 4.6). Four sites had more than one type of environmental opportunity, and the opportunities occurring most frequently were related to decreasing hydrologic disturbance and improvements in sedimentation/water turbidity conditions.

Similarly for potential new stream-reach development, of the 27 NSD opportunities assessed in the Roanoke River basin, all 27 met other criteria that would preclude development. These 27 sites were evaluated for association with indicators of opportunity for environmental improvement to derive a list of combined hydropower-environmental opportunities.

The screening level analysis identified at least one associated environmental improvement opportunity at each of the 27 NSD sites representing a total of 97.6 MW of potential capacity (Table 4.4). Most of the opportunities were one of three types: better flow management to reduce hydrologic disturbance, new whitewater boating opportunities, and increased reservoir fishing opportunity, and many sites had more than one associated environmental opportunity (Figure 4.7).

Table 4.3. Criteria for classifying interactions between environmental issues and hydropower opportunities that may result in an environmental benefit in the Roanoke basin (RO). Key: TW = tailwater, RES = reservoir, and "---" indicates no applicability.

		Hydro Opportunity Type	
Environmental Criteria	Environmental Opportunity	Non-Powered Dams	New Stream-Reach Developments
Does not meet EPA criteria for dissolved oxygen (DO)	Aeration from new development/adding a turbine could increase DO in downstream reaches with DO impairment.	---	RTW
Does not meet EPA criteria for sedimentation/siltation or turbidity	New development/adding turbine could provide better flow management in downstream reaches with excessive sedimentation or turbidity impairments.	---	TW
Does not meet EPA criteria for temperature	New development/adding a turbine could provide better flow management in downstream reaches with temperature impairments.	---	TW
High level of hydrologic disturbance	New development/adding a turbine could provide better flow management in downstream reaches with high hydrologic disturbance.	---	TW
Presence of a dam that is ecologically important for anadromous fish restoration	Assume improvements to fish passage can be made as part of project development, either through facility modification or dam removal.	TW&RES	TW&RES
Trout are present but management (e.g., stock enhancement) is lacking.	Trout fishery can be enhanced (e.g., by stocking or flow modification) to provide more opportunity for public utilization.	TW	---
No whitewater boating at present although slope and flow meet criteria for whitewater opportunity	Where there exists sufficient slope and flow and whitewater boating is not present, conditions could be created in conjunction with new development to provide whitewater recreation.	TW	---
Existing or potential reservoirs above minimum size and without present fishing access	Public access could be provided to reservoirs of sufficient size and presently limited access.	RES	RES

Caveat: There is inherent uncertainty about how a given opportunity would be realized. For example, for the opportunities strongly tied to flow management, it is assumed that powering a NPD or building an NSD would provide some mechanism(s) for managing flows to better meet environmental objectives like improving water quality or recreation. Ultimately, the exact mechanism or manner in which a hydropower opportunity addresses a specific environmental issue depends on a suite of factors whose description is beyond the scope of a Phase 1 Scoping Assessment.

Table 4.4. Summary of the number and capacity of non-powered dams and potential new stream-reach development sites that have associated opportunities for environmental improvement in the Roanoke basin. This assessment of potential new hydropower capacity is conservative because it does not include other hydropower opportunity types nor does it include potential system-level benefits.

	Non-Powered Dams		New Stream-Reach Development	
Environmental Opportunity	# Sites	MW	# Sites	MW
Aeration incorporated into new development or adding a turbine could increase DO in downstream reaches that are currently DO impaired.	0	0	0	0
New development or adding a new turbine could provide better flow management in downstream reaches that have sedimentation or turbidity impairments.	3	0.85	2	2.51
New development or adding a new turbine could provide better thermal control in downstream reaches exhibiting temperature impairment.	1	0.42	0	0
New development/adding turbine could provide better flow management in downstream reaches exhibiting high hydrologic disturbance.	4	1.04	15	63.9
Adding hydropower operation could provide better flow management in existing whitewater paddling reaches below existing dams.	2	0.65	NA	NA
Assume improvements to fish passage can be made as part of project development, either through facility modification or dam removal.	2	2.98	0	0
New development/adding turbine could enhance existing trout population through stocking or habitat modifications.	2	0.69	NA	NA
New development/adding turbine could modify flows to provide new whitewater boating opportunity.	2	0.32	13	54.2
New development/adding turbine could create access to improve reservoir recreational fishing opportunity.	1	0.30	18	61.0
Total number and megawatts of sites that have at least one potential environmental opportunity	9	4.8	27	97.6

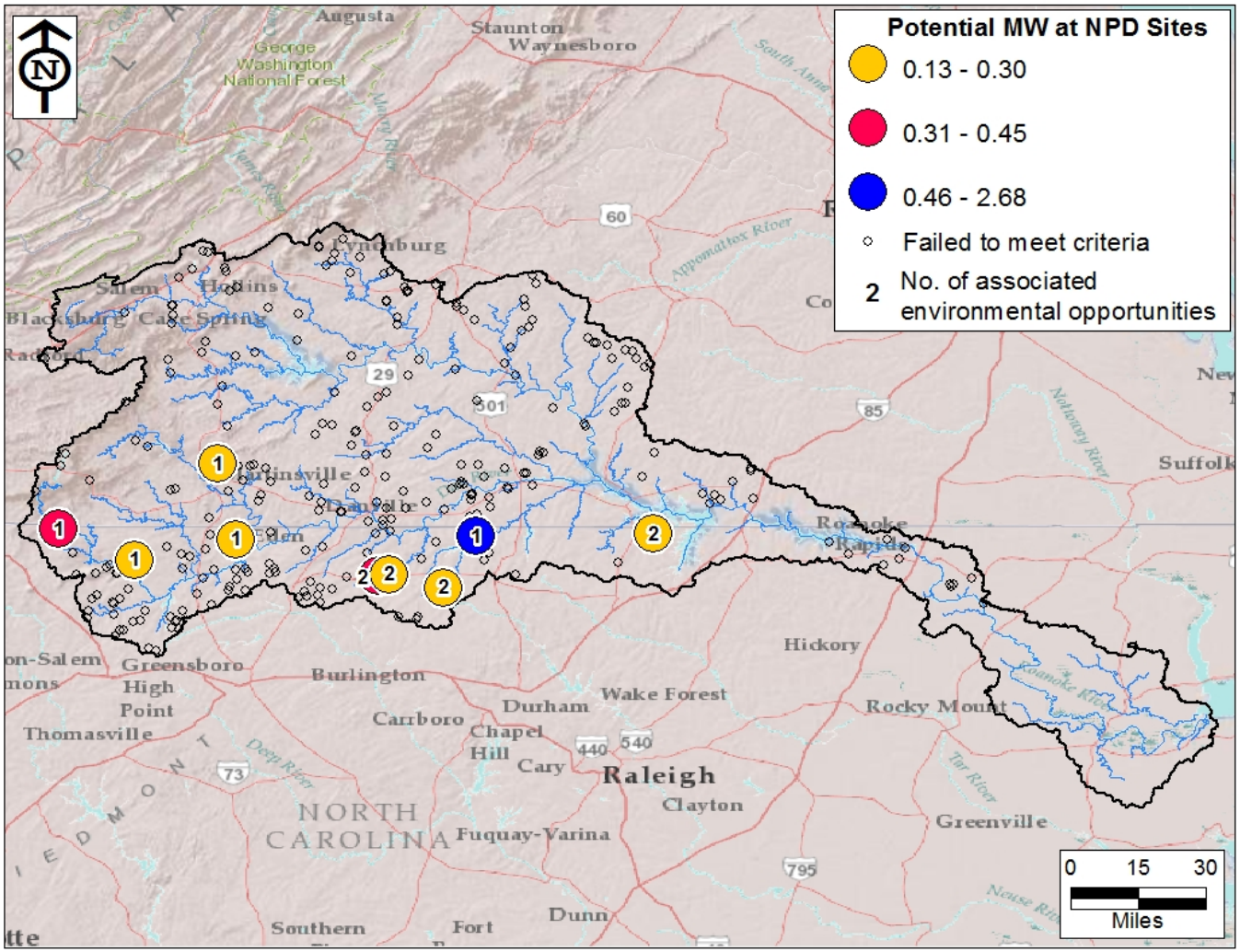

Figure 4.6. Location and potential hydropower capacity (megawatts) of non-powered dams with associated environmental opportunities in the Roanoke River basin. The number in the circle indicates how many different environmental opportunities are associated with each site.

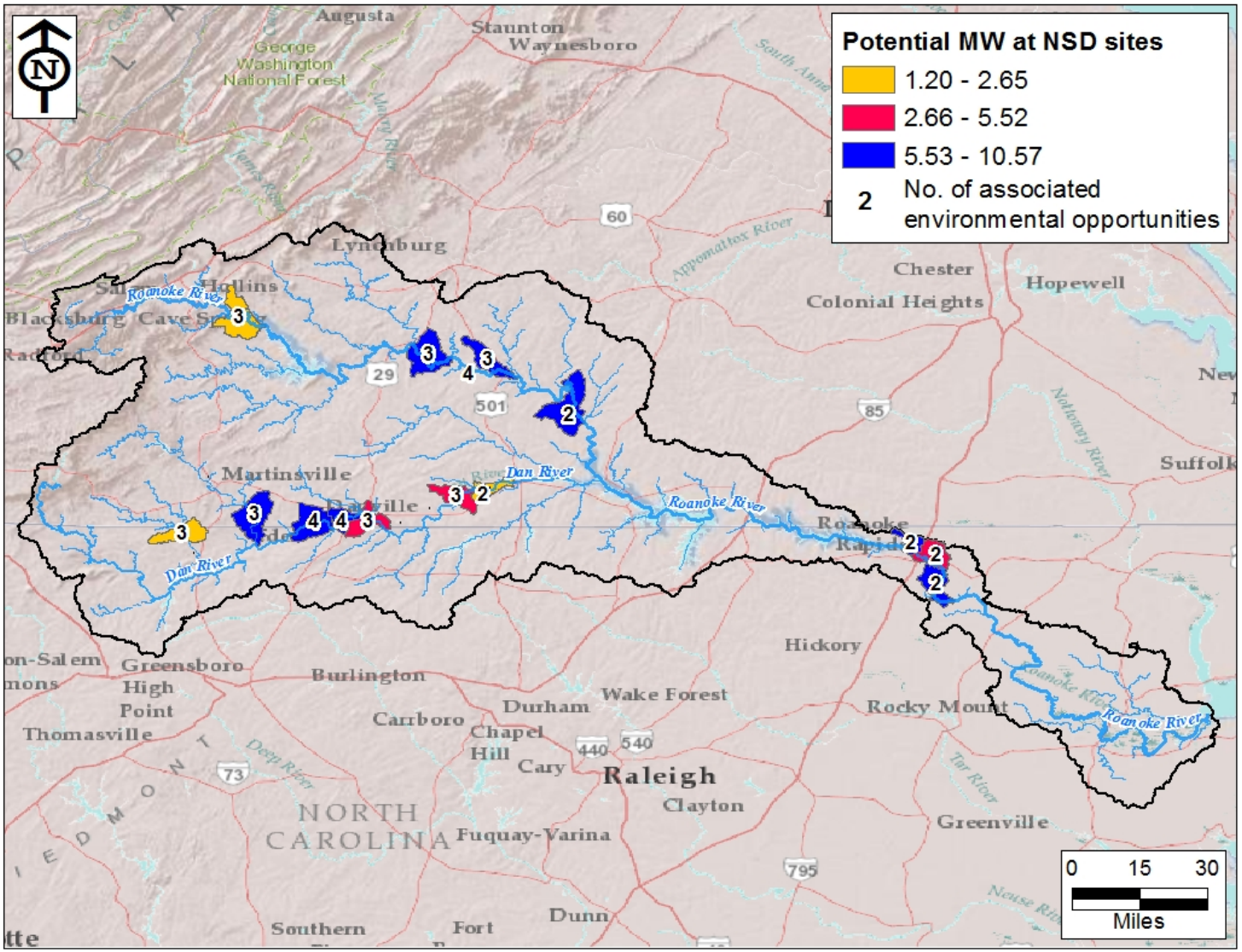

Figure 4.7. Location (by catchment) of potential new stream-reach development sites that have more than one associated environmental opportunity.

4.6 Summary

For the Roanoke River basin, the geospatial approach we used identified several different combinations of possible hydropower/environmental improvement opportunities.

4.6.1 Non-Powered Dams

The assessment narrowed the list of 273 NPD sites to 19 that met the megawatt capacity of a viable hydropower opportunity (0.1 MW for NPD and 1 MW for NSD) and only 9 of the 19 had at least one associated environmental opportunity.

4.6.2 New Stream Development

For potential new sites, our assessment determined that all 27 candidate sites identified in the NHAAP NSD analysis were spatially associated with at least one environmental opportunity, and 10 of those sites were associated with three or more environmental opportunities, suggesting that those sites might be priority sites for further investigation.

4.6.3 Conclusion

Considering the results for both NPDs and NSDs together, the environmental opportunities that seem most prevalent are related to 1) providing better hydrologic conditions for ecological processes (e.g., moderating daily flow fluctuations or mimicking natural periodic flood flows) and 2) providing more recreational fishing and boating opportunities. In neither case was our analysis able to include the need or demand for such improvements. For example without talking to stakeholders, we do not know whether current ecological resources are suffering from hydrologic disturbance or whether there is a demand for more fishing or whitewater boating opportunity. It is important to realize that this analysis is only a preliminary assessment, and an important next step is to meet with stakeholders in the Roanoke River basin to confirm the methodology and the results it produced.

5.0 Discussion

The *preliminary* Phase 1 Scoping Assessments for the Connecticut River and Roanoke River basins provide a scoping-level scientific assessment of combined hydropower-environmental opportunities for each basin. These preliminary assessments should provide useful information for review by DOE, the national steering committee, and key basin stakeholders about the feasibility of opportunities for hydropower development and associated environmental improvements in the respective basins. This closing section of the 2013 annual report for the BSOA initiative contains a brief discussion of the strengths and weaknesses of the Phase 1 technical approach and methodology and a description of planned future direction and research activities for the BSOA initiative.

5.1 Technical Approach and Methodologies

The Phase 1 approach is designed for conducting rapid initial assessments of hydropower and associated environmental opportunities at a basin scale. Key strengths of the approach are that it is nationally deployable, relatively quick to implement (6 months or less), and useful for examining and visualizing opportunities under a variety of scenarios. The BSOA data model and geospatial database enable the approach to be implemented for any basin in the United States. The data model and database can be used to standardize identification and visualization of opportunities across basins, but are also flexible enough to allow for customized assessments of opportunities. The database schema and associated GIS tools developed to populate the database can be used to quickly build a BSOA geospatial database for a given basin. Thus, the primary time constraint in future assessments will likely be data acquisition. Additional beta tools have been developed for facilitating complex queries of the database (i.e., queries of potential opportunities) and should continue to be refined in FY14.

The BSOA data model is central to Phase 1 methodology. The data model outlines a process flow, key data elements, relationships between data elements, and criteria for examining interactions among data elements to identify combined opportunities. A strength of this model is the criteria that define opportunities. Criteria can be objective or subjective, depending on the objectives of the analysis and interests of the stakeholders. However, defining criteria becomes increasingly difficult as relationships among types of hydropower opportunities, environmental issues, and stakeholder interests become more complex. Assuming criteria can be defined, the data model provides a means by which opportunities may be screened quickly in a uniform manner. The criteria presented herein represent an initial consideration of attributes that were deemed relevant for conducting preliminary assessments in the Connecticut and Roanoke river basins. In addition to refining these criteria, additional criteria should be identified in FY14 based on anticipated stakeholder feedback.

Several key assumptions were made in the Phase 1 development process that are important to discuss with respect to the preliminary results presented herein and the future direction of the project. One assumption is that a hydrologic catchment is an appropriate spatial unit for examining relationships (positive or negative) between hydropower opportunities and environmental issues. The purpose of using catchments (or some other spatial polygon) is twofold. First, it resolves an analytical challenge of spatially relating hydropower opportunities and environmental issues that may be spatially disparate but functionally linked. In doing so, it also helps to satisfy a goal of the BSOA initiative to expand the scale of analysis to identify commonality among the sometimes disparate goals of regional stakeholders.

Catchments were chosen because they are hydrologically related, which is important to consider when evaluating relationships between hydropower opportunities and environmental issues. Because catchments are not uniform in size and shape, there may be some spatial ambiguity when relating hydropower opportunities and environmental issues. However, this issue exists for other spatial polygons as well and is difficult to address because the exact spatial extent of hydropower-environmental interactions is not known. This potential bias was deemed acceptable for the purposes of a rapid basin-scale assessment, although methods to reduce this potential bias should continue to be explored in FY14.

Related to the above assumption is the assumption that the spatial extents of tailwaters and reservoirs used in this preliminary assessment were appropriate for aggregating catchment-scale interactions for a given hydropower opportunity. A goal in defining these extents is to choose areas that are hydrologically and ecologically appropriate with respect to the interactions being examined. However as previously mentioned, this is difficult to do because the exact spatial extent of hydropower-environmental interactions is not known. A second goal is to refine these extents to better represent actual conditions, taking into account factors such as adjacent dams, topography, etc., and thereby improve independence among adjacent hydropower opportunities. This is also difficult to do because of uncertainties and a lack of data about tailwater and reservoir boundaries for individual sites. For example, representations of reservoirs were not available in the NHD data set for all hydropower opportunities in this assessment. In addition, the spatial representations of tailwaters and reservoirs used in this preliminary assessment were not modified to account for potential overlap between adjacent sites. Methods for improving tailwater and reservoir boundaries should be evaluated in FY14.

It is important to note that for the preliminary Phase 1 assessments described herein that interactions between hydropower opportunities and environmental issues were treated as equally weighted and not additive; i.e., one opportunity was not considered more important than another at the same location, and the total number of opportunities at one location did not make it more or less important than another. The reason for doing this was to present the full realm of opportunities in an unbiased manner that hopefully facilitates discussion among stakeholders and helps them identify the opportunities that are most valuable to regional interests. It may be feasible to weight opportunities in the analysis if a reasonable process for doing so is vetted in FY14.

One more important assumption of the Phase 1 process is that the environmental issues included in the analysis are appropriate for a rapid opportunity assessment. During Step 4 of the Phase 1 development process, the PNNL/ORNL team developed a comprehensive list of common environmental issues that might pertain to hydropower development in the United States. This list was used to help guide the compilation of information about key issues in the Connecticut and Roanoke basins. During this process, it was discovered that perhaps not all of the issues may be relevant or important for a basin-scale opportunity analysis. In addition, it was often difficult to find or create suitable spatial data to represent environmental issues in the analysis and to define defensible criteria for examining interactions between hydropower and environmental issues. For these reasons, the list of common environmental issues and associated criteria for defining interactions should be further refined in FY14.

5.2 Future Direction and Research Activities

Research conducted under the BSOA initiative during 2013 started with the design of a stepwise technical approach for Phase 1 Scoping Assessments, proceeded to development of a new quantitative

geospatial methodology to integrate hydropower and environmental opportunities, and culminated with preliminary basin-scale assessments of hydropower and associated environmental opportunities in the Connecticut River and Roanoke River basins. Building on these accomplishments, the future (FY14) direction and research activities should include outreach to obtain feedback from key stakeholders about the preliminary assessments; refinements of the methodology; packaging, dissemination, and peer review of BSOA results by potential users, such as hydropower industry, regulatory agencies, and environmental groups; finalization of the Phase 1 Scoping Assessment for the Connecticut River and Roanoke River basins; and, application of the BSOA approach and methodology to a third basin, the Big Horn/Powder River basin in Wyoming/Montana. Additional material about these topics follows.

- *Outreach and Feedback.* Outreach to key stakeholders in each basin in FY13 was limited to informing them about the Phase 1 efforts. More substantial outreach is planned for FY14 to obtain feedback on the methods and results of the preliminary Phase 1 Scoping Assessments for the Connecticut and Roanoke basins. Such feedback will help to better incorporate stakeholder interests, knowledge, and experience concerning regulatory, statutory, and water management contexts for each basin. However, the FY14 effort will necessarily remain relatively focused because extensive stakeholder engagement is the purpose of Phase 2 of a BSOA.
- *Refinement of the Methodology*. Research could be undertaken to test the limits of the Phase 1 approach to move beyond identification of site-specific hydropower and environmental opportunities and potentially evaluate basin-scale interactions, i.e., synergistic effects among sites. In particular, methodology will be developed to assess the connection between indirect or unaffiliated environmental opportunities and hydropower opportunities and to assess opportunities for restoring hydrologic and stream network connectivity while pursuing hydropower development. Previously, basin-scale opportunities were generally considered beyond the scope of a Phase 1 assessment because of analytical complexities. However, over the course of carrying out the preliminary Phase 1 assessments in FY13, this potential was considered to be possible. If successful, this would achieve an original goal of this initiative, to "rapidly" assess hydropower and environmental opportunities across a basin at both the site and basin scales.
- *Packaging, Dissemination, and Peer Review of BSOA Results.* The results derived from the BSOA initiative are intended to be shared broadly with stakeholders working on hydropower and environmental issues within river basins across the United States. An initiative goal is to develop a logical technical approach for conducting a Phase 1 Scoping Assessment that can be applied by regional stakeholder groups, although developing standalone software or tools is not anticipated as part of this process. It is unknown at this time whether the GIS tools that are being developed to support the BSOA data model, including the geospatial database schema and ArcGIS tools for populating and querying the database, will become available for public use. A goal of this project is to continue refining the functionality and usability of these tools to make them more widely applicable. Similar tools can be developed and used by experienced GIS analysts, but it is recommended they seek guidance from the PNNL/ORNL team.
- *Finalization of the Connecticut and Roanoke Assessments*. The Phase 1 Scoping Assessments for the Connecticut and Roanoke basins should be finalized after receiving feedback from DOE and key stakeholders, and refining the methodology.
- *Phase 1 Scoping Assessment for the Big Horn/Powder Basin*. Much of the work during FY13 was focused on development of the Phase 1 approach. As the approach is further refined in FY14, it will be informative to apply it in a focused effort for an additional basin that was not included in the initial

development phase of the project. As noted in Section 2.1, the national steering committee selected the Big Horn/Powder River basin for the FY14 effort.

6.0 References

The references are organized by the section to enable ready extraction when the Phase 1 Scoping Assessments are finalized as standalone documents during FY14.

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Appendix A

Stakeholders for the Preliminary Phase 1 Scoping Assessment for the Connecticut Basin

Appendix A

Stakeholders for the Preliminary Phase 1 Scoping Assessment for the Connecticut Basin

This appendix lists Connecticut Basin stakeholder entities and their contacts.

A.1 Stakeholder Identification

The stakeholders are categorized as follows: hydropower operators, national environmental groups, federal agencies, and commonwealth and state agencies.

A.1.1 Hydropower Operators

A.1.1.1 Ampersand Gilman Hydro, LP, formerly Dalton Hydro, LLC

The Gilman Dam is located at river mile 300 on the Connecticut River in the towns of Lunenburg, Vermont, and Dalton, New Hampshire, and has a generating capacity of 4.05 megawatts (MW). The Gilman Dam recently underwent modifications to install fish passage facilities to support fish migration. The resulting impoundment from the dam extends approximately 200 miles upstream to the confluence of the Johns River (LIHI 2013).

Ampersand Energy Partners LLC contact: info@ampersandenergy.com (617-933-7200).

A.1.1.2 Dodge Falls Associates, LP

The Dodge Falls Dam is located in Bath, New Hampshire, and Ryegate, Vermont, 268 miles from the mouth of the Connecticut River. The dam is located 4 miles downstream from TransCanada's McIndoes hydroelectric station. The hydroelectric station has a generating capacity of 5 MW (LIHI 2009).

Dodge Falls Associates LP contact: Richard Norman, President (rnorman@essexhydro.com; 617-367-0032).

A.1.1.3 FirstLight Hydro Generating Company

Turner Falls Dam comprises of two dams, the Gill and Montague dams, which are connected via a natural rock island in the Connecticut River near the town of Montague, Massachusetts. The dam is located 120 miles upstream from the mouth of the Connecticut River in Montague, Massachusetts. The Turner Falls reservoir extends 20 miles upstream to the base of the TransCanada's Vernon Dam. Turner Falls Dam has a generating capacity of 6 MW. Two miles downstream from the Turner Falls Dam is the Cabot Hydroelectric Station, which has a generating capacity to 61.8 MW. The Turner Falls Dam and the Cabot Hydroelectric Station maintain fish passage facilities. The Northfield Mountain Pump Storage Project pumps water from the Turner Falls Impoundment into an upper reservoir in the town of Northfield, Massachusetts. It has a total generating capacity of 1,119.2 MW. The Turner Falls

Hydroelectric Project and the Northfield Mountain Pumped Storage Project are currently undergoing relicensing via the Federal Energy Regulatory Commission's (FERC's) integrated licensing process (FirstLight Power 2013a,b).

FirstLight Contact: TBD.

A.1.1.4 Holyoke Gas & Electric Department

The Holyoke Dam, located at river mile 80 on the Connecticut River, has a generating capacity of 43 MW. The damming of the Connecticut River at this location results in 2,290 acres of reservoir that extends approximately 25 miles upstream from the dam. The Robert E. Barrett Fishway aids in the passage of migratory fish via the operation of two elevators at the Holyoke Dam (Holyoke Gas & Electric 2007).

Holyoke Gas & Electric contacts: TBD.

A.1.1.5 Public Service Company of New Hampshire

The Canaan Dam is located in the town of Canaan, Vermont, and lies approximately 1 mile south of the Canadian border on the Connecticut River. The facility has a generating capacity of 1.1. MW (FERC 2009).

Public Service contact: TBD.

A.1.1.6 TransCanada

TransCanada Hydro Northeast operates 13 hydroelectric stations and associated dams and reservoirs on the Connecticut and Deerfield (a tributary to the Connecticut River) rivers. Six hydroelectric stations occur along the main stem of the Connecticut River. The Moore Hydroelectric Station has a generating capacity of 192 MW and is located in Littleton, New Hampshire, and Waterford, Vermont. The Comerford and McIndoes hydroelectric stations are located in Monroe, New Hampshire, and Barnet, Vermont, and have 144-MW and 11-MW capacities, respectively. The Wilder Hydroelectric Station has a generating capacity of 41 MW and is located in Lebanon, New Hampshire, and Hartford, Vermont. Bellows Falls Station is located in Walpole, New Hampshire, and Rochinham, Vermont, and has a generating capacity of 49 MW. Vernon Hydroelectric Station has a generating capacity of 37 MW and is located in Vernon, Vermont, and Hinsdale, New Hampshire. The Wilder, Bellows Falls, and Vernon stations are currently undergoing relicensing via the FERC's integrated licensing process (TransCanada 2012).

TransCanada contact: John Ragonese (603-498-2851).

A.1.1.7 U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (USACE) New England District manages several flood-control dams within the Connecticut River basin. In addition, the USACE along with The Nature Conservancy (TNC) and various other partners have been developing a basin-wide hydrologic model and decision support tool for the Connecticut River watershed. The tool is intended to help stakeholders better evaluate the environmental, economic, and social impacts of various management decisions within the basin.

USACE contact: Chris Hatfield (christopher.l.hatfield@ usace.army.mil; 978-318-8520).

A.1.2 National Environmental Groups

A.1.2.1 American Rivers

American Rivers is "the leading organization working to protect and restore the nation's rivers and streams" and has helped protect and restore more than 150,000 miles of rivers through advocacy efforts, on-the-ground projects, and the annual release of America's Most Endangered Rivers® (American Rivers 2011). American Rivers has been working to remove dams and restore habitat in the Connecticut River basin (American Rivers 2013).

The American Rivers Northeast office contact: Brian Graber, Director River Restoration Program (413-585-5896).

A.1.2.2 Sierra Club

The mission of the Sierra Club is "To explore, enjoy, and protect the wild places of the earth; to practice and promote the responsible use of the earth's ecosystems and resources; to educate and enlist humanity to protect and restore the quality of the natural and human environment; and to use all lawful means to carry out these objectives" (Sierra Club 2013). The Sierra Club has a local chapter in each state within the Connecticut River basin.

Contacts within each chapter are as follows:

- Connecticut Chapter: John Blake, Chair (jblake@crystalrock.com; 860-642-1715)
- Massachusetts Chapter: Ryan Black, Director (Ryan.Black@sierraclub.org; 617-423-5775)
- New Hampshire Chapter: Catherine Corkery, Director (catherine.corkery@sierraclub.org; 603-224-8222)
- Vermont Chapter: Steve Crowley, Chair (steve.crowley1@gmail.com; 802-658-5782).

A.1.2.3 The Nature Conservancy

The mission of TNC is "to conserve the lands and waters on which all life depends" (TNC 2013). TNC works across the four states in which the Connecticut River basin flows. Land acquisition by TNC within the basin began in 1960 with 46 acres and has grown to include protection of nearly a quarter-million acres. TNC also focuses efforts on restoration of stream flow, connectivity, and floodplains (TNC 2013).

TNC contact: Kim Lutz, Connecticut River Basin Program Director (klutz@tnc.org; 413-584-1016).

A.1.2.4 Trout Unlimited

The mission of Trout Unlimited (TU) is "to conserve, protect, and restore North America's coldwater fisheries and their watersheds" (TU 2013).

TU contact for the Connecticut River valley: James Matteau, Chapter President (jimmatteau@gmail.com).

A.1.3 Federal Agencies

A.1.3.1 U.S. Army Corps of Engineers

As stated previously, the USACE New England district manages several flood control dams within the Connecticut River basin. See Section A.1.1.7 for contact information.

A.1.3.2 Department of the Interior

U.S. Fish and Wild Service

The U.S. Fish and Wildlife Service (FWS) is "the premier government agency dedicated to the conservation, protection, and enhancement of fish, wildlife and plants, and their habitats" (FWS 2013). FWS is the only federal agency whose primary responsibility is management of these natural resources for the American public. FWS is responsible for implementing and enforcing the Endangered Species Act, Migratory Bird Treaty Act, and Marine Mammal Protection Act (FWS 2013).

USFWS contact: Andrew French (Andrew_french@fws.gov; 413-548-8002 ext. 111)

National Park Service

The National Park Service (NPS) manages the 401 parks of the National Park System and helps administer dozens of affiliated sites, the National Register of Historic Places, National Heritage Areas, National Wild and Scenic Rivers, National Historic Landmarks, and National Trails. The purpose of the NPS is "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (NPS 2013).

NPS contact: TBD.

U.S. Geological Survey

The U.S. Geological Survey (USGS) "serves the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life" (USGS 2013).

USGS contact: Virginia de Lima, Director USGS Connecticut Water Science Center (vdelima@usgs.gov; 860-291-6741).

A.1.3.3 National Oceanic and Atmospheric Administration (National Marine Fisheries Service)

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) is "responsible for the stewardship of the nation's living marine resources and their habitat" (NOAA 2013). NMFS is responsible for the management, conservation, and protection of living marine resources within the United States' Exclusive Economic Zone (water 3 to 200 miles offshore). Using the tools provided by the Magnuson-Stevens Act, NMFS assesses and predicts the status of fish stocks, ensures compliance with fisheries regulations, and works to reduce wasteful fishing practices. Under the Marine Mammal Protection Act and the Endangered Species Act, NMFS recovers protected marine species (i.e., whales, turtles) without unnecessarily impeding economic and recreational opportunities (NOAA 2013). NMFS responsibilities also include hydropower regulation and FERC proceedings.

NMFS contact: Sean McDermott (sean.mcdermott@noaa.gov; 978-281-9113).

A.1.3.4 Department of Agriculture

Forest Service

The mission of the U.S. Forest Service (USFS) is to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations. The USFS manages 193 million acres of public lands in national forests and grasslands across the United States (USFS 2013).

USFS contact: Gillian Baine, Strategic Programs Director, Northern Research Station (718-225-3061).

Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS), originally known as the Soil Conservation Service, has expanded to become a conservation leader for all natural resources, ensuring that private lands are conserved, restored, and more resilient to environmental challenges. The NRCS works with private landowners through conservation planning and assistance designed to benefit the soil, water, air, plants, and animals that result in productive lands and healthy ecosystems (NRCS 2013). The NRCS maintains offices in each state within the Connecticut River basin.

NRCS contacts:

- Connecticut: Lisa Coverdale, State Conservationist (lisa.coverdale@ct.usda.gov; 860-871-4011)
- Massachusetts: Christine Clarke, State Conservationist (christine.clarke@ma.usda.gov; 413-253-4350)
- New Hampshire: Richard Ellsmore, State Conservationist (richard.ellsmore@hn.usda.gov; 603-868-7581)
- Vermont: Vicky Drew, State Conservationist (vicky.drew@vt.usda.gov; 802-951-6496 ext. 242).

A.1.3.5 Federal Energy Regulatory Commission

FERC is an independent agency that regulates the interstate transmission of electricity, natural gas, and oil; reviews proposals to build liquefied natural gas terminals and interstate natural gas pipelines; and licenses certain non-federal hydropower projects (FERC 2013).

FERC contact: Gerald Cross, Regional Engineer Office of Energy Projects (Gerald.cross@ferc.gov; 212-631-8124).

A.1.3.6 Environmental Protection Agency

The mission of the U.S. Environmental Protection Agency (EPA) is "to protect human health and the environment" (EPA 2013b). The Connecticut River basin falls within the management jurisdiction of the EPA Region 1 New England District. The EPA also manages the National Estuaries Program to protect and restore estuaries across the country. The Long Island Sound is part of the Connecticut River estuary and is part of the EPA's National Estuaries Program.

EPA Contacts:

- Curt Spalding, EPA Region 1 Administrator (spalding.curt@epa.gov; 671-918-1010)
- Mark Tedesco, Director EPA Long Island Sound Office (tedesco.mark@epa.gov; 203-977-1541).

A.1.4 State Agencies, Commonwealths, Councils, and Commissions

A.1.4.1 Connecticut River Watershed Council

The CRWC works across four states (New Hampshire, Vermont, Massachusetts, and Connecticut) to provide restoration and protection to the Connecticut River watershed. The geographic scope of management includes a diversity of habitats that span the headwaters and tidal environments (CRWC 2013).

CRWC contact: Andy Fisk (afisk@ctriver.org; 413-772-2020 ext. 208).

A.1.4.2 Connecticut River Joint Commissions

The Connecticut River Joint Commissions (CRJC) is a partnership between the states of Vermont and New Hampshire representing a diverse group of citizens within the Connecticut River valley. The mission of the CRJC "…is to preserve and protect the visual and ecological integrity and sustainable

working landscape of the Connecticut River Valley, and to guide its growth and development through grassroots leadership (CRJC 2013)." With the exception of a few designated positions, commissioners serve as volunteers and are appointed for 3-year terms by the state's governors.

CRJC contact: Rebecca Brown, President (contact@crjc.org, 603-727-9484).

A.1.4.3 The State of Connecticut

Department of Energy and Environmental Protection

"The Connecticut Department of Energy and Environmental Protection (DEEP) is charged with conserving, improving and protecting the natural resources and the environment of the state of Connecticut as well as making cheaper, cleaner and more reliable energy available for the people and businesses of the state. The agency is also committed to playing a positive role in rebuilding Connecticut's economy and creating jobs – and to fostering a sustainable and prosperous economic future for the state" (DEEP 2013). The Connecticut DEEP is responsible for managing the environmental quality of air, land, and water resources as well as natural resources such as fisheries, wildlife, forests, and wetlands.

Connecticut DEEP Watershed Manager contacts:

- Chris Malik (860-424-3959)
- Susan Peterson (860-424-3854)
- Eric Thomas (860-424-3548).

A.1.4.4 The Commonwealth of Massachusetts

Massachusetts Department of Environmental Protection

"The Department of Environmental Protection is the state agency responsible for ensuring clean air and water, the safe management of toxics and hazards, the recycling of solid and hazardous wastes, the timely cleanup of hazardous waste sites and spills, and the preservation of wetlands and coastal resources" (Commonwealth of Massachusetts 2013a).

MDEP contact: Gary Moran, Deputy Commissioner Operations and Environmental Compliance (gary.moran@stae.ma.us; 617-292-5775).

Massachusetts Department of Fish and Game

The Massachusetts "…*Department of Fish & Game* works to preserve the state's natural resources and people's right to conservation of those resources..." through management of "…marine and freshwater fisheries, wildlife species, plants, and natural communities, as well as the habitats that support them" (Commonwealth of Massachusetts 2013b).

MDFG contact: Bob Greco, Chief of Staff (bob.greco@state.ma.us; 617-626-1556).

A.1.4.5 The State of New Hampshire

New Hampshire Department of Environmental Services

"The mission of the New Hampshire Department of Environmental Services is to help sustain a high quality of life for all citizens by protecting and restoring the environment and public health in New Hampshire" NHDES (2008). The NHDES manages air and water quality across the state.

NHDES contact: Bob Minicucci, Planning, Prevention & Assistance Unit (environmentalleadership@des.nh.gov; 603-271-2941).

New Hampshire Department of Fish and Game

The New Hampshire Department of Fish and Game (NHDFG) is responsible for managing, protecting, and conserving the fish, wildlife, and marine resources within the state (NHFG 2013).

NHDFG Contact: Glenn Normandeau, Executive Director (603-271-3511).

A.1.4.6 The State of Vermont

Vermont Department of Environmental Conservation

The Vermont Department of Environmental Conservation (VDEC) "…manages water and air quality; regulates solid and hazardous wastes; and administers a number of voluntary pollution and waste reduction programs. While the DEC issues most of the state's environmental permits, the department does more than just set forth regulations and assure compliance. Among other responsibilities, department staff members collect data; conduct research; run volunteer programs; develop educational and outreach materials and programs; administer grants; and work with conservation organizations and state and federal agencies to examine critical environmental issues" (VDEC 2004).

VDEC contact: Pete LaFlamme, Director (pete.laflamme@state.vt.us; 802-828-1544).

Vermont Fish and Wildlife Department

The Vermont Fish and Wildlife Department is responsible for the state-wide protection and conservation of fish, wildlife and their habitats (VFWD 2013).

VFWD contacts:

- Roderick Wentworth, Environmental Assessment (rod.wentworth@state.vt.us; 802-595-5179)
- Jon Kart, Fish and Wildlife Biologist (jon.kart@state.vt.us; 802-595-1810).

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DEEP (Department of Energy & Environmental Protection). 2013. About Us. <http://www.ct.gov/deep/cwp/view.asp?a=2690&q=322476&deepNav_GID=1511>. Accessed on September 5, 2013.

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LIHI (Low Impact Hydropower Institute). 2013. Gilman Hydroelectric Project. <http://www.lowimpacthydro.org/lihi-pending-application-gilman-hydroelectric-project-ferc-no.-2392-ampersand-gilman-hydro-lp.html>. Accessed on September 4, 2013.

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VDEC (Vermont Department of Environmental Conservation). 2004. Welcome to the DEC. <http://www.anr.state.vt.us/dec/about.htm>. Accessed on September 5, 2013.

VFWD (Vermont Fish and Wildlife Department). 2013. Vermont Fish & Wildlife Department About Us. <http://www.vtfishandwildlife.com/about_history.cfm>. Accessed on September 5, 2013.

Appendix B

Stakeholders for the Preliminary Phase 1 Scoping Assessment for the Roanoke Basin

Appendix B

Stakeholders for the Preliminary Phase 1 Scoping Assessment for the Roanoke Basin

This appendix lists the Roanoke Basin stakeholder entities and their contacts.

B.1 Stakeholder Identification

The stakeholders are categorized as follows: hydropower operators, national environmental groups, federal agencies, and commonwealth and state agencies.

B.1.1 Hydropower Operators

B.1.1.1 Appalachian Power

Appalachian Power owns and operates two hydropower projects on the Roanoke River. The larger of the two Appalachian Power projects is the 636-megawatt (MW) Smith Mountain Project (FERC No. 2210), a combination pumped storage and conventional hydropower project with two developments. The upstream, pumped storage part of the project is the Smith Mountain Development, which has a generating capacity of 586 MW and a 20,260-acre reservoir known as Smith Mountain Lake. The downstream, conventional hydropower part of the project is the Leesville Development, which has a generating capacity of 50 MW and a 3,260-acre reservoir known as Leesville Lake (FERC 2009). The smaller of the two Appalachian Power projects is the Niagara Project (FERC No. 2466), which has a generating capacity of 2.4 MW and a 62-acre reservoir (FERC 1994).

Appalachian Power contact: Liz Parcell (ebparcell@aep.com; 540-489-2540).

B.1.1.2 Dominion Power

Dominion Power owns and operates the 329-MW Roanoke Rapids and Gaston Project (FERC No. 2009), which is located immediately downstream from the Corps' John H. Kerr Project. The Gaston Development has a generating capacity of 225 MW and a 20,300-acre reservoir (Lake Gaston). The Gaston Development occupies about 252 acres of federal land administered by the U.S. Army Corps of Engineers (USACE). The Roanoke Rapids Development has a generating capacity of 104 MW and a 4,600-acre reservoir (Roanoke Rapids Lake) (FERC 2004).

Dominion Power contacts:

- Jim Thornton (james_thornton@dom.com; 804-273-3257)
- Bob Graham (bob.graham@dom.com; 804-271-5377).

B.1.1.3 U.S. Army Corps of Engineers

The USACE (Wilmington District) owns and operates two hydropower projects in the Roanoke Basin. The larger of the two Corps projects is the 206-MW John H. Kerr Project, which is located on the

Roanoke River and has a 48,900-acre reservoir (Corps 2013a). The smaller of the two Corps projects is the 14-MW Philpott Project, which is located on the Smith River and has a 2,880-acre reservoir (Corps 2013b).

USACE contact: Frank Yelverton (Frank.Yelverton@usace.army.mil; 910-251-4640).

B.1.2 National Environmental Groups

B.1.2.1 American Rivers

American Rivers is "the leading organization working to protect and restore the nation's rivers and streams" and has helped protect and restore more than 150,000 miles of rivers through advocacy efforts, on-the-ground projects, and the annual release of America's Most Endangered Rivers® (American Rivers 2011). In the Roanoke basin, American Rivers has been active in opposing a proposal to lift the state of Virginia's 1982 statewide ban on uranium mining. A uranium mining company proposed lifting the ban to allow for uranium mining on a tributary to the Roanoke in Pittsylvania County, Virginia (American Rivers 2011).

American Rivers contact: Peter Raabe (praabe@americanrivers.org; 919-682-3500).

B.1.2.2 National Wildlife Federation/Virginia Conservation Network

The National Wildlife Federation (NWF) is "America's conservation organization protecting wildlife for our children's future" (NWF 2013). NWF's affiliate in Virginia is the Virginia Conservation Network (VCN), a network of more than 100 organizations committed to protecting Virginia's natural resources (VCN 2013). NWF's affiliate in North Carolina is the North Carolina Wildlife Federation (NCWF), the mission of which is to be the leading advocate for all North Carolina wildlife and its habitat (NCWF 2013).

VCN contacts:

- Nathan Lott (Nathan@vcnva.org; 804-644-0283)
- Susan Ankrum (vcn@vcnva.org).

NCWF contact: Christopher North (chris@ncwf.org).

B.1.2.3 Sierra Club

The mission of the Sierra Club is "To explore, enjoy, and protect the wild places of the earth; To practice and promote the responsible use of the earth's ecosystems and resources; To educate and enlist humanity to protect and restore the quality of the natural and human environment; and to use all lawful means to carry out these objectives" (Sierra Club 2013).

There are two local Sierra Club groups in the Roanoke basin in Virginia, the Roanoke Group and the Thunder Bridge Group (Virginia Chapter Sierra Club 2013).

Virginia Chapter Sierra Club, Roanoke Group contact: Bill Modica (modicabill2@aol.com).

In the North Carolina portion of the Roanoke Basin, there is one Sierra Club group, the Cypress Group, which serves 24 counties in eastern North Carolina (North Carolina Chapter Sierra Club 2013).

North Carolina Chapter Sierra Cub, Cypress Group contacts:

- David Schwartz (dcschwartz@hotmail.com)
- Barney Kane (microbemanager@gmail.com).

B.1.2.4 The Nature Conservancy

The mission of The Nature Conservancy (TNC) is "to conserve the lands and waters on which all life depends" (TNC 2013). In the Roanoke basin, TNC works with many public and private partners to protect the significant natural areas along the 137-mile stretch of the Roanoke River downstream from Roanoke Rapids Dam. In 1989, TNC purchased 10,626 acres from Georgia-Pacific Corporation to create the Roanoke River National Wildlife Refuge and add land to the state of North Carolina's Roanoke River Wetlands. In 1994, Georgia-Pacific Corporation and TNC entered into an agreement to jointly manage and protect approximately 21,000 acres along the Roanoke River. In 2006, TNC purchased 22,000 acres along the Roanoke River from International Paper as part of the largest-ever land conservation project in the southern United States (TNC Roanoke 2013; Peoples 2013).

TNC continues to be involved in efforts to protect and conserve the Lower Roanoke basin, and is an active participant in the USACE's ongoing "Section 216 study" for the John H. Kerr Project (Peoples 2013). This study is sponsored by the USACE (along with the State of North Carolina and the Commonwealth of Virginia) as authorized under Section 216 of the River and Harbor and Flood Control Act of 1970 (Public Law 91-611). Section 216 authorizes the USACE to review the operations of its existing water projects to improve their environmental performance. The Section 216 study identifies, reviews, and summarizes current operating and administrative procedures at the Kerr Project, as well as approaches and constraints to changing these procedures. The Section 216 study will be used, along with information gathered for the other identified areas of interest, to evaluate the impacts and feasibility of implementing any recommended changes to the operation or structure of Kerr Dam (Water Wiki 2013).

TNC contacts:

- Chuck Peoples (cpeoples@tnc.org; 252-583-0007) in North Carolina
- Scott Boven (sboven@tnc.org; 804-295-6106) in Virginia.

B.1.2.5 Trout Unlimited

The mission of Trout Unlimited (TU) is "to conserve, protect and restore North America's coldwater fisheries and their watersheds" (TU 2013). The Roanoke Valley chapter of TU is "a diverse group of over 265 people with the common interest of pursuing the Trout Unlimited mission" (Roanoke Valley TU 2013).

TU contact: Rick Weiss (rgweiss@comcast.net).

B.1.3 Federal Agencies

B.1.3.1 U.S. Army Corps of Engineers

As discussed above, the USACE owns and operates the John H. Kerr Project, and owns the land on which Dominion Power's Gaston Development is located. USACE contacts are listed above (Section B.1.1.3).

B.1.3.2 U.S. Department of the Interior

U.S. Fish and Wild Service

The U.S. Fish and Wildlife Service (FWS) is "the premier government agency dedicated to the conservation, protection, and enhancement of fish, wildlife and plants, and their habitats" (FWS 2013). FWS is the only federal agency whose primary responsibility is management of these natural resources for the American public. FWS is responsible for implementing and enforcing the Endangered Species Act, Migratory Bird Treaty Act, and Marine Mammal Protection Act (FWS 2013).

FWS contact: John Ellis (john_ellis@fws.gov; 919-856-4520, ext. 26)

National Park Service

The National Park Service (NPS) manages the 401 parks of the National Park System and helps administer dozens of affiliated sites, the National Register of Historic Places, National Heritage Areas, National Wild and Scenic Rivers, National Historic Landmarks, and National Trails. The purpose of the NPS is "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (NPS 2013).

NPS contact: Fred Dieffenbach (fred_dieffenbach@nps.gov; 802-457-3368).

Bureau of Indian Affairs

The mission of the Bureau of Indian Affairs (BIA) is to "enhance the quality of life, to promote economic opportunity, and to carry out the responsibility to protect and improve the trust assets of American Indians, Indian tribes, and Alaska Natives" (BIA 2013). BIA currently provides services (directly or through contracts, grants, or compacts) to approximately 1.9 million American Indians and Alaska Natives. In the Roanoke basin, BIA is primarily concerned with issues affecting the Tuscarora Indian Nation in North Carolina.

BIA contact: TBD.

U.S. Geological Survey

The U.S. Geological Survey (USGS) "serves the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life" (USGS 2013).

USGS contacts:

- Ana Maria Garcia (agarcia@usgs.gov; 919-571-4058)
- Cliff Hupp (crhupp@usgs.gov; 703-648-5207)
- Joe Hightower (jhightower@ncsu.edu; 919-515-8836).

B.1.3.3 National Oceanic and Atmospheric Administration (National Marine Fisheries Service)

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) is "responsible for the stewardship of the nation's living marine resources and their habitat" (NOAA 2013). NMFS is responsible for the management, conservation, and protection of living marine resources within the United States' Exclusive Economic Zone (water 3 to 200 miles offshore). Using the tools provided by the Magnuson-Stevens Act, NMFS assesses and predicts the status of fish stocks, ensures compliance with fisheries regulations and works to reduce wasteful fishing practices. Under the Marine Mammal Protection Act and the Endangered Species Act, NMFS recovers protected marine species (i.e., whales, turtles) without unnecessarily impeding economic and recreational opportunities (NOAA 2013).

NMFS contact: Fritz Rohde (fritz.rohde@noaa.gov; 252-838-0828).

B.1.3.4 U.S. Department of Agriculture

Forest Service

The mission of the U.S. Forest Service (USFS) is to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations. The USFS manages 193 million acres of public lands in national forests and grasslands across the United States (USFS 2013).

USFS contact: TBD.

Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS), originally known as the Soil Conservation Service, has expanded to become a conservation leader for all natural resources, ensuring that private lands are conserved, restored, and more resilient to environmental challenges. NRCS works with private landowners through conservation planning and assistance designed to benefit the soil, water, air, plants, and animals that result in productive lands and healthy ecosystems (NRCS 2013).

NRCS contact: TBD.

B.1.3.5 Federal Energy Regulatory Commission

The Federal Energy Regulatory Commission (FERC) is an independent agency that regulates the interstate transmission of electricity, natural gas, and oil; reviews proposals to build liquefied natural gas terminals and interstate natural gas pipelines; and licenses certain non-federal hydropower projects (FERC 2013). In the Roanoke basin, FERC has issued licenses for the Smith Mountain Project (FERC

No. 2210), the Niagara Project (FERC No. 2466), and the Roanoke Rapids and Gaston Project (FERC No. 2009). FERC continues to monitor safety and compliance with license conditions at all three projects.

FERC contact: David Turner (david.turner@ferc.gov).

B.1.3.6 U.S. Environmental Protection Agency

The mission of the U.S. Environmental Protection Agency (EPA) is "to protect human health and the environment" (EPA 2013b).

EPA contact: TBD.

B.1.3.7 Southeastern Power Administration

The Southeastern Power Administration (SEPA) is one of four power administrations within the U.S. Department of Energy. SEPA is responsible for marketing electric power and energy generated at reservoirs operated by the USACE, including the John H. Kerr Project in the Roanoke basin. SEPA markets power to more than 491 preference customers in the states of Georgia, Florida, Alabama, Mississippi, southern Illinois, Virginia, Tennessee, Kentucky, North Carolina, and South Carolina (SEPA 2013).

SEPA contact: Herb Nadler (herbn@sepa.doe.gov; 706-213-3800).

B.1.4 Commonwealth and State Agencies

B.1.4.1 Roanoke River Basin Bi-State Commission

The Roanoke River Basin Bi-State Commission (RRBBC) was established as a bi-state commission composed of members from the Commonwealth of Virginia and the State of North Carolina. The purpose of the commission is to do the following:

- Provide guidance, conduct joint meetings, and make recommendations to local, state, and federal legislative and administrative bodies, and to others as it deems necessary and appropriate, regarding the use, stewardship, and enhancement of the Roanoke basin's water and other natural resources.
- Provide a forum for discussion of issues affecting the basin's water quantity, water quality, and other natural resources.
- Promote communication, coordination, and education among stakeholders within the basin.
- Identify basin-related problems and recommend appropriate solutions.
- Undertake studies and prepare, publish, and disseminate information through reports and other communications related to water quantity, water quality, and other natural resources of the basin (RRBBC 2013).

RRBBC contact: TBD.

B.1.4.2 Commonwealth of Virginia

Department of Game and Inland Fisheries

The mission of the Virginia Department of Game and Inland Fisheries (VDGIF) is

- to manage Virginia's wildlife and inland fish to maintain optimum populations of all species to serve the needs of the Commonwealth
- to provide opportunity for all to enjoy wildlife, inland fish, boating and related outdoor recreation and to work diligently to safeguard the rights of the people to hunt, fish and harvest game as provided for in the Constitution of Virginia
- to promote safety for persons and property in connection with boating, hunting and fishing
- to provide educational outreach programs and materials that foster an awareness of and appreciation for Virginia's fish and wildlife resources, their habitats, and hunting, fishing, and boating opportunities (VDGIF 2013).

VDGIF contact: Dan Michaelson (434-392-4369, ext. 102).

Department of Environmental Quality

The Virginia Department of Environmental Quality (VDEQ) "protects and enhances Virginia's environment, and promotes the health and well-being of the citizens of the Commonwealth" (VDEQ 2013a).

VDEQ contacts:

- Robert Burgholzer (rwburgholzer@deq.virginia.gov; 804-698-4405)
- Richard Weeks (rfweeks@deq.virginia.gov; 804-698-4484)
- Scott Kudlas (swkudlas@deq.virginia.gov; 804-698-4456).

Virginia Roanoke River Basin Advisory Committee

The Virginia Roanoke River Basin Advisory Committee (VRRBAC), which is part of VDEQ, was established in the executive branch of state government as an advisory committee to the Virginia delegation to the Roanoke River Basin Bi-State Commission (see description above). The Committee assists the delegation in fulfilling its duties and carrying out the objectives of the Commission (VRRBAC 2013).

VRRBAC contacts: TBD.

Department of Conservation and Recreation

The mission of the Virginia Department of Conservation and Recreation (VDCR) is to provide opportunities that encourage and enable people to enjoy, protect, and restore Virginia's natural and cultural treasures. VDCR's work falls into several broad categories. The agency manages, protects, and provides access to numerous state parks throughout the commonwealth. Similarly, VDCR manages

several natural area preserves. Particularly significant natural resources are protected in the preserves, and many provide opportunities for hiking and nature observation (VDCR 2013).

VDCR contacts:

- Robert Munson (Robert.Munson@dcr.virginia.gov; 804-786-6140)
- Ernest Brown (ebrown@dcr.state.va.us; 757-925-2468).

Department of Historic Resources

The mission of the Virginia Department of Historic Resources (VDHR) is to foster, encourage, and support the stewardship of Virginia's significant historic architectural, archaeological, and cultural resources (VDHR 2013). VDHR is the State Historic Preservation Office (SHPO) for Virginia.

VDHR contacts: TBD.

Department of Forestry

The mission of the Virginia Department of Forestry (VDF) is to protect and develop healthy, sustainable forest resources for Virginians. VDF protects 15.8 million acres of forest land from fire, insects, and disease and manages 22 State Forest lands totaling 67,920 acres for timber, recreation, water, research, wildlife, and biodiversity.

VDF contacts: TBD.

Virginia State Water Control Board

The Virginia State Water Control Board is a seven-member board appointed by the Governor and is responsible for administrating the Virginia Water Control Law. The board adopts regulations and considers special orders resolving violations of its regulations and permits that have had a related public hearing. Day-to-day administration of the board's programs is delegated to VDEQ. Among other things, the board is responsible for setting standards of quality for state waters (Water Quality Monitoring, Information and Restoration Act) and water-quality controls; determining requirements for treating sewage and industrial waste and for the recovery and reuse of wastewater; and developing coordinated state policy, plans, and programs for the conservation and economic development of the state's water resources (Virginia State Water Control Board 2013).

Water Quality Control Board contacts: TBD.

B.1.4.3 State of North Carolina

Department of Agriculture and Consumer Services

The North Carolina Department of Agriculture and Consumer Services (NCDACS) has divisions with responsibilities in regulatory and service areas that include (among many other things) agricultural environmental issues, soil and water conservation, and forest management and protection (NCDACS 2013).

NCDACS contact: Dewitt Hardee (dewitt.hardee@ncagr.gov; 919-733-7125).

North Carolina Forest Service

The mission of the NCDACS North Carolina Forest Service (NCFS) is to ensure adequate and quality forest resources for the state to meet present and future needs. NCFS is mandated to protect, manage, and develop the forest resources of the state. The techniques used to accomplish this mandate involve management of existing resources, development and creation of new and better forests, and protection of these valuable resources (NCFS 2013).

NCFS contact: Robert Lipford (rob.lipford@ncdenr.gov; 252-442-1626).

Department of Environment and Natural Resources

The North Carolina Department of Environment and Natural Resources (NCDENR) is the lead stewardship agency for the preservation and protection of North Carolina's natural resources. NCDENR administers regulatory programs designed to protect air quality, water quality, and the public's health. NCDENR also offers technical assistance to businesses, farmers, local governments, and the public and encourages responsible behavior with respect to the environment through education programs provided at NCDENR facilities and through the state's school system. Through its natural resource divisions, NCDENR works to protect fish, wildlife, and wilderness areas. The agency's activities range from helping to make sure drinking water is safe to managing state parks and forests for safe and enjoyable outdoor recreation experiences (NCDENR 2013).

NCDENR contacts: TBD.

Office of Conservation, Planning, and Community Affairs

The NCDENR Office of Conservation, Planning, and Community Affairs works to develop and implement a comprehensive approach to guide statewide natural resource conservation. As part of these efforts, the Conservation Planning Tool has been developed to streamline the process of identifying and prioritizing the areas in North Carolina's landscape that are essential for conservation (NCOCPCA 2013).

NCOCPCA contact: Linda Pearsall (Linda.Pearsall@ncdenr.gov; 919-715-4195).

Division of Water Resources

The mission of the NCDENR Division of Water Resources (NCDWR) is to provide the strategic information necessary to manage the state's water resources for the health and welfare of the public, the continued economic growth of the state, the integrity of North Carolina's surface waters, and the sustainability of its groundwaters. The Public Water Supply Section within NCDWR ensures that North Carolina's citizens and visitors are provided with safe drinking water. The Water Resources Management Section within NCDWR administers programs for river basin management, water supply assistance, water conservation, and water resources development. The Water Resources Management Section also conducts special studies on instream flow needs and serves as the state liaison with federal agencies on major water resources related projects (NCDWR 2013).

NCDWR contacts:

- Jim Mead (jim.mead@ncdenr.gov; 919-715-5428)
- Tom Fransen (tom.fransen@ncdenr.gov; 919-715-0381)
- Tom Reeder (tom.reeder@ncdenr.gov; 919-715-3045).

Division of Water Quality

The NCDENR Division of Water Quality (NCDWQ) is the agency responsible for statewide regulatory programs in surface water and groundwater protection. The mission of the NCDWQ is to protect and enhance North Carolina's surface water and groundwater resources for the citizens of North Carolina and future generations. NCDWQ issues pollution control permits, monitors permit compliance, evaluates environmental quality, and carries out enforcement actions for violations of environmental regulations (NCDWQ 2013).

NCDWQ contacts:

- Adugna Kebede (agunda.kebede@ncdenr.gov; 919-733-5083, ext. 515)
- Melanie Williams (Melanie.williams@ncdenr.gov; 919-807-6447)
- Eric Fleek (eric.fleek@ncdenr.gov; 919-743-8469).

Division of Parks and Recreation

The mission of the NCDENR Division of Parks and Recreation (NCDPR) is to conserve and protect representative examples of the natural beauty, ecological features, and recreational resources of statewide significance; to provide outdoor recreational opportunities in a safe and healthy environment; and to provide environmental education opportunities that promote stewardship of the state's natural heritage (NCDPR 2013).

NCDPR contact: Brian Strong (brian.strong@ncdenr.gov; 919-715-8711).

Division of Coastal Management

The NCDENR Division of Coastal Management (NCDCM) works to protect, conserve, and manage North Carolina's coastal resources through an integrated program of planning, permitting, education, and research (NCDCM 2013). NCDCM carries out the state's Coastal Area Management Act, the Dredge and Fill Law, and the federal Coastal Zone Management Act of 1972 in the 20 coastal counties, using rules and policies of the North Carolina Coastal Resources Commission. NCDCM also receives oversight (and part of its funding) from NOAA's Office of Ocean and Coastal Resource Management (NCDCM 2013).

NCDCM contacts: TBD.

Division of Marine Fisheries

The NCDENR Division of Marine Fisheries (NCDMF) is responsible for the stewardship of the state's marine and estuarine resources. NCDMF's jurisdiction encompasses all coastal waters and extends to 3 miles offshore (NCDMF 2013).

NCDMF contact: Sara Winslow (sara.winslow@ncdenr.gov; 252-264-3911).

North Carolina Wildlife Resources Commission

The mission of the North Carolina Wildlife Resources Commission (NCWRC) is to conserve and sustain the state's fish and wildlife resources through research, scientific management, wise use, and public input. NCWRC is the regulatory agency responsible for enforcing North Carolina's fishing, hunting, trapping, and boating laws (NCWRC 2013).

NCWRC contact: Bennett Wynne (wynnemb@suddenlink.net; 252-522-9736).

Department of Cultural Resources, Office of Archives and History

The mission of the North Carolina Department of Cultural Resources Office of Archives and History (NCOAH) is to collect, preserve, and use the state's historic resources so that present and future residents may better understand their history (NCOAH 2013). NCOAH is the SHPO for North Carolina.

NCOAH contacts: TBD.

North Carolina Electric Membership Corporation

The North Carolina Electric Membership Corporation (NCEMC) is the power supplier for most of North Carolina's member electric cooperatives. NCEMC provides reliable, affordable, and safe electric and related services, including operation of a load management system, engineering and construction management, power supply planning, and demand-side management planning (NCEMC 2013).

NCEMC contacts: TBD.

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