TransCanada
In business to deliver

US Northeast Hydro Region
Concord Hydro Office
4 Park Street, Suite 402
Concord NH 03301-6373

tel 603.225.5528
fax 603.225.3260
web www.transcanada.com

April 15, 2013

VIA ELECTRONIC FILING
Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Re: TransCanada Hydro Northeast Inc.'s Proposed Study Plan, Response to Commission Staff's Additional Information Requests, Correction of PAD Deficiencies and Study Reports

Project Nos. 1892-026, 1855-045, and 1904-073

Dear Secretary Bose:

TransCanada Hydro Northeast Inc. ("TransCanada") is the owner and licensee of the Wilder Hydroelectric Project (FERC No. 1892) (the "Wilder Project"), the Bellows Falls Hydroelectric Project (FERC No. 1855) (the "Bellows Falls Project"), and the Vernon Hydroelectric Project (FERC No. 1904) (the "Vernon Project"). The current licenses for these projects each expire on April 30, 2018. On October 31, 2012, TransCanada filed with the Commission its Notice of Intent ("NOI") to seek new licenses for each project, along with a separate Pre-Application Document ("PAD") for each project.

FirstLight Hydro Generating Company ("FirstLight") is the licensee of the Turners Falls Hydroelectric Project (FERC No. 1889) (the "Turners Falls Project") and the Northfield Mountain Pumped Storage Project (FERC No. 2485) (the "Northfield Mountain Project").[1] The current licenses for both the Turners Falls Project and the Northfield Mountain Project expire on

[1] The Wilder Project, the Bellows Falls Project, the Vernon Project, the Turners Falls Project and the Northfield Mountain Project are collectively referred to herein as the "Connecticut River Projects."

April 30, 2018. On October 31, 2012, FirstLight filed with the Commission its NOI to seek new licenses for the Turners Fall Project and the Northfield Mountain Project, along with a single PAD for both projects.

On December 21, 2012, Commission Staff issued its Scoping Document for its National Environmental Policy Act analysis of the Connecticut River Projects ("SD1"). Commission Staff indicated in SD1 their intent to prepare a single environmental impact statement for the Connecticut River Projects. In January 2013 in various locations near the projects in New Hampshire, Vermont and Massachusetts, Commission Staff held six project specific scoping meetings and one additional scoping meeting to help identify the cumulative effects of licensing the Connecticut River Projects.

Subsequently, state and federal agencies, local officials, non-governmental organizations, and other interested parties (collectively referred to as stakeholders) filed with the Commission letters and documents containing comments on the PADs and identifying resources potentially affected by hydro project operations. Together with many of these comments, stakeholders requested that specific studies be performed to examine and determine project effects for the environmental impact analysis that will be needed to issue new licenses for the projects.

In addition, by letter dated March 1, 2013, Commission Staff identified deficiencies in the PADs that needed to be corrected, requested certain items of additional information, and provided their own study requests with respect to TransCanada's projects based upon review of the PADs and public testimony from scoping meetings. Under the Integrated Licensing Process (ILP), study requests are required to address the seven criteria listed in 18 CFR § 5.9(b).

Pursuant to 18 C.F.R. § 5.11, TransCanada hereby submits the following materials and information, which are included with this filing:

1. Responses to Commission Staff's Identification of PAD Deficiencies, Requests for Additional Information and Status of Study Reports Referenced in the PADs
2. Study Request Responsiveness Summary
3. Proposed Study Plan, containing 33 individual study plans
4. Schedule for ILP Study Plan Consultation Meetings with stakeholders and Commission staff

1. Responses to Commission Staff's Identification of PAD Deficiencies, Request for Additional Information, and Status of Study Reports Referenced in the PADs

As noted above, Commission's Staff March 1, 2013 letter requested (i) corrections to deficiencies in the PADs, (ii) additional information for TransCanada's projects, (iii) study reports that TransCanada referenced in its PAD that were not yet available when the PADs were filed with the Commission on October 31, 2012, and (iv) additional comments for Preliminary Licensing Proposal (PLP) and License Application. TransCanada has addressed each of these requests and files responses in the document titled Responses to Commission Staff's Identification of PAD Deficiencies, Requests for Additional Information and Status of Study Reports included with this filing. Responses to Commission Staff's study requests are addressed along with stakeholder study requests in TransCanada's Proposed Study Plan.

2. Study Request Responsiveness Summary

TransCanada includes with this filing a document titled Study Request Responsiveness Summary. This document identifies each study request by requestor, indicates which of TransCanada's study plans is responsive to the request, and the rationale for why a particular study request was not addressed through a study plan.

3. Proposed Study Plan

TransCanada is proposing studies and data collection efforts in its Proposed Study Plan to address the effects of continued operation of TransCanada's projects. TransCanada's Proposed Study Plan has thirty-three individual studies and data collection efforts. Each of these is described in detail in the document included with this filing titled TransCanada's Proposed Study Plan for the Wilder, Bellows Falls and Vernon Projects.

4. Schedule for Study Plan Meetings

In accordance with 18 C.F.R. § 5.11, TransCanada will hold a study plan meeting open to stakeholders, specifically the study requestors and the public, within 30 days of this filing. TransCanada recognizes that a single meeting will not be adequate to clarify and discuss its Proposed Study Plan. Therefore the purpose of the first meeting will be a general overview of the entire suite of studies, identification of stakeholder interest communities or working groups, and immediate data collection initiatives. Subsequent meetings will discuss study plans based upon common issues with interested stakeholder working groups. The initial study meeting and subsequent meetings are listed below including the resource topic and study plans to be discussed.

Stakeholders interested in participating in working groups are encouraged to attend Study Plan Meeting #1 and the subsequent in-person meetings scheduled for the study plan subjects identified below. Attendance is encouraged at these initial meetings. With the exception of Study Plan Meeting # 1, there should be an opportunity to attend via telephone conference. Subsequent meetings on the subject study plans will be scheduled accordingly and either by teleconference or in person. Interested parties are encouraged to contact John Ragonese, TransCanada's Relicensing Project Manager at john_ragonese@transcanada.com if the wish to be notified of teleconference call-in information prior to the meetings.

For the purpose of associating Study Plan Meeting subjects with Study Numbers, please refer to the following:

Erosion	Study Nos. 1-3
Water Resources and Modeling	Study Nos. 4-6
Aquatics	Study Nos. 7-25
Terrestrial	Study Nos. 26-29
Recreation	Study Nos. 30-31
Aesthetics	Study No. 32
Cultural and Historic Resources	Study No. 33

Study Plan Meeting #1 – Overview of Proposed Study Plan, Identification of Interested Stakeholder Working Groups and Immediate Data Collection Initiatives

Date & Time: Monday, May 13, 2013 at 9:00 a.m. – 4:00 p.m.

Location: Kilton Public Library Conference Room
80 Main Street
West Lebanon, NH 03784
603-298-8544

Study Plan Meeting #2 – Water Resources and Modeling (morning); Erosion (afternoon)

Date & Time: Thursday, May 16, 2013 at 9:00 a.m. – 4:00 p.m.

Location: Vermont Room at the Fairfield Inn
104 Ballardvale Drive,
White River Junction, VT 05001
1-802-291-9911

Study Plan Meeting #3 - Aquatics

Date & Time: Monday, May 20, 2013 at 9:00 a.m. – 4:00 p.m.

Location: Vermont Room at the Fairfield Inn
104 Ballardvale Drive,
White River Junction, VT 05001
1-802-291-9911

Study Plan Meeting #4 - Aquatics

Date & Time: Monday, May 23, 2013 at 9:00 a.m. – 4:00 p.m.

Location: Vermont Room at the Fairfield Inn
104 Ballardvale Drive,
White River Junction, VT 05001
1-802-291-9911

Study Plan Meeting #5 – Terrestrial (morning); Aquatics (afternoon)

Date & Time: Thursday, June 6, 2013 at 9:00 a.m. – 4:00 p.m.
Morning meeting at 9:00 a.m.
Afternoon meeting at 1:00 p.m.

Location: Vermont Room at the Fairfield Inn
104 Ballardvale Drive,
White River Junction, VT 05001
1-802-291-9911

Study Plan Meeting #6 – Recreation (morning), Aesthetics, and Cultural and Historic Resources (afternoon)

Date & Time: Friday, June 7, 2013 at 9:00 a.m. – 4:00 p.m.
Morning meeting at 9:00 a.m.
Afternoon meeting at 1:00 p.m.

Location: Vermont Room at the Fairfield Inn
104 Ballardvale Drive,
White River Junction, VT 05001
1-802-291-9911

Pursuant to 18 C.F.R. § 5.12, comments on the Proposed Study Plan are due within 90 days of this filing. Accordingly, the deadline for submitting comments on TransCanada's Proposed Study Plan is July 15, 2013.

If there are any questions regarding the information provided in this filing or the process, please contact me at 603-498-2851 or by emailing john_ragonese@transcanada.com.

Sincerely,

John L. Ragonese
FERC License Manager

Attachments: Distribution List
Responses to Commission Staff's Identification of PAD Deficiencies, Requests for Additional Information and Status of Study Reports
Proposed Study Plan for the Wilder, Bellows Falls and Vernon Projects
Study Request Responsiveness Summary

cc: Distribution List

Distribution List for the Wilder, Bellows Falls, and Vernon Projects

Executive Director
Advisory Council on Historic Preservation
1100 Pennsylvania Ave NW, Suite 803
Washington, DC 20004
achp@achp.gov

Paul Ford
Acting Regional Administrator
Federal Emergency Management Agency, Region 1
99 High Street, 6th Floor
Boston, MA 02110
paul.ford@fema.dhs.gov

Kenneth Hogan
Connecticut River Relicensing Team Leader
Federal Energy Regulatory Commission
888 First Street NE RM 63-16
Washington, DC 20426
Kenneth.Hogan@ferc.gov

Office of Energy Projects
Federal Energy Regulatory Commission
888 First Street NE RM 61-02
Washington, DC 20426

Office of General Counsel
Federal Energy Regulatory Commission
888 First Street NE RM 101-56
Washington, DC 20426

Kevin Mendik
Hydro Program Coordinator
National Park Service, Northeast Region
15 State Street, 10th Floor
Boston, MA 02109
Kevin_Mendik@nps.gov

Ed Cappone
Service Coordinator Hydrologist
National Weather Service, Northeast River Forecast Ctr
445 Myles Standish Blvd.
Taunton, MA 02780
Edward.Capone@noaa.gov

John K. Bullard
Regional Administrator
NOAA Fisheries Service Northeast Regional Office
55 Great Republic Drive
Gloucester, MA 01930-2298
john.bullard@noaa.gov

Col. Charles P. Samaris
Commander and Dist. Engineer
U.S. Army Corps of Engineers
696 Virginia Road
Concord, MA 01742-2751
cenae-pa@usace.army.mil

Christopher Hatfield, P.E.
Planning Branch
U.S. Army Corps of Engineers, New England District
695 Virginia Road
Concord, MA 01742-2750
Christopher.L.Hatfield@usace.army.mil

Ralph Abele
Water Quality Control Branch (WQB)
U.S. EPA Region 1 - New England
5 Post Office Sq, Ste 100 –
MailCode OEP06-02
Boston, MA 02109-3912
abele.ralph@epa.gov

John Warner
Asst Supervisor, Conservation Planning Assistance and Endangered Species
U.S. Fish and Wildlife Service
70 Commercial Street
Concord, NH 03301-5087
John_Warner@fws.gov

Distribution List for the Wilder, Bellows Falls, and Vernon Projects

Melissa Grader
U.S. Fish and Wildlife Service, Silvio O. Conte National Fish and Wildlife Refuge
103 E. Plumtree Road
Sunderland, MA 01375-9480
Melissa_Grader@fws.gov

Kenneth Sprankle
Connecticut River Coordinator
U.S. Fish and Wildlife Service
103 E. Plumtree Road
Sunderland, MA 01375-9480
Ken_Sprankle@fws.gov

Andrew French
Project leader
U.S. Fish and Wildlife Service, Silvio O. Conte National Fish and Wildlife Refuge
103 E. Plumtree Road
Sunderland, MA 01375-9480
andrew_french@fws.gov

Keith Robinson
Director
U.S. Geological Survey
331 Commerce Way
Pembroke, NH 03275
dc_nh@usgs.gov

Giovanna Peebles
State Historic Preservation Officer
Vermont Div. of Historic Preservation
National Life Building, Drawer 20
Montpelier, VT 05620-0501
giovanna.peebles@state.vt.us

Rachel Ruppel
Connecticut River Joint Commissions / UVLSPRC
10 Water Street, Suite 225
Lebanon, NH 03766
rruppel@uvlsrpc.org

Brett Towler
Northeast Region – Fish Passage Team
U.S. Fish and Wildlife Service
300 Westgate Center Drive
Hadley, MA 01035
Brett_Towler@fws.gov

Wendi Weber
Regional Director
U.S. Fish and Wildlife Service
300 Westgate Center Drive
Hadley, MA 01305-9589
Wendi_Weber@fws.gov

Barnaby J. Watten
Chief
U.S. Geological Survey
One Migratory Way, .O. Box 796
Turners Falls, MA 01376-0796
bwatten@usgs.gov

Regional Director
U.S. Geological Survey
10 Bearfoot Road
Northboro, MA 01532-1528
dc_ma@usgs.gov

Rebecca Brown
Connecticut River Joint Commissions
10 Water Street, Suite 225
Lebanon, NH 03766
rbrown@aconservationtrust.org

Connecticut Valley Flood Control Commission
P.O. Box 511
Greenfield, MA 01302
crvfcc@crocker.com

Distribution List for the Wilder, Bellows Falls, and Vernon Projects

Brad Simpkins
Interim Director/State Forester
New Hampshire Div of Forests and Lands
172 Pembroke Road, P.O. Box 1856
Concord, NH 03301-1856
brad.simpkins@dred.state.nh.us

Sara Cairns
Environmentalist III
New Hampshire Div of Forests and Lands - Natural Heritage Bureau
172 Pembroke Road, P.O. Box 1856
Concord, NH 03301-1856
Sara.Cairns@dred.state.nh.us

Owen David
401 WQC Coordinator
New Hampshire Dept of Environmental Services
P.O. Box 95
Concord, NH 03302-0095
Owen.David@des.nh.gov

Jacquie Colburn
Coordinator
New Hampshire Dept of Environmental Services
P.O. Box 95
Concord, NH 03302-0095
jacquie.colburn@des.nh.gov

Harry T Stewart
NHDES Water Division Director
New Hampshire Dept of Environmental Services
P.O. Box 95
Concord, NH 03302-0095
Harry.Stewart@des.nh.gov

Gregg Comstock
Supervisor, Water Quality Planning Section
New Hampshire Dept of Environmental Services
P.O. Box 95
Concord, NH 03302-0095
gregg.comstock@des.nh.gov

Edna M. Feighner
Review & Compliance Coordinator
New Hampshire Dept of Historical Resources
19 Pillsbury Street - 2nd floor
Concord, NH 03301-3570
Edna.Feighner@dcr.nh.gov

Matt Carpenter
Biologist II
New Hampshire Fish and Game Dept
11 Hazen Drive
Concord, NH 03301
matthew.carpenter@wildlife.nh.gov

Gabe Gries
Warmwater Project Leader
New Hampshire Fish and Game Dept
15 Ash Brook Court
Keene, NH 03431
gabe.gries@wildlife.nh.gov

Raymond S. Burton
Executive Councilor
State of NH Executive Council
338 River Road
Bath, NH 03740
rburton@nh.gov

Daniel St. Hilaire
Executive Councilor
State of NH Executive Council
107 No. Main Street - State House Rm 207
Concord, NH 03301
dst.hilaire@nh.gov

David K. Wheeler
Executive Councilor
State of NH Executive Council
523 Mason Road
Milford, NH 03055
dwheeler@nh.gov

Distribution List for the Wilder, Bellows Falls, and Vernon Projects

Rod Wentworth
Environmental Assessment
Vermont Dept of Fish & Wildlife
103 South Main St, Bldg 10 South
Waterbury, VT 05671-0408
rod.wentworth@state.vt.us

Bob Popp
Department Botanist
Vermont Dept of Fish & Wildlife - Natural Heritage Project
5 Perry St. Suite 40
Barre, VT 05641
bob.popp@state.vt.us

Ken Cox
Fisheries Biologist
Vermont Dept of Fish & Wildlife - Natural Heritage Project
100 Mineral St, Suite 303
Springfield, VT 05641
ken.cox@state.vt.us

Justin Johnson
Deputy Commisioner
Vermont Dept of Environmental Conservation
1 National Life Drive, Main 2
Montpelier, VT 05620-3522
justin.johnson@state.vt.us

Brian T. Fitzgerald
Streamflow Protection Coordinator
Vermont Dept of Environmental Conservation
1 National Life Drive, Main 2
Montpelier, VT 05620-3522
brian.fitzgerald@state.vt.us

Marie Levesque Caduto
Watershed Coordinator
Vermont Dept of Environmental Conservation
100 Mineral St, Suite 303
Springfield, VT 05671-0408
marie.caduto@state.vt.us

John H. Churchill
Chief
Abenaki Nation of Missisquoi
P.O. Box 133
Swanton, VT 05488
Dawnland@Missisquoi.comcastbiz.net

Wade Blackwood
Executive Director
American Canoe Assocoation
1340 Central Blvd., Suite 210
Fredericksburg, VA 22401
wblackwood@americancanoe.org

Amy Singler
Assoc. Director, River Restoration
American Rivers
25 Main Street, Suite 220
Northampton, MA 01060
asingler@americanrivers.org

John Seebach
Chairman, HRC and Director, Hydropower Reform Initiative
American Rivers / Hydro Reform Coalition
1101 14th Street NW, Suite 1400
Washington, DC 20005
jseebach@americanrivers.org

Mark Singleton
Executive Director
American Whitewater
P.O. Box 1540
Cullowhee, NC 28723
mark@americanwhitewater.org

Kevin Colburn
National Stewardship Director
American Whitewater
P.O. Box 1540
Cullowhee, NC 28723
kevin@americanwhitewater.org

Distribution List for the Wilder, Bellows Falls, and Vernon Projects

Ken Kimball
Director of Research
Appalachian Mountain Club
P.O. Box 298
Gorham, NH 03581
kkimball@amcinfo.org

Appalachian Trail Conservancy
P.O. Box 264
South Egremont, MA 01258
atc-nero@appalachiantrail.org

Atlantic Salmon Federation
P.O. Box 807
Calais, ME 04619-0807
savesalmon@asf.ca

Doug Rarker
Executive Director
Audubon Society of Vermont
255 Sherman Hollow Road
Huntington, VT 05462
dparker@audobon.org

Kelly and John Stettner
Black River Action Team & Mt. Ascutney
Local River Subcommittee
101 Perley Gordon Road
Springfield, VT 05156
blackrivercleanup@yahoo.com

Andrea Donelon
River Steward
Connecticut River Watershed Council
15 Bank Row Street
Greenfield, MA 01301
adonlon@ctriver.org

David Deen
River Steward
Connecticut River Watershed Council
P.O. Box 206
Saxtons River, VT 05154-0206
ddeen@ctriver.org

Ron Rhodes
River Steward
Connecticut River Watershed Council
P.O. Box 94
South Pomfret, VT 05067
rrhodes@ctriver.org

Ken Alton
Trustee
Connecticut River Watershed Council
P.O. Box 3
Strafford, VT 05072
kindredalton@gmail.com

Liz Austin
Trustee
Connecticut River Watershed Council
c/o 15 Bank Row
Greenfield, MA 01301
lizaustin44@comcast.net

Jonathan Peress
Dir. Clean Energy and Climate Change
Program
Conservation Law Foundation
27 North Main Street
Concord, NH 03801-4930
njperess@clf.org

John Kassell
President
Conservation Law Foundation
62 Summer Street
Boston, MA 02110
jkassel@clf.org

Distribution List for the Wilder, Bellows Falls, and Vernon Projects

Chris Kilian
VP and Director
Conservation Law Foundation
15 State Street, Suite 4
Montpelier, VT 05602
ckilian@clf.org

Paul Pouliot
Council Chief and Speaker
Cowasuck Band of the Pennacook - Abenaki People
P.O. Box 52, 840 Suncook Valley Rd
Alton, NH 03809-0052
cowasuck@cowasuck.org

Nancy Millette Doucet
Chief
Koasek Traditional Abenaki of the KOAS
Main Street
North Haverhill, NH 03774
Info@KoasekAbenaki.Org

Paul Bunnell
Co-Chief
Koasek Traditional Band of the Sovereign Abenaki Nation
P.O. Box 147
Post Mills, VT 05058-0147
Koasek@ymail.com

Curtis Fisher
Regional Exec. Dir.
National Wildlife Federation
149 State Street, Suite 1
Montpelier, VT 05602
fisherc@nwf.org

Tom Christopher
New England FLOW
252 Fort Pond Inn Road
Lancaster, MA 05123
tom.christopher@comcast.net

Carol Foss
Director of Conservation
New Hampshire Audubon
84 Silk Farm Road
Concord, NH 03301
cfoss@nhaudubon.org

Beth Flagler
Program Administrator
New Hampshire Rivers Council
54 Portsmouth Street
Concord, NH 03301
info@NHRivers.org

Janice Boynton
Executive Director
New Hampshire Wildlife Federation
54 Portsmouth Street
Concord, NH 03301
ed@nhwf.org

Will Abbott
VP for Policy & Land Management
Society for the Protection of NH Forests
54 Portsmouth Street
Concord, NH 03301
wabbott@forestsociety.org

Kathryn Mickett Kennedy
Applied River Scientist
The Nature Conservancy
25 Main Street, Suite 220
Northampton, MA 01060
kkennedy@tnc.org

Rose Paul
Director of Science and Stewardship
The Nature Conservancy
27 State Street, Suite 4
Montpelier, VT 05602
rpaul@tnc.org

Distribution List for the Wilder, Bellows Falls, and Vernon Projects

Daryl Burtnett
State Director
The Nature Conservancy
22 Bridge Street, 4th Floor
Concord, NH 03301
dburtnett@tnc.org

Chris Moore
Chair, Vermont TU
Trout Unlimited
P.O. Box 713
Lebanon, NH 03766
vermont.tu@gmail.com

Ken Grecsek
Member
Trout Unlimited
P.O. Box 713
Lebanon, NH 03766
Kenneth.Grecsek@tomtom.com

Ray Obar
Member
Trout Unlimited
P.O. Box 713
Lebanon, NH 03766
robar1949@comcast.net

Jim MacCartney
River Restoration Specialist
Trout Unlimited
P.O. Box 3302
Concord, NH 03302
jmaccartney@tu.org

Elizabeth Maclin
VP for Eastern Conservation
Trout Unlimited
1300 N. 17th St, Suite 500
Arlington, VA 22209-2404
emaclin@tu.org

Don Pugh
Member-Consultant
Trout Unlimited
10 Old Stage Rd
Wendell, MA 01379
don.pugh@yahoo.com

Brian Shupe
Executive Director
Vermont Natural Resources Council
9 Bailey Avenue
Montpelier, VT 05602
bshupe@vnrc.org

Ryan McCall
President
Vermont Paddlers Club/Vermont River Conservancy
29 Main Street, Suite 11
Montpelier, VT 05602
ryanmtnman@gmail.com

Steve Libby
Executive Director
Vermont River Conservancy
29 Main Street, Suite 11
Montpelier, VT 05602
vrc@vermontriverconservancy.org

Anne Bussler and David Bussler
305 Missing Link Rd.
Rockingham, VT 05101
abussler@k12s.phast.umass.edu

Bernard Folta
P.O. 148
Claremont, NH 03743
bernief@atlof.net

Distribution List for the Wilder, Bellows Falls, and Vernon Projects

John Howard
First Light-GDF Suez
99 Millers Falls Road
Northfield, MA 01360
john.howard@gdfsuezna.com

Paul Ducheny
Holyoke Gas and Electric
99 Suffolk Street
Holyoke, MA 01040
ducheney@hged.com

Stewart Read
Owner
Island Corporation
33 Bridge Street
Bellows Falls, VT 05101

Eve Vogel
Assistant Professor, Dept. of Geosciences
University of Massachusetts
233 Morrill Science Ctr, 611 N. Pleasant St
Amherst, MA 01003-9297
evevogel@geo.umass.edu

Anita Milman
Asst. Professor, Environmental Policy
University of Massachusetts
Room 210; 160 Holdsworth Way
Amherst, MA 01003-9285
amilman@eco.umass.edu

Administrator
Cheshire County
33 West Street
Keene, NH 03431
jpratt@co.cheshire.nh.us

Guy A. Santagate
City Manager
City of Claremont
58 Opera House Square
Claremont, NH 03743
citymanager@claremontnh.com

Fiske Free Library
108 Broad Street
Claremont, NH 03743-2673
msmith@claremontnh.com

George H. Stowell Free Library
24 School Street
Cornish Flat, NH 03746-0360

Proctor Library
5181 Route 5
Ascutney, VT 05030-0519

Rockingham Free Public Library
65 Westminster Street
Bellows Falls, VT 05101
rockref@sover.net

Silsby Free Public Library
226 Main St, P.O. Box 307
Charlestown, NH 03603-0307
silsby@charlestown-nh.gov

Distribution List for the Wilder, Bellows Falls, and Vernon Projects

Tom Kennedy
Director of Planning
Southern Windsor County RPC
Ascutney Professional Building - Route 5,
P.O. Box 320
Ascutney, VT 05030
Tkennedy@swcrpc.net

Tim Murphy
Executive Director
Southwest Regional Planning Commission
20 Central Square, 2nd Floor
Keene, NH 03431
tmurphy@swrpc.org

Springfield Town Library
43 Main Street
Springfield, VT 05156-2997

Administrator
Sullivan County
14 Main Street
Newport, NH 03773
manager@sullivancountynh.gov

Steven A. Neill
Chairman, Selectboard
Town of Charlestown
P.O. Box 385
Charlestown, NH 03603-0385
Jessica@charlestown-nh.gov

John Hammond
Chairman, Selectboard
Town of Cornish
488 Town House Rd
Cornish, NH 03745
townbos@comcast.net

Tim Cullenen
Town Manager
Town of Rockingham
P.O. Box 370
Bellows Falls, VT 05101-0370
tcullenen@rockbf.org

Kristi Morris
Chairman, Selectboard
Town of Springfield
96 Main St
Springfield, VT 05156
kmorris@lovejoytool.com

Whitney R. Aldrich
Chairman, Selectboard
Town of Walpole
P.O. Box 729
Walpole, NH 03608-0729
waldrich@walpolenh.us

James Mullen
Town Manager
Town of Weathersfield
P.O. Box 550
Ascutney, VT 05030-0550
townmgr@weathersfield.org

John Tansey
Chairman, Selectboard
Town of Windsor
29 Union St.
Windsor, VT 05089
NFulton@norwich.vt.us

Walpole Town Library
48 Main Street, P.O. Box 487
Walpole, NH 03608-0487
LibraryDirector@WalpoleTownLibrary.o
rg

Distribution List for the Wilder, Bellows Falls, and Vernon Projects

County Clerk
Windham County
P.O. Box 207
Newfane, VT 05345-0207

Chris Campany
Executive Director
Windham Regional Commission
139 Main St. Suite 505
Brattleboro, VT 05301
ccampany@sover.net

County Clerk
Windsor County
12 The Greene #101
Woodstock, VT 05091
smicka@windsor-vt.gov

Windsor Public Library
43 State Street
Windsor, VT 05089-1213
librarian@windsorlibrary.org

Michael Hatchey
VP Regulatory Affairs and Compliance
TransCanada Hydro Northeast Inc
110 Turnpike Road, Suite 300
Westborough, MA 01581
mike_hatchey@transcanada.com

Erin O'Dea
Legal Counsel
TransCanada Hydro Northeast Inc
110 Turnpike Road, Suite 300
Westborough, MA 01581
erin_odea@transcanada.com

John Whittaker
Partner
Winston & Strawn LLP
1700 K Street, N.W.
Washington, DC 20006-3817
JWhittaker@winston.com

Maryalice Fischer
Normandeau Associates, Inc.
917 Route 12 Suite 1
Westmoreland, NH 03467
mfischer@normandeau.com

Mike Romeo
Nuclear Safety Assurance Director
Vermont Yankee
320 Governor Hunt Road
Vernon, VT 05354
mromeo@entergy.com

Brooks Memorial Library
224 Main Street
Brattleboro, VT 05301
info@brookslibraryvt.org

David Singer
City Council President
City of Greenfield
14 Court Square
Greenfield, MA 01301
towncouncil@townofgreenfield.org

Hinsdale Public Library
122 Brattleboro Rd
P.O. Box 6
Hinsdale, NH 03451-0006

Distribution List for the Wilder, Bellows Falls, and Vernon Projects

Mount Casear Union Library
628 Old Homestead Highway
Swanzey, NH 03446
mculibrary@yahoo.com

Bernie Buteau
State Liaison Engineer
Vermont Yankee
320 Governor Hunt Road
Vernon, VT 05354
bbuteau@entergy.com

Butterfield Library
Main Street, P.O. Box 123
Westminster, VT 05158-0123

Chesterfield Public Library
524 Route 63
Chesterfield, NH 03443-3607
info@chesterfieldlibrary.org

Greenfield Public Library
402 Main Street
Greenfield, MA 01301
librarian@greenfieldpubliclibrary.org

Lydia Taft Pratt Library
156 West Street, P.O. Box 70
West Dummerston, VT 05357-0070

Putney Public Library
55 Main Street
Putney, VT 05346-0193
putpub@svcable.net

Barbara Sondag
Town Manager
Town of Brattleboro
230 Main Street
Brattleboro, VT 05301
bsondag@brattleboro.org

Jon McKeon
Chairman, Selectboard
Town of Chesterfield
P.O. Box 175
Chesterfield, NH 03443-0175
admin@nhchesterfield.com

John Smith
Chairman, Selectboard
Town of Hinsdale
P.O. Box 13
Hinsdale, NH 03451-0013
JSmith@clark-mortenson.com

Deborah J. Davis
Chairman, Selectboard
Town of Swansey
P.O. Box 10009
Swanzey, NH 03446
selectmen@town.swanzey.nh.us

Russell Austin
Chairman, Selectboard
Town of Westmoreland
P.O. Box 55
Westmoreland, NH 03467-0055
townofwestmoreland@myfairpoint.net

Westmoreland Public Library
33 South Village Road
Westmoreland, NH 03467-4514

Lewis White
Chairman, Selectboard
Town of Dummerston
1523 Middle Road
Dummerston, VT 05346
white@dummerston.org

Cynthia Stoddard
Town Manager
Town of Putney
P.O. Box 233
Putney, VT 05346-0233
putneytc@putneyvt.org

Patricia O'Donnell
Chairman, Selectboard
Town of Vernon
P.O. Box 66
Vernon, VT 05354-0066
odonnellvt@comcast.net

Matthew Daska
Town Manager
Town of Westminster
P.O. Box 147
Westminster, VT 05158-0147
mdaskal@westminstervt.org

Vernon Free Library
567 Governor Hunt Road
Vernon, VT 05354-0094
vernonfreelibrary@comcast.net

Dinah Reed
Assistant Planner
Wantastiquet Local River
Subcommittee
139 Main Street, Suite 505
Brattleboro, VT 05301
dreed@sover.net

Larry and Roger Scott
Ekolott Farm
179 Scott Road
Newbury, VT 05051
riverside_emus@hotmail.com

Nancy Millette Doucet
Chief
Main Street
North Haverhill, NH 03774
Info@KoasekAbenaki.org

Gregory D. Lewis
City Manager
City of Lebanon
51 North Park St.
Lebanon, NH 03776
greg.lewis@lebcity.com

Fairlee Public Library
221 US Route 5 North, P.O. Box 125
Fairlee, VT 05045-0125
fairlee.library@gmail.com

Hartford Library
1587 Maple St, P.O. Box 512
Hartford, VT 05047-0512
Hartford@vals.state.vt.us

Distribution List for the Wilder, Bellows Falls, and Vernon Projects

Howe Library
13 South Street
Hanover, NH 03755
reference@thehowe.org

Michael King
Executive Director
North Country Council Inc.
107 Glessner Road
Bethlehem, NH 03574
mking@nccouncil.org

Administrator
Orange County
5 Court Street
Chelsea, VT 05038

Bradford Public Library
21 South Main Street, P.O. Box 619
Bradford, VT 05033-0619

Converse Free Library
38 Union Street
Lyme, NH 03768-9702
info@lymenhlibrary.org

Administrator
Grafton County Commissioners Office
3855 Dartmouth College Highway
North Haverhill, NH 03774

Haverhill Library Association
67 Court Street
Haverhill, NH 03765-0117
mail@HaverhillLibrary.org

Latham Memorial Library
16 Library Lane, P.O. Box 240
Thetford, VT 05074-0240

Norwich Public Library
368 Main Street
Norwich, VT 05055-0290
lucinda.walker@norwichlibrary.org

Orford Free Library
311 Route 25A
Orford, NH 03777-0186

Piermont Public Library
130 Route 10
Piermont, NH 03779-0006

Thomas E. Unkles
Chairman
Town of Bradford
PO Box 339
Bradford, VT 05033-0339
administrator@bradford-vt.us

Distribution List for the Wilder, Bellows Falls, and Vernon Projects

Julia Griffin
Town Manager
Town of Hanover
41 South Main St.
Hanover, NH 03755
townmgr@hanovernh.org

Glenn English
Town Manager
Town of Haverhill
2975 Dartmouth College Highway
North Haverhill, NH 03774
townmanager@haverhill-nh.com

Alma Roystan
Chairman
Town of Newbury
PO Box 126
South Newbury, VT 05051-0126
clerk@newburyvt.org

Tom Steketee
Chairman
Town of Orford
2529 Route 25A
Orford, NH 03777
orfordselectmen@orfordnh.us

Tara Bamford
North Country Council Inc.
Riverbend Local River Subcommittee
107 Glessner Road
Bethlehem, NH 03574
tbamford@nccouncil.org

Tenney Memorial Library
4886 Main Street, PO Box 85
South Newbury, VT 05051-0085
tenneylibrary@gmail.com

Mary Daly
Chairman
Town of Fairlee
PO Box 95
Fairlee, VT 05045-0095
townadministrator@fairleevt.org

Hunter Reisburg
Town Manager
Town of Hartford
171 Bridge St
White River Junction, VT 05001
kparker@hartford-vt.org

Neil Fulton
Town Manager
Town of Norwich
300 Main St
Norwich, VT 05055
manager@norwich.vt.us

Robert Lang
Chairman
Town of Piermont
PO Box 27
Piermont, NH 03779-0027
piermontbos@gmail.com

Donn Downey
Chairman
Town of Thetford
PO Box 126
Thetford, VT 05074-0126
donndowney@mac.com

Distribution List for the Wilder, Bellows Falls, and Vernon Projects

Christine Walker
Executive Director
Upper Valley Lake Sunapee Regional Planning Commission
10 Water St, Suite 225
Lebanon, NH 03766
cwalker@uvlsrpc.org

Peter Gregory
Executive Director
Two Rivers-Ottauquechee Regional Commission
3117 Rose Hill – The King Farm
Woodstock, VT 05091
pgregory@trorc.org

West Lebanon Library
57 Main Street
West lebanon, NH 03784-1614
library@lebcity.com

O. Ross McIntyre, MD
34 Lamphire Hill Lane
Lyme, NH 03768
o.ross.mcintyre@dartmouth.edu

Dr. Norman Sims
16 Linden Ave
Greenfield, MA 01301
sims@honors.umass.edu

Mr. Bob Nasdor
American Whitewater
65 Blueberry Hill Lane
Sudbury, MA 01776
bob@americanwhitewater.org

Ms. Linda Fowler
Pine Park Association
Dartmouth College
Dept. of Government
6108 Silsby Hall
Hanover, NH 03755
Linda.I.Fowler@dartmouth.edu

Brian Kunz
Pine Park Association
Dartmouth College
Dept. of Government
6108 Silsby Hall
Hanover, NH 03755
Brian.f.kunz@dartmouth.edu

Peter B. Wright
43 Portland Street
Keene, NH 03431

Peter DesMeules
1344 Galaxy Hill Road
North Pomfret, VT 05053

John Taylor
Trails Program Director
PO Box 1215
Norwich, VT 05055
John.taylor@uvtrails.org

Rick Van de Poll, Ph.D
30 N. Sandwich Road
Center Sandwich, NH 03227
rickvdp@gmail.com

Distribution List for the Wilder, Bellows Falls, and Vernon Projects

Robert Welsch
Chair
Lebanon Heritage Commission
51 North Park Street
Lebanon, NH 03766
Robert.welsch@lebcity.com

Nicole S. Cormen
Councilor-at-large
c/o City of Lebanon
51 North Park Street
Lebanon, NH 03766
nscormen@gmail.com

Tad Nunez
Director of Parks & Recreation
171 Bridge Street
White River Junction, VT 05001
tnunez@harford-vt.org

Michael A. Swiger
Van Ness Feldman, LLP
Counsel for FirstLight Hydro
1050 Thomas Jefferson St., NW
Suite 700
Washington, DC 20007
mas@vnf.com

Richard N. Palmer, Ph.D., PE
Dept. of Civil Engineering
University of MA, Amherst
224 Marston Hall
130 Natural Resources Rd
Amherst, MA 01003-9293
palmer@ecs.umass.edu

Richard Holmes
Charlestown Conservation Commission
PO Box 385
Charlestown, NH 03603
Jessica@charlestown-nh.gov

Nancy C. Collier
President
Hanover Conservancy
16 Buck Rd
Hanover, NH 03755
info@hanoverconservancy.org

Adair D. Mulligan
Executive Director
Hanover Conservancy
16 Buck Rd
Hanover, NH 03755
info@hanoverconservancy.org

Roger Noonan
President
New England Farmers Union
PO Box 226
5 State Street, 3rd Floor
Shelburne Falls, MA 01370
info@newenglandfarmersunion.org

Jennifer Tufts
The Greater Northfield Watershed Association
PO Box 44
Northfield, MA 01360
jentufts@comcast.net

Bill Llewelyn
Chair
Northfield Conservation Commission
69 Main Street
Northfield, MA 01360
Northfield.conscom@gmail.com

Elizabeth H. Muzzey
Director & State Historic Preservation Officer
NH Division of Historical Resources
19 Pillsbury Street
Concord, NH 03301-3570
Elizabeth.Muzzey@dcr.nh.gov

Peg Merrens
Vice President, Conservation
Upper Valley Land Trust
19 Buck Road
Hanover, NH 03755
Peg.Merrens@uvlt.org

Christopher S. Nesbitt
Vice-Chair
Upper Valley Land Trust
19 Buck Road
Hanover, NH 03755
chrisnesbitt@focusacquistion.com

Gregory D. Lewis
City Manager
City of Lebanon, NH
City Hall
51 N. Park Street
Lebanon, NH 03766
Greg.lewis@lebcity.com

Simon L. Carr
Chair
Town of Lyme, NH Selectmen
1 High Street
PO Box 126
Lyme, NH 03768
Dina@LymeNH.Gov

Charles J. Smith
Town of Lyme, NH Selectmen
1 High Street
PO Box 126
Lyme, NH 03768
Dina@LymeNH.Gov

Shelley Hadfield, Consultant
City of Lebanon, NH
51 N. Park Street
Lebanon, NH 03766
Shelley.hadfield@lebcity.com

John T. B. Mudge
25 Lamphire Hill Lane
Lyme, NH 03768
jmudgenh@aol.com

Noah Pollock
President
Friends of the CT River Paddlers' Trail
55 Harrison Ave
Burlington, VT 05401
Noah.pollock@gmail.com

Megan Hooker
American Whitewater
P.O. Box 1540
Cullowhee, NC 28723
megan@americanwhitewater.org

Andrew Gast-Bray
City Planner
City of Lebanon, NH
51 N. Park Street
Lebanon, NH 03766
Andrew.gast-bray@lebcity.com

Sabrina Stanwood
Administrator
Natural Heritage Bureau
Division of Forests & Lands
172 Pembroke Rd.
PO Box 1856
Concord, NH 03302-1856
Sabrina.stanwood@dred.state.nh.us

Stephan Syz
Vermont River Conservancy
29 Main Street
Montpelier, VT 05602
ssyz@vermontriverconservancy.org

F. William Lipfert, Jr.
Jennifer Lipfert
1349 NH Route 12A
Cornish, NH 03745
'wlipfert@yahoo.com'

Kimberly A. Lutz
Director-CT River Program
The Nature Conservancy
Connecticut River Program
25 Main Street, Suite 200
Northampton, MA 01060
klutz@tnc.org

Joseph Graveline
President
The Nolumbeka Project, Inc.
88 Columbus Ave
Greenfield, MA 01301
Oldgraywolf@verizon.net

Peter Gregory
AICP
Executive Director
Two Rivers-Ottauquechee Reg.
Commission
128 King Farm Road
Woodstock, VT 05091
pgregory@trorc.og

Mark Wamser, PE
Gomez and Sullivan Engineers
41 Liberty Hill Road
PO Box 2179
Henniker, NH 03242
mwamser@gomezandsullivan.com

UNITED STATES OF AMERICA

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

TRANSCANADA HYDRO NORTHEAST INC.

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

Responses to Commission Staff's Identification of PAD Deficiencies, Requests for Additional Information, and Status of Study Reports

April 15, 2013

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Attachment B - Stantec 2013 Report - Westboro Rail Yard

Attachment C - Stantec 2012 Report - Westboro Rail Yard

Attachment D - TransCanada Stantec email correspondence - Westboro Rail Yard

Attachment E - Cultural Resources Mapbooks

Attachment F - Phase 1A Archaeological Reconnaissance Survey - Vernon

Attachment G - Holmes et al. 1991 Report - Archaeological Reconnaisssance Survey for the Proposed Riverbank Erosion Control Study

Attachment H – Normandeau 2012 Water Quality Monitoring Report, Data and TransCanada email correspondence with resources agencies

INTRODUCTION

On October 31, 2012, TransCanada Hydro Northeast Inc. ("TransCanada") filed with the Federal Energy Regulatory Commission ("Commission" or "FERC"), Notices of Intent to file applications for new licenses for the existing Wilder Hydroelectric Project (FERC Project No. 1892-026); Bellows Falls Hydroelectric Project (FERC Project No. 1855-045); and Vernon Hydroelectric Project (FERC Project No. 1904-073) ("Projects") in accordance with 18 C.F.R. § 5.5. The current license for each Project expires on April 30, 2018. TransCanada is using FERC's Integrated Licensing Process (ILP) as set forth in Title 18 of the US Code of Federal Regulations (C.F.R.), Part 5 to relicense the three Projects.

Simultaneous to filing of the NOIs, TransCanada filed Preliminary Application Documents (PADs) for each of the three Projects. The PADs provided FERC and interested parties with summaries of existing, relevant, and reasonably available information that was in TransCanada's possession as supplemented by a due diligence search of other sources of information about the Projects and related environmental resources.

On March 1, 2013, the Commission issued a directive to TransCanada related to certain deficiencies in the PADs. The Commission also determined that there is a need for additional information (AIRs), and issued study requests in order to gain information necessary for preparation of environmental documents related to relicensing of the three Projects.

This document constitutes TransCanada's response to the Commission's March 1, 2013 directive on PAD deficiencies, and requests for additional information. The Commission's study requests also included in the March 1, 2013 directive are addressed in a simultaneous filing of TransCanada's Proposed Study Plan (PSP).

A. RESPONSE TO PAD DEFICIENCIES

Wilder, Bellows Falls, and Vernon Hydroelectric Projects

1. Project Facilities and Operations

a. Deficiency: "Please provide land use maps which include key features such as the [Wilder] project boundary and TransCanada facilities within or adjacent to the impoundment as required per § 5.6(d)(2)(ii) of the regulations."

a. Response: Large-scale mapbooks for the Wilder, Bellows Falls, and Vernon Projects are being filed in Attachment A to this PAD deficiency/AIR response. The project boundary and project facilities (including project recreational facilities owned and managed by TransCanada) are shown. GIS ESRI files (.dbf; .prj; .sbn; .sbx; .shp; .xml; and .shx) depicting the project boundary are also being filed as compressed digital files under the file names WilderFACILITY.zip, Bellows FallsFACILITY.zip and VernonFACILITY.zip

b. Deficiency: "Please provide the dependable capacity of the [Wilder] project and the basis for the determination of the dependable capacity as required per § 5.6(d)(2)(iii)(E) of the regulations."

b. Response: The most recent dependable capacity (seasonal claimed capacity) for each project as reported to ISO-NE is as follows. Wilder is tested in the winter and summer each year; Bellows Falls and Vernon are calculated based on hydraulics.

Seasonal Claimed Capacity (MW)	Winter	Summer
Wilder	41.156	39.083
Bellows Falls	48.54	48.54
Vernon	32.0	32.0

2. Geology, Topography, and Soils

a. Deficiency: "The PAD provides general information about soil types along the reservoir; however it does not provide maps. Therefore, please provide mapping at a usable scale showing the existing geology, topography, and soils along the reservoir as required by § 5.6(d)(3)(ii) of the regulations."

a. Response: Large-scale mapbooks for the Wilder, Bellows Falls and Vernon Projects are being filed in Attachment A to this PAD deficiency/AIR response. Existing geology, topography and soil types are depicted. GIS ESRI files (.dbf; .prj;

.sbn; .sbx; .shp; .xml; and .shx) depicting the soils and geology are being filed as a compressed digital files under the file names WilderSOIL.zip, BellowsFallsSOIL.zip, VernonSOIL.zip

b. Deficiency: "The PAD provides general information about erosion along the reservoir, however it does not provide descriptions and maps. Therefore, please provide a description of the reservoir shoreline erosion sites as required by § 5.6(d)(3)(ii)(C) of the regulations, including steepness, composition, cover, and a description of existing instability including a description of project operations that are known to, or may cause, these instabilities."

b. Response: Because all of the detail regarding each specific location where erosion is present along reservoirs currently does not exist, it was not included in the PADs in accordance with 18 C.F.R. § 5.6 (d)(3). TransCanada is proposing three erosion studies (Studies 1, 2, and 3) n the Proposed Study Plan (PSP) in response to study requests that will provide additional information about specific erosion sites. However, much of the data requested is available in the *Lower Connecticut River Shoreline Survey Report – 2010* conducted for TransCanada by Kleinschmidt Associates, Inc. A summary of that information is presented in the following tables. The individual erosion sites summarized in these tables are shown in the mapbooks referenced in the previous response. The Kleinschmidt report had not been finalized by the date of PAD filing, but it has been provided to Commission staff and is now available at www.transcanda-relicensing.com.

Wilder Project Erosion (from Kleinschmidt, 2010)

Type, Land Use and Land Cover	Feet
Active (Major)	**41,813.5**
Agricultural	**37,895.1**
Other	37,895.1
Bank Scour	2,838.3
Bank Slumping	34,958.9
Upper Bank Scour	97.9
Forested	**3,223.7**
Conifer	588.7
Bank Slumping	588.7
Deciduous	1,119.7
Bank Slumping	1,119.7
Mixedwood	1,515.3
Bank Slumping	1,515.3
Grassland	**519.0**
Manicured Lawn	519.0
Bank Slumping	519.0
Residential	**175.8**
Mixedwood	175.8
Bank Scour	97.1
Bank Slumping	78.7
Active (Minor)	**3,880.0**
Agricultural	**3,580.2**
Other	3,580.2
Bank Slumping	3,580.2
Forested	**99.9**
Mixedwood	99.9
Bank Slumping	99.9
Residential	**199.8**
Manicured Lawn	199.8
Bank Slumping	199.8
Historic-Stabilized	**21,458.2**
Forested	**13,235.1**
Deciduous	354.1
Bank Slumping	354.1
Mixedwood	12,881.0
Other	12,881.0

Type, Land Use and Land Cover	Feet
Industrial	**3,140.2**
Other	3,140.2
Other	3,140.2
Residential	**5,082.9**
Manicured Lawn	1,603.6
Bank Slumping	499.8
Other	1,103.7
Mixedwood	3,479.3
Bank Slumping	199.1
Other	3,180.6
Upper Bank Scour	99.5
Grand Total	**67,151.6**

Bellows Falls Project Erosion (from Kleinschmidt, 2010)

Type, Land Use and Land Cover	Feet
Active (Major)	**32,009.5**
Agricultural	**23,279.0**
Farmland	23,279.0
Bank Slumping	23,279.0
Commercial	**99.7**
Other	99.7
Bank Slumping	99.7
Forested	**4,431.7**
Conifer	1,048.8
Bank Slumping	1,048.8
Deciduous	740.6
Bank Slumping	740.6
Mixedwood	2,642.3
Bank Slumping	2,642.3
Industrial	**187.8**
Other	187.8
Bank Slumping	187.8
Residential	**4,011.2**
Manicured Lawn	1,138.9

Type, Land Use and Land Cover	Feet
Bank Slumping	1,138.9
Mixedwood	2,872.3
Bank Slumping	2,872.3
Active (Minor)	**1,811.0**
Agricultural	**480.2**
Farmland	480.2
Bank Slumping	480.2
Forested	**522.6**
Forested Wetland	522.6
Bank Slumping	522.6
Grassland	**558.6**
Shrubland	558.6
Bank Scour	558.6
Industrial	**249.6**
Other	249.6
Bank Slumping	249.6
Total	**33,820.5**

Vernon Project Erosion (from Kleinschmidt, 2010)

Type, Land Use and Land Cover	Feet
Active (Major)	**3,854.7**
Agricultural	**2,245.7**
Farmland	2,245.7
Bank Slumping	2,245.7
Forested	**1,333.8**
Deciduous	173.8
Bank Slumping	173.8
Mixedwood	1,159.9
Bank Slumping	1,159.9
Residential	**275.3**
Manicured Lawn	275.3
Bank Slumping	275.3
Active (Minor)	**4,130.9**

Type, Land Use and Land Cover	Feet
Agricultural	**1,649.8**
Farmland	1,649.8
Bank Slumping	1,649.8
Forested	**2,481.0**
Deciduous	2,181.7
Bank Slumping	2,181.7
Mixedwood	299.3
Bank Slumping	299.3
Total	**7,985.6**

c. Deficiency: "In particular, we note the presence of a brownfield site at the Westboro Railyard, in West Lebanon, NH, just below the confluence of the White River. The issues raised in the public meetings highlighted the potential for mobilization of contaminated materials or groundwater into the Connecticut River, exacerbated by the operation of the project. Therefore, when correcting the deficiency, please also include any additional information associated with this brownfield site and as it may pertain to this concern."

c. Response: TransCanada disputes the claim that this issue constitutes a deficiency to the PAD. There is no evidence that suggests that this location, which is outside the project boundary, is affected by the Wilder Project. The supporting information we are providing responds to the request for "any additional information associated with this site as it may pertain to this concern." We have identified two reports, one of which was published in January 2013, after the release of the PAD.

As described below, we believe that these reports formed the basis of the claim expressed by representatives from the City of Lebanon and in public comments during the scoping meeting. However, in our opinion, the reports were either misinterpreted or the statements in the reports were misquoted at the scoping meeting. There are two discussions in the 2013 Stantec document for which a "possible contribution**"** from "periodic water level fluctuations" in the river and on-going detection of petroleum products in monitoring wells seem to be occurring. However, we believe, and subsequently confirmed, the author of the report is referring to seasonal runoff or periodic high flow levels not the sub-daily flow levels associated with dispatched generation and project operations. The following paragraphs summarize the issue.

The Westboro Railyard is located along the east side of the Connecticut River at is confluence with the White River. The site was in active use from 1848 through the late 1970s. After 20 years of inactivity, rail service was restored at the site through an agreement between the New Hampshire Department of Transportation and the Claremont Concord Rail Company, which currently uses a portion of the property for rail storage. The site encompasses the entire former railyard including the former Tidewater Oil site and the former Purcell Oil facility. On December 9, 1974, oil was observed on the surface of the Connecticut River about 10 feet from the river's east bank, which forms the western boundary of the Westboro Railyard site. The site has been investigated and various remedial measures implemented since then. A summary of the history of the site is provided on pages 1-11 in: "*2012 Groundwater Monitoring Summary Report and GMP Renewal Application, Westboro Roundhouse, 26 Railroad Avenue, West Lebanon, New Hampshire, 03784, NHDES Site #: 199210036, Project Type: LAST, Project Numbers: 3990 and 13124 (Stantec, 2013)*." The full report is included as Attachment B to this PAD deficiency/AIR response.

Stantec (2013) suggests that the likely cause of detections of petroleum products in groundwater monitoring wells between the suspected source and the riverbank is periodic water level fluctuations in the river coupled with the presence of the clay berm installed parallel to the Connecticut River as part of an oil containment system installed in 1975. The source document for Stantec's statement is: *"Results of Laser Induced Fluorescence Survey, Westboro Roundhouse, 26 Railroad Avenue, West Lebanon, New Hampshire, 03784, NHDES Site #: 199210036, Project Type: LAST, Project Numbers: 3990 (Stantec, 2012)."* The full report is included as Attachment C to this PAD deficiency/AIR response.

We reviewed the source documents, which provide an explanation of the suggested relationship of water fluctuations in the river and detection of petroleum products in monitoring wells. Based on our review, during periods of high flood flows, the normal flow of groundwater towards the river is reversed, which causes petroleum product migration from the area toward the river to slow or stop. This causes petroleum products to pool along the riverbank in the vicinity of the monitoring wells and causes them to be detected during monitoring events.

It appears that "fluctuating flows" stated in the reports refers to seasonal high water events that correspond to natural inflow below the Wilder dam or that exceed Wilder's generating capacity and TransCanada's ability to control or manage those flows through project operations. There is no evidence that project operations are exacerbating the mobilization of contaminated materials or groundwater in the river.

Our conclusion is supported by the March 15, 2013, email communication from Stantec, specifically from the Project Manager, Leigh-Anne Sapienza, for the subject monitoring and reports. **She states, "The discussion of the inundation of WP-6 refers to seasonal high water events."** A copy of this email communication is included as Attachment D to this PAD deficiency/AIR response.

3. Recreation and Land Use

a. Deficiency: "For each recreation facility within or adjacent to the project boundary, please provide a description of the facility, uses, location, ownership, capacity, and management (all three PAD's)."

a. Response: Presented below are revised versions of the Wilder, Bellows Falls, and Vernon PAD tables listing recreation sites within the project boundary (table 3.10-1 in each PAD), to include known information related to TransCanada's ownership status and proximity within the project boundary.

These additions are shown in ***bold italics*** in the tables below. In preparing these revised tables, our research showed two sites (Norwich Landing and East Wilder Boat Launch) in the Wilder PAD were incorrectly identified as TransCanada-owned sites. These sites are not owned by TransCanada but lie adjacent to the project boundary.

Information on recreational capacity does not exist, so was not included in the PADs in accordance with 18 C.F.R. § 5.6 (d)(3). TransCanada is proposing a recreation facility inventory and use and needs study in the Proposed Study Plan (PSP) in response to study requests that will provide additional information about recreation facility capacity.

In addition to the changes in the tables, TransCanada has prepared revised recreation figures showing the project recreation sites relative to the project boundary and land ownership status surrounding those sites. These figures were created to address PAD deficiency A.1.a above and are being filed as Attachment A to this PAD deficiency/AIR response.

Recreation Sites within the Wilder Project Boundary (updated table 3.10-1 from the Wilder PAD; Sources: CRJC, 2008; Pollock, 2009).

Site Name	Site Type	RM	Town	Manager	*Owned by TransCanada*	*Inside Project Boundary*
Newbury-Haverhill Bridge Access	Boat ramp (improved)	257.5	Haverhill, VT	VTDFG		
Bedell Bridge State Park	Boat rap (improved) and picnicking	255	Haverhill, NH	NH Parks and Recreation		
Bugbee Landing Access Point	Ramp (small dock with unimproved ramp)	248	Bradford, VT	VTDFG		
Orford Boat Landing	Boat ramp (improved)	239	Orford, NH	Town of Orford with NH Fish & Game Dept.		
Richardson Conservation Land	Boat launch (walk in carry/car-top access)	234	Orford, NH	Town of Orford		
North Thetford Landing	Boat ramp (improved)	232.5	Thetford, VT	State of VT		
Hewes Brook Boat Launch	Boat launch (car-top access)	228	Lyme, NH	Lyme Conservation Commission		
Ompompanoosuc Launch	Boat launch (unimproved ramp)	225	Pompanoosuc, VT	State of VT		
Norwich Landing	Boat launch (car-top access)	216	Norwich, VT	Town of Norwich	***No***	***No***

Site Name	Site Type	RM	Town	Manager	***Owned by TransCanada***	***Inside Project Boundary***
Fullington Landing	Boat Ramp (improved)	221	Hanover, NH	NH Fish & Game Dept.		
Ledyard Canoe Club	Canoe launch	218.5	Hanover, NH	Dartmouth College		
East Wilder Boat Launch	Boat Ramp (improved)	216	West Lebanon, NH	City of Lebanon	***No***	***No***
Hartford (Wilder) Picnic Area at Kilowatt Park*	Small dock and day use area	219.3	Hartford, VT	Town of Hartford, VT	***Yes***	***Yes***
Wilder Dam (Olcott Falls) Boat Launch*	Boat launch (improved), athletic fields and picnic facilities	216	Hartford, VT	Town of Hartford, VT	***Yes***	***Yes***
Fishladder & Angler Parking*	Angler access	215	Hartford, VT	TransCanada	***Yes***	***Yes***
Lebanon (Wilder Dam) Picnic Area, Vista, and hiking trails*	Day use (hiking and picnicking)	215	West Lebanon, NH	TransCanada	***Yes***	***Yes***
Wilder Dam Portage and downstream natural areas*	Portage trail, angler access, and natural area	215.5	West Lebanon, NH	TransCanada	***Yes***	***Yes***

Notes: * indicates TransCanada recreation site as noted on the current FERC approved Exhibit R – Recreation Map.

Recreation Sites within the Bellows Falls Project Boundary (updated table 3.10-1 from the Bellows Falls PAD; Source: CRJC, 2008).

Site Name	Site Type	RM	Town	Manager	*Owned by TransCanada*	*Inside Project Boundary*
Andrews Road	Boat ramp (cartop)	192	Claremont, NH	State of NH		
Wilgus State Park	Boat ramp (cartop)	191	Weathersfield, VT	State of VT		
Ashley Ferry Boat Landing	Boat ramp	187	Claremont, NH	State of NH		
Hoyts Landing	Boat ramp and fishing platform	179	Springfield, VT	State of VT		
Patch Park	Boat ramp (cartop, unimproved)	178	Charlestown, NH	Town of Charlestown		
Charlestown Boat Launch and Picnic Area[a]	Boat ramp and picnicking	177	Charlestown, NH	TransCanada	***Yes***	***Yes***
Green Mountain Marina	Boat ramp and marina	173.5	Rockingham, VT	Private		
Herrick's Cove Boat Launch & Picnic Area[a]	Boat ramp and picnic site	173	Rockingham, VT	TransCanada	***Yes***	***Yes***
Pine Street Boat Launch and Portage Trail Take-Out[a]	Boat ramp	170	N. Walpole, NH	TransCanada	***Yes***	***Yes***
Bellows Falls Fish Ladder Visitor Center[a]	Environmental education	169.2	Rockingham, VT	TransCanada	***Yes***	***Yes***
Bellows Falls Dam Portage Put-In[a]	Boat ramp (cartop), and Portage trail	168.5	Walpole, NH	TransCanada	***Yes***	***Yes***

[a] Indicates TransCanada recreation site as noted on the current FERC-approved Exhibit R – Recreation Map.

Recreation Sites within the Vernon Project Boundary (updated table 3.10-1 from Vernon PAD; Source: CRJC, 2008).

Site Name	Site Type	RM	Town	Manager	*Owned by TransCanada*	*Inside Project Boundary*
Putney Boat Landing	Boat ramp	157	Putney, VT	State of VT		
Dummerston Landing	Boat ramp (cartop)	152	Dummerstown, VT	State of VT		
River Road Access	Boat ramp	149	Chesterfield, NH	Town of Chesterfield, NH		
Old Ferry Road Access	Boat ramp	147	Brattleboro, VT	State of VT		
Retreat Meadows Boat Launch	Boat ramp (cartop)	145	Brattleboro, VT	Brattleboro Retreat		
West River Marina	Commercial marina	145	Brattleboro, VT	Private (open to public)		
Norm's Marina	Boat ramp	144	Hinsdale, NH	Private (open to public, fee)		
Hinsdale Island	Boat ramp (cartop)	144	Hinsdale, NH	State of NH		
Fisherman Access Area*	Angler Access	142	Vernon, VT	TransCanada	***Yes***	***No***
Prospect Street Launch	Boat ramp	139	Hinsdale, NH	Town of Hinsdale, NH		
Vernon Canoe Portage*	Canoe Portage Take-out	138	Vernon, VT	TransCanada	***Yes***	***Yes***
Vernon Glen Picnic Area*	Picnic Area	138	Vernon, VT	TransCanada	***Yes***	***Yes***

Site Name	Site Type	RM	Town	Manager	***Owned by TransCanada***	***Inside Project Boundary***
Vernon (Governor Hunt) Recreation Area & Boat Launch* (below Vernon dam)	Boat ramp (cartop only above the dam) and fish ladder display area	137	Vernon, VT	TransCanada	***Yes***	***Yes***
Vernon Neck Open Space*	Open Space	136	Hinsdale, NH	TransCanada	***Yes***	***Yes***

Notes: * indicates TransCanada recreation site as noted on the current FERC approved Exhibit R – Recreation.

B. ADDITIONAL INFORMATION REQUESTS

Wilder Hydroelectric Project

1. Recreation and Land Use

a. AIR: "Although Figure 3.10-1 [in the PAD] provides a map of the Wilder project boundary and recreation sites, it is difficult to discern the exact location of these sites with respect to one another and whether each site is located within the project boundary. Please map this area in greater detail (i.e., larger scale) including the project boundary and recreation facilities as displayed in Figure 3.10-1."

a. Response: A large-scale mapbook for the Wilder Project is included in Attachment A to this PAD deficiency/AIR response. The Wilder Project boundary, project facilities, including project recreational facilities owned and managed by TransCanada are shown. GIS ESRI files (.dbf; .prj; .sbn; .sbx; .shp; .xml; and. shx) depicting the project boundary are being filed as a compressed digital file under the file name WilderFACILITY.zip

This mapbook contains revised recreation figures showing the project recreation sites relative to the project boundary and land ownership status surrounding those sites. These figures were created to also address the PAD deficiency A.1.a above.

b. AIR: "When detailing recreation use estimates, the PAD references a TransCanada 2009 document in Section 3.10.3 that is not listed in the references. Please provide the reference for the document, methods of data collection, and an explanation of how use estimates were derived."

b. Response: The correct reference for this, relative to the Wilder, Bellows Falls and Vernon Projects is:

TransCanada. 2009. TransCanada Licensed Hydropower Development Recreation Report (FERC Form 80 Report). April 2009.

Data collection methods included observations from staff, professional judgment, use information from local area clubs (e.g., snowmobile, fishing, etc.), anecdotal evidence from law enforcement officials that visit the site on peak weekends, and population growth projections for the local areas.

c. AIR: "Please provide any existing information and maps on land use and land classification for all lands within the project boundary, associated buffers, the authorized non-project use of project lands, and to the extent known, any lands immediately adjacent to the project boundary and within the floodplain. In addition to a general description, this information should include aerial photographs and local or regional planning agency land use classifications."

c. Response: A large-scale mapbook for the Wilder Project is included in Attachment A to this PAD deficiency/AIR response. The Wilder Project land cover maps show the land cover type classifications for lands adjacent to and within the project boundary. These maps show the land cover classifications previously presented in figure 3-7.2 in the PAD at a much closer scale. GIS ESRI files (.dbf; .prj; .sbn; .sbx; .shp; .xml; and. shx) depicting the project boundary are being filed as a compressed digital file under the file name WilderLAND.zip

d. AIR: "Please provide further explanation of TransCanada's shoreline management practices including the number of permits issued, standard permit conditions, clarification of New Hampshire state requirements for minimum shoreline buffer, and any other pertinent information related to shoreline management."

d. Response: TransCanada has not entered into any agreements for non-project use of project lands within the Wilder Project. Information related to the two lease agreements currently in place at the Bellows Falls Project is included in the response to Bellows Falls AIR 1.d below.

The following provides additional information related to the New Hampshire state requirements for minimum shoreline buffers and other pertinent information related to permitting development along shoreline and general shoreline management of the Connecticut River in the state.

New Hampshire Shoreland Water Quality Protection Act (NH RSA 483B) – Summary of Requirements

A state Shoreland Permit is required for most new construction, excavation or filling in the protected shoreland, although some waivers are allowed. The intent of the law and implementing regulations (Env-Wq 1400) is to minimize water quality impacts from riverfront development. The law and permitting applies only to new construction, change in size of existing structures or impervious surfaces, and the like, not to existing conditions.

The Connecticut River along its entire NH length is regulated under NH RSA 483B. The protected shoreland area is referenced from the high water mark of a river. Requirements and restrictions are based on the setback distance from the reference line, increasing with proximity to the water body, as summarized below:

Within 250 feet from the reference line – The Protected Shoreland (under NH RSA 483B)

Impervious Surface Area Limitation

If a homeowner or developer wishes to exceed 30% impervious surface coverage of the area of the lot within the protected shoreland, a stormwater management system designed and certified by a professional engineer that will not concentrate stormwater runoff or contribute to erosion must be implemented and if any grid segment within the waterfront buffer (see below) does not meet the minimum required 50 point tree, sapling, shrub and groundcover score, each deficient grid segment must be planted with additional vegetation to at least achieve the minimum required score. If a homeowner or developer wishes to exceed 20% impervious area, a stormwater management plan must be implemented to infiltrate increased stormwater from development.

Other Restrictions

- There can be no establishment/expansion of salt storage yards, auto junk yards, solid waste and hazardous waste facilities.
- Setback requirements for all new septic systems are determined by soil characteristics.
    - 75 feet for rivers and areas where the there is no restrictive layer within 18 inches and where the soil down gradient is not porous sand and gravel (perc>2 min.).
    - 100 feet for soils with a restrictive layer within 18 inches of the natural soil surface.
    - 125 feet where the soil down gradient of the leachfield is porous sand and gravel (perc rate equal to or faster than 2min/in.).
- When selling developed waterfront property, a *Site Assessment Study* is required for all properties with on-site septic that are contiguous to or within 200 feet of waterbodies subject to the Act.
- An Alteration of Terrain Permit is required for any project that proposes to disturb more than 50,000 sq ft of contiguous terrain if any portion of the project is within the protected shoreland or disturbs an area having a grade of 25% or greater within 50 feet of any surface water.

From 50 – 150 feet from the reference line – Natural Woodland Buffer Limitations

- At least 25 percent of the area between 50 feet and 150 feet from the reference line must be maintained in an unaltered state. Unaltered State means vegetation is allowed to grow without cutting, limbing, trimming, pruning, mowing or other similar activities except as needed for plant health, normal maintenance and renewal. Existing lawns, fields and beaches and landscaped areas are not considered unaltered areas.

From 0 – 50 feet from the reference line – Waterfront Buffer and Primary Building Setback.

- All primary structures must be set back at least 50 feet from the reference line. Towns may maintain or enact greater setbacks.
- Within 50 feet from the reference line, a waterfront buffer must be maintained. Within the waterfront buffer, tree coverage is managed with a 50 x 50 foot grid and point system, based on a minimum number and size of trees. Trees and saplings may be removed provided the sum score of the remaining trees, saplings, shrubs and groundcover within the affected grid segment is at least 50 points (see

http://des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-5.pdf for details on the point/grid system).

- No natural ground cover can be removed except for a footpath to the water that does not exceed 6 feet in width and does not concentrate stormwater or contribute to erosion. Natural ground cover must remain intact. No cutting or removal of vegetation below 3 feet in height (excluding previously existing lawns and landscaped areas).
- Stumps, roots, and rocks must remain intact in and on the ground unless specifically approved by the department.
- Pesticide and herbicide applications can be applied by a licensed applicator only.
- Only low phosphorus, slow release nitrogen fertilizer can be used beyond 25 feet of the reference line. Only limestone may be used within 25 feet of the reference line.

2. Cultural Resources

a. AIR: In section 4.10.2 [of the PAD], you propose to conduct a cultural resources study that may include Phase IB Intensive Archaeological Investigations. You also propose to formally evaluate the National Register of Historic Places (National Register)-eligibility of the project facilities. However, you have not provided a map specifically defining the APE, and we are unclear on how you would specifically carry out the various tasks involving your proposed study [items a) through h) in the detailed AIR for this resource].

a. Response: The response to this AIR can be found in the Proposed Study Plan (PSP) (Study 33), which is being filed concurrently with this PAD deficiency/AIR response. The proposed study addresses the elements noted in this AIR. APE maps are included as Attachment E to this filing. The Wilder Phase1A report described in Study Plan 33 will be eFiled as a restricted document due to the sensitive nature of the information in the report, with the Commission by May 15, 2013.

Bellows Falls Hydroelectric Project

1. Project Facilities and Operations

a. AIR: On page 3-128 the PAD states the shoreline of the reservoir is 72 miles; however, on pages 2-24 and 3-18 it states it is 74 miles long. Therefore, so that we may fully understand and evaluate your proposal and determine the appropriate studies needed, please provide clarification regarding the length of the reservoir shoreline.

a. Response: The length of the shoreline is approximately 74 miles long; however, this value is an estimated length only and not based on a precise ground survey.

2. Recreation and Land Use

a. AIR: "Although Figure 3.10-1 [in the PAD] provides a map of the Bellows Falls project boundary and recreation sites, it is difficult to discern the exact location of these sites with respect to one another and whether each site is located within the project boundary. Please map this area in greater detail (i.e., larger scale) including the project boundary and recreation facilities as displayed in Figure 3.10-1."

a. Response: A large-scale mapbook for the Bellows Falls Project is included as Attachment A to this PAD deficiency/AIR response. The Bellows Falls project boundary, project facilities, including project recreational facilities owned and managed by TransCanada are shown. GIS ESRI files (.dbf; .prj; .sbn; .sbx; .shp; .xml; and .shx) depicting the project boundary are being filed as a compressed digital file under the file name BellowsFallsFACILITY.zip

c. AIR: "Please provide any existing information and maps on land use and land classification for all lands within the project boundary, associated buffers, the authorized non-project use of project lands, and to the extent known, any lands immediately adjacent to the project boundary and within the floodplain. In addition to a general description, this information should include aerial photographs and local or regional planning agency land use classifications."

c. Response: A large-scale mapbook for the Bellows Falls Project is included in Attachment A to this PAD deficiency/AIR response. The Bellows Falls Project land cover maps show the land cover type classifications for lands adjacent to and within the project boundary. These maps show the land cover classifications previously presented in figure 3-7.2 in the PAD at a much closer scale. GIS ESRI files (.dbf; .prj; .sbn; .sbx; .shp; .xml; and .shx) depicting the project boundary are being filed as a compressed digital file under the file name BellowsFallsLAND.zip

d. AIR: "Please provide further explanation of TransCanada's shoreline management practices including the number of permits issued, standard permit conditions, clarification of New Hampshire state requirements for minimum shoreline buffer, and any other pertinent information related to shoreline management."

d. Response: With regard to a clarification of New Hampshire state requirements for minimum shoreline buffers, please refer to the response to AIR B.1.d related to the Wilder Project, above.

TransCanada does have agreements with local farmers (Agricultural Licenses) for TransCanada owned land within the Bellows Falls project boundary (sites recognized by the local names of Upper Meadows, Great Meadows and Lower Meadows on USGS topo and other maps). The Bellows Falls Project TransCanada Recreation Sites & Land Ownership maps referenced above as part of the response to the deficiency A.3.a shows lands within the project boundary that are under agricultural lease and actively farmed. These authorized non-project uses of project lands are executed under Agricultural License Agreements issued by

TransCanada to the farmers. Two articles within the license, Article 3: Use and Maintenance, and Article 13 Water; Environmental, directly address farmers' use of the properties and their environmental stewardship of the land. Article 13 specifically includes language requiring the farmer to maintain a 100-foot buffer between the fields and the Connecticut River. Currently there are two such agreements in place at the Bellows Falls Project.

TransCanada Agricultural License Agreement articles:

USE AND MAINTENANCE

Licensee agrees to use the Property only for agricultural purposes, in accordance with the best management practices, applicable to the crop, published by the New Hampshire Department of Agriculture, Markets & Food and the Vermont Agency of Agriculture, Food and Markets (as applicable depending on location of the land), and to do so in a manner consistent with the agricultural practices and standards of state and county where the land is located, and to allow the Property to qualify as agricultural land for property tax purposes.

Licensee shall maintain the Property, which includes all improvements located thereon, in the same condition and state of repair as exists as of the date of the commencement of this Agreement, or with respect to any improvements which may be subsequently added to or become a part of the Property, as of the date said improvements were completed, ordinary wear thereof and damages by the elements or other acts of God excepted. TransCanada shall have the right to enter upon and inspect the Property and the operations of Licensee thereon, to ensure Licensee's proper maintenance. TransCanada shall notify Licensee prior to such inspections, for purposes of coordinating TransCanada's entry with respect to any pesticide or herbicide applications.

Licensee shall have the right, at Licensee's own expense (unless otherwise agreed in writing by the parties hereto), to make or permit to be made, from time to time during the term of this Agreement, such alterations, additions, modifications, changes and repairs in and to the Property as Licensee may find necessary or convenient for operation of the Property for the agricultural purposes permitted herein; provided, however, that Licensee shall not make any alteration, addition, modification, change or repair that will decrease the value of, or constitute waste with respect to, the Property. Any alteration, addition, modification, change or repair shall become the sole and exclusive property of TransCanada, unless otherwise agreed in writing by the parties hereto. Other than provided herein, Licensee shall not, without the prior written consent of TransCanada, erect any structures or fencing, make any alteration to the permanent water delivery system on or about the Property, or cut any trees or make any alterations or improvements to the non-agricultural portions of the Property.

All equipment installed on the Property by Licensee and all furniture, fixtures and other personal property placed upon the Property by Licensee, shall remain the property of Licensee and Licensee shall be required upon the expiration of the term of this Agreement or earlier termination, to remove diligently and expeditiously any and all of said equipment, furniture, fixtures, or other personal property from the Property at Licensee's cost and expense; provided, however, that Licensee may, upon obtaining advance written approval from TransCanada, leave such equipment, furniture, fixtures or other personal property on the Property upon expiration of the Agreement term, in which event such property shall become the property of TransCanada.

In the case of any injury or damage to the Property resulting from Licensee's removal of any equipment, furniture, fixtures or other personal property, Licensee shall promptly repair the same, at its expense, in a good and workmanlike manner.

Licensee shall not prevent or obstruct TransCanada's access to the Property. If Licensee installs gates or fences at the Property, Licensee shall provide TransCanada with keys to all locks.

Licensee shall:

Take all actions and do all things necessary to comply with and abide by all laws, rules, regulations, and ordinances, as the same may be amended, supplemented or otherwise modified, enacted or promulgated, by the United States, the State of New Hampshire or Vermont (as applicable depending on location of the land), any municipality or local government, or any irrigation district, flood control district or similar organization, and their agents, respecting or affecting the Property;

Obtain and maintain in force State Worker's Compensation Insurance on all employees for only those who enter the Property in such amounts required by applicable laws, rules and regulations; and

Assure that those portions of the Property not planted in crops are kept free of weeds and are otherwise maintained in a manner to comply with all applicable laws, rules, regulations, guidelines and directives of any applicable governmental agency, body, or board of commission.

Licensee shall comply with the laws of the State of Vermont, Windham County, and Sullivan County, New Hampshire (as applicable depending on location of the land), and the United States, applicable to the use of herbicides, pesticides, insecticides, defoliants, non-organic fertilizers, soil conditioners, fuels, lubricants and other potentially hazardous substances in the conduct of farming operations on the Property. Licensee shall not apply any pesticide, herbicide or chemical product on the Property which may leave a residue that will adversely affect the growing of crops. Upon the termination of this Agreement, Licensee shall furnish to TransCanada a written list of the chemicals applied to the Property, together with the quantity and dates of application. Licensee shall also use care in the application of chemicals to the crops grown on the Property so as to avoid damage to crops grown on adjacent parcels of land owned by third parties.

In the event Licensee uses bees to pollinate crops grown on the property, Licensee shall take all steps necessary to prevent contamination of any honey produced by said bees and shall hold TransCanada harmless from and indemnify TransCanada against any losses, claims, liabilities, penalties, or fines of whatever nature arising from the use of bees on the Property.

Licensee acknowledges that it is sophisticated in farming matters in the area of the Property, is familiar with the Property, has been provided access thereto and conducted its own study and analysis thereof, and is relying solely on that analysis in determining the suitability of the Property for Licensee's intended use. TransCanada makes no warranty, either express or implied, concerning the suitability of the soil or water for Licensee's intended use.

Any and all mineral rights in the Property are specifically excluded from this Agreement.

Licensee agrees not to use or occupy said premises for any unlawful purpose. Licensee may not assign said Agreement or any part thereof without the prior written consent of TransCanada.

Licensee is aware and acknowledges that TransCanada and other third parties operate or plan to operate energy facilities on the Property, including electric power generating stations and appurtenant facilities, buried pipelines, and above-ground electric lines. TransCanada retains the right (i) to hold and flow water against and upon the Property, by reason of the construction, maintenance, or operation of existing and future dams and hydro-electric generating facilities or any of them, which dams and facilities are presently or may in the future be located on property other than the Property, and, (ii) in connection with the construction, maintenance, or operation of such dams and facilities, to take and use the water of the Connecticut River without any restrictions whatsoever as to the quantity and times of such taking or as to the use thereof, and (iii) to interfere with and to regulate the flow of and to discharge, withhold and divert the waters of the Connecticut River, over, upon and from the Property. Licensee acknowledges and agrees that there may be damage to Licensee's crops, equipment or other facilities on the Property as a result of TransCanada's reserved rights hereunder and that Licensee shall have no claim against TransCanada for such damages. Licensee shall conduct its activities in a manner that does not interfere with TransCanada's use of the Property for power generation purposes, or with those third parties to whom TransCanada has granted rights to use the Property for such purposes. Licensee also acknowledges that its agricultural activities may be restricted or disrupted as a result of TransCanada's or its grantees' use of the Property, and shall make no claim against TransCanada for such restrictions or disruptions.

WATER; ENVIRONMENTAL

Licensee's use of agricultural water on the property shall comply in all respects with all applicable federal, state and local laws, rules, regulations and ordinances governing or relating to the use of such water. Licensee shall pay all charges and costs for agricultural water usage.

Licensee shall allow the natural beaver activity cycle of causing periodic flooding and draining to continue uninterrupted in order to protect the Northeastern bulrush (*Scirpus ancistrochaetus*), a federally and state listed endangered species known to exist on or near the Property.

If flooding further encroaches on the agricultural portion of the field, then Licensee shall install and maintain water level control devices (aka beaver baffles) as reasonably required to prevent further flooding. Under no circumstances shall Licensee remove beaver dams to facilitate drainage of fields to allow for access and/or mowing. Licensee shall notify TransCanada and the applicable state agency(ies) (i.e., the Vermont Agency of Natural Resources and/or the New Hampshire Department of Environmental Services) before any action described in this subsection 13.3 is taken.

Licensee shall mow the inundated portion of the Property only <u>once</u> during late summer (i.e., after July 15) to serve as a buffer to the wetland and to provide ground-nesting bird habitat.

Licensee shall delay mowing of hay crop on the <u>entire</u> agricultural portion of the Property until after July 15 to protect ground-nesting bird reproduction. For crops other than hay (for example, alfalfa or soybean), delayed mowing is not required.

Licensee shall maintain a 100 foot buffer along the Connecticut River, which shall be allowed to naturally re-vegetate. In addition, Licensee shall maintain a 50 foot vegetated buffer along streams running to the Connecticut River. Technical assistance from the appropriate state agencies can be provided to establish the buffer edge location.

Licensee shall comply with all applicable federal, state, local and other laws, rules, regulations, ordinances and agency directives relating to the protection of the environment. Licensee shall be responsible for, and agrees to indemnify and hold TransCanada harmless from, any environmental claims, damages, costs, penalties, fees or fines resulting from or a breach of this Article or otherwise caused by Licensee's operations on the Property.

3. Cultural Resources

a. AIR: "We ask you to include information in your study proposal for Bellows Falls cultural resources as outlined above for the Wilder Project under B 2"

a. Response: The response to this AIR can be found in the Proposed Study Plan (PSP) (Study 33), which is being filed concurrently with this PAD deficiency/AIR response. The proposed study addresses the elements noted in this AIR. APE maps are included as Attachment E to this filing. The Bellows Falls Phase1A report described in Study Plan 33 will be eFiled as a Restricted Document due to the sensitive nature of the information in the report, with the Commission by May 15, 2013.

Vernon Hydroelectric Project

1. Recreation and Land Use

a. AIR: "Although Figure 3.10-1 [in the PAD] provides a map of the Vernon project boundary and recreation sites, it is difficult to discern the exact location of these sites with respect to one another and whether each site is located within the project boundary. Please map this area in greater detail (i.e., larger scale) including the project boundary and recreation facilities as displayed in Figure 3.10-1."

a. Response: A large-scale mapbook for the Vernon Project is included in Attachment A to this PAD deficiency response. The Vernon project boundary, project facilities, including project recreational facilities owned and managed by TransCanada are shown. GIS ESRI files (.dbf; .prj; .sbn; .sbx; .shp; .xml; and .shx) depicting the project boundary are being filed as a compressed digital file under the file name VernonFACILITY.zip.

This mapbook contains revised recreation figures showing the project recreation sites relative to the project boundary and land ownership status surrounding those sites. These figures were created to address PAD deficiency A.1.a above.

c. AIR: "Please provide any existing information and maps on land use and land classification for all lands within the project boundary, associated buffers, the authorized non-project use of project lands, and to the extent known, any lands immediately adjacent to the project boundary and within the floodplain. In addition to a general description, this information should include aerial photographs and local or regional planning agency land use classifications."

c. Response A large-scale mapbook for the Vernon Project is included in Attachment A to this PAD deficiency/AIR response. The Vernon Project land cover maps show the land cover type classifications for lands adjacent to and within the project boundary. These maps show the land cover classifications previously presented in figure 3-7.2 in the PAD at a much closer scale. GIS ESRI files (.dbf; .prj; .sbn; .sbx; .shp; .xml; and .shx) depicting the project boundary are being filed as a compressed digital file under the file name VernonLAND.zip

d. AIR: "Please provide further explanation of TransCanada's shoreline management practices including the number of permits issued, standard permit conditions, clarification of New Hampshire state requirements for minimum shoreline buffer, and any other pertinent information related to shoreline management."

d. Response: TransCanada has not entered into any agreements for non-project use of project lands within the Vernon Project. Information related to lease agreements at the Bellows Falls Project is included in the response to Bellows Falls AIR 1.d above. With regard to a clarification of New Hampshire state requirements for minimum shoreline buffers, please refer to the response to AIR d.1.d related to the Wilder Project, above.

C. STUDY REPORTS

AIR: "Throughout each of the PADs, TransCanada refers to information from numerous studies it conducted prior to submittal of the PADs. These study reports were not yet available when the PADs were filed with the Commission on October 31, 2012. Additionally, the PADs reference several other documents that are not readily available to the Commission or the public. As such, we request that you file the following study reports and reference documents with the Commission:"

Response: The following table lists the requested study reports and reference documents and status related to filing with the Commission.

Study Request Documents

	Document Citation	Status
C.1	Cherau, S. and B. O'Donnchadha. 2008. Phase IA archaeological Reconnaissance Survey, Vernon Hydroelectric Project (FERC No. 1904, Windham County, Vermont and Cheshire County, New Hampshire. Public Archaeology Laboratory, Pawtucket, RI. Submitted to TransCanada Northeast Hydro, Concord, NH.	This document is part of this filing. Attachment F
C.2	Holmes, R.D., M.T. Mulhollard, and C.D. Hertiz. 1991. Archaeological Reconnaissance Survey for the Proposed Riverbank Erosion Control Study, Massachusetts, Vermont, and New Hampshire. University of Massachusetts, Archaeological Services Report. Submitted to Northeast Utilities, Hartford, CT	This document is part of this filing. Attachment G
C.3	Hubbard, Michael, Suzanne Cherau, Jenifer Elam, John Daly, and Ora Elquist. 2012. Phase IA Archaeological Reconnaissance Survey, Wilder Hydroelectric Project (FERC No. 1892), Windsor and Orange Counties, Vermont, and Grafton County, New Hampshire. Public Archaeology Laboratory, Pawtucket,RI.. Submitted to TransCanada Hydro Northeast, Inc. Concord, NH.	This report is in draft and will be submitted to NH and VT SHPOs by May 15, 2013.
C.4	TransCanada and Normandeau Associates Inc. (Normandeau) water quality sampling data and reports.	Attachment H The attached draft report was submitted for agency review on February 22, 2013. To date, the only comments received were from the New Hampshire Fish and Game Department. We are still anticipating comments from NHDES. VTDEC has deferred to NHDES for comments. Report and NHFGD comments are in attached to this pdf. Appendix A to

	Document Citation	Status
		the report is eFiled separately as AIRC4AttachmentHBaselineWQ Data 2012AppendixA.zip Additional water quality monitoring is included in the PSP, Study Plan 6 in response to resource agency study requests.
C.5	TransCanada and Normandeau Associates Inc. (Normandeau) Jesup's milk vetch/Wilder flow and the RTE study reports.	TransCanada recently received agency comments on both reports. Those comments are being incorporated into final reports and will be filed by April 30, 2013.
C.6	In addition, during the January 29, 2013 scoping meeting, TransCanada noted that the geologic, geotechnical, seepage and stability study along the Vernon Neck had recently been completed. Please file the results of the geologic, geotechnical, seepage and stability study along the Vernon Neck study.	This was an apparent misunderstanding. This study requested by the New York Regional Office (D2SI) has not been conducted, but is scheduled to be done in spring 2013, with a report prepared by fall. The report will be filed when completed.

D. ADDITIONAL COMMENTS FOR PRELIMINARY LICENSING PROPOSAL AND LICENSE APPLICATION

Comment: "While each PAD did provide descriptions of aesthetic and visual characteristics of the respective project dam and adjacent facilities as required by § 5.6(d)(3)(ix), there were few accompanying photos. So we may perform an analysis of project effects on aesthetic resources, when submitting your PLP for each project please provide additional photograph evidence from public areas such as recreation facilities, public roadways, and designated trails of project features including the dam, appurtenant facilities, and facilities in towns and villages."

Response: TransCanada will provide photographic evidence of aesthetic and visual characteristics with the Preliminary License Proposal (PLP) or Draft License Application for each of the projects.

Attachment A

Project Mapbooks and corresponding electronic ESRI GIS shapefiles are eFiled as separate files due to file size and the corresponding file names are indicated in *italics* below

1. Wilder Project *AttachmentAWilderMapbooksABCD.pdf*
    a. Project Boundary, TransCanada Lands, Facilities and Recreation Sites; *WilderFACILITY.zip*
    b. Soils over topography; *WilderSOIL.zip*
    c. Soils over aerial photos; *WilderSOIL.zip*
    d. Geology; *WilderSOIL.zip*
    e. Land Cover, Land Use; *WilderLAND.zip*
2. Bellows Falls *AttachmentABellowsFallsMapbooksABCD.pdf*
    a. Project Boundary, TransCanada Lands, Facilities and Recreation Sites, *BellowsFallsFACILITY.zip*
    b. Soils over topography; *BellowsFallsSOIL.zip*
    c. Soils over aerial photos; *BellowsFallsSOIL.zip*
    d. Geology; *BellowsFallsSOIL.zip*
    e. Land Cover, Land Use; BellowsFallsLAND.zip
3. Vernon *AttachmentAVernonMapBooksABCD.pdf*
    a. Project Boundary, TransCanada Lands, Facilities and Recreation Sites; *VernonFACILITY.zip*
    b. Soils over topography; *VernonSOIL.zip*
    c. Soils over aerial photos; *VernonSOIL.zip*
    d. Geology; *VernonSOIL.zip*
    e. Land Cover, Land Use; *VernonLAND.zip*

Attachment B

This attachment is eFiled as a separate pdf file due to file size. The corresponding file name is indicated in *italics* below

Stantec. 2013. 2012 Groundwater Monitoring Summary Report and GMP Renewal Application, Westboro Roundhouse, 26 Railroad Avenue, West Lebanon, New Hampshire, 03784, NHDES Site #: 199210036, Project Type: LAST, Project Numbers: 3990 and 13124

AttachmentBWestboroRailYard2012GWMonitoringReport.pdf

Attachment C

This attachment is eFiled as a separate pdf file due to file size. The corresponding file name is indicated in *italics* below

Stantec. 2012. Results of Laser Induced Fluorescence Survey, Westboro Roundhouse, 26 Railroad Avenue, West Lebanon, NH, 03784. NHDES Site #: 199210036, Project Type: LAST, Project Numbers: 3990 (Stantec, 2012)

AttachmentCWestboroRailYardIISProxy.pdf

Attachment D

This attachment is eFiled as a separate pdf. The corresponding file name is indicated in *italics* below

TransCanada-Stantec email correspondence regarding clarification of statements in 2012 Groundwater Monitoring Summary Report and GMP Renewal Application, Westboro Roundhouse

AttachmentDWestboroRailYardemailcommunicationStantec.pdf

Attachment E

This attachment is eFiled as two separate pdf files due to file size. The corresponding file names are indicated in *italics* below

Wilder APE Cultural Resources Mapbooks

AttachmentEWilderProjectPhase1AAPEmap.pdf

Bellows Falls APE Cultural Resources Mapbooks

AttachmentEBellowsFallsProjectPhase1AAPEmap.pdf

Attachment F

This attachment is eFiled as a pdf files due to file size. The corresponding file names are indicated in *italics* below. This is a RESTRICTED document due to the specific references to sensitive cultural and historic information.

Cherau, S. and B. O'Donnchadha. 2008. Phase IA archaeological Reconnaissance Survey, Vernon Hydroelectric Project (FERC No. 1904, Windham County, Vermont and Cheshire County, New Hampshire. Public Archaeology Laboratory, Pawtucket, RI. Submitted to TransCanada Northeast Hydro, Concord, NH.

RESTRICTEDAttachmentFVernon FinalPhaseIASurvey2008.pdf

Attachment G

This attachment is eFiled as a pdf files due to file size. The corresponding file names are indicated in *italics* below. This is a RESTRICTED document due to the specific references to sensitive cultural and historic information.

Holmes, R.D., M.T. Mulhollard, and C.D. Hertiz. 1991. Archaeological Reconnaissance Survey for the Proposed Riverbank Erosion Control Study, Massachusetts, Vermont, and New Hampshire. University of Massachusetts, Archaeological Services Report. Submitted to Northeast Utilities, Hartford, CT.

RESTRICTEDAttachmentGHolmes1991UMASSArchaeologicalReconnSurvey.pdf

Attachment H

This attachment is eFiled as two separate pdf files and one zipped excel file due to file size. The corresponding file names are indicated in *italics* below

Normandeau Associates, Inc. 2012 Baseline Water Quality Study, Wilder Hydroelectric Project No. 1892, Bellows Falls Hydroelectric Project No. 1855, Vernon Hydroelectric Project No. 1904. Agency Draft Report. Prepared for TransCanada Hydro Northeast Inc. February 2013.

AttachmentHTransCanada Baseline WQ Study Report_Agency Draft 2-8-13.pdf

Normandeau Associates, Inc. Appendix Tables - 2012 Baseline Water Quality Study, Wilder Hydroelectric Project No. 1892, Bellows Falls Hydroelectric Project No. 1855, Vernon Hydroelectric Project No. 1904. Agency Draft Report. Prepared for TransCanada Hydro Northeast Inc. February 2013.

AttachmentHBaselineWQ Data 2012AppendixA.zip

Email correspondence between TransCanada and agencies transmitting draft pre-PAD Water Quality report and receipt of comments from G. Gries of New Hampshire Fish and Game Department.

AttachmentHEmailCommentNHFGD2012WQStudy.pdf

UNITED STATES OF AMERICA

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

TRANSCANADA HYDRO NORTHEAST INC.

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

Study Request Responsiveness Summary

April 15, 2013

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INTRODUCTION

On October 31, 2012, TransCanada Hydro Northeast Inc. (TransCanada) filed with the Federal Energy Regulatory Commission (Commission or FERC), Notices of Intent to file applications for new licenses for the existing Wilder Hydroelectric Project (FERC Project No. 1892-026); Bellows Falls Hydroelectric Project (FERC Project No. 1855-045); and Vernon Hydroelectric Project (FERC Project No. 1904-073) (Projects) in accordance with 18 C.F.R. § 5.5. The current license for each project expires on April 30, 2018. TransCanada is using FERC's Integrated Licensing Process (ILP) as set forth in Title 18 of the US Code of Federal Regulations (C.F.R.), Part 5 to relicense the three Projects.

Simultaneous to filing of the NOIs, TransCanada filed Pre-Application Documents (PADs) for each of the three projects. The PADs provided FERC and interested parties with summaries of existing, relevant, and reasonably available information that was in TransCanada's possession as supplemented by a due diligence search of other sources of information about the projects and related environmental resources.

On December 21, 2012, the Commission issued its Scoping Document 1 (SD1) for the projects, and in January 2013 several public scoping meetings were held for interested parties to provide comments on the project PADs, to provide comments and suggestions to the Commission on the SD1, and to identify any resource studies that would help provide a framework for collecting pertinent information on the resource areas under consideration necessary for the Commission to prepare the Environmental Impact Statements (EISs) for the projects.

TransCanada received a total of 245 individual study requests related to the Wilder, Bellows Falls, and Vernon Projects in 23 letters from entities and individuals that were filed with or requested by the Commission on or before March 1, 2013. Additional comments without formal study requests were received from another 21 interested parties, but those are not addressed in this responsiveness summary. This document summarizes each individual study request (by requester) and TransCanada's response.

Some study requests did not meet one or more of the seven Integrated Licensing Process (ILP) study request criteria (18 C.F.R. § 5.9(b)) in substantive ways and have been excluded from the PSP on that basis. In such cases, our response indicates which of the seven ILP study plan criteria (18 C.F.R. § 5.9(b)(1)-(7)) that the request failed to meet.

Study requests that have been incorporated into study plans are identified in the tables that follow and are addressed in more detail in TransCanada's Proposed Study Plan (PSP) being filed simultaneously with the Commission. The following table identifies the acronyms used for study requesters in their respective responsiveness tables and throughout the PSP.

Request Submittal Authors	Acronym Used in the PSP
Appalachian Mountain Club, Vermont River Conservancy, and Friends of the Connecticut River Paddler's Trail	AMC-VRC-FRs
City of Lebanon, New Hampshire Planning Office	Leb
Connecticut River Joint Commissions	CRJC
Connecticut River Watershed Council	CRWC
Federal Energy Regulatory Commission	FERC
Lipfert, F. William, Jr. and Jennifer Lipfert	Lipfert
Mudge, John T. B.	Mudge
National Park Service	NPS
New England Flow and American Whitewater	NEF-AW
New England Flow, American Whitewater and Appalachian Mountain Club	NEF-AW-AMC
New Hampshire Department of Environmental Services	NHDES
New Hampshire Fish and Game Department	NHFG
New Hampshire Natural Heritage Bureau	NHNHB
The Nature Conservancy	TNC
The Nolumbeka Project	Nolumb
Town of Lyme, New Hampshire, City of Lebanon, New Hampshire, and O. Ross McIntyre	Lyme-Leb-McInt

Request Submittal Authors	Acronym Used in the PSP
Town of Rockingham, Vermont Conservation Commission	Rock
Trout Unlimited, Deerfield River Chapter	TU
Trustees of Pine Park Association, Hanover New Hampshire	Han
Two Rivers-Ottauquechee Regional Commission	TwoRiv
US Fish and Wildlife Service	FWS
Vermont Agency of Natural Resources	VANR
Vermont State Historical Preservation Office	VTSHPO

Appalachian Mountain Club, Vermont River Conservancy, and Friends of the Connecticut River Paddlers' Trail

Date of Letter: 2/28/2013. Three letters were filed, one for each project.

Study Request No.	Project	AMC-VRC-FRs Study Request	Response
1	Wilder, Bellows Falls, Vernon	Study of Project Facilities to Support Multiple-day Self-Powered Boating Trips on the CT River	Addressed in Study Plan No. 30
2	Wilder	Controlled Whitewater Flow Study for the Sumner Falls Reach	Addressed in Study Plan No. 31
2	Bellows Falls	Controlled Whitewater Flow Study in the Bypass Reach below the Bellows Falls Dam	Addressed in Study Plan No. 31
2	Vernon	Study of the Proper Presentation and Preservation of Important Historical Resources	TransCanada has not developed a study plan for this request. This is a mitigation request for an educational program (materials, kiosk, etc.) at the site, and preservation of historical records of the site that TransCanada might have. TransCanada considers this to be a request for a specific mitigation measure associated with historic resources more typical of what would be found in a Programmatic Agreement or Management Plan for Historic Resources, rather than a study request. Since this study request would not inform measures that could be considered for a new license it does not meet FERC study criteria 6.
3	Wilder		
4	Bellows Falls		

Study Request No.	Project	AMC-VRC-FRs Study Request	Response
3	Bellows Falls	Study of the Potential to Create a Whitewater Park in the Bellow Falls Bypass Reach	TransCanada has not developed a study plan for this request. This is a mitigation request for a specific recreational enhancement - a white water park. A suitability analysis must be completed to determine the suitability and capability for white water recreation in the Bellows Falls bypass. Boating fatalities have occurred in the past in this reach and therefore a thorough analysis must be undertaken prior to any recommended mitigation or proposal. However, preliminary analysis is included in Study Plan 31. In addition, multiple agencies have requested aquatic habitat assessments and fish passage studies that also encompass this reach. All of which requires a thorough analysis of all resources affected and suitability prior to considering this as a reasonable component in an overall project mitigation strategy.
3	Vernon	Study of the Economic Health of Ownership and Creation of a Decommissioning or Trust Fund	TransCanada has not developed a study plan for this request. This issue will be addressed in the economic analysis and amortization requirement in each Project License. Existing information available to FERC is sufficient to address this issue. Consequently this request does not meet FERC study criteria 4.
4	Wilder		
5	Bellows Falls		

City of Lebanon, New Hampshire Planning Office

Date of Letter: Received by FERC on 2/25/2013

The City of Lebanon referenced 18 CFR § 5.9(b) the ILP Study Plan Criteria in the header of its letter to FERC regarding relicensing of the Wilder Project. However, the letter included only comments on the Wilder PAD, and no study requests as defined by 18 CFR § 5.9(b).

Connecticut River Joint Commissions, Inc.

Date of Letter: 3/1/2013

Study Request No.	Project	CRJC Study Request	Response
1	Wilder, Bellows Falls, Vernon	Study Request for Watershed-wide Storm water Model	The primary issues relative to the TransCanada projects, for which this study request is proposed, are being addressed through methods similar to those requested but within a more limited geographic scope than proposed in this request . Developing a model for the entire Connecticut River watershed would be beyond the defined geographic scope of the projects and would be cost prohibitive (FERC study criteria 7). See Study Plan Nos. 4, 5, 7, 9, 27, 30, 33

Connecticut River Watershed Council

Date of Letter: 3/1/2013

Study Request No.	Project	CRWC Study Request	Response
1	Wilder	Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations for Wilder Dam	Addressed in Study Plan Nos. 2 and 3
2	Bellows Falls	Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations for Bellows Falls Dam	Addressed in Study Plan Nos. 2 and 3
3	Vernon	Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations for Vernon Dam	Addressed in Study Plan Nos. 2 and 3
4	Wilder, Bellows Falls, Vernon	Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects	TransCanada does not propose to develop a specific study plan that addresses climate change as it relates to project operations. Such a study would not necessarily inform potential mitigation measures (FERC study criteria 4) and would be cost prohibitive (FERC study criteria 7). Potential operational measures that could be considered will be informed by the water level and project operations modeling (Study Plan 4 and 5, and water quality monitoring (Study plan 6).

Study Request No.	Project	CRWC Study Request	Response
5	Wilder	Continuous water temperature monitoring (25 minute intervals) at various locations within the Wilder Hydroelectric Project Impoundment and Tailrace, and Connecticut River downstream of the Wilder Dam	Addressed in Study Plan No. 6
6	Bellows Falls	Continuous water temperature monitoring (25 minute intervals) at various locations within the Bellows Falls Hydroelectric Project Impoundment and Tailrace, and Connecticut River downstream of the Bellows Falls Dam	Addressed in Study Plan No. 6
7	Vernon	Continuous water temperature monitoring (25 minute intervals) at various locations within the Vernon Hydroelectric Project Impoundment and Tailrace, and Connecticut River downstream of the Vernon Dam	Addressed in Study Plan No. 6
8	Wilder	Water quality monitoring within the project impoundment and tailrace, Wilder Hydroelectric Project	Addressed in Study Plan No. 6
9	Bellows Falls	Water quality monitoring within the project impoundment and tailrace, Bellows Falls Hydroelectric Project	Addressed in Study Plan No. 6
10	Vernon	Water quality monitoring within the project impoundment and tailrace, Vernon Hydroelectric Project	Addressed in Study Plan No. 6
11	Wilder, Bellows Falls, Vernon	Model River Flows and Water Levels Upstream and Downstream from the Wilder, Bellows Falls, and Vernon Stations and Integration of Project Modeling with Downstream Project Operations	Addressed in Study Plan Nos. 4 and 5

Study Request No.	Project	CRWC Study Request	Response
12	Bellows Falls	Bellows Falls Bypass Flow (aquatic resources)	Addressed in Study Plan No. 9
13	Wilder, Bellows Falls, Vernon	Channel Morphology and Benthic Habitat Impacts at the Vernon, Bellows Falls and Wilder Projects	Addressed in Study Plan No. 8
14	Wilder, Bellows Falls, Vernon	In-stream Flow Habitat Assessment Downstream of Wilder, Bellows Falls, and Vernon Dams	Addressed in Study Plan No. 9
15	Wilder, Bellows Falls, Vernon	Determine the Fish Assemblage in Vernon, Bellows Falls and Wilder Project-Affected Areas	Addressed in Study Plan No. 10
16	Wilder, Bellows Falls, Vernon	Impacts of Water Level Fluctuations on Aquatic Vegetation, Including Invasive Species, in the Vernon, Bellows Falls and Wilder Project Impoundments and Riverine Reaches	Addressed in Study Plan Nos. 27 and 29
17	Wilder, Bellows Falls, Vernon	Impacts of the Vernon, Bellows Falls and Wilder Project Impoundment Water Fluctuations on Resident Fish Spawning	Addressed in Study Plan No. 14
18	Wilder, Bellows Falls, Vernon	Impacts of Water Fluctuations Downstream of the Vernon, Bellows Falls and Wilder Projects on Resident Fish Spawning	Addressed in Study Plan No. 15
19	Wilder, Bellows Falls, Vernon	Impacts of the Vernon, Bellows Falls and Wilder Project Operations on Tributary and Backwater Area Access and Habitats	Addressed in Study Plan No. 13

Study Request No.	Project	CRWC Study Request	Response
20	Wilder, Bellows Falls, Vernon	Determine Upstream Passage Needs for Riverine Fish Species in the Bellows Falls, Wilder and Vernon Fishways	Addressed in Study Plan No. 17
21	Wilder, Bellows Falls, Vernon	Shad Population Model for the Connecticut River	TransCanada did not develop a study plan for this request. For a number of reasons, TransCanada does not believe this is a reasonable request. The effects of the Vernon and Bellows Falls projects on the whole of the population of American shad in the Connecticut River is proportionally small given the other impacts shad experience in the river (e.g., entrainment at Mt. Tom and Vermont Yankee, and three dams below Vernon). The numerous American shad studies TransCanada is proposing will identify project-specific effects on American shad. The cost to create a shad population model for the Connecticut River compared to the effects of the projects on the resource is excessive (FERC study criteria 7).
22	Vernon	Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival	Addressed in Study Plan No. 21

Study Request No.	Project	CRWC Study Request	Response
23	Bellows Falls, Vernon	Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Areas of the Turners Falls, Northfield Mountain Pumped Storage and Vernon Project Areas and downstream from Bellows Falls Dam	Addressed in Study Plan No. 21
24	Vernon	Impact of Vernon Project Operations on Downstream Migration of Juvenile American Shad	Addressed in Study Plan No. 22
25	Wilder, Bellows Falls, Vernon	American Eel Survey Upstream of the Vernon, Bellows Falls, and Wilder dams	Addressed in Study Plan No. 11
26	Wilder, Bellows Falls, Vernon	Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River	Addressed in Study Plan No. 20
27	Wilder, Bellows Falls, Vernon	Upstream American Eel Passage Assessment at Vernon, Bellows Falls and Wilder Projects	Addressed in Study Plan No. 18
28	Wilder, Bellows Falls, Vernon	Downstream American Eel Passage Assessment at Vernon, Bellows Falls, and Wilder	Addressed in Study Plan No. 19
29	Wilder, Bellows Falls, Vernon	Assessment of Adult Sea Lamprey (*Petromyzon marinus*) Spawning within the Wilder, Bellows Falls, and Vernon Project Areas	Addressed in Study Plan No. 16
30	Wilder, Bellows Falls	Effects of the Wilder and Bellows Falls Projects on the Dwarf Wedgemussel (*Alasmidonta heterodon*)	Addressed in Study Plan No. 24

Study Request No.	Project	CRWC Study Request	Response
31	Wilder, Bellows Falls, Vernon	Project Effects on Populations of Tessellated Darter, *Etheostoma olmstedi*	Addressed in Study Plan No. 12

Federal Energy Regulatory Commission

Date of Letter: 3/1/2013

Study Request No.	Project	FERC Study Request	Response
1	Wilder, Bellows Falls, Vernon	Water Level Fluctuation Study	Addressed in Study Plan Nos. 4 and 5
2	Wilder, Bellows Falls, Vernon	River Bank Transect Study	Addressed in Study Plan No. 2
3	Wilder, Bellows Falls, Vernon	Historical River Bank Position and Erosion	Addressed in Study Plan No. 1
4	Wilder, Bellows Falls, Vernon	Riverbank Erosion Study	Addressed in Study Plan Nos. 2 and 3
5	Wilder, Bellows Falls, Vernon	Aquatic Habitat Mapping	Addressed in Study Plan No. 7
6	Wilder, Bellows Falls, Vernon	Aquatic Habitat Instream Flow Study	Addressed in Study Plan No. 9
7	Wilder, Bellows Falls, Vernon	Baseline Fisheries Population Study	Addressed in Study Plan No. 10
8	Wilder, Bellows Falls, Vernon	Assessment of Fish Impingement, Entrainment, and Survival Study	Addressed in Study Plan No. 23

Study Request No.	Project	FERC Study Request	Response
9	Bellows Falls, Vernon	American Shad Upstream Migration and Behavioral Study	Addressed in Study Plan No. 21
10	Wilder, Bellows Falls, Vernon	Recreation Facility Inventory and Use & Needs Assessment	Addressed in Study Plan No. 30
11	Bellows Falls	Whitewater Boating Flow Assessment	Addressed in Study Plan No. 31
12	Vernon	Vernon Project Cultural Resources Study	Addressed in Study Plan No. 33

Lipfert, F. William, Jr., and Jennifer Lipfert

Date of Letter: 3/1/2013

Study Request No.	Project	Lipfert Study Request	Response
1	Wilder	Evaluate the benefits of imposing a rate of change limitation in flow of 5,000 cfs per hour (or similar value) at Wilder.	This request does not meet the criteria for a study request under §5.9(b) in that it lacks sufficient detail to define how the study would be conducted or what data would be used (FERC study criterion 5 and 6). However, TransCanada will be performing several erosion studies and using hydraulic and operations models to assess project impacts including all contributing factors and assessment of potential mitigative factors as requested in this study request. See Study Plan Nos. 1 through 5

Mudge, John T. B.

Date of Letter: 2/27/2013

Study Request No.	Project	Mudge Study Request	Response
1	Wilder	Evaluate the effects of the operation of the Wilder Dam on the erosion of farmland along the Connecticut River	Addressed in Study Plan Nos. 2 and 3

National Park Service

Date of Letter: 2/28/2013

Study Request No.	Project	NPS Study Request	Response
1	Wilder, Bellows Falls, Vernon	Study of Project Facilities to Support Multiple-day Self-Powered Boating Trips on the Connecticut River	Addressed in Study Plan No. 30
2a	Bellows Falls	Controlled Whitewater Flow Study in the Bypass Reach Below the Bellows Falls Dam With Potential for Development of a Whitewater Park	Addressed in Study Plan No. 31
2b	Wilder	Controlled Whitewater Flow Study at Sumner Falls	Addressed in Study Plan No. 31

Study Request No.	Project	NPS Study Request	Response
3	Wilder, Bellows Falls, Vernon	Preservation of Cultural, Historical, and Educational Resources	TransCanada has not developed a study plan for this request. This is a mitigation request for an educational program (materials, kiosk, etc.) at the site, and preservation of historical records of the site that TransCanada might have. TransCanada considers this to be a request for a specific mitigation measure associated with historic resources more typical of what would be found in a Programmatic Agreement or Management Plan for Historic Resources, rather than a study request. Since this study request would not inform measures that could be considered for a new license it does not meet FERC study criteria 6.
4	Wilder, Bellows Falls, Vernon	Creation of a Decommissioning Fund	TransCanada has not developed a study plan for this request. This issue will be addressed in the economic analysis and amortization requirement in each Project License. Existing information available to FERC is sufficient to address this issue. Consequently this request does not meet FERC study criteria 4.

New England Flow and American Whitewater

Date of Letter: 3/1/2013 (two letters, one each for Wilder and Bellows Falls)

Study Request No.	Project	NEF-AW Study Request	Response
1	Wilder	We request a "Controlled Whitewater Flow Study" for the Sumner Falls Reach.	This request does not meet the criteria for a study request under §5.9(b). It lacks study methodology, level of effort and cost, and the nexus appears to be based on pre-Project conditions rather than the existing project. However, this study was requested by others following the study criteria and the concept will be addressed by Study Plan No. 31
2 3	Wilder Bellows Falls	We request a study of the adequacy of camping, sanitary and other facilities such as portages available for multiple-day kayaking or canoe trips.	This request does not meet the criteria for a study request under §5.9(b). It lacks study methodology, level of effort and cost, and the nexus appears to be based on pre-Project conditions rather than existing. However, this study was requested by others following the study criteria and the concept will be addressed by Study Plan No. 30
3 4	Wilder Bellows Falls	We request an economic analysis for the site recreation potential.	This request does not meet the criteria for a study request under §5.9(b). It lacks a level of effort and cost (FERC study criteria 7), and the nexus appears to be based on pre-Project conditions rather than existing Project operations (FERC study criteria 7).

Study Request No.	Project	NEF-AW Study Request	Response
4 5	Wilder Bellows Falls	Compensation for Impacts of Lost Whitewater Recreation.	This request does not meet the criteria for a study request under §5.9(b). It lacks study methodology (FERC study criteria 6), level of effort and cost (FERC study criteria 7), and the nexus appears to be based on pre-Project conditions rather than existing Project operations (FERC study criteria 5). Additionally, it is a request for mitigation.
1	Bellows Falls	We Request a Controlled Whitewater Flow Study in the bypass reach below the Bellows Falls Dam.	This request does not meet the criteria for a study request under §5.9(b). It lacks study methodology (FERC study criteria 6), level of effort and cost (FERC study criteria 7), and the nexus appears to be based on pre-Project conditions rather than existing Project operations (FERC study criteria 5). However, this study was requested by others following the study criteria and the concept will be addressed by Study Plan No. 31

Study Request No.	Project	NEF-AW Study Request	Response
2	Bellows Falls	We request a study to provide public Access for whitewater boating, rafting, and canoeing.	This request does not meet the criteria for a study request under §5.9(b). It lacks study methodology (FERC study criteria 6), level of effort and cost (FERC study criteria 7), and the nexus appears to be based on pre-Project conditions rather than existing Project operations (FERC study criteria 5). However, elements of this study were requested by others following the study criteria and the concept will be addressed by Study Plans No. 30 and 31.

New England Flow, American Whitewater, and Appalachian Mountain Club

Date of Letter: 2/28/2013 (three letters filed under one cover letter)

Study Request No.	Project	NEF-AW-AMC Study Request	Response
1	Wilder	Controlled Whitewater Flow Study for the Sumner Falls Reach	Addressed in Study Plan No. 31

Study Request No.	Project	NEF-AW-AMC Study Request	Response
1	Bellows Falls	Whitewater Park Feasibility Study	TransCanada has not developed a study plan for this request. This is a mitigation request for a specific recreational enhancement - a white water park. A suitability analysis must be completed to determine the suitability and capability for white water recreation in the Bellows Falls bypass. Boating fatalities have occurred in the past in this reach and therefore a thorough analysis must be undertaken prior to any recommended mitigation or proposal. However, preliminary analysis is included in Study Plan 31. In addition, multiple agencies have requested aquatic habitat assessments and fish passage studies that also encompass this reach. All of which requires a thorough analysis of all resources affected and suitability prior to considering this as a reasonable component in an overall project mitigation strategy.
1	Vernon	Mitigation for Impacts on the Connecticut River and Loss of Whitewater Recreation below each dam	TransCanada did not develop a study plan for this request. This is a request for mitigation based on pre-project conditions. The baseline for project impact analysis is the current projects and operations. Therefore, there is no nexus to the projects as licensed, FERC study criteria 5.
4	Wilder		
5	Bellows Falls		
2	Wilder	Camping, Sanitary and Other Facilities Such as Portages Available for Multiple-day	Addressed in Study Plan No. 30

Study Request No.	Project	NEF-AW-AMC Study Request	Response
2	Vernon	Kayaking or Canoe Trips	
3	Bellows Falls		
2	Bellows Falls	Public Access Study	Addressed in Study Plan No. 30
3	Wilder	Economic Impacts Assessment	TransCanada considers it premature to conduct a contingent valuation study pertaining to whitewater boating opportunities at Sumner Falls and the Bellows Falls bypassed reach until the potential whitewater boating opportunities are defined. TransCanada plans to do this by implementing Study Plan 31. The request for a contingent valuation study at Vernon is based on pre-project conditions. The baseline for project impact analysis is the current projects and operations. Therefore, there is no nexus to the projects as licensed, FERC study criteria 5.
3	Vernon		
4	Bellows Falls		

New Hampshire Department of Environmental Services

Date of Letter: 3/1/2013

Study Request No.	Project	NHDES Study Request	Response
1a	Wilder	Recreational Survey and Enhancement Study at Wilder Hydroelectric Project	Addressed in Study Plan No. 30

Study Request No.	Project	NHDES Study Request	Response
1b	Bellows Falls	Recreational Survey and Enhancement Study at Bellows Falls Hydroelectric Project	Addressed in Study Plan No. 30
1c	Vernon	Recreational Survey and Enhancement Study at Vernon Hydroelectric Project	Addressed in Study Plan No. 30
2	Wilder, Bellows Falls, Vernon	Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival	Addressed in Study Plan No. 21
3	Wilder, Bellows Falls, Vernon	Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River	Addressed in Study Plan No. 20
4	Bellows Falls, Vernon	Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Areas of the Turners Falls, Northfield Mountain Pumped Storage and Vernon Project Areas and downstream from Bellow Falls Dam	Addressed in Study Plan No. 21
5	Bellows Falls	Bellows Falls Bypass Flow (aquatic resources)	Addressed in Study Plan No. 9

Study Request No.	Project	NHDES Study Request	Response
6	Wilder, Bellows Falls, Vernon	Shad Population Model for the Connecticut River	TransCanada did not develop a study plan for this request. For a number of reasons, TransCanada does not believe this is a reasonable request. The effects of the Vernon and Bellows Falls projects on the whole of the population of American shad in the Connecticut River is proportionally small given the other impacts shad experience in the river (e.g., entrainment at Mt. Tom and Vermont Yankee, and three dams below Vernon). The numerous American shad studies TransCanada is proposing will identify project-specific effects on American shad. The cost to create a shad population model for the Connecticut River compared to the effects of the projects on the resource is excessive (FERC study criteria 7).
7	Wilder, Bellows Falls, Vernon	American Eel Survey Upstream of the Vernon, Bellows Falls, and Wilder Dams	Addressed in Study Plan No. 11
8	Wilder, Bellows Falls, Vernon	Channel Morphology and Benthic Habitat Impacts at the Vernon, Bellows Falls and Wilder Projects	Addressed in Study Plan No. 8
9	Wilder, Bellows Falls, Vernon	Downstream American Eel Passage Assessment at Vernon, Bellows Falls, and Wilder	Addressed in Study Plan No. 19

Study Request No.	Project	NHDES Study Request	Response
10	Wilder, Bellows Falls, Vernon	In-stream Flow Habitat Assessment Downstream of Wilder, Bellows Falls, and Vernon Dams	Addressed in Study Plan No. 9
12	Wilder, Bellows Falls, Vernon	Impacts of Water Fluctuations Downstream of the Vernon, Bellows Falls and Wilder Projects on Resident Fish Spawning	Addressed in Study Plan No. 15
12	Wilder, Bellows Falls	Effects of the Wilder and Bellows Falls Projects on the Dwarf Wedgemussel (*Alasmidonta heterodon*)	Addressed in Study Plan No. 24
13	Wilder, Bellows Falls, Vernon	Determine the Fish Assemblage in Vernon, Bellows Falls and Wilder Project-Affected Areas	Addressed in Study Plan No. 10
14a	Wilder, Bellows Falls, Vernon	Model River Flows and Water Levels Upstream and Downstream from the Wilder, Bellows Falls, Vernon, Turners Falls and Northfield Mountain Pump Storage Stations and Integration of Project Modeling with Downstream Project Operations	Addressed in Study Plan Nos. 4 and 5
15a	Wilder, Bellows Falls, Vernon	Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation, Including Invasive Species, in the Vernon, Bellows Falls and Wilder Project Impoundments and Riverine Reaches	Addressed in Study Plan Nos. 27 and 29
16	Wilder, Bellows Falls, Vernon	Impacts of the Vernon, Bellows Falls and Wilder Project Impoundment Water Fluctuations on Resident Fish Spawning	Addressed in Study Plan No. 14
17	Wilder, Bellows Falls, Vernon	Impacts of the Vernon, Bellows Falls and Wilder Project Operations on Tributary and Backwater Area Access and Habitats	Addressed in Study Plan No. 13

Study Request No.	Project	NHDES Study Request	Response
18	Wilder, Bellows Falls, Vernon	Impingement and Entrainment of Resident Fish Species at the Wilder, Bellows Falls and Vernon Intakes	Addressed in Study Plan No. 23
19	Wilder, Bellows Falls, Vernon	Assessment of Adult Sea Lamprey (*Petromyzon marinus*) Spawning within the Wilder, Bellows Falls, and Vernon Project Areas	Addressed in Study Plan No. 16
20	Wilder, Bellows Falls, Vernon	Determine Upstream Passage Needs for Riverine Fish Species in the Bellows Falls, Wilder and Vernon Fishways	Addressed in Study Plan No. 17
21a	Wilder	Wilder Hydroelectric Project: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations	Addressed in Study Plan Nos. 2 and 3
21b	Bellows Falls	Bellows Falls Hydroelectric Project: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations	Addressed in Study Plan Nos. 2 and 3
21c	Vernon	Vernon and Turners Falls Hydroelectric Projects: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations in New Hampshire	Addressed in Study Plan Nos. 2 and 3
22a	Wilder	Continuous water temperature monitoring (25 minute intervals) at various locations within the Wilder Hydroelectric Project Impoundment and Tailrace, and Connecticut River downstream of the Wilder Dam	Addressed in Study Plan No. 6

Study Request No.	Project	NHDES Study Request	Response
22b	Bellows Falls	Continuous water temperature monitoring (25 minute intervals) at various locations within the Bellows Falls Hydroelectric Project Impoundment and Tailrace, and Connecticut River downstream of the Bellows Falls Dam	Addressed in Study Plan No. 6
22c	Vernon	Continuous water temperature monitoring (25 minute intervals) at various locations within the Vernon Hydroelectric Project Impoundment and Tailrace, and Connecticut River downstream of the Vernon Dam	Addressed in Study Plan No. 6
23	Wilder, Bellows Falls, Vernon	Project Effects on Populations of Tessellated Darter, *Etheostoma olmstedi*	Addressed in Study Plan No. 12
24	Wilder, Bellows Falls, Vernon	Upstream American Eel Passage Assessment at Vernon, Bellows Falls and Wilder Projects	Addressed in Study Plan No. 18
25a	Wilder	Wilder Hydroelectric Project: Water quality monitoring within the project impoundment and tailrace	Addressed in Study Plan No. 6
25b	Bellows Falls	Bellow Falls Hydroelectric Project: Water quality monitoring within the project impoundment, bypass, and tailrace	Addressed in Study Plan No. 6
25c	Vernon	Vernon Hydroelectric Project: Water quality monitoring within the Vernon project impoundment and tailrace and in the Turner Falls Impoundment in New Hampshire	Addressed in Study Plan No. 6
26	Vernon	Impact of Vernon Project Operations on Downstream Migration of Juvenile American Shad	Addressed in Study Plan No. 22

Study Request No.	Project	NHDES Study Request	Response
27	Wilder, Bellows Falls, Wilder	Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects	TransCanada does not propose to develop a specific study plan that addresses climate change as it relates to project operations. Such a study would not necessarily inform potential mitigation measures (FERC study criteria 4) and would be cost prohibitive (FERC study criteria 7). Potential operational measures that could be considered will be informed by the water level and project operations modeling (Study Plan 4 and 5, and water quality monitoring (Study plan 6).

New Hampshire Fish and Game Department

Date of Letter: 2/27/2013

Study Request No.	Project	NHFG Study Request	Response
1a	Wilder	Recreational Survey and Enhancement Study at Wilder Hydroelectric Project	Addressed in Study Plan No. 30
1b	Bellows Falls	Recreational Survey and Enhancement Study at Bellows Falls Hydroelectric Project	Addressed in Study Plan No. 30
1c	Vernon	Recreational Survey and Enhancement Study at Vernon Hydroelectric Project	Addressed in Study Plan No. 30

Study Request No.	Project	NHFG Study Request	Response
2	Vernon	Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival	Addressed in Study Plan No. 21
3	Wilder, Bellows Falls, Vernon	Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River	Addressed in Study Plan No. 20
4	Vernon	Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Areas of the Turners Falls, Northfield Mountain Pumped Storage and Vernon Project Areas and downstream from Bellow Falls Dam	Addressed in Study Plan No. 21
5	Bellows Falls	Bellows Falls Bypass Flow (aquatic resources)	Addressed in Study Plan No. 9

Study Request No.	Project	NHFG Study Request	Response
6	Wilder, Bellows Falls, Vernon	Shad Population Model for the Connecticut River	TransCanada did not develop a study plan for this request. For a number of reasons, TransCanada does not believe this is a reasonable request. The effects of the Vernon and Bellows Falls projects on the whole of the population of American shad in the Connecticut River is proportionally small given the other impacts shad experience in the river (e.g., entrainment at Mt. Tom and Vermont Yankee, and three dams below Vernon). The numerous American shad studies TransCanada is proposing will identify project-specific effects on American shad. The cost to create a shad population model for the Connecticut River compared to the effects of the projects on the resource is excessive (FERC study criteria 7).
7	Wilder, Bellows Falls, Vernon	American Eel Survey Upstream of the Vernon, Bellows Falls, and Wilder Dams	Addressed in Study Plan No. 11
8	Wilder, Bellows Falls, Vernon	Channel Morphology and Benthic Habitat Impacts at the Vernon, Bellows Falls and Wilder Projects	Addressed in Study Plan No. 8
9	Wilder, Bellows Falls, Vernon	Downstream American Eel Passage Assessment at Vernon, Bellows Falls, and Wilder	Addressed in Study Plan No. 19

Study Request No.	Project	NHFG Study Request	Response
10	Wilder, Bellows Falls, Vernon	In-stream Flow Habitat Assessment Downstream of Wilder, Bellows Falls, and Vernon Dams	Addressed in Study Plan No. 9
11	Wilder, Bellows Falls, Vernon	Impacts of Water Fluctuations Downstream of the Vernon, Bellows Falls and Wilder Projects on Resident Fish Spawning	Addressed in Study Plan No. 15
12	Wilder, Bellows Falls	Effects of the Wilder and Bellows Falls Projects on the Dwarf Wedgemussel (*Alasmidonta heterodon*)	Addressed in Study Plan No. 24
13	Wilder, Bellows Falls, Vernon	Determine the Fish Assemblage in Vernon, Bellows Falls and Wilder Project-Affected Areas	Addressed in Study Plan No. 10
14	Wilder, Bellows Falls, Vernon	Model River Flows and Water Levels Upstream and Downstream from the Wilder, Bellows Falls, and Vernon Stations and Integration of Project Modeling with Downstream Project Operations	Addressed in Study Plan Nos. 4 and 5
15	Wilder, Bellows Falls, Vernon	Impacts of Water Level Fluctuations on Aquatic Vegetation, Including Invasive Species, in the Vernon, Bellows Falls and Wilder Project Impoundments and Riverine Reaches	Addressed in Study Plan Nos. 27 and 29
16	Wilder, Bellows Falls, Vernon	Impacts of the Vernon, Bellows Falls and Wilder Project Impoundment Water Fluctuations on Resident Fish Spawning	Addressed in Study Plan No. 14
17	Wilder, Bellows Falls, Vernon	Impacts of the Vernon, Bellows Falls and Wilder Project Operations on Tributary and Backwater Area Access and Habitats	Addressed in Study Plan No. 13

Study Request No.	Project	NHFG Study Request	Response
18	Wilder, Bellows Falls, Vernon	Impingement and Entrainment of Resident Fish Species at the Wilder, Bellows Falls and Vernon Intakes	Addressed in Study Plan No. 23
19	Wilder, Bellows Falls, Vernon	Assessment of Adult Sea Lamprey (*Petromyzon marinus*) Spawning within the Wilder, Bellows Falls, and Vernon Project Areas	Addressed in Study Plan No. 16
20	Wilder, Bellows Falls, Vernon	Determine Upstream Passage Needs for Riverine Fish Species in the Bellows Falls, Wilder and Vernon Fishways	Addressed in Study Plan No. 17
21a	Wilder	Wilder Hydroelectric Project: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations	Addressed in Study Plan Nos. 2 and 3
21b	Bellows Falls	Bellows Falls Hydroelectric Project: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations	Addressed in Study Plan Nos. 2 and 3
21c	Vernon	Vernon Hydroelectric Project: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations	Addressed in Study Plan Nos. 2 and 3
22a	Wilder	Continuous water temperature monitoring (25 minute intervals) at various locations within the Wilder Hydroelectric Project Impoundment and Tailrace, and Connecticut River downstream of the Wilder Dam	Addressed in Study Plan No. 6

Study Request No.	Project	NHFG Study Request	Response
22b	Bellows Falls	Continuous water temperature monitoring (25 minute intervals) at various locations within the Bellows Falls Hydroelectric Project Impoundment and Tailrace, and Connecticut River downstream of the Bellows Falls Dam	Addressed in Study Plan No. 6
22c	Vernon	Continuous water temperature monitoring (25 minute intervals) at various locations within the Vernon Hydroelectric Project Impoundment and Tailrace, and Connecticut River downstream of the Vernon Dam	Addressed in Study Plan No. 6
23	Wilder, Bellows Falls, Vernon	Project Effects on Populations of Tessellated Darter, *Etheostoma olmstedi*	Addressed in Study Plan No. 12
24	Wilder, Bellows Falls, Vernon	Upstream American Eel Passage Assessment at Vernon, Bellows Falls and Wilder Projects	Addressed in Study Plan No. 18
25a	Wilder	Wilder Hydroelectric Project: Water quality monitoring within the project impoundment and tailrace	Addressed in Study Plan No. 6
25b	Bellows Falls	Bellow Falls Hydroelectric Project: Water quality monitoring within the project impoundment, bypass, and tailrace	Addressed in Study Plan No. 6
25c	Vernon	Vernon Hydroelectric Project: Water quality monitoring within the project impoundment and tailrace	Addressed in Study Plan No. 6
26	Vernon	Impact of Vernon Project Operations on Downstream Migration of Juvenile American Shad	Addressed in Study Plan No. 22

New Hampshire Natural Heritage Bureau

Date of Letter: 2/27/2013

Study Request No.	Project	NHNHB Study Request	Response
Appendix A	Wilder, Bellows Falls, Vernon	Impacts of Water Level Fluctuation in Project Impoundments on Wetlands	Addressed in Study Plan Nos. 27 and 29
Appendix B	Wilder, Bellows Falls, Vernon	Establishment of Permanent Plots to Assess the Impacts of Ongoing Operations on Floodplain Forest Communities	TransCanada has not developed a study plan for this request. The purpose of this request is to identify long term trends in changes to floodplain forests. Therefore, this is a mitigation request and hence there is no nexus to the projects as licensed, and the request does not meet FERC study criteria 5. Further, since this study request would not inform measures that could be considered for a new license it does not meet FERC study criteria 6. However, an assessment of current project effects on floodplain forests is included in Study Plan No. 27.
Appendix C	Wilder	River Levels Relative to Jesup's Milk-Vetch Populations	Based on comments from the New Hampshire Natural Heritage Bureau (NHNHB), the Jesup's milk vetch study conducted in 2012 and provided to NHNHB for review addresses the concerns of this study request. That report will be filed with FERC by April 30, 2013.

Study Request No.	Project	NHNHB Study Request	Response
Appendix D	Wilder, Bellows Falls, Vernon	River Levels Relative to RTE Plant Species and Exemplary Natural Communities	TransCanada has not developed a study plan for this request as we believe we have completed a study that addresses this request. In its PAD comments, NHNHB noted that from Section 3.9.1: "The RTE project area does not include areas affected by dam releases form Wilder…" and NHNHB requests that the RTE project area be extended downstream to the next Impoundment area. Page 3-1 of the Wilder PAD (and the Bellows Falls and Vernon PADs) defines the RTE project area incorrectly. The correct definition should read "within a 1,000-foot buffer to the project affected area" which includes the riverine reaches. Section 3.1 of the 2012 RTE study report correctly states (and Figure 3.1-1 illustrates): "The study area (Figure 3.1.-1) includes the riverine environment within and immediately adjacent to the range of normal operational flows and impoundment elevations of the Projects. This area extends from the upper limits of the Wilder impoundment in Newbury, Vermont and Haverhill, New Hampshire to Vernon dam at Vernon, Vermont and Hinsdale, New Hampshire. Therefore, based on comments from NHNHB, the Rare, Threatened and Endangered Plant Species study conducted in 2012 and provided to NHNHB for review addresses the concerns of this study request. That report will be filed with FERC by April 30, 2013.

The Nature Conservancy

Date of Letter: 3/1/2013

Study Request No.	Project	TNC Study Request	Response
1	Wilder, Bellows Falls, Vernon	Evaluation of Project Effects on Impoundment Water Surface Elevations and River Flow Regime	Addressed in Study Plan Nos. 4 and 5
2	Wilder, Bellows Falls, Vernon	Instream Flow Habitat Assessment	Addressed in Study Plan No. 9
3	Wilder, Bellows Falls, Vernon	Impacts of Water Level Fluctuations on Floodplain, Wetland, Riparian, and Littoral Vegetation Communities and Habitats	Addressed in Study Plan No. 27
4	Wilder, Bellows Falls, Vernon	Determine fish assemblage structure in project-affected areas	Addressed in Study Plan No. 10
5	Wilder, Bellows Falls	Effects of the Wilder and Bellows Falls Projects on the Dwarf Wedgemussel (*Alasmidonta heterodon*)	Addressed in Study Plan No. 24
6	Wilder, Bellows Falls, Vernon	Project Effects on Populations of Tessellated Darter, *Etheostoma olmstedi*	Addressed in Study Plan No. 12

The Nolumbeka Project, Inc.

Date of Letter: 2/28/2013

Study Request No.	Project	Nolumb Study Request	Response
1	Wilder, Bellows Falls, Vernon	Comprehensive investigation and mapping of ancient traversing trail systems and fishing stations, etc.	The area to be studied by this request is not clearly defined (FERC study criteria 6), but appears to identify areas outside of TransCanada's three projects. Also, no nexus to the projects is provided (FERC study criteria 5). However, surveys requested by others at all three projects should address the requesters concern for conducting field studies within each project's APE. Reports containing confidential site information will have a limited distribution that will be determined by state agencies. See Study Plan No. 33
2	Wilder, Bellows Falls, Vernon	Comprehensive field survey of wildlife and botanical species/habitat	This request does not meet the criteria for a study request under §5.9(b). The requester does not define a geographic range or study methodology (FERC study criteria 6), and no nexus between project operations and effects on the requested study resource is identified (FERC study criteria 5). However, some aspects of this request are similar to valid study requests by others. See Study Plan Nos. 26, 27, 28, 29
3	N/A	Stabilization of the Wissatinneway property	This site is not in the area of the TransCanada Projects. Therefore it has no nexus to the project (FERC study criteria 5).

Study Request No.	Project	Nolumb Study Request	Response
4	N/A	Creation of a National Historical Park around the Great Falls fight site	This site is not in the area of the TransCanada Projects. Therefore it has no nexus to the project (FERC study criteria 5).
5	N/A	Falls Brook cleanup	This site is not in the area of the TransCanada Projects. Therefore it has no nexus to the project (FERC study criteria 5).

Town of Lyme, New Hampshire Office of the Selectboard, City of Lebanon, New Hampshire City Manager, and O. Ross McIntyre

Date of Letter: 2/26/2013

Study Request No.	Project	Lyme-Leb-McInt Study Request	Response
1	Wilder	Obtain data concerning piping erosion at the shoreline of the Wilder Dam impoundment and ascertain whether erosion may be reduced by changes in water level management practices	Addressed in Study Plan Nos. 2 and 3

Town of Rockingham, Vermont Conservation Commission

Date of Letters: 3/1/2013 (five submittals)

Study Request No.	Project	Rock Study Request	Response
4.2.1	Bellows Falls	Evaluate the projects operation and maintenance on Riverbank erosion (including the potential effects on protected species, cultural resources and structural integrity) of the Saxtons River Commissary Brook Estuary, Herrick's Cove and Upper Meadows areas	Addressed in Study Plan No. 3
4.2.2	Bellows Falls	Evaluate the Water Quantity and Quality of water entering the project area reservoir and impoundment area especially the Saxtons River, Commissary Brook Estuary and Williams River Estuary, Upper Meadows, Herricks Cove and CT River Reach around the BF Island formed by the canal.	Addressed in Study Plan No. 27, also see Study Plan No. 6
4.2.4	Bellows Falls	Terrestrial Resources: Williams River Estuary and Commissary Brook Estuary, Upper Meadows; – surveying TransCanada properties to document and locate where there are no buffers – (Upper Meadows) – federally endangered species – protection of the Northeastern Bulrush	Addressed in Study Plan Nos. 27 and 29

Study Request No.	Project	Rock Study Request	Response
4.2.6	Bellows Falls	Evaluate the adequacy of existing recreation and public use facilities in meeting existing and future regional public use and river access needs, the effect of project operations on quality and availability of flow-dependent and water level-dependent recreation opportunities	Addressed in Study Plan No. 30
4.2.8	Bellows Falls	Evaluate the adequacy of the aesthetics between the dam and the Hydro Power Plant area Canal	Addressed in Study Plan No. 32

Trout Unlimited, Deerfield River Chapter

Date of Letter: 3/1/2013

Study Request No.	Project	TU Study Request	Response
1	Bellows Falls, Vernon	Shad Population Model for the Connecticut River	TransCanada did not develop a study plan for this request. For a number of reasons, TransCanada does not believe this is a reasonable request. The effects of the Vernon and Bellows Falls projects on the whole of the population of American shad in the Connecticut River is proportionally small given the other impacts shad experience in the river (e.g., entrainment at Mt. Tom and Vermont Yankee, and three dams below Vernon). The numerous American shad studies TransCanada is proposing will identify project-specific effects on American shad. The cost to create a shad population model for the Connecticut River compared to the effects of the projects on the resource is excessive (FERC study criteria 7).
2	Bellows Falls, Vernon	Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival	Addressed in Study Plan No. 21

Study Request No.	Project	TU Study Request	Response
3	Bellows Falls, Vernon	Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Areas of the Turners Falls, Northfield Mountain Pumped Storage and Vernon Project Areas and downstream from Bellow Falls Dam	Addressed in Study Plan No. 21
4	Bellows Falls, Vernon	Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River	Addressed in Study Plan No. 20
5	Bellows Falls, Vernon, Wilder	American Eel Survey Upstream of the Vernon and Bellows Falls dams	Addressed in Study Plan No. 11
6	Wilder, Bellows Falls, Vernon	Downstream American Eel Passage Assessment at Vernon and Bellows Falls	Addressed in Study Plan No. 19
7	Wilder, Bellows Falls, Vernon	Model River Flows and Water Levels Upstream and Downstream from the Wilder, Bellows Falls, and Vernon Stations and Integration of Project Modeling with Downstream Project Operations	Addressed in Study Plan Nos. 4 and 5
8	Wilder, Bellows Falls, Vernon	Upstream American Eel Passage Assessment at Vernon and Bellows Falls Projects	Addressed in Study Plan No. 18
9	Vernon	Impact of Vernon Project Operations on Downstream Migration of Juvenile American Shad	Addressed in Study Plan No. 22

Trustees of Pine Park Association, Hanover New Hampshire

Date of Letter: 2/27/2013

Study Request No.	Project	HAN Study Request	Response
1	Wilder	Obtain data concerning piping erosion at the shoreline of the Wilder Dam impoundment and ascertain whether erosion may be reduced by changes in water level management practices by the dam operator	Addressed in Study Plan Nos. 1, 2, 3, 4, 5

Two Rivers-Ottauquechee Regional Commission

Date of Letter: 3/1/2013

Study Request No.	Project	Two-Riv Study Request	Response
1	Wilder	Comprehensive Recreation and River Access Study	Addressed in Study Plan No. 30
2	Wilder	Study on the Economic Activity Generated by Recreational Activity in the Project Area	TransCanada did not develop a study plan for this request. It was unclear in the request as to how the information obtained would be used in the development of new license conditions (FERC study criterion 5 and 6).
3	Wilder	River Bank Erosion Study	Addressed in Study Plan Nos. 2 and 3

Study Request No.	Project	Two-Riv Study Request	Response
4	Wilder	Comprehensive Decommissioning Study	TransCanada has not developed a study plan for this request. This issue will be addressed in the economic analysis and amortization requirement in each Project License. Existing information available to FERC is sufficient to address this issue. Consequently this request does not meet FERC study criteria 4.

U.S. Fish and Wildlife Service

Date of Letter: 3/1/2013

Study Request No.	Project	FWS Study Request	Response
1	Wilder, Bellows Falls, Vernon	Model River Flows and Water Levels Upstream and Downstream from the Wilder, Bellows Falls, and Vernon Stations and Integrate Project Modeling with downstream Project Operations	Addressed in Study Plan Nos. 4 and 5
2	Wilder, Bellows Falls, Vernon	Instream Flow Habitat Assessment Downstream of Wilder, Bellows Falls, and Vernon Dams	Addressed in Study Plan No. 9
3	Bellows Falls	Bellows Falls Bypass Flow (aquatic resources)	Addressed in Study Plan No. 9

Study Request No.	Project	FWS Study Request	Response
4	Bellows Falls, Vernon	Impacts of the Operations of the Turners Falls, Northfield Mountain Pumped Storage, Vernon and Bellows Falls Projects on Shad Spawning, Spawning Habitat, and Egg Deposition	Addressed in Study Plan No. 21
5	Bellows Falls, Vernon	Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival	Addressed in Study Plan No. 21
6	Vernon	Impact of Vernon Project Operations on Downstream Migration of Juvenile American Shad	Addressed in Study Plan No. 22
7	Bellows Falls, Vernon	Shad Population Model for the Connecticut River	TransCanada did not develop a study plan for this request. For a number of reasons, TransCanada does not believe this is a reasonable request. The effects of the Vernon and Bellows Falls projects on the whole of the population of American shad in the Connecticut River is proportionally small given the other impacts shad experience in the river (e.g., entrainment at Mt. Tom and Vermont Yankee, and three dams below Vernon). The numerous American shad studies TransCanada is proposing will identify project-specific effects on American shad. The cost to create a shad population model for the Connecticut River compared to the effects of the projects on the resource is excessive (FERC study criteria 7).

Study Request No.	Project	FWS Study Request	Response
8	Wilder, Bellows Falls, Vernon	American Eel Survey Upstream of the Vernon, Bellows Falls, and Wilder Dams	Addressed in Study Plan No. 11
9	Wilder, Bellows Falls, Vernon	Upstream American Eel Passage Assessment at Vernon, Bellows Falls, and Wilder Projects	Addressed in Study Plan No. 18
10	Wilder, Bellows Falls, Vernon	Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River	Addressed in Study Plan No. 20
11	Wilder, Bellows Falls, Vernon	Downstream American Eel Passage Assessment at the Vernon, Bellows Falls, and Wilder Project	Addressed in Study Plan No. 19
12	Wilder, Bellows Falls, Vernon	Assessment of Adult Sea Lamprey Spawning within the Wilder, Bellows Falls, and Vernon Project Areas	Addressed in Study Plan No. 16
13	Wilder, Bellows Falls	Effects of the Wilder and Bellows Falls Projects on the Dwarf Wedgemussel	Addressed in Study Plan No. 24
14	Wilder, Bellows Falls, Vernon	Project Effects on Populations of Tessellated Darter	Addressed in Study Plan No. 12
15	Wilder, Bellows Falls, Vernon	Determine the Fish Assemblage in Vernon, Bellows Falls and Wilder Project-Affected Areas	Addressed in Study Plan No. 10
16	Wilder, Bellows Falls, Vernon	Determine Upstream Passage Needs for Riverine Fish Species in the Bellows Falls, Wilder and Vernon Fishways	Addressed in Study Plan No. 17

Study Request No.	Project	FWS Study Request	Response
17	Wilder, Bellows Falls, Vernon	Impacts of the Vernon, Bellows Falls, and Wilder Project Impoundment Level Fluctuations on Resident Fish Spawning	Addressed in Study Plan No. 14
18	Wilder, Bellows Falls, Vernon	Impacts of the Vernon, Bellows Falls and Wilder Project Operations on Tributary and Backwater Area Access and Habitats	Addressed in Study Plan No. 13
19	Wilder, Bellows Falls, Vernon	Impacts of Water Level Fluctuations on Aquatic Vegetation, Including Invasive Species, in the Vernon, Bellows Falls and Wilder Project Impoundments and Riverine Reaches	Addressed in Study Plan Nos. 27 and 29
20	Wilder, Bellows Falls, Vernon	Water Quality Modeling	Addressed in Study Plan No. 6
21	Wilder, Bellows Falls, Vernon	Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects	TransCanada does not propose to develop a specific study plan that addresses climate change as it relates to project operations. Such a study would not necessarily inform potential mitigation measures (FERC study criteria 4) and would be cost prohibitive (FERC study criteria 7). Potential operational measures that could be considered will be informed by the water level and project operations modeling (Study Plan 4 and 5, and water quality monitoring (Study plan 6).

Vermont Agency of Natural Resources

Date of Letter: 3/1/2013

Study Request No.	Project	VANR Study Request	Response
1	Wilder, Bellows Falls, Vernon	Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations (separate requests for each project, each request identified as request 1)	Addressed in Study Plan Nos. 2 and 3
2	Wilder, Bellows Falls, Vernon	Water quality monitoring within the project impoundment and tailrace (separate requests for each project, each request identified as request 2)	Addressed in Study Plan No. 6
3	Wilder, Bellows Falls, Vernon	Continuous water temperature monitoring at various locations within the impoundment and tailrace, and downstream Connecticut River (separate requests for each project, each request identified as request 3)	Addressed in Study Plan No. 6
4	Wilder, Bellows Falls, Vernon	Model river flows and water levels upstream and downstream from the Wilder, Bellows Falls and Vernon stations and integration of project modeling with downstream project operations	Addressed in Study Plan Nos. 4 and 5

Study Request No.	Project	VANR Study Request	Response
5	Wilder, Bellows Falls, Vernon	Climate change as it relates to continued operation of the Vernon, Bellows Falls and Wilder projects	TransCanada does not propose to develop a specific study plan that addresses climate change as it relates to project operations. Such a study would not necessarily inform potential mitigation measures (FERC study criteria 4) and would be cost prohibitive (FERC study criteria 7). Potential operational measures that could be considered will be informed by the water level and project operations modeling (Study Plan 4 and 5, and water quality monitoring (Study plan 6).
6	Bellows Falls	Bypass flow and habitat (aquatic resources)	Addressed in Study Plan No. 9
7	Wilder, Bellows Falls, Vernon	In-stream flow habitat assessment of downstream reaches	Addressed in Study Plan No. 9
8	Wilder, Bellows Falls, Vernon	Project effects on channel morphology and benthic habitat impacts	Addressed in Study Plan No. 8
9	Vernon	Juvenile shad outmigration	Addressed in Study Plan No. 22

Study Request No.	Project	VANR Study Request	Response
10	Vernon	Shad population model for the Connecticut River	TransCanada did not develop a study plan for this request. For a number of reasons, TransCanada does not believe this is a reasonable request. The effects of the Vernon and Bellows Falls projects on the whole of the population of American shad in the Connecticut River is proportionally small given the other impacts shad experience in the river (e.g., entrainment at Mt. Tom and Vermont Yankee, and three dams below Vernon). The numerous American shad studies TransCanada is proposing will identify project-specific effects on American shad. The cost to create a shad population model for the Connecticut River compared to the effects of the projects on the resource is excessive (FERC study criteria 7).
11	Bellows Falls, Vernon	Impact of project operations on shad spawning, spawning habitat and egg deposition	Addressed in Study Plan No. 21
12	Bellows Falls, Vernon	Telemetry study of upstream and downstream migrating adult American shad to assess passage routes, effectiveness, delays, and survival	Addressed in Study Plan No. 21
13	Wilder, Bellows Falls, Vernon	Fish assemblage in project-affected areas	Addressed in Study Plan No. 10

Study Request No.	Project	VANR Study Request	Response
14	Wilder, Bellows Falls, Vernon	Impacts of downstream water fluctuations on resident fish spawning	Addressed in Study Plan No. 15
15	Wilder, Bellows Falls, Vernon	Upstream American eel survey	Addressed in Study Plan No. 11
16	Wilder, Bellows Falls, Vernon	Project effects on populations of tessellated darter, *Etheostoma olmstedi*	Addressed in Study Plan No. 12
17	Wilder, Bellows Falls, Vernon	Assessment of adult sea lamprey (*Petromyzon marinus*) spawning within the project areas	Addressed in Study Plan No. 16
18	Wilder, Bellows Falls, Vernon	Impacts of impoundment water level fluctuations on resident fish spawning	Addressed in Study Plan No. 14
19	Wilder, Bellows Falls, Vernon	Impacts of project operations on tributary and backwater area access and habitats	Addressed in Study Plan No. 13
20	Wilder, Bellows Falls, Vernon	Evaluation of timing of downstream migratory movements of American eels on the mainstem Connecticut River	Addressed in Study Plan No. 20
21	Wilder, Bellows Falls, Vernon	Downstream American eel passage	Addressed in Study Plan No. 19
22	Wilder, Bellows Falls, Vernon	Upstream American eel passage assessment	Addressed in Study Plan No. 18

Study Request No.	Project	VANR Study Request	Response
23	Wilder, Bellows Falls, Vernon	Impingement and entrainment of resident fish species at project intakes	Addressed in Study Plan No. 23
24	Wilder, Bellows Falls, Vernon	Determine upstream passage needs for riverine fish species at project fishways	Addressed in Study Plan No. 17
25	Wilder, Bellows Falls, Vernon	Impact of impoundment water level fluctuations on wetlands (separate requests for each project, each request identified as request 25)	Addressed in Study Plan No. 27
26	Wilder, Bellows Falls, Vernon	Impacts of water level fluctuations on aquatic vegetation, including invasive species, in project impoundments	Addressed in Study Plan Nos. 27 and 29
27	Wilder, Bellows Falls	Project effects on the dwarf wedgemussel (*Alasmidonta heterodon*)	Addressed in Study Plan No. 24

Study Request No.	Project	VANR Study Request	Response
28	Wilder, Bellows Falls, Vernon	Assess the impact of project operations on state-listed rare, threatened and endangered plant species and significant natural communities	TransCanada did not develop a study plan for this request as we believe we have completed a study that addresses this request. Based on comments from the Vermont Agency of Natural Resources (VANR), the Rare, Threatened and Endangered (RTE) Plant Species study conducted in 2012 and provided to VANR for review addresses the concerns of this study request. That report will be filed with FERC by April 30, 2013. The intent of the VANR request for surveying the entire 100-year floodplain was, in our opinion, addressed in the 2012 study in that what species and communities were found were the ones that could be affected by Project operations. Further, in TransCanada's discussions with the resource agencies prior to the 2012 RTE study, the 100-year floodplain never came up in study consultation, and this request is not appropriate now since project affected areas were surveyed in 2012. We also surveyed species unlikely to be affected by project operations (category 2 species in the 2012 RTE study).
29	Wilder, Bellows Falls, Vernon	Survey the number, species and behavior of adult dragonflies and emerging nymphs within the project areas	Addressed in Study Plan No. 25
30	Wilder, Bellows Falls, Vernon	Survey for new and existing populations of adult Cobblestone and Puritan tiger beetle populations within the project areas	Addressed in Study Plan No. 26

Study Request No.	Project	VANR Study Request	Response
31	Wilder, Bellows Falls, Vernon	Survey the distribution, population size and habitat conditions of Fowler's Toad (*Bufo fowleri*) within the project areas	Addressed in Study Plan No. 28
32	Wilder, Bellows Falls, Vernon	Recreational survey and enhancement study	Addressed in Study Plan No. 30
33	Wilder, Bellows Falls, Vernon	Assess the amount of development within the floodplain of the lower Connecticut River	TransCanada did not develop a study plan for this request. The purpose of this request is to determine if river profile operations could be modified in locations to allow over-land flow in floodplains where waters would not cause damage or endanger public safety and community investments. Therefore, this is a mitigation request and there is no nexus to the projects as licensed, and the request does not meet FERC study criteria 5. Further, since this study request would not inform measures that could be considered for a new license it does not meet FERC study criteria 6. However, an assessment of current project effects on floodplain forests is included in Study Plan No. 27.
34	Bellows Falls	Bellows Falls aesthetic flow study	Addressed in Study Plan No. 32

Vermont Division for Historic Preservation, State Historic Preservation Office

Date of Letter: 3/1/2013

Study Request No.	Project	VT SHPO Study Request	Response
1	Wilder, Bellows Falls	Phase IB within archeologically sensitive areas and potential site locations that are actively eroding	Addressed in Study Plan No. 33
2	Wilder, Bellows Falls	Phase II of currently recorded archeological sites in the Project APE	Addressed in Study Plan No. 33
3	Wilder, Bellows Falls	Phase II of any other archeological site identified by Phase IB	Addressed in Study Plan No. 33
4	Wilder	National Register Evaluation Report	Addressed in Study Plan No. 33
5	Vernon	Phase IB within archeologically sensitive areas and potential site locations that are actively eroding based on 2013 Monitoring Report	Addressed in Study Plan No. 33
6	Vernon	Phase II of known archeological sites in the Project APE	Addressed in Study Plan No. 33

UNITED STATES OF AMERICA

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

TRANSCANADA HYDRO NORTHEAST INC.

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

Proposed Study Plan

April 15, 2013

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INTRODUCTION

Pursuant to the regulations of the Federal Energy Regulatory Commission (Commission or FERC), 18 C.F.R. § 5.11, TransCanada Hydro Northeast Inc. (TransCanada) presents this Proposed Study Plan (PSP) for the relicensing of the Wilder Hydroelectric Project (FERC Project No. 1892), Bellows Falls Hydroelectric Project (FERC Project No. 1855), and Vernon Hydroelectric Project (FERC Project No. 1904).

This PSP includes those studies relevant and necessary to analyze the effects of continued operations of the projects. TransCanada is proposing 33 studies and data collection efforts in response to informal comments from stakeholders during scoping meetings in January 2013, as well as to the formal comments and study requests filed with FERC after the scoping meetings.

STUDY REQUESTS

TransCanada received a total of 245 individual study requests from FERC staff, federal and state resource agencies, municipalities, one regional planning commission, non-governmental organizations, and the public (collectively referred to as stakeholders; see table 1). Additional comments without formal study requests were received from 21 commenters representing a state agency, municipalities, non-governmental organizations, a power producer, local conservation commissions, a heritage commission, a university, a farmers union, and residents

Table 1. Stakeholders who filed formal study requests, and acronyms used in this PSP

Request Submittal Authors	Acronym Used in the PSP
Appalachian Mountain Club, Vermont River Conservancy, and Friends of the CT River Paddler's Trail	AMC-VRC-FRs
City of Lebanon, New Hampshire Planning Office	Leb
Connecticut River Joint Commissions, Inc.	CRJC
Connecticut River Watershed Council	CRWC
Federal Energy Regulatory Commission	FERC
Lipfert, F. William Jr. and Jennifer Lipfert	Lipfert
Mudge, John B. T.	Mudge
National Park Service	NPS
New England Flow and American Whitewater	NEF-AW
New England Flow, American Whitewater and Appalachian Mountain Club	NEF-AW-AMC

Request Submittal Authors	Acronym Used in the PSP
New Hampshire Department of Environmental Services	NHDES
New Hampshire Fish and Game Department	NHFG
New Hampshire Natural Heritage Bureau	NHNHB
The Nature Conservancy	TNC
The Nolumbeka Project, Inc.	Nolumb
Town of Lyme, New Hampshire, City of Lebanon, New Hampshire, and O. Ross McIntyre	Lyme-Leb-McInt
Town of Rockingham, Vermont Conservation Commission	Rock
Trout Unlimited, Deerfield River Chapter	TU
Trustees of Pine Park Association, Hanover New Hampshire	Han
Two Rivers-Ottauquechee Regional Commission	TwoRiv
US Fish and Wildlife Service	FWS
Vermont Agency of Natural Resources	VANR
Vermont State Historical Preservation Office	VT SHPO

Some study requests did not meet one or more of the seven ILP study request criteria (18 C.F.R. § 5.9(b)) in substantive ways and either have been excluded from the PSP on that basis; or where reasonable and of nominal additional cost to the study, have been incorporated into study plans developed from other requests that did fulfill the ILP study criteria. Our responses to each of the 245 study requests are provided in the Study Request Responsiveness Summary, which precedes this PSP within this overall filing.

STUDY PLANS

This PSP includes 33 study plans, most of which incorporate multiple requests and encompass all three projects. Study plans that are specific to a project are so noted. The list of study plans, estimated costs, and implementation schedule are included in table 2.

RELATIONSHIP BETWEEN TRANSCANADA PROJECTS AND FIRSTLIGHT PROJECTS

A number of study requests propose study areas for TransCanada studies that are outside the proposed geographic study area. In general, the proposed study plans define the geographic study area as those lands within the project boundaries and the lands and waters affected by project operations in the riverine sections below Wilder and Bellows Falls dams.

The section below Vernon dam has also been identified as a potential instream study reach for some study requests, based upon a post-PAD report released by FirstLight, which contends it is not affected by the operation of the Turners Falls Project (FERC No. 1889). At this time, TransCanada disputes the results of the report, pending review and evaluation of the study.

TransCanada identifies the Vernon instream project extent as the downstream side of Vernon dam because the upstream extent of the Turner Falls impoundment, after construction of the Northfield Pumped Storage Project (FERC No. 2485), reaches and causes backwater effects up to the downstream face of the Vernon dam. Vernon discharges into an impoundment that is largely managed for the operational benefit of both the Turners Falls Project and the Northfield Mountain Pumped Storage Project. Further, in its PAD for the Turners Falls Project, FirstLight denotes the upper boundary of the Turners Falls impoundment as the base of Vernon dam.

Therefore, evaluation of the section below Vernon dam is not proposed for most studies pending a more thorough analysis of the FirstLight study, and if necessary, any follow-up modified study that addresses concerns raised by TransCanada and potentially other stakeholders. While TransCanada acknowledges that discharges from the Vernon Project fluctuate, all observations, monitoring, and measurements suggest there is no effect from Vernon Project discharges into the impounded reach managed for dual purposes by the FirstLight projects.

Table 2. Summary of ILP study plans, costs, and schedule

Study Number	Study Title	Preliminary Estimated Cost ($s)	Preliminary Data Collection Initiatives	Study Year One[a]	**Study Year Two** (including data analysis and reports for Year One studies)
1	Historical Riverbank Position and Erosion Study	55,000		x	x
2	Riverbank Transect Study	245,000	x	x	x
3	Riverbank Erosion Study	460,000		x	x
4	Hydraulic Modeling Study	320,000	x	x	x
5	Operations Modeling Study	143,000	x	x	x
6	Water Quality Study	185,000		x	x
7	Aquatic Habitat Mapping Study	170,000	x	x	
8	Channel Morphology and Benthic Habitat Study	175,000		x	x
9	Instream Flow Study	350,000 – 500,000		x	x
10	Fish Assemblage Study	220,000	x	x	
11	American Eel Survey	85,000		x	x
12	Tessellated Darter Survey	75,000		x	x
13	Tributary and Backwater Fish Access and Habitats Study	50,000		x	x
14	Resident Fish Spawning in Impoundments Study	80,000		x	x

Study Number	Study Title	Preliminary Estimated Cost ($s)	Preliminary Data Collection Initiatives	Study Year One[a]	Study Year Two (including data analysis and reports for Year One studies)
15	Resident Fish Spawning in Riverine Sections Study	60,000		x	x
16	Sea Lamprey Spawning Assessment	150,000		x	
17	Upstream Passage of Riverine Fish Species Assessment	120,000		x	x
18	American Eel Upstream Passage Assessment	195,000		x	x
19	American Eel Downstream Passage Assessment	200,000 – 250,000		x	x
20	American Eel Downstream Migration Timing Assessment	30,000		x	
21	American Shad Telemetry Study - Vernon	150,000	x	x	
22	Downstream Migration of Juvenile American Shad - Vernon	125,000 – 150,000		x	x
23	Fish Impingement, Entrainment, and Survival Study	65,000			x
24	Dwarf Wedgemussel and Co-occurring Mussel Study	80,000 – 130,000	x	x	x
25	Dragonfly and Damselfly Inventory and Assessment	96,000	x	x	x
26	Cobblestone and Puritan Tiger Beetle Survey	45,000		x	x

Study Number	Study Title	Preliminary Estimated Cost ($s)	Preliminary Data Collection Initiatives	Study Year One[a]	Study Year Two (including data analysis and reports for Year One studies)
27	Floodplain, Wetland, Riparian, and Littoral Habitats Study	198,000	x	x	x
28	Fowler's Toad Survey	49,000		x	x
29	Northeastern Bulrush Survey	23,000		x	x
30	Recreation Facility Inventory and Use & Needs Assessment	350,000		x	x
31	Whitewater Boating Flow Assessment - Bellows and Sumner Falls	86,000		x	x
32	Bellows Falls Aesthetic Flow Study	40,000		x	
33	Cultural and Historic Resources Study	61,000 – 66,000	x	x	
TOTAL ESTIMATED STUDY COST:		**$4,739,000 - $5,019,000**			

a. Study Year One will begin after October 2, 2013 (20 days after FERC's study plan determination expected on September 12, 2013), unless specific studies are the subject of dispute by mandatory conditioning agencies. In those cases, Study Year One will begin on December 11, 2013, upon FERC's Study Dispute Determination (see 18 C.F.R. § 5.13(d) and § 5.14).

IMMEDIATE STUDY PLAN DATA NEEDS

The ILP study schedule dictates a study year to be from October through September. The seasonality of field investigation for different target species being studied also varies. Further, many studies are interrelated, with data from some studies needed for the analysis of others. In many cases, field work in study year 1 will be followed by analysis of project effects at the start of year 2 and reported on prior to the field session in year 2.

TransCanada is initiating specific data collection efforts identified in table 2 under "Preliminary Data Collection Initiatives" where those efforts will facilitate other studies that will rely on collecting baseline data starting in Spring 2013. TransCanada will explain the reasons for initiating this effort at its May 13, 2013, meeting, and will seek stakeholder and FERC concurrence for its initiative. Costs for these efforts are included in table 2.

Preliminary data collection initiatives include:

- Obtain Light Detection and Ranging or Laser Imaging Detection and Ranging (LiDAR) and Digital Photogrammetry of up to 185 miles of the Connecticut River, which would encompass all potential project-affected areas. Data from this will help to provide a current picture of the river corridor with immense detail and accuracy to support model refinement and numerous studies.

- Obtain side-scan sonar data and bathymetry data in all accessible areas within the impoundments. Data will support habitat mapping, HEC-RAS model refinement, and numerous aquatic studies. Substrate and littoral zone analysis may also be conducted. Data and mapping would serve as the basis for selecting study sites and establishing transect locations for all other aquatic habitat studies.

- Installation of pressure transducers for depth monitoring in a variety of locations both upstream and downstream of the dams. Data will support calibration of the hydraulic model, habitat index curves, reservoir operational characteristics, and would provide a monitoring record.

- Erosion monitoring initial site identification and full river transect surveys, and installation of pressure transducers for continuous reservoir elevation data collection. This information will provide hydrographic and topographic cross sections and reservoir operational characteristics that can be used for model refinements and hydraulic modeling, and will support erosion studies.

TransCanada is also considering early implementation of the following studies:

- Initial survey and site selection for Study 24, Dwarf Wedgemussel and Co-Occurring Mussel Study Phase 1. This information is needed early to identify sites where dwarf wedgemussel densities are high enough to permit quantitative sampling, behavioral studies, or habitat studies for the study's

Phase 2 survey in 2014. Early concurrence by resource agencies is needed to develop the timeline and plan for Phase 2.

- Cultural and Historic Resources Study (Study 33), is proposed to be implemented in 2013 because some of the requested work was completed prior to the related study requests. The draft Phase IA archaeological reconnaissance reports for Wilder and Bellows Falls will be submitted by May 15, 2013, to the Vermont and New Hampshire State Historic Preservation Offices. The Vernon Project archaeological monitoring program under its current Historic Resources Management Plan is scheduled to be conducted in 2013 with the report to be submitted before December 31, 2013.

CONSULTATION AND REPORTING SCHEDULE

As required under the Commission's regulations, 18 C.F.R. § 5.11(e), TransCanada will hold an initial consultation meeting to discuss the PSP on May 13, 2013. The purpose of this meeting is to clarify and discuss the PSP with Commission staff and stakeholders (specifically the study requestors); identify study plan interest working group participants; describe immediate data collection initiatives; and review the subsequent meeting schedule.

Study Plan Meeting #1 – Overview of Proposed Study Plan, Identification of Interested Stakeholder Working Groups and Preliminary Data Collection Initiatives

Date & Time: Monday, May 13, 2013, at 9:00 a.m. – 4:00 p.m.

Location: Kilton Public Library Conference Room
80 Main Street
West Lebanon, NH 03784
603-298-8544

TransCanada will convene various resource working groups at subsequent meetings to engage with Commission staff and stakeholders in ongoing consultation prior to the stakeholder PSP comment deadline on July 14, 2013. The meetings are intended to provide a forum to work toward consensus on the final TransCanada Study Plan to be filed by August 13, 2013. Initial working group meetings are scheduled as follows:

Water Resources and Modeling; and Erosion

Date & Time: Thursday, May 16, 2013, at 9:00 a.m. – 4:00 p.m.
Modeling meeting at 9:00 a.m.
Erosion meeting at 1:00 p.m.

Location: Vermont Room at the Fairfield Inn
104 Ballardvale Drive
White River Junction, VT 05001
1-802-291-9911

Aquatics

Dates & Times: Monday, May 20, 2013, at 9:00 a.m. – 4:00 p.m.
Monday, May 23, 2013, at 9:00 a.m. – 4:00 p.m.
Thursday, June 6, 2013, at 1:00 p.m. – 4:00 p.m.

Location: Vermont Room at the Fairfield Inn
104 Ballardvale Drive
White River Junction, VT 05001
1-802-291-9911

Terrestrial

Date & Time: Thursday, June 6, 2013, at 9:00 a.m. – 1:00 p.m.

Location: Vermont Room at the Fairfield Inn
104 Ballardvale Drive,
White River Junction, VT 05001
1-802-291-9911

Recreation and Aesthetics and Cultural and Historic Resources

Date & Time: Friday, June 7, 2013, at 9:00 a.m. – 4:00 p.m.
Recreation meeting at 9:00 a.m.
Aesthetics and Cultural and Historic Resources meeting at 1:00 p.m.

Location: Vermont Room at the Fairfield Inn
104 Ballardvale Drive,
White River Junction, VT 05001
1-802-291-9911

Meeting notes from all consultation and working group meetings will be available for distribution to working group participants and filed with the Commission within 2 weeks of each meeting.

Outside of the preliminary data collection and possible study initiatives described above, most studies are planned for implementation during one or two study years, following FERC's study plan approval and assuming no Notices of Formal Study Disputes are filed by mandatory conditioning agencies during the 20-day period after FERC's study plan determination which is expected on September 12, 2013.

Study progress reports will be submitted at important study milestones and will summarize, for each study:

- pre-field season activities completed or in progress;
- field season activities; and
- post-field season activities completed

In keeping with the ILP study schedule, interim study reports for studies extending beyond 1 year will be submitted within 1 year of FERC's study plan approval, with final reports for all studies submitted within o years of FERC's study plan approval.

STUDY 1

HISTORICAL RIVERBANK POSITION AND EROSION STUDY

RELEVANT STUDY REQUESTS

FERC-03

STUDY GOALS AND OBJECTIVES

The goal of this study is to assess the historic erosion and river bank movement within the Wilder, Bellows Falls, and Vernon Project boundaries to consider the effect and contribution of project operations on erosion in a reasoned way. FERC contends that although erosion, in and of itself, is not necessarily an adverse effect, areas of excessive erosion that are a direct result of project operations or that may be having an adverse effect on another resource are of concern. Potential resources that may be affected are aquatic, terrestrial, cultural, recreation, or socioeconomic.

Documentation of historic riverbank information, surveys, and photos would provide an opportunity to quantify or compare changes over an extended time period and provide a relative scale and potential quantification of erosion among various locations over time within each project along the Connecticut River. The results of this study alone will not enable a determination of the effects of project operations on erosion, but, together with other related studies, will facilitate conclusions as to the association and effect of project operations on active erosion at various locations within or areas affected by the three projects.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

No relevant resource management goals of agencies or Indian tribes with jurisdiction over the subject resources directly apply to this study.

ASSOCIATION WITH OTHER STUDIES

The results of this study, together with other studies, will facilitate assessments of the association and effect of project operations on active erosion at various locations. These studies include:

- Riverbank Transect Study (Study 2) – transects will be selected for more detailed monitoring and determination of project operations relative to conditions at specific erosion sites of interest.

- Riverbank Erosion Study (Study 3) – results will characterize the processes of erosion that occur, and attempt to ascertain the causes of erosion and the effects of erosion on other resources.

- Hydraulic Modeling (Study 4) and Operations Modeling (Study 5) - will provide water level, flow and velocity information over time.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Several studies of riverbank erosion have been conducted, but they have mostly addressed specific erosion sites along the shoreline, and did not include comparative mapping efforts to determine where the river channel has moved or by how much. Previous studies also did not estimate areas of land lost or gained as a result of those movements.

The study prepared for the U.S. Army Corps of Engineers (USACE) in 1979 (Simons et al., 1979) was one of the first comprehensive studies along the Connecticut River to assess the causes of river shoreline erosion. The study mainly provided a discussion of the various types of erosion taking place on the river at that time and identified specific erosion locations and various causes of erosion taking place. The 2010 erosion study conducted by Kleinschmidt Associates (Kleinschmidt, 2011) for TransCanada in the Wilder, Bellows Falls, and Vernon Project areas identified areas along the shoreline where erosion was classified as stable or active and provided mapping of these areas. However, that report provides a snapshot of relatively recent conditions and provides no perspective relative to changes in erosion sites over time. The mapping data that were obtained for that study may be used in this study.

Archival mapping and information is needed to identify where erosion has taken place and to characterize the degree of erosion that has occurred over time.

PROJECT NEXUS

Erosion is likely to occur whenever moving water intersects with land. It is a natural process with both beneficial and adverse potential effects. The PADs describe a daily run-of-river/peaking mode of operation that results in impoundment and tailwater flow fluctuations, resulting in fluctuations of water levels. As referenced in the PADs, Simons et al. (1979) identifies water fluctuations as a factor in erosion. Areas of excessive erosion that are a direct result of project operations or that may be having an adverse effect on another resource are of concern. The potential resources that may be affected are aquatic, terrestrial, cultural, recreation, and socioeconomic.

This study aims to identify riverbank erosion conditions observed over a longer time period, allowing a comparison of historic and present conditions. Coupled with information from related studies (2, 3, 4, and 5), these data could help provide a better understanding of potential project effects on erosion.

STUDY AREA AND STUDY SITES

The study area includes the shoreline of the Wilder, Bellows Falls, and Vernon impoundments, as well as the shoreline of the riverine reaches downstream of the Wilder and Bellows Falls dams, and is limited to the project lands immediately below Vernon dam which is adjacent to the project boundary of the Turners Falls Project. Thus, the study area will extend from the upstream limit of the Wilder impoundment to the upstream limit of the Turners Falls Project impoundment (FERC No. 1889).

METHODS

The methods used for this study do not precisely follow those requested by FERC. The methods requested would require significantly more effort specifically as related to conducting literature and document search at local towns and Registry of Deeds for historical information, land purchases, easements, land surveys, and real estate data. TransCanada's estimation is that significant effort and cost would be required to acquire what is likely to amount to little to no relevant data and information. All acquired information would require extensive analysis, manipulation, and processing to enable even the most modest comparisons to existing aerial photogrammetry and mapping. Therefore, this study will use the following methods:

- Conduct a document search within TransCanada's own records to identify historical information on project maps locating the edge of river and erosion monitoring.
- Research available Federal Emergency Management Agency (FEMA) flood insurance studies where field surveys may have been conducted at key locations along the impoundments.
- Research available aerial photographic records, such as those available from the National Agriculture Imagery Program and Natural Resources Conservation Service (NRCS).
- Digitize the river's edge from various historical references and attempt to overlay them for comparison. Lacking consistent reference points and control, overlaying these layers may require various map fitting functions to enable them to match up as best as possible. These efforts may introduce potential misrepresentations of the historical river's edge which would prevent calculation of total bank loss in any location. However, depending upon the age of the source data, it should be possible to identify significant areas of bank loss, channel migration, and the associated historical periods over which it has occurred.

ANALYSIS

The information acquired will be used to qualify and attempt to quantify historic bank movement and erosion. Results from related studies (2, 3, 4, and 5) will also inform the analysis and conclusions of this study. The mapping and information gathered will be overlain and compared to identify locations where the river channel has moved over time. Where possible, efforts will be made to estimate the quantity of land lost or gained. Such estimates will depend on the variability, comparable accuracy, and degree of consistent horizontal control among the various sources to allow for comparable layering without significant adjustment.

At a minimum, it is expected that, given reasonable well depicted shorelines, significant areas of bank loss from erosion and channel migration will be detectable. Correlating bank loss to a specific period or time frame, historical hydrologic events, or other causal agents depends upon the accuracy and periodicity of the source information.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

This study involves gathering various forms of historical information including property maps, aerial photographs, and other maps and information that can be compared to assess river channel movement and erosion over time. This is a generally accepted document research methodology.

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study. The report will summarize the data gathered and analyzed and present written and visual comparisons of data gathered from this study and identify all sources of information. A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the Preliminary Licensing Proposal (PLP) or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

This is a 1-year study. All research related to this study and the analysis will be completed during the first study year (2014).

LEVEL OF EFFORT AND COST

The preliminary estimated cost for this study is $55,000.

REFERENCES

Kleinschmidt. 2011. Lower Connecticut River Shoreline Survey Report—2010: Bellows Falls Project (FERC No. 1855), Wilder Project (FERC No. 1892), Vernon Project (FERC No. 1904). March 2011. Prepared for TransCanada Hydro Northeast Inc. Westborough, MA.

Simons, D.B., Andrews, J.W., Li, R.M., and M.A. Alawady. 1979. Connecticut River Streambank Erosion Study—Massachusetts, New Hampshire, and Vermont. Prepared for the U.S. Army Corps of Engineers, New England Division.

STUDY 2

RIVERBANK TRANSECT STUDY

RELEVANT STUDY REQUESTS

FERC-02,-04; NHDES-21a, -21b, -21c; NHFG-21a, -21b, -21c; VANR-01; CRWC-01, -02, -03; Han-01; Lipfert-01; Lyme-Leb-McInt-01; Mudge-01, TwoRiv-03

STUDY GOALS AND OBJECTIVES

In their study requests, FERC, NHDES, NHFG, VANR, CRWC, and others have identified water level fluctuations and flow peaking related to Wilder, Bellows Falls, and Vernon Project operations as a potential contributing factor to bank erosion and soil loss in project-affected areas. In response to that request, the goal of this study is to monitor riverbank erosion at selected sites in the impoundments and project-affected riverine sections below Wilder and Bellows Falls dams.

The erosion monitoring will include repeated cross sections, ground photographs, and water level monitoring at 20 sites (10 associated with Wilder dam, 6 with Bellows Falls, and 4 with Vernon). Relationships observed between changing water levels and the timing of bank erosion will help establish whether water level fluctuations, described in terms of magnitude, periodicity and duration, and increased shear stresses resulting from project operations are correlated with erosion in project-affected areas. Observed water level fluctuations and shear stresses from nonproject-related factors will also be investigated.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

NHDES	• State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.
NHFG	• General goals related to healthy ecosystems to support fish and wildlife. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).
VANR	• State water quality standards for designated uses of Class B waters relative to flow alteration, water level fluctuation and anti-degradation provisions. The Connecticut River below Wilder dam is listed as impaired waters on the Section 303(d) due to flow alterations.

ASSOCIATION WITH OTHER STUDIES

A number of other studies should be completed in conjunction with this study. The initial surveys of full river transects in this study will provide topographic cross sections that can be used in Hydrologic Engineering Center - River Analysis System (HEC-RAS) modeling to be conducted as part of the Hydraulic Modeling Study (Study 4). In turn, the modeling results from Study 4 will be useful in determining shear stresses acting on the monitored banks during different flow conditions. Water level monitoring as part of this study could prove useful in calibrating hydraulic modeling efforts in Study 4. Depending on the location of the monitoring sites, this study may also prove useful for the Channel Morphology and Benthic Habitat Study (Study 8) and other studies focused on habitat and recreational issues that might be affected by erosion.

The results of this study will also be used to help interpret longer term bank movement that will be assessed in the Historical Riverbank Position and Erosion Study (Study 1). An investigation of the processes and causes of erosion in the Riverbank Erosion Study (Study 3) will rely heavily on the results of this study and will be helpful in selecting sites representing a range of conditions, some having experienced significant channel migration and others exhibiting long-term bank stability.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Background information about project operations, river and watershed characteristics, and previous studies completed in the area were detailed in the PADs. Erosion in the project-affected areas was previously mapped by Simons et al. (1979) and Kleinschmidt (2011). Bank height, bank slope, land use, and land cover were identified at each erosion site in Kleinschmidt (2011); however, no assessment was made of the trends or rates of erosion at each project.

Surficial geology maps prepared on U.S. Geological Survey (USGS) 7.5’ topographic quadrangles published by the NH Geological Survey are, or soon will be, available for most of the study area. NRCS soils maps have also been developed and are available for most of the project areas. A thorough review of these maps will be important for ensuring the selected monitoring sites encompass a range of soil types and geomorphic settings.

Glacial Lake Hitchcock occupied most of the Connecticut River Valley in the project areas at the end of the last ice age, depositing thick sequences of varved lacustrine clays and other fine sediments. These sediments have been investigated for many years by geologists (Ridge and Larsen, 1990) and a review of this literature as part of Study 3, the Riverbank Erosion Study, will provide additional information on the location, thickness, and stratigraphy of such deposits. These studies will be used to better understand conditions at monitoring sites where varved clays are present.

PROJECT NEXUS

Study requesters consider water level fluctuations and peaking flows downstream of dams as a potential cause of erosion. Simons et al. (1979) attributes water fluctuations, both natural and those associated with dam operations, to be a factor in erosion in the project-affected areas. This study will ascertain the relative importance of water level fluctuations associated with project operations in the erosion process relative to other contributing factors and how the importance of water level fluctuations in the erosion process varies with soil type and geomorphic setting. Water level fluctuations, particularly those associated with the projects, represent only one process increasing the potential for bank instability with the cumulative effect of multiple processes that either increase the driving forces of instability (e.g., high shear stress, water seepage) or decrease the resisting forces (e.g., loss of bank vegetation; loss of soil cohesion) ultimately leading to erosion.

Comparing the site-specific conditions at each transect study site with rates of erosion will provide key input to determining whether routine project operations, high flood flows, or a combination of factors is causing bank erosion.

STUDY AREA AND STUDY SITES

The study will be conducted at 20 bank transects (10 associated with Wilder, 6 with Bellows Falls, and 4 with Vernon). FERC requested 30 transects (10 for each project); the 10 proposed for Wilder are appropriate given the impoundment length and the higher rate of erosion compared to the other projects (Kleinschmidt, 2011), and the erosion concerns expressed by numerous study requesters. However, fewer sites are recommended at the other projects because of shorter impoundment length and lower rates of erosion. The 20 total transects will still enable a comparison of conditions at sites both upstream and downstream of each project and representing a range of soil types and bank characteristics. The exact location of the transect sites will be based on a review of previous erosion studies (e.g., Simons et al., 1979; Kleinschmidt, 2011), analysis of soils and surficial geology maps, initial field reconnaissance, inspection of historical aerial photographs, and examination of project operations data to ensure the sites encompass a range of soil types, stratigraphic conditions, vegetation densities, erosion types, bank slopes (and other morphological characteristics), water level fluctuations, and peaking flow conditions.

Once an initial list of potential transect sites is developed based on these criteria, an effort will be made to select sites that address site-specific concerns raised in study requests associated with the New Hampshire bank near Wilder dam such as at River Road in Lyme just south of the North Thetford Road; River Road a quarter mile south of the East Thetford Bridge, the Mudge and McIntyre properties in Lyme, Pine Park in Hanover, and the Lipfert property in Cornish.

The study area includes the shoreline of the Wilder, Bellows Falls, and Vernon impoundments, as well as the shoreline of the riverine reaches downstream of the Wilder and Bellows Falls dams and limited to the project lands immediately below Vernon dam which is adjacent to the project boundary of the Turners Falls Project.

Thus, the study area will extend from the upstream limit of the Wilder impoundment to the upstream limit of the Turners Falls Project impoundment (FERC No. 1889).

METHODS

The following methodology will be used with tasks completed in the listed order, if possible:

Site Selection

The 20 transect sites will be selected so a range of soil types, stratigraphic conditions, vegetation densities, erosion types, bank slopes (and other morphological characteristics), water level fluctuations, and peaking flow conditions are incorporated into the analysis. Site selection will be based on a review of previous erosion studies (e.g., Simons et al., 1979; Kleinschmidt, 2011), analysis of soils and surficial geology maps, initial field reconnaissance, inspection of historical aerial photographs, and examination of project operations data;

Establishing Monitoring Sites

The initial monitoring of the sites will include establishing full river cross sections using standard topographic and bathymetric survey methods. The surveys will be completed using an electronic total station and referenced to a project datum, both vertically and horizontally. Permanent, recoverable control points at the site will also be established. Subsequent monitoring of the cross sections will include only one bank of the river and will extend from a point 50 feet upland from the top of bank to a wadeable depth into the water with data to be collected at a sufficient density to accurately describe the slope geometry. In addition to establishing the survey transects, the initial site monitoring will also characterize site and bank conditions with information to be collected on bank stratigraphy, soil type and horizons, bank stability, vegetation, water seeps, channel features (e.g., mid-channel bars), and valley features (e.g., downstream constrictions). Multiple oriented ground photograph stations will also be established at each site to capture changes in bank conditions through time; the ground photographs will be retaken at the same locations during each subsequent visit to the sites.

Repeat Surveys

As requested by FERC, surveys at the 20 sites will be resurveyed and ground photographs retaken at least four times per year for 2 years. The surveys will occur immediately after high spring flows, early and late summer, and then in late fall with additional surveys conducted within 15 days of any significant high water event (monitoring trigger flow to be determined after review of exceedance curves of natural inflows). Evidence for ice-related conditions will be recorded during the survey immediately following high spring flows. While NHDES, NHFG, and VANR have also requested monitoring of several bank transects on a biweekly basis for one year at 18 monitoring sites (three in each project impoundment and three downstream of each dam), this additional monitoring is not incorporated into this study as such information will only be valuable if active soil loss occurs nearly continuously throughout the year. The significant added cost is not warranted given the limited additional benefit to be gained from the more intensive monitoring.

Surface Water Level Monitoring

To monitor surface water levels, pressure transducers will be submerged in stilling wells placed in the river at the 20 monitoring sites. The transducers will be set to automatically record water levels at 15-minute intervals. To calibrate the submerged transducers, up to six additional transducers will need to be deployed to record changes in air pressure. These additional transducers will be placed at or near monitoring sites, but may not be needed at all sites because air pressure does not generally vary significantly over short distances with minimal elevation variations. Data will be retrieved from the transducers each time surveying is scheduled at the monitoring sites. The pressure transducers will be removed during the winter months to prevent breakage but the stilling wells will remain in place to ease redeployment of the transducers in the second year. Flow variation is generally limited in the winter months, so the absence of data collection in the winter months should not alter study results. Flow records at the dams will provide some information on winter flows if a significant rain-on-snow event occurs.

The bank monitoring techniques described above were selected to match as closely as possible those requested by FERC with water level monitoring added so correlations can be identified, if present, between erosion and highwater events or frequent water fluctuations.

ANALYSIS

The data collected as part of this study will be analyzed to determine if the timing of documented bank erosion is associated with flood events or project operational water level fluctuations. The repeated topographic surveys and ground photographs will document the location, amount, and timing of erosion for a 2-year period. Site characteristics and recorded water levels will be compared with the erosion monitoring data to determine if high rates of erosion are associated with certain soil types, bank heterogeneities (i.e., sand-clay interfaces), bank seeps, or water level fluctuations. Graphs, tables, and matched photos will be developed to highlight comparisons between different data sets.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The various methods to be used in the Riverbank Transect Study conform to generally accepted scientific practice. Topographic surveys and repeat ground photography are standard methods that have been used in geomorphic monitoring studies for decades (Lawler, 1993).

DELIVERABLES

A report will be prepared that presents methods, analysis and results of the study. The report will include GIS shapefiles of monitored sites, topographic cross sections showing changes through time, graphical presentation of water stage in relation to volumes of soil loss, bank features, and other site characteristics.

An interim study report will be prepared after the first year of study is complete. The report will be provided to stakeholders for review and comment. A draft final study report will be prepared after the study analysis is complete in study year two. Stakeholder comments on the draft final report will be included in the final study report with an explanation of any stakeholder comments not incorporated.

Interim and final study reports will be provided after completion of the first and second year, respectively of field work associated with this study and Study 3.

Results and conclusions will be reported in either PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application**.**

SCHEDULE

This study will be a 2-year study. Because final study reports are to be completed by September 2015 in keeping with the ILP schedule, two full seasons of monitoring is not possible, but two complete years of sampling over three seasons could occur. Site selection will occur in late 2013 after FERC study plan approval. Establishment of the monitoring sites could begin in late 2013 as well, permitting at least one round of surveying before winter 2013/2014 begins. A full year of monitoring would occur in 2014 and another partial year of monitoring completed in spring and early summer 2015. Hydraulic modeling (Study 4) will be integrated into the study after field sampling ends to analyze relationships between shear stress and bank erosion. The monitoring results will then be incorporated in to final study reports for both this study and the Riverbank Erosion Study (Study 3).

LEVEL OF EFFORT AND COST

The preliminary estimated cost for this 2-year study is $245,000.

REFERENCES

Kleinschmidt Associates. 2011. Lower Connecticut Shoreline Survey Report – 2010. Prepared for: TransCanada Hydro Northeast. 18 pp.

Lawler, D.M. 1993. The Measurement of River Bank Erosion and Lateral Channel Change: A review: Earth Surface Processes and Landforms. Volume 18, pp. 777–821.

Lawson, D.E. 1985. Erosion of Northern Reservoir Shores: An Analysis and Application of Pertinent Literature: U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory Monograph 85-1. 198 pp.

NHFG (New Hampshire Fish and Game Department). 1998. New Hampshire Fish and Game Department Strategic Plan (1998–2010). Concord, NH.

Ridge, J.C. and F.D. Larsen. 1999. Re-evaluation of Antevs' New England Varve Chronology and New Radiocarbon Dates of Sediments from Glacial Lake Hitchcock: Geological Society of America Bulletin 102:889–899.

Simons, D.B., Andrews, J.W., Li, R.M., and M.A. Alawady. 1979. Connecticut River Streambank Erosion Study Massachusetts, New Hampshire, and Vermont. Prepared for the U.S. Army Corps of Engineers, New England Division.

Study 3

RIVERBANK EROSION STUDY

RELEVANT STUDY REQUESTS

FERC-04; NHDES-21a, -21b, -21c; NHFG-21a, -21b, -21c; VANR-01; CRWC-01, -02, -03; Han-01; Lipfert-01; Lyme-Leb-McInt-01; Mudge-01; Rock-01; TwoRiv-03

STUDY GOALS AND OBJECTIVES

In their study requests, FERC, NHDES, NHFG, VANR, and others have identified water level fluctuations and flow peaking from Wilder, Bellows Falls, and Vernon Project operations as a potential contributing factor to bank erosion and soil loss in project affected areas. In response to those concerns, the goal of this study is to provide baseline data relative to erosion in project-affected areas.

The objectives of this study are to:

- determine the location of erosion in project-affected areas and compare these locations with previously compiled erosion maps (e.g., Kleinschmidt, 2011; Simons et al., 1979);
- characterize the processes of erosion (e.g., piping, slumping, slips);
- ascertain the likely causes of erosion (e.g., high flows, groundwater seeps, eddies, water level fluctuations related to project operations); and
- identify the effects of shoreline erosion on other resources (e.g., aquatic habitat).

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

NHDES	• State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.
NHFG	• General goals related to healthy ecosystems to support fish and wildlife. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).

VANR • State water quality standards for designated uses of Class B waters relative to flow alteration, water level fluctuation and anti-degradation provisions. The Connecticut River below Wilder dam is listed as impaired waters on the Section 303(d) due to flow alterations.

ASSOCIATION WITH OTHER STUDIES

A number of other studies should be completed in conjunction with this study. To determine if erosion might be related to project-related water level fluctuations and peaking downstream of the three dams, Hydraulic Modeling (Study 4) and Operations Modeling (Study 5), will be critical in determining the flow velocity, stage, and duration along the riverbanks, all potential factors in the erosion process.

Flow deflection around sand/gravel bars and channel/valley constrictions are important factors in understanding the distribution of erosion, so the substrate related results of Aquatic Habitat Mapping (Study7) will also be important for discerning the causes of erosion. A determination of how the amount and location of erosion has changed through time will be based primarily on the findings of the Historical Riverbank Position and Erosion Study (Study 1). Additionally, the Riverbank Transect Study (Study 2) will provide important information to be used in characterizing the processes of erosion and determining its causes.

All of the data collection for these studies could be completed simultaneously with this study, but ultimately the conclusions of this study will depend significantly on the results of those other studies. The results of this study will assist in drawing conclusions related to the Floodplain, Wetland, Riparian, and Littoral Habitats Study (Study 27). The Recreation Facility Inventory and Use and Needs Assessment (Study 30) will identify recreation sites that may be affected by erosion.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Considerable information is already available that will be useful in this study. Much of this information has been detailed in the PADs, but the most useful sources of data are further described below. Erosion in the project-affected areas was previously mapped by Simons et al. (1979) and Kleinschmidt (2011). These data will provide the basis for determining if the location and amount of erosion has changed through time and in response to significant flood events such as Tropical Storm Irene. Erosion mapping has also occurred on other portions of the Connecticut River (Field, 2004) and will provide important comparative information on erosion in areas not affected by the projects.

Surficial geology maps prepared on USGS 7.5' topographic quadrangles published by the NH Geological Survey are, or soon will be, available for most of the study area. NRCS soils maps have also been developed and are available online for most of the study area. The surficial geology and soils maps will provide critical baseline information on the erodibility and permeability of bank sediments, height of riverbanks, and valley constrictions, all important factors controlling erosion.

Glacial Lake Hitchcock occupied most of the Connecticut River Valley in the study area at the end of the last ice age, depositing thick sequences of varved lacustrine clays and other fine sediments. These sediments have been investigated for many years by geologists (Ridge and Larsen, 1990) and a review of this literature will provide additional information on the location, thickness, and stratigraphy of such deposits and thus will be helpful for understanding the distribution of erosion sites.

All of the existing information described above will be important for understanding the distribution, processes, and causes of erosion, but additional information is needed to fill in areas where surficial mapping has not been completed, and to provide greater resolution of surficial features and subsurface stratigraphy than is currently available.

PROJECT NEXUS

Project-related water level fluctuations and peaking flows downstream of dams is considered a potential cause of erosion by the resource agencies requesting this erosion study. While Simons et al. (1979) attributes all water fluctuations to be a factor in erosion in the project-affected areas, they also distinguish the effects based upon more extensive, sustained periods of inundation followed by rapid drawdown from restricted, subdaily inundation. Considerable erosion also occurs on free-flowing portions of the Connecticut River not influenced by dams (Field, 2004), so erosion would likely still be occurring in the project-affected areas if the dams were not present. Water level fluctuations in general represent only one process increasing the potential for bank instability with the cumulative effect of multiple processes that either increase the driving forces of instability (e.g., high shear stress, water seepage) or decrease the resisting forces (e.g., loss of bank vegetation; loss of soil cohesion) ultimately leading to erosion.

Consequently, while project operations could be a direct cause of erosion, bank instability is most likely the result of the cumulative effects of both project and non-project related factors. Under some conditions, project operations could reduce bank erosion. Bank instability is greater where permeable sand layers occur above impermeable clay layers, because water seepage out of the bank becomes concentrated along a single layer (Lawson, 1985). Bank stability in project-affected areas is likely greater where water level fluctuations do not repeatedly expose a sand-clay interface in the bank sediments. Detailed information to be collected as part of this study on bank stratigraphy, depth to sand-clay interfaces, and their relationship to past water level fluctuations is needed to confirm if reductions in bank instability are resulting from project operations.

STUDY AREA AND STUDY SITES

The study area includes the shoreline of the Wilder, Bellows Falls, and Vernon impoundments, as well as the shoreline of the riverine reaches downstream of the Wilder and Bellows Falls dams and limited to the project lands immediately below

Vernon dam which is adjacent to the project boundary of the Turners Falls Project. Thus, the study area will extend from the upstream limit of the Wilder impoundment to the upstream limit of the Turners Falls Project impoundment (FERC No. 1889).

Mapping of erosion and other bank features will be done continuously along all banks in the study area, including both eroding and non-eroding areas. Several specific sites of erosion were mentioned in study requests by New Hampshire landowners and towns in the Wilder impoundment and just downstream, including River Road in Lyme just south of the North Thetford Road, River Road a quarter mile south of the East Thetford Bridge), Mudge and McIntyre properties in Lyme, and Pine Park in Hanover. The study area encompasses these sites as well as others known to be of concern to landowners and will gather information relevant to the site-specific requests.

METHODS

The following methodology will be used with tasks completed in the listed order, if possible:

Literature Review

A review of published literature will be undertaken on riverine and reservoir erosion and additional geological/hydrologicl studies completed within or near the study area. A thorough review of the literature will provide a full understanding of fluvial processes on large rivers and documented causes of erosion on rivers and dam-regulated impoundments. Citing relevant literature to support conclusions drawn from other studies is a standard practice in all technical and scientific research.

Watershed Characterization

General information on the drainage basin area is already available in the PADs, but additional information is needed on valley width, meander dimensions, and tributary influences. An effort will be made to compare variations in conditions on the Connecticut River adjacent to tributaries with different land use and human effects (e.g., tributaries with dams vs. tributaries without dams). Watershed characterization is an essential element of geomorphic studies and is necessary for establishing relationships between different features (e.g., distribution of erosion relative to the position along or tightness of a meander bend).

Analysis of Historical Aerial Photographs, Topographic Maps, and Archival Information

The materials for this analysis will be gathered as part of the Historical Riverbank Position and Erosion Study (Study 1) and will be important for reconstructing river conditions prior to the construction of dams, effects of other human activities (e.g., channel straightening, railroad construction, project operational changes) on channel migration, and the control of tributary confluences on channel morphology. A comparison of channel processes and rates of erosion before and after dam construction or operational changes may be possible depending on the information discovered. Historical documents can be a rich source of information for geomorphologists reconstructing historical fluvial processes and river channel locations (Gurnell et al., 2003). Furthermore, the use of historical ground photographs found in archival records collected for Study 1 may also be an important tool for documenting recent landscape change along rivers, particularly in New England (Bierman et al., 2005).

Bathymetric Survey

A bathymetric survey will be completed along 20 transects as part of the Riverbank Transect Study (Study 2). Additional bathymetric information will be collected throughout project-affected areas from the Aquatic Habitat Mapping Study (Study 7) that will benefit numerous studies including this study. For this study, bathymetric information will be critical for determining the depth of water along the riverbanks and for revealing submerged bars that may be deflecting flow toward the riverbanks or formed in response to eddies at channel/valley constrictions. Bathymetric surveys are standard practice for geomorphic studies of large rivers.

Surficial Mapping of Geomorphic Surfaces (i.e., Floodplain, Glaciogenic Terraces) on the Connecticut River Valley Bottom

Surficial maps for most of the study area have been published by the NH Geological Survey and will provide critical information on the height of river banks, subsurface material, and location of valley constrictions. Supplemental information will need to be gathered in areas not mapped and to provide greater resolution where multiple geomorphic surfaces of varying heights may be present in proximity to the river's shoreline. The additional mapping will be completed with topographic maps, aerial photographs, and field checking of more complex areas. Geologists with years of research experience studying Glacial Lake Hitchcock deposits will also be consulted. If Light Detection and Ranging (LiDAR) data are collected as part of other studies (e.g., Study 4), the resulting topographic information will help further refine the surficial geology maps, but the mapping could occur without such data. Surficial geological mapping serves as baseline data for most geomorphology studies.

Field Mapping of Bank Conditions

Several channel and river bank features will be mapped continuously along the river, using the most recent digital orthophotographs as a base map, to locate the beginning and end points of mapped features (e.g., an eroding bank). The channel and bank features that will be mapped in the field include: 1) bank heights (possibly supplemented with surficial mapping results); 2) bank stability (e.g., severely eroding, moderately eroding, stable); 3) types of erosion features (e.g., piping, undercutting, slumping, tension cracks); 4) bank composition (e.g., alluvial floodplain sediments, non-alluvial glacial or lake sediments, or bedrock – supplemented with surficial mapping results); 5) grade controls (e.g., dams, waterfalls, bridges, other valley constrictions); 6) past management activities (e.g., location of berming, straightening, bank armoring, concentration of surface runoff); 7) depositional features (e.g., point bars, mid-channel bars, beaches, delta bars at tributary confluences); and 9) other features (e.g., large wood accumulations, deep pools, tributary confluences). One additional feature, the total width of mature trees growing along the river’s edge, will be mapped directly from digital orthophotos. All of the mapped features will be input into a GIS database that will show the character of the channel and banks continuously along the river. Features mapped in other studies, e.g., the Floodplain, Wetland, Riparian and Littoral Habitats Study (Study 27), and the Cultural and Historic Resources Study (Study 33) may provide additional data for those locations.

The mapping will be completed using a hand-held ArcPad computer with an embedded Trimble GPS and will allow mapped data to be immediately input as a GIS shapefile. Digital orthophotos of the study area will be loaded into the ArcPad computer to assist in accurately locating the position of mapped features. The analysis of GIS data of mapped features will provide: 1) statistical information on individual features (e.g., total length of eroding banks; percentage of channel banks that are bedrock); 2) comparative information between features (e.g., location of eroding banks in relation to areas of concentrated runoff); 3) a means of identifying the causes for certain channel conditions (e.g., eroding banks adjacent to mid-channel bars); and 4) a method for the rapid viewing of multiple parameters at the watershed scale (e.g., the distribution of erosion relative to the location of clay banks). Consequently, the mapping of channel features will be critical for determining the causes of erosion. The mapping of channel features is a common methodology in fluvial geomorphology and the techniques to be used are similar to the U.S. Environmental Protection Agency’s (EPA’s) National Hydrography Dataset Reach Indexing Tool.

Stratigraphic Descriptions

The composition of bank material will be characterized during the field mapping of bank conditions. However, the layering of sediments within the banks can play an instrumental role in bank stability with contacts between permeable sand above impermeable clay providing a zone along which water can preferentially seep out of the bank. Consequently, identification of the various sedimentary layers within a bank is critical to understanding the distribution and causes of erosion. Stratigraphic descriptions of at least 20 bank exposures will be completed as part of the Riverbank Transect Study (Study 2), but additional descriptions will be needed to fully characterize the range of conditions present in the study area. At least one stratigraphic column will need to be measured for each geomorphic surface identified during surficial mapping. Linking stratigraphic descriptions to geomorphic surfaces will enable generalizations of stratigraphic layering to be made over a broad area because stratigraphy will be generally uniform for a given surface. This will limit the effort needed to describe subsurface stratigraphy and will provide information on stratigraphy even where bank exposures are obscured due to vegetation, riprap, or other reasons. The stratigraphic descriptions will be completed using standard geological and soil techniques with the elevation of the top and bottom of each observed stratigraphic layer measured relative to the top of the bank with a measuring tape or stadia rod. The true elevation of the reference point at the top of the bank will be determined using survey grade GPS as the true elevation of stratigraphic contacts will be needed to make comparisons with water surface elevations established through hydraulic modeling. Each stratigraphic layer will be described in terms of texture (i.e., grain size), color, internal bedding, permeability, and other characteristics useful for determining the depositional environment of the sediment (e.g., lake, floodplain, delta). Stratigraphic descriptions are a common methodology used in many geomorphology studies.

Topographic Surveying

Topographic cross sections of the banks will be completed at 20 sites as part of the Riverbank Transect Study (Study 2) to closely monitor erosion over 2 years and better characterize the processes of erosion. However, additional surveying, including cross sections and plan maps, will need to be completed for other purposes in this study including, for instance to compare bank slopes of stable and eroding banks, determine the shapes and dimensions of slump features, and measure the amount of bank recession that has occurred around fixed features (e.g., bridge abutments, riprap). Topographic surveying is an integral part of most geomorphology studies, and the standard surveying techniques used in such studies are described by Simon and Castro (2003).

Hydraulic Modeling

HEC-RAS one-dimensional (1-D) hydraulic modeling is being completed of the entire study area as part of the Hydraulic Modeling Study (Study 4). HEC-RAS modeling will provide information on flow stage, velocity, and shear stress, important factors in the erosion process. The FERC study request for a riverbank erosion study specifically requests that "bank shear assessments" be completed to compare different sites for their susceptibility to erosion, a request that will be the focus of the Riverbank Transect Study (Study 2). For this study, 2-D modeling at up to six sites using River2D may be necessary to understand complex sites where HEC-RAS modeling does not adequately describe eddy flows that might develop, for example, upstream of valley constrictions or flow deflection that might occur, for example, around a mid-channel bar or island. 2-D modeling, if necessary, will occur in conjunction with the Instream Flow Study (Study 9), and only at selected sites, extending over only hundreds of feet of river.

The methods described above were selected to match as closely as possible those recommended in the relevant study requests, and the overall study approach has been crafted to address concerns raised in the various study requests and scoping meeting comments.

ANALYSIS

The data collected as part of this study will be analyzed within the context of the four study objectives of identifying the location, processes, causes, and potential effects of erosion. Changes in the location of erosion through time will be achieved through comparisons on GIS of at least three map years (1979, 2010, and to be completed in 2014) with pie charts and maps to be used to determine if river bank erosion has increased through time as suggested in some of the study requests. Historic maps and aerial photographs to be compared during the Historical Riverbank Position and Erosion Study (Study 1) may be useful for extending the temporal record of how the location and amount of erosion has changed through time.

Information collected on bank characteristics at multiple places within the study area will be compared with erosion processes described in the literature to establish how erosion proceeds through time at a given site. The results of this analysis will be presented as a channel evolutionary model that will illustrate with photographs, sketches, and tables how the morphology of the riverbank changes through time as erosion progresses and material is shifted from the upper bank to the lower bank and ultimately transported downstream. Information gathered during the Riverbank Transect Study (Study 2) will also be used in developing the evolutionary model of bank erosion.

An analysis of erosion causes will be completed by identifying the propensity of erosion to occur in association with certain conditions. For example, erosion focused in areas where sand-clay interfaces are frequently exposed due to water level fluctuations may suggest project operations are partially responsible for the erosion. Conversely, the presence of significant erosion on the outside bend of meanders may suggest higher shear forces from natural flood flows are contributing to bank erosion. The results of the Hydraulic Modeling Study (Study 4) and the Riverbank Transect Study (Study 2) will be important in establishing these associations and identifying the major factors contributing to erosion.

Maps showing the location of different bank conditions and features along the river will be used to investigate whether bank erosion has the potential to affect other resources. For example, if erosion is occurring where riparian vegetation is present then riparian habitat could be considered potentially affected by bank failure with the results of Floodplain, Wetland, Riparian and Littoral Habitats Study (Study 27) to be integrated with this study. Similar associations may also be established to identify possible effects on aquatic habitat. Habitats sensitive to fine sediment deposition, such as spawning gravel, could be considered threatened if considerable lengths of bank erosion are occurring immediately upstream. The Channel Morphology and Benthic Habitat Study (Study 8), the Aquatic Habitat Mapping Study (Study 7), and the Recreation Facility Inventory (Study 30), as well as several fish spawning studies (e.g., Studies 14, 15, and 16), will be needed to identify if and where effects on other resources are occurring as the result of bank erosion.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The various methods to be used in the Riverbank Erosion Study conform to generally accepted scientific practice as detailed in the Methods section above.

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study. The report will include GIS shapefiles of monitored sites, topographic cross sections showing changes through time, graphical presentation of water stage in relation to volumes of soil loss, bank features, and other site characteristics. An interim study report will be prepared after the first year of study is complete. The report will be provided to stakeholders for review and comment. A draft final study report will be prepared after the study analysis is complete in study year two. Stakeholder comments on the draft final report will be included in the final study report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

This study will be conducted as a 2-year study. The literature review, watershed characterization, and mapping of geomorphic surfaces could begin in late 2013, following FERC's study plan approval, or in early 2014 with field mapping, supplementary topographic and bathymetric surveying, and stratigraphic descriptions completed in summer and fall 2014. Hydraulic modeling will be integrated into the study at the outset of 2015 to analyze the effects of large floods and water level fluctuations on bank erosion. Information from other studies will also be integrated into this study during 2015 to address project goals and analyze the results.

LEVEL OF EFFORT AND COST

The preliminary estimated cost for this study is $460,000.

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Study 4

Hydraulic Modeling Study

RELEVANT STUDY REQUESTS

FERC-01; FWS-01; NHDES-14a; NHFG-14; VANR-04; CRWC-11; TNC-01; TU-07

STUDY GOALS AND OBJECTIVES

In their study requests, FERC, FWS, NHDES, NHFG, VANR, CRWC, TNC, and TU indicated an interest in understanding the effects of changing flows and water surface elevations at the Wilder, Bellows Falls, and Vernon Projects on environmental resources. The goal of this study is to develop a hydraulic model to derive hydraulic parameters such as water levels and flows across the study area and at locations of interest identified in other studies. The results of the hydraulic model will inform other studies thereby permitting the evaluation of the effects of project operations on aquatic, terrestrial, and geologic resources.

The objective of this study is to:

- develop hydraulic parameters such as water levels, flows, and velocities for other studies including the Operations Model Study (Study 5).

Study requests also identify an interest in understanding how operations at the three TransCanada projects affect operations of the FirstLight projects (Northfield Mountain Pumped Storage and Turners Falls). That is beyond the scope of TransCanada's hydraulic and operations models and is the responsibility of FirstLight to develop that determination. TransCanada will provide FirstLight with output from its models in the form of discharge at Vernon dam. This would serve as the upstream inflow in the model FirstLight develops to assess the effect on its operation.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

Federal and state resource agencies described various jurisdictional resource management goals for this study in their requests, as summarized below:

FWS

- General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives; and to conserve, protect and enhance habitats for fish, wildlife, and plants affected by the projects.
- General goals related to aquatic resources including protection, enhancement, or restoration of aquatic and riparian habitats; providing instream flows to meet the requirements of diadromous and resident fish and wildlife including invertebrates; and

minimizing project effects on water quality and aquatic habitat.

NHDES	• State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.
NHFG	• General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).
VANR	• State water quality standards for designated uses of Class B waters relative to flow alteration, water level fluctuation, and anti-degradation provisions. The Connecticut River below Wilder dam is listed as impaired waters on the Section 303(d) list due to flow alterations.
	• General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.

ASSOCIATION WITH OTHER STUDIES

The operations model developed in the Operations Modeling Study (Study 5) will use the hydraulic parameters from this study, and derive a time-series database of hourly water levels and flows from operational scenarios. The results of this study and Study 5 will be used to assess project effects on the following, at a minimum: erosion processes (Studies 2 and 3); aquatic resources (Studies 8, 12, 13, 14, 15, 16, 22, 24, 25, and 26); terrestrial resources (Studies 26, 27, 28, and 29); and recreation and aesthetic resources (Studies 31 and 32).

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

The PADs for the Wilder, Bellows Falls, and Vernon Projects provide detailed information on current project operations including normal operations, inflow, river profile operation, high flow operation, and flood control and navigation. The PADs also provide information on the existing environment and resource effects. However, presently there is no tool that enables correlation of current project operations related to flows and water levels to observed shoreline phenomena (e.g., erosion), habitats, and distribution of biota at various locations other than at the dam or immediate tailrace. This study coupled with the Operations Modeling Study (Study 5) is designed to provide that determination.

PROJECT NEXUS

The three projects are operated to pass flows and maintain water levels in the impoundments in accordance with conditions established in the current license and in response to daily hydrologic conditions and energy prices. Operations modeling facilitates the optimization and simulation of detailed hourly operations over an annual period based upon those variables. The operations model, discussed in more detail in Study 5, will inform short-term operations scheduling by simulating the optimization of complex characteristics of energy pricing, inflows, minimum flows, and impoundment and tailwater conditions.

No changes are proposed to project operations and therefore, no new effects on environmental resources from operations are anticipated. For long-term planning purposes, and in light of the potential for expected variability in hydrology and energy pricing, the operations model (Study 5) will inform operations to balance license, hydrologic, energy, and environmental resource conditions.

The modeling conducted under this study will provide a key link to understanding hydraulic parameters such as flow and water levels at locations of interest to inform specific study objectives of other the studies cited above.

STUDY AREA AND STUDY SITES

The hydraulic model study area will include the main stem of the Connecticut River extending from immediately downstream of McIndoes dam to the downstream boundary of the Vernon Project.

METHODS

The HEC-RAS software, Version 4.1.0 (USACE, 2010) will be used in this study to develop a model to perform 1-D hydraulic calculations for the study area. FERC referenced use of the HEC-RAS model in its study request.

The hydraulic model will simulate steady routing of river flow through impoundments and along river reaches for operations and hydrology scenarios developed for Study 5. River reach characterization will be performed by the selection of cross section locations using the Environmental Systems Research Institute (ESRI) Geographic Information System (ArcGIS) Version 10.0 (ESRI, 2010), HEC-GeoRAS Version 10 (USACE, 2012), and USGS topographic maps.

Cross sections will be placed around hydraulic structures, stream junctions, and locations of interest identified by other ILP studies. Cross section locations will be based on river morphology to capture changes in channel and floodplain width, slope, and storage. The HEC-RAS model will use GIS and Digital Elevation Models (DEMs) to derive the elevation data for the cross sections (USDA, 2013; USGS, 2013). DEM data will be augmented by more detailed topographic and bathymetric survey data collected in Study 7 (Aquatic Habitat Mapping) and at locations of interest identified by other studies.

Specific steps to develop the HEC-RAS hydraulic model for the study area are as follows:

- Compile hydrology and operations data from operations modeling performed in Study 5. Hydrology data compiled in Study 5 encompasses a range of wet, dry, and normal conditions, and includes hydrologic conditions reasonably expected to occur across the subsequent licensed period. Set up the hydraulic model for the study area:

  - Cross Sections

    - Cut cross sections in GIS from readily-available, 10-meter USGS National Elevation Data (NED) DEMs. References indicate the 10-meter DEMs are available for the study area (USGS, 2013; USDA, 2013).

    - Refine cross sections with more detailed data provided by project data (impoundment bathymetry, dam foundations, side channel spillways), and field studies performed by other studies (site-specific bathymetric and topographic surveys). Study findings may indicate a need for more extensive topographic surveying such as LiDAR, although it is not planned in this study at this time.

  - Impoundment Storage

    - Set up impoundment storage at modeled water surface elevations to replicate available data.

    - Employ dynamic routing in the model through the impoundments to allow for data output at cross section locations within the impoundments.

  - Manning's n-values

    - Input Manning's n-values for main channel and overbanks based on a combination of readily available field and photographic observations, published sources, and standard references (Chow, 1959; Barnes, 1967).

- Perform steady flow routing along the study reach for a range of flow and elevation operating conditions. Operation scenarios will include the full range of baseline operating conditions consisting of the projects' currently licensed minimum flows and impoundment upper and lower operating limits as described in the project PADs.

- Use the hydraulic model to derive hydraulic parameters such as water level, flow, and velocity at locations of interest, as identified in other studies. Provide the hydraulic parameters to the operations model in Study 5.

The method for integration of this study with the Study 5 operations model, and other resource studies that will depend on hydraulic modeling to interpret project effects, will occur by the following process (identical to Study 5):

- The existing operations model will be updated for base operating conditions (see Study 5).
- Site-specific topographic and bathymetric surveys, which will be collected as part of other resource studies, will be provided to the HEC-RAS modelers for hydraulic model setup. Hydraulic data collected as part of other field resource studies will be provided to the HEC-RAS modelers as a check for model flow, elevation, and velocity at the specific locations where data was collected.
- The HEC-RAS model will be set-up and run to derive hydraulic parameters such as water levels and flows at locations of interest as identified in other studies, and to provide hydraulic parameters for studies that will assess project effects.
- The operations model will be run using the hydraulic parameters derived from the HEC-RAS model. Data summarizing the effects at locations of interest will inform the other resource studies.

Additional model refinements will be made to both the HEC-RAS and operations models based on other resource studies, and additional model runs will be made, as applicable.

ANALYSIS

Hydrology and operation scenarios will be exported from the operations model (Study 5) for import into the hydraulic model. The hydraulic parameters derived from the hydraulic model will be provided for use in other studies.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The HEC-RAS software program was designed by the U.S. Army Corps of Engineers to perform 1-D, hydraulic calculations for natural and man-made channels. HEC-RAS is widely used and accepted by the engineering community and regulatory agencies. For example, this model is the standard for USACE projects; the Federal Emergency Management Agency (FEMA) has accepted HEC-RAS for performing national flood insurance studies; NRCS has adopted HEC-RAS as their main river hydraulics model; the Federal Highway Administration has accepted it for its use on highway hydraulics studies; and many state and local agencies across the country have also adopted HEC-RAS for use in hydraulic studies. HEC-RAS has become a standard in the industry for river hydraulic modeling.

DELIVERABLES

Hydraulic parameters will be developed and provided for use in the operations model and for analysis of project effects on resources that are the subject of other studies. A report will be prepared that presents methods, analysis, and results of the study.

Results and conclusions will be reported in either the PLP or draft license applications for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

The hydraulic model will be preliminarily set up by the end of 2013. Refinements to the model will be made in the first study year (2014) after first year study field work (topographic and bathymetric surveys, river flow and water level data collection) becomes available from other studies. Model runs, additional model refinements, and additional model runs will be made during the second study year, as applicable.

LEVEL OF EFFORT AND COST

The preliminary estimated cost for this study is approximately $320,000 for work performed in 2013 and 2014, and includes costs for LiDAR and/or aerial photos. The preliminary estimated cost for work to be performed in 2015 cannot be estimated at this time and will be based on the specific areas of interest to be identified in other studies and the results of analysis performed from field studies.

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Study 5

Operations Modeling Study

RELEVANT STUDY REQUESTS

FERC-01; FWS-01; NHDES-14a; NHFG-14; VANR-04; CRWC-11; TNC-01; TU-07

STUDY GOALS AND OBJECTIVES

In their study requests, FERC, FWS, NHDES, NHFG, VANR, RWC, TNC, and TU indicated an interest in understanding the effect of operations at the Wilder, Bellows Falls, and Vernon Projects on environmental resources. The goal of this study is to develop an operations model that will provide information on the effect of flows and water levels, resulting from hydrology and operational scenarios, on environmental resources.

The objective of this study is to develop a time-series database of hourly water levels and flows for various selected operational scenarios, to enable other studies to assess the effects of project operations on aquatic, terrestrial, and geologic resources at locations of interest. The values will be available at many locations on the river system, including identified econodes.

Study requests also identify an interest in understanding how operations at the three TransCanada projects affect operations of the Northfield Mountain Pumped Storage and Turners Falls Projects. That is beyond the scope of TransCanada's hydraulic and operations models and is the responsibility of FirstLight to develop that determination. TransCanada will, however, provide FirstLight with output from its models in the form of discharge at Vernon dam. This would serve as the upstream inflow in the model FirstLight develops to assess the effect on its operation. This two model approach (TransCanada-First Light) will effectively meet the agency and stakeholder requests but will preserve the separation of operations decisions, which is a necessity and requirement within the power market in which we both operate our businesses.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

Federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS

- General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives; and to conserve, protect and enhance habitats for fish, wildlife and plants affected by the projects.
- General goals related to aquatic resources including protection, enhancement, or restoration of aquatic and riparian habitats; providing instream flows to meet the requirements of diadromous

and resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.

NHDES

- State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.

NHFG

- General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).

VANR

- State water quality standards for designated uses of Class B waters relative to flow alteration, water level fluctuation, and anti-degradation provisions. The Connecticut River below Wilder dam is listed as impaired waters on the Section 303(d) due to flow alterations.
- General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.

ASSOCIATION WITH OTHER STUDIES

The Vista Decision Support System (Vista DSS™) operations model in this study is TransCanada's central tool for assessing project effects on aquatic, terrestrial, and geologic resources under current operating scenarios. Completion of this study is dependent on hydraulic parameters from the hydraulic model (Study 4). The results of this study and Study 4 will be used to assess project effects on the following, at a minimum: erosion processes (Studies 2 and 3); aquatic resources (Studies 8, 12, 13, 14, 15, 16, 22, 24, 25, and 26); terrestrial resources (Studies 26, 27, 28, and 29); and recreation and aesthetic resources (Studies 31 and 32).

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

The PADs for the Wilder, Bellows Falls, and Vernon Projects provide detailed information on current project operations including normal operations, inflow, river profile operation, high flow operation, and flood control and navigation. The PADs also provide information on the existing environment and resource effects. However, presently there is no tool that enables correlation of current project operations related to flows and water levels to observed shoreline phenomena (e.g., erosion), habitats, and distribution of biota. This study coupled with the hydraulic model (Study 4) is designed to provide that tool.

PROJECT NEXUS

The three projects are operated to pass flows and maintain water levels in the impoundments in accordance with conditions established in the current license and in response to daily hydrologic conditions and energy prices.

In an operations environment, modeling facilitates the optimization of detailed hourly operations on a continuous basis, considering the key input variables and objectives. The inputs include inflows, constraints on impoundment water levels and river flows, and market prices. Objectives are first to meet defined constraints and then maximize the value of energy generation with the flexibility that remains. In the study environment, the modeling simulates or mimics the above stated process.

No changes are proposed to project operations and therefore, no new effects on environmental resources from operations are anticipated. For long-term planning purposes, and in light of the potential for expected variability in hydrology and energy pricing, the operations model will inform operations to balance license, hydrologic, energy, and environmental resource conditions.

The modeling conducted under this study will provide a key link to understanding hydraulic parameters such as flow and water levels at locations of interest, to meet specific study objectives of the other studies cited above.

STUDY AREA AND STUDY SITES

The operations model was developed to simulate operations of the Wilder, Bellows Falls, and Vernon Projects. Dams at these three projects create three impoundments, which are represented as “headponds” in the operations model. The model also includes the upstream Dodge Falls Hydroelectric Project (FERC No. 8011) and the Fifteen Mile Falls Project (FERC No. 2077). Three upstream storage impoundments, Lake Francis, First Connecticut Lake, and Second Connecticut Lake, are also included in the operations model.

The study focus area for the model is the Wilder, Bellows Falls, and Vernon Projects and their effects. Several large tributaries to the Connecticut River are included in the study area as hydrology inflows for the operations modeling. The hydrology data set represents inflows from large tributaries that include but are not limited to: Passumpsic, Waits, Ompompanoosuc, White, Ottaquechee, Black, Williams, and West rivers in Vermont, and the Ammonoosuc, Mascoma, Sugar, and Cold rivers in New Hampshire. In addition to tributary inflows, the hydrology developed for the operations model also includes uniform lateral inflows from upland watersheds.

METHODS

The Vista DSS™ software system developed by Hatch Ltd will be used in this study. Vista DSS™ is a proprietary system that provides a framework to model detailed operations of water resources and hydroelectric operations. It comprises nine integrated modules, under a Windows operating system, and uses robust database technologies and a sophisticated Windows user interface.

It is a network flow model that simulates operation of water control structures and effects in associated river reaches and reservoirs, and is used primarily to reliably meet license conditions (including minimum flows, and impoundment limits) and maximize value from energy production. A cornerstone of the model is the continuous determination of optimum operational actions on an iterative basis, responding to changing conditions such as hydrologic inflows and energy pricing.

The model consists of a series of nodes and arcs to define specific system features such as hydrology (inflows from tributaries and upstream watersheds), river junctions, impoundments, tailwater, spillways, and power generating units. In the model, "econodes" represent specific areas of interest. Econodes will be identified in the operations model to provide an understanding of the effect of flows and water levels resulting from hydrology and operational scenarios on environmental resources.

Specific steps to develop the operations model include:

- Revise the operations model developed in 1992 in the following areas:
  - update the generating unit performance characteristics;
  - update the operational constraints (license conditions);
  - update the model hydrology dataset through 2011 and select five representative hydrology years based on inflow volume and annual energy production;
  - update the model with econodes that define areas of interest as identified from other resource studies;
  - define econode elevation relationships with flows and downstream node elevations, using the hydraulic model results developed from Study 4;
  - define new river reaches, associated with the updated econodes, and the routing parameters; and
  - update econode environmental assessment indices rating curves (function of flow and/or elevation) from other studies.
  - Update the hourly schedule for 2010 energy pricing, which is deemed to be representative of the fluctuating nature of the market prices.
- Run the operations model for a range of baseline operating conditions using five representative hydrology years.
- Provide time-series database of hourly water levels and flows and associated assessment indices to enable other studies to assess the effects of operations on environmental resources at locations of interest. The time-series database will enable assessments regarding the variability, rate of change,

and frequency of fluctuation within the impoundments and tailraces based on criteria and areas of interest identified by other studies.

The method for integration of this study with the hydraulic model (Study 4) and other resource studies that will depend on hydraulic modeling to interpret project effects will occur by the following process:

1. The existing operations model will be updated for base operating conditions.

2. Topographic and bathymetric surveys, which will be collected as part of other resource studies, will be provided to the HEC-RAS modelers for hydraulic model setup. Hydraulic data collected as part of other field resource studies will be provided to the HEC-RAS modelers as a check/calibration step for model flow, elevation and velocity at the specific locations where data was collected.

3. The HEC-RAS model will be set-up and run to derive the following relationships

    a. econode water level as a function of flowrate at the econode; for riverine sections;

    b. econode water level as a function of flowrate at the econode, and the water level at the downstream reservoir; for backwater sections; and

    c. routing characteristics for all main stem river reaches (lag time and routing/attenuation parameters.)

4. The operations model will be run using the above hydraulic parameters derived from the HEC-RAS model. Data summarizing the effects at locations of interest will inform the other resource studies.

5. Additional model refinements will be made to both the HEC-RAS and operations models based on other resource studies, and additional model runs will be made, as applicable.

ANALYSIS

Hydrology and operation scenarios will be exported from the operations model for import to the hydraulic model (Study 4). The hydraulic parameters derived from the hydraulic model will then be formatted into hydraulic index curves for use in other studies.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

Vista DSS™ has become a standard in the water resource and power sector for operations analysis and simulation. This model is widely used by power companies for assisting in hydropower operations and for undertaking strategic studies. It has been implemented for many North American power companies (e.g., Manitoba Hydro [5,000-MW], Bonneville Power Administration [BPA; 20,000-MW], PacifiCorp, Tacoma Power, Southern California Edison, NextEra Energy, Nalcor Energy, Saskpower), as well as several international companies (Panama Canal Authority, Mighty River Power in New Zealand, and Volta River Authority in Ghana).

DELIVERABLES

The methods and results from the Hatch Vista operations model, alternative scenarios, and database development will be summarized in a final report.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

The Vista DSS™ operations model will be set up for the base operating conditions by the end of 2013. The integration of hydraulic parameters from Study 4 will occur in the first study year (2014). Refinements to the model will be made after study field work (topographic and bathymetric surveys, river flow and water level data collection) becomes available from preliminary field work or other studies. Model runs, additional model refinements, and additional model runs will be made during the second study year, as applicable.

LEVEL OF EFFORT AND COST

The preliminary estimated cost for operations model setup and execution for the base operating condition and three alternative operations scenarios, including the addition of updated econodes and associated hydraulic parameters derived in Study 4, is approximately $143,000.

REFERENCES

NHFG (New Hampshire Fish and Game Department). 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Additional Technical References:

Bridgeman, S.G., Huysentruyt, J., Allen, R.B., and Olason, T. 1996. Automation Strategies of New England Power Company for the Connecticut & Deerfield Rivers, H. G. Acres Seminar, Niagara Falls, Canada.

Bridgeman, S.G., Huysentruyt, J., Olason, T., Allen, R.B., Kirshen, P. 1996. Hydroelectric Generation Scheduling for the Connecticut and Deerfield River Systems, ASCE Proceedings of Fifth Water Resources Operations Management Workshop. Arlington, VA.

Bridgeman, S.G., Allen, R.B., Welt, F., Olason, T., Lafreniere, M., Babel, L., and Kuepper, B.P. 2001. Buena Vista, International Water Power & Dam Construction.

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Olason, T., Welt, F., and Shields, D. 2005. Short-Term Generation and Transaction Scheduling at Manitoba Hydro using the Vista Decision Support System, Waterpower XIV, Austin, TX. July 18 – 22, 2005.

USGS. 2012. Gage Streamflow Data. http://waterservices.usgs.gov/rest/DV-Test-Tool.html.

Study 6

WATER QUALITY MONITORING AND CONTINUOUS TEMPERATURE MONITORING

RELEVANT STUDY REQUESTS

FWS-20; NHDES-22a, -22b, -22c; NHDES-25a, -25b, -25c; NHFG-22a, -22b, -22c; NHFG-25a, -25b, -25c; VANR-02, -03b, 03c; CRWC-05, -06, -07, -08, -09, -10

STUDY GOALS AND OBJECTIVES

In their study requests, FWS, NHDES, NHFG, VANR, and CRASC stated that TransCanada should monitor water quality to determine the operational effects of the Wilder, Bellows Falls, and Vernon Projects on water quality.

The goal of this study is to determine potential project effects on water quality parameters of: dissolved oxygen (DO), water temperature, turbidity, conductivity, nutrients, and chlorophyll-*a*. Documentation of these parameters will provide information on the effects of project operations on water quality over an extended period of time and during low flow summer conditions. The water quality data collected will be compared to Vermont and New Hampshire water quality standards to help determine if the projects are meeting state water quality standards.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS

- General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives; and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.
- General goals related to aquatic resources including protection, enhancement, or restoration of aquatic and riparian habitats; and minimizing project effects on water quality and aquatic habitat.

NHDES

- State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.

NHFG

- General goals related to healthy ecosystems to support fish and wildlife. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).

VANR	•	State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat. The Connecticut River below Wilder dam is listed as impaired waters on the Section 303(d) due to flow alterations.

ASSOCIATION WITH OTHER STUDIES

This study is not directly associated with other studies. However, water quality data collected in other aquatic resources studies will provide additional snapshot data points that may be included in the water quality data set as applicable. The results of this study would not be directly used to inform the conclusions of other studies other than to provide general data of turbidity levels that could be used with Study 3, the Riverbank Erosion Study.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Existing information is extensive and was cited and/or summarized in the project PADs. Specific to the TransCanada projects, after the upgrade of four of the generating units at Vernon, NHDES issued a 401 Water Quality Certificate that required DO and temperature monitoring for the Vernon Project; sampling for this occurred in 2011 and 2012. In addition, water quality data (temperature, specific conductivity, pH, DO, nutrients, and chlorophyll-a) were collected by TransCanada in 2012 (Normandeau, 2013) in all three project areas from mid-June to mid-September as part of the 2012 Baseline Water Quality Study in accordance with a study plan that was reviewed and contributed to by NHDES and VANR.

Water quality data collected during the 2012 baseline study is representative of conditions during a low flow, warm weather period. Obtaining an additional year of water quality data during a warm weather period with more typical flows will better enable project effects to be distinguished from other factors that affect water quality. In addition, turbidity data and data from background monitoring stations upstream of the impoundments were not collected during the 2012 water quality sampling.

PROJECT NEXUS

The Wilder, Bellows Falls, and Vernon Projects impound respectively 45, 26, and 26 miles of the Connecticut River. The projects are operated primarily on a daily run-of-river basis, whereby over the course of a day, the projects pass the average daily inflow. Peaking often occurs during the course of the day, and the existing minimum flow requirements are 675, 1,083, and 1,250 cfs, respectively, although actual minimum flows are slightly higher to take advantage of generating unit efficiencies.

License authorized operating limits for Wilder, Bellows Falls, and Vernon impoundments are 5, 3, and 8 feet, respectively; daily fluctuations, based on inflow and operations, vary between projects but are in the range of 2 to 3 feet normally. Water quality, especially temperature and DO, can be affected by the impoundments and the operation of hydropower projects in general. This study will provide information on how the project operations may affect water quality within the impoundments and tailraces. This study will supplement TransCanada's 2012 study results included in Normandeau (2013). The data obtained by this study will document whether the Connecticut River in the vicinity of the projects is in compliance with the water quality standards of both states.

STUDY AREA AND STUDY SITES

The study area will include the Wilder, Bellows Falls, and Vernon impoundments, as well as riverine locations upstream of the impoundments, the project tailraces, the Bellows Falls bypassed reach, and the mouths of key tributaries. The study will include the same 13 stations sampled during 2012 and three additional background stations upstream of the influence of the three project impoundments. Thus, the study area will extend from above the upstream limit of the Wilder impoundment (at approximately river mile [RM] 264) to the tailwaters of the Vernon Project at the same station established during the 2012 sampling (V-TR).

Continuous water temperature monitoring at 15-minute intervals will be conducted at the mouths of the following 10 major tributaries to the Connecticut River: Waits, Ompompanoosuc, Mascoma, White, Sugar, Black, Williams, Cold, Saxtons, and West Rivers. Monitoring sites will be located such that the data are representative of the water temperature of the tributary inflow to the Connecticut River. Continuous water temperature monitoring will also occur at the 16 locations in the Connecticut River as noted in the preceding paragraph. In addition, this study will include continuous water temperature monitoring at transects at the monitoring locations within the impoundments.

METHODS

The methodology for weekly impoundment vertical profiles, weekly impoundment nutrient and chlorophyll-*a* samples, and continuous (15-minute interval) dataloggers for temperature, DO, specific conductivity, and pH, in the project impoundments and tailraces will be the same as those used in the 2012 sampling program (Normandeau, 2013). In addition, turbidity probes will be added to each of the mainstem Connecticut River multi-parameter dataloggers. From the first week of June through September 30, tributary dataloggers will continuously monitor water temperature only. At each of the three datalogger monitoring locations in the three impoundments, at least 10 days of data will be collected at 15-minute increments during a period of low flow (<3 x 7Q10) and high temperatures (preferably over 23^{o}C) between June 1 and September 30.

At the datalogger monitoring locations within the impoundments, during the 10-day low flow and high temperature period, transects will be established for additional water temperature data collection. These transects will consist of three stations (including the mid-channel long-term datalogger) perpendicular to the flow with the water temperature dataloggers at depths of 1 meter, mid-depth, and 1 meter from the bottom recording at least 10 days of data at 15-minute intervals.

Study requesters recommended 15-minute increment water temperature datalogging at the transects and profiles from April 1 until November 15. However, the data from water temperature profiles and transects during the 10-day low flow and high temperature period, along with the other water temperature data will be sufficient to determine the effects of project operations on water temperature and to develop isotherm maps during the likely worst case time period for possible reservoir stratification.

YSI 6920 V2 multiple-parameter water quality sondes will be used as in the 2012 study. The continuous monitors will be maintained, calibrated, and data-downloaded on a weekly basis during the monitoring period. This interval should be suitable for waters of relative high quality as found in this portion of the Connecticut River. Onset HOBO Water Temperature Pro v2 dataloggers or the equivalent will be used to record water temperatures at the 10 sites within the tributaries and the 9 mainstem Connecticut River stations not occupied by multi-parameter dataloggers. All sampling locations will be located and re-occupied by handheld GPS unit with a 10-foot horizontal level of accuracy.

ANALYSIS

Water quality results from this study as well as incidental data collected during other aquatic studies will be graphically compared to both state water quality standards and project operations, including hourly generation, impoundment elevation, discharge, and daily weather conditions at nearby National Oceanic and Atmospheric Administration (NOAA) weather stations during the study period, and will be compared to historical average daily weather conditions. In addition, the average daily flows at the West Lebanon and Walpole USGS gages during the May 15 to September 30 period as compared to the average daily values for the 1972 to 2012 period will be provided. The water quality results from this study will also be compared to water quality data gathered in 2012 to contrast weather and flow conditions between the two sets of water quality data. The information acquired will be used to qualify and quantify water quality data for the Connecticut River and identify project operations or other factors that may affect water quality.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

This study involves collecting water quality data using methods and equipment generally accepted by the scientific community.

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study. The report will present the results of the 2014 water quality monitoring program, compare the results with the 2012 water quality monitoring data presented in Normandeau (2013), and assess the need for any additional water quality monitoring.

A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

Water quality sampling will begin by the first week in June and continue through September 30 of the first study year (2014). TransCanada will consult with the resource agencies regarding the need for subsequent monitoring following the compilation of the first study year results.

Resource agency study requests recommended a time frame for the continuous water temperature monitoring of April 1 to November 15. However, the longer monitoring time period would likely involve ice conditions in April and generally higher flow conditions in April and May (and potentially in November) that are often beyond the control of the project facilities. Deployment of temperature dataloggers during April and May under high flow conditions may represent a safety hazard and may also result in loss of dataloggers. Resource agency stated study objectives relate to determining project effects on water temperature. During the cool weather months of April, May, October, and November, it is unclear how the projects could adversely affect water temperature and aquatic resources.

LEVEL OF EFFORT AND COST

The preliminary estimated cost of this study is $185,000 for a 1-year monitoring program.

REFERENCES

NHFG (New Hampshire Fish and Game Department). 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Normandeau (Normandeau Associates, Inc.). 2013. 2012 Baseline Water Quality Study. Wilder Hydroelectric Project No. 1892, Bellows Falls Hydroelectric Project No. 1855, Vernon Hydroelectric Project No. 1904. Agency Draft Report. Prepared for TransCanada Hydro Northeast, Inc. February 8, 2013.

Study 7

AQUATIC HABITAT MAPPING

RELEVANT STUDY REQUESTS

FERC-05

STUDY GOALS AND OBJECTIVES

In its study request, FERC identified issues related to potential effects on fish and aquatic resources due to operations of the Wilder, Bellows Falls, and Vernon projects. Specifically, low flow conditions and low impoundment water levels at certain times may affect the ability of fish and other aquatic species to use aquatic habitats.

The goal of this study is to survey, identify, and map aquatic habitat at the Wilder, Bellows Falls, and Vernon Project-affected areas and assess potential effects under current operations.

The objectives of this study are to:

- survey and map the aquatic habitat types distributed within the project impoundments, tailwaters, and downstream riverine corridors from the upper extent of the Wilder impoundment and downstream to Vernon dam, including the Bellows Falls bypassed reach and the tailwater just below Vernon dam; and

- describe potential influences of project impoundments and project operations on the distribution of aquatic habitat within the reaches to be assessed.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

Since only FERC requested this study, there are relevant resource management goals of agencies or Indian tribes with jurisdiction over the subject resources that directly apply to this study. However, since this study will inform numerous other studies as described below, resource management goals listed in the associated study plans can be considered relevant to this study.

ASSOCIATION WITH OTHER STUDIES

Aspects of several other studies are dependent on information gathered from this aquatic habitat mapping study. For all studies listed below, acquisition of aquatic habitat mapping data will need to be completed prior to commencement of these interdependent studies.

- Instream Flow Study (Study 9) will use the results of this study to assist with study site and transect selection and, to some extent, the proposed study method (i.e., 1-D, 2-D, Demonstration Flow Assessment).

- Resident Fish Spawning in Riverine Sections Study (Study 15) will use habitat types, depth, and substrate information derived from this study to locate suitable spawning habitat and assess project effects.

- Tributary and Backwater Area Fish Access and Habitats (Study 13) will use aquatic habitat data and bathymetry information collected during impoundment mapping as part of its assessment.

- Aquatic habitat data will be used for identification of appropriate sampling locations to assess the distribution and relative abundance of tessellated darter within the project-affected areas (Study 12).

- Aquatic habitat data will be used in the analysis of distribution of resident riverine and diadromous fish species within project-affected areas (Study 10).

- Floodplain, Wetland, Riparian, and Littoral Habitats Study (Study 27) will use aquatic habitat and bathymetric data to define the littoral zone, quantify the effects of water level changes on wetland and littoral vegetation communities, and quantify suitable habitat for aquatic vegetation.

- Hydraulic Modeling Study (Study 4) and Operations Modeling Study (Study 5) will rely on the results of this study for modeling purposes, and these models will determine the association and effect of project operations versus other influences on conditions observed at specific locations within the impoundments and downstream affected areas. These tools are critical for evaluating and determining potential influences of project operations on the distribution of aquatic habitat within the reaches to be assessed. They will also be critical to assessing and determining project-related association and effects within the above-mentioned associated studies as well as numerous other studies.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Minimal information exists pertaining to characteristics, types, and proportions of aquatic habitat within the project impoundments, tailwaters and riverine reaches. A localized qualitative habitat evaluation was conducted by Yoder et al. (2009) in a few selected sites in conjunction with the assessment of fish assemblage in the mainstem Connecticut River. Specific aquatic habitat data within all project reaches is lacking, and this study will serve to fill those data gaps

PROJECT NEXUS

Currently, water levels in the impoundments, tailwaters, and downstream riverine areas fluctuate due in part from the daily operations of all three projects. In addition, there is no minimum flow requirement in the Bellows Falls bypassed reach. As a result, aquatic habitats may be exposed under low flow conditions, and low impoundment water levels may be adversely affected and/or not used by aquatic species during various life stages. Changes in flow or periods of low flow may also cause stranding and associated mortality of fish or other aquatic species (e.g., mussels and macroinvertebrates).

This study will help establish a baseline condition of aquatic habitats in the Connecticut River from the head of the Wilder impoundment to Vernon dam under current licensed project operations.

STUDY AREA AND STUDY SITES

The study area includes all project impoundments and riverine sections of the Connecticut River from the Wilder Project to Vernon dam. Impoundment sections include from Wilder dam upstream 45 miles, from Bellows Falls dam upstream 26 miles, and from Vernon dam upstream 26 miles. The total run-of-river distance of impoundments is approximately 97 miles. Riverine reaches consist of a 17-mile segment downstream of Wilder dam and a 6-mile segment downstream of Bellows Falls dam. In addition, the 3,500-foot-long Bellows Falls bypassed reach will be mapped as will the immediate tailwater section below Vernon dam.

METHODS

Aquatic habitat differs between lotic (flowing water) and lentic (standing water) ecosystems. As a result, the aquatic habitat mapping process and types of habitat identified differ. Bathymetric and habitat mapping of the lentic impoundment sections are anticipated to begin in the spring\summer of 2013. Mapping of lotic riverine reaches will take place at the minimum flow or lowest flow available at the time of the survey.

Impoundment Aquatic Habitat and Bathymetry Survey Methods

Impoundment habitat data will be collected using a side scan sonar system (Humminbird® 1197c, Side Imaging system). Impoundment bathymetric data will be collected using a calibrated 200-kHz Odom® Hydrotrac single-beam echosounder. Collection of habitat and bathymetric data in the impoundments will use an RTK unit (Leica® Viva GS14) for positional information. The RTK unit will provide vertical water surface positional information to compensate for fluctuations in water levels as well as differentials in water surface elevations within each impoundment. This allows the bathymetry survey to output river bed surface elevations by calculating the difference of the elevation of the survey vessel and the water depth while the survey is in progress. The RTK unit also provides horizontal positional information necessary for georeferencing the side scan images collected for the assessment of impoundment habitat data.

Bathymetry and habitat data will be collected along predetermined survey lines and can be collected concurrently in the central portions of the impoundments where the equipment used will operate on separate frequencies that do not interfere with each another. Bathymetry and habitat data will be collected separately along the shorelines of the impoundments to avoid interference with the collection of bathymetric data by the Odom echosounder from the 800 kHz side scan sonar frequency. Collection of shoreline impoundment habitat data using the side scan sonar data will occur only when the impoundment is within normal elevation range to ensure complete coverage of the shoreline habitat. Bathymetry data will be collected at a 2-foot interval scale in the center of the impoundments, and 1-foot interval scale in the backwater areas and along the shoreline of the impoundments, which will provide sufficient detail to assess the potential effects of reservoir fluctuations on aquatic habitat.

Portions of the Wilder, Bellows Falls, and Vernon impoundments will not be able to be mapped using side scan sonar due to shallow water depths, turbulence (i.e., near rapids or falls), or dense beds of aquatic vegetation. Results from sections of the impoundments that are not accessible for quantification by side scan sonar will be presented in geo-referenced substrate classifications conducted using a technique appropriate for the conditions (e.g., view tube, ponar grab, wading). Those observations will be imported into GIS and used in conjunction with results of the side scan surveys.

Impoundment Habitat Data Processing

Accurate side scan track data will be imported into GIS and used to reference the sonar imagery to its place on the river bottom. The resulting shapefile will be subjected to visual quality control inspection for positional accuracy and image quality. When sufficient images are present to provide coverage of the impoundments, dominant habitat types will be delineated resulting in a 2-D representation of the riverbed divided into habitat types. A total of six substrate types will be identified based on the dominant habitat type, (1) sand/silt/clay, (2) gravel/cobble, (3) boulder, (4) rip-rap, (5) ledge, and (6) woody debris. Given the resolution provided by this technique, it is not possible to differentiate substrate types finer than gravel, and as a result, sand, silt and clay will be grouped into a single class. Likewise, gravel and cobble will also be classified as a single category, because the particle sizes cannot be differentiated in some cases. Habitat types will be delimited down to a minimum map unit of 100 ft^2 (0.002 acre). However, in most cases habitats smaller than this area will be discernible and included in the substrate dataset. The final product of this process will be a GIS shapefile containing the aquatic habitat types for each of the three project impoundments.

Classifications of all habitat types from side scan imagery will be validated while in the field. Validations will consist of visual assessment within shallow water habitats and/or clear water conditions as well as pole and ponar grab samples for deeper water areas. Each of these validations will have a recorded position associated with them and will be compared to the final side scan impoundment habitat product.

Impoundment Bathymetric Data Processing

Bathymetric data will be imported into GIS, and positional data will be audited for outliers. The upper elevation of the operational range for each impoundment will be digitized based on available digital orthophotos and verified through the use of field observations during periods when inflows approach station capacity and/or during scheduled periods when impoundments are full. Using GIS, bathymetric data points will be spatially subsampled and interpolated to create a 3-D surface. The resulting surface will be verified by field observations and aerial photography.

The 3-D surfaces generated for each impoundment will be converted to a series of 2-foot bathymetric contours with 1-foot bathymetric contours in the littoral portions of the impoundments.

Riverine Aquatic Habitat Methods

Riverine habitat mapping will be performed drifting downstream in a small johnboat equipped with oars and a small outboard motor, or by canoe if boat access is limited or difficult. A depth transducer mounted to the side of the boat and a Trimble GPS unit attached to an onboard laptop computer or data logger will be used to continually monitor depth and record real-time GPS positions. The GPS will also be used to record habitat boundaries and any other features such as islands, split channels, and tributaries. In addition, a hand-held GPS unit will record habitat unit boundaries as a backup. In shallow areas, the survey will generally follow the thalweg (deepest part of the channel). In long pools and runs, the survey crew will attempt to locate the deepest portion of the channel. In instances of islands or split channels, the primary channel will be mapped, and a visual examination will be performed on the secondary channel to determine habitat type correspondence between the two channels. If differences are noted, the other channel will also be mapped. The Bellows Falls bypassed reach will be mapped on foot.

Riverine habitat types are often referred to as mesohabitats. Generally the three major mesohabitat types recognized are pool, run, and riffle although these types are often broken down into sub-types depending on the river channel morphology. Unless a specific type of habitat is considered important for a given aquatic species, the actual habitat types are not as critical as being consistent in identifying those types in the field. For this study the mesohabitat types expected to be used are:

- Pool – deep, low velocity with a generally well defined control and retains water at zero discharge;
- Glide – shallow with moderate velocity distributed across the channel, without a well defined thalweg, sometimes referred to as shallow pool if velocities are low;
- Run – deep to moderately deep with fast velocity in a well defined thalweg, surface may be turbulent, substrate variable;
- Riffle – shallow with gravel, cobble, or boulder substrate, fast water with turbulent flow or white-water, possible exposed substrate;
- Rapid – shallow bedrock, boulder with turbulent white-water flow and possible exposed substrate, may be brief and abrupt across the stream channel or extend for a greater distance; and
- Other – may include backwaters or other mesohabitat types if primary types are believed to be insufficient for characterization. The mapping protocol will allow for additional types or sub-types to be added according to the best judgment of the field personnel.

Pool and run habitat may be broken down further into deep and shallow depending on results of depth distributions derived from mapping results. Additional information that will be collected for each mesohabitat unit includes dominant and subdominant substrate and bank or instream cover type (ledges, boulders, vegetation, etc.). Substrate will be classified into (1) organics, (2) silt and clay, (3) sand, (4) gravel, (5) cobble, (6) boulder, and (7) bedrock.

ANALYSIS

Upon completion of collection, impoundment aquatic habitat and bathymetric data will be processed using ArcGIS. A GIS shapefile consisting of uniquely defined habitat polygons will be created for each impoundment using the habitat data collected during the side scan sonar sampling. A second GIS shapefile, composed of 2-foot bathymetric contours, will be generated for each project impoundment using data collected from the single beam echosounder. Finer resolution (i.e., 1-foot bathymetric contours) will be included in the littoral portions of the shapefile for each impoundment. Tabular and graphical output from the impoundment aquatic habitat and bathymetric study will also be used for presentation and analysis in other study reports that are dependent on results from this study.

Upon completion of the collection of riverine aquatic habitat mapping, the data will be entered into spreadsheets for review and summary. Frequency of habitat types will be developed, and habitat boundaries will be plotted on aerial maps to determine habitat area and locations. Data summaries from this study will also be presented in reports from other studies that are dependent on the results from this study.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The study methodology is consistent with generally accepted practices. Similar lentic and lotic surveys have been conducted for other FERC hydroelectric relicensings including the Brassua Project (FERC No. 2615), Green River Project (FERC No. 2629), Yadkin-Pee Dee Project (FERC No. 2206), Claytor Lake Project (FERC No. 739), Smith Mountain Project (FERC No. 2210), and most recently, the Turners Falls Project (FERC No. 1889).

DELIVERABLES

A study report will be provided after this one year. Study deliverables will include a presentation to resource agency personnel and other relicensing participants. At a minimum, the report will include a summary of data collected, habitat descriptions, aerial and/or topographic habitat maps and flow and project operations during surveys. In addition, all data used to produce the report will be included in an appendix.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

Impoundment aquatic habitat and bathymetry surveys will be conducted between June 2013 and November 2013. Surveying will take approximately 17 days for the Wilder impoundment, approximately 12 days for the Bellows Falls impoundment, and approximately 10 days for the Vernon impoundment. It is anticipated that all field work will take approximately 39 days. Data analysis and production of maps will be done completed by January 2014 to support the several dependent studies to be conducted in 2014 and 2015.

Riverine aquatic habitat mapping will take place under summer low flow conditions and project minimum flows. Surveys may be completed under scheduled shutdown or scheduled maintenance efforts if possible. Generally, a survey conducted by two individuals in a boat or canoe can cover 5 miles a day. Based strictly on river miles, the riverine surveys would take approximately 5 to 6 days. However, boat access constraints in some locations will increase the estimated survey time. Mapping of the Bellows Falls bypassed reach can take place anytime because flow levels in this reach are not a function of normal project operations.

LEVEL OF EFFORT AND COST

The estimated cost for this study is $170,000.

REFERENCES

Yoder, C.O., L.E. Hersha, and B. Appel. 2009. Fish Assemblage and Habitat Assessment of the Upper Connecticut River: A Preliminary Result and Data Presentation. Final Project Report. Submitted to U.S. Environmental Protection Agency, Region 1, Boston, MA. Center for Applied Bioassessment & Biocriteria, Midwest Biodiversity Institute, Columbus, OH.

Study 8

CHANNEL MORPHOLOGY AND BENTHIC HABITAT STUDY

RELEVANT STUDY REQUESTS

NHDES-08; NHFG-08; VANR-08; CRWC-13

STUDY GOALS AND OBJECTIVES

In their study requests, NHDES, NHFG, VANR, and CRWC describe concerns regarding the potential for the Wilder, Bellows Falls, and Vernon Project facilities and operations to affect fluvial processes related to movement of coarse sediment (e.g., gravel, cobble) in the project-affected areas, and associate this concern with potential effects on benthic habitat. Specific concerns include interruption of sediment supply, composition, and transport, and associated effects on fluvial processes, including channel formation. Potentially affected resources include habitat for resident and anadromous fish and benthic habitat for aquatic invertebrates.

The goal of this study is to understand how the projects affect bedload distribution, particle size and composition in relation to habitat availability for different life-history stages of anadromous and riverine fish, and for invertebrates.

The objectives of this study are to:

- assess the distribution and extent of the existing substrate types, including gravel and cobble bars within the project-affected areas; and
- identify the current conditions of the channel and determine the stability of the present substrate/benthic habitat and potential project-related effects on these habitats.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

State resource agencies described various jurisdictional resource management goals for this study, as summarized below.

NHDES	•	State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.
NHFG	•	General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).
VANR	•	State water quality standards for designated uses of Class B

waters relative to levels of water quality that fully supports aquatic biota and habitat.

- VFWD general goals related to conserving, enhancing, and restoring natural communities, habitats, species, and the ecological processes that support them (specifically mentioning state-listed mussel species and sea lamprey, a state Species of Greatest Conservation Need (SGCN); and providing fish- and wildlife-based activities including viewing, harvesting and utilization of fish, plant, and wildlife resources. Goals reference Vermont's Wildlife Action Plan (Kart et al., 2005).

- VFWD specific goals related to freshwater mussel habitats and sea lamprey, a state SGCN.

ASSOCIATION WITH OTHER STUDIES

Implementation of this study will be coordinated with other studies that address erosion, sediment transport, hydraulics, and associated fluctuations in water surface elevations, as well as those that address aquatic habitats for fish and invertebrates.

Information obtained as part of this study will provide information to help assess the suitability of habitats for other dependent studies including Tessellated Darter Survey (Study 12), Resident Fish Spawning (Studies 14 and 15), Sea Lamprey Spawning Assessment (Study 16), Dragonfly and Damselfly Inventory and Assessment (Study 25), and Dwarf Wedgemussel and Co-Occurring Mussel Study (Study 24).

This study is also contingent on other studies because it requires substrate information from Aquatic Habitat Mapping (Study 7) for areas not easily accessible; flow speeds, depths, sheer stress and sediment mobility developed as part of the Hydraulic Modeling Study (Study 4); sediment supply in the study area from the Riverbank Erosion Study (Study 3); and potentially site-specific information gathered from the Riverbank Transect Study (Study 2) and Tributary and Backwater Fish Access and Habitats Study (Study 13).

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Existing information on channel morphology and benthic habitat in the project-affected areas is limited. The study requests reference previous studies performed on tributaries to the Connecticut River. While the described methodologies used for those studies may be relevant to this study, information that was developed as part of the referenced studies is of marginal relevance to the objectives of this study. This study will develop baseline information on channel morphology and benthic habitats to inform the related studies.

PROJECT NEXUS

Dams may affect geomorphic resources and associated benthic habitat and biota by affecting movement of sediment in riverine systems. This study will assess geomorphic resources and benthic habitat in the project-affected areas and whether identified geomorphic resources and benthic habitats may be directly and/or indirectly affected by project facilities and operations.

STUDY AREA AND STUDY SITES

The study area includes study sites in the riverine reaches in the project-affected areas as well as sites in tributaries that are not in the project-affected area. Study sites will be selected at three general areas, including:

- upstream (US)-Type Study Sites: Upstream from the Wilder, Bellows Falls, and Vernon impoundments;
- downstream (DS)-Type Study Sites: Downstream from the Wilder and Bellows Falls dams; and
- tributary Study Sites: In selected tributaries to the Connecticut River in the riverine reaches downstream from the Wilder and Bellows Fall dams and in tributaries to the project impoundments.

Study sites at the head of the impoundments may be representative of both DS-Type and US-Type study sites, and will therefore provide for some efficiency in data collection. For example, a DS-Type study site downstream from the Wilder Project that is riverine at lower flows may be referenced as a US-Type study site upstream from the Bellows Falls Project if backwater effects propagate upstream from the Bellows Fall Project at higher flows.

METHODS

The methods used in this study will include desktop and field study to assess channel morphology and benthic habitats, and are consistent methodologies described in the study requests. Desktop studies will be used to preliminarily identify field study sites. Study site suitability will be field verified prior to performing the field studies. Field and desktop studies will be coordinated with other studies as appropriate.

Preliminary (desktop) site selection will include review of aerial photographs, USGS topographic maps, previous project studies, and other readily available information. This work will use applicable substrate information collected in the Aquatic Habitat Mapping Study (Study 7) as well as information such as aerial imagery compiled in the early phases of other concurrent studies. Criteria used in the selection of preliminary study sites using preliminary information will include apparent depositional areas such as mid-channel bars and other features that may suggest active accumulation of coarse-grain sediments.

Tributary study sites will be selected at representative locations in the vicinity of the confluences of tributaries with the Connecticut River in the project-affected areas. Selection of the these sites will be based on factors including potential sediment supply from the tributaries to the Connecticut River, and will include tributaries to the project impoundments and to riverine reaches of the Connecticut River downstream from the project dams.

Field verification of the preliminary study sites will be performed to establish approximately 12 DS-/US-Type study sites in the project-affected areas and up to 6 tributary study sites that are not in the project-affected areas. Factors considered in the selection of study sites will include safe access for performance of field studies; and presence of coarse-grain sediments. Tributary study sites will be selected in a similar manner to the DS- and US-types using existing information (e.g., aerial images), but information developed as part of other studies may not be available because these sites are not in the project-affected areas.

Field study work will be completed in 2014. Field verification of preliminary study sites will be performed in late 2013 after FERC study plan approval or in early 2014 prior to the initiation of site studies. Field studies will occur during low flows in the summer and again during the late summer/early fall of 2014. Field work will include two visits to each site for data collection, including observation and documentation of conditions.

Field study work will be performed during daylight hours and may require the use of small watercraft to safely and efficiently access study sites. Site visits will be coordinated to reduce the potential to encounter high flow conditions that could preclude effective performance of the field studies. Field investigations will include mapping of study sites using GPS equipment. Standardized field forms will be used and will include pebble counts using established methodologies (e.g., Wolman pebble counts); evaluation of substrate embeddedness; and photo-documentation of each site. The anticipated size of each study site is expected to be approximately 1 acre. Mapping of each study site will include delineating the approximate boundary using GPS equipment. It is expected that pebble counts and evaluation of embeddedness will be performed at up to six representative locations within each study site; these locations within each study site will be identified as point locations using GPS equipment.

ANALYSIS

Desktop studies will be performed as part of the reduction of field data along with analyses using information developed as part of other concurrent studies as described below. Pebble count and embeddedness data will be reduced and presented using standard methodologies and practices. The desktop analyses of field data will include reductions of pebble count information to provide gradations of coarse-grained material and qualitative descriptions of embeddedness.

Desktop analyses will include review of the HEC-RAS and operations model output (HEC-RAS model to be developed as part of hydraulic modeling in Study 4). Output data from that study's HEC-RAS model that will be used for this analysis include calculated flow speeds and shear stresses. HEC-RAS output data will not be available for tributary study sites, and associated analyses will therefore not be directly applicable to these sites. Analyses of tributary study sites will be performed using information on channel morphology and benthic habitats collected during site visits. Additional information that may be used as part of the analyses of tributary study sites will include information on fluctuations in water surface elevations obtained from the Tributary and Backwater Fish Access and Habitats Study (Study 13).

Additional analyses performed as part of this study will include review of information on coarse-substrate dependent biota in the project-affected areas. Reporting will include description of the suitability of the identified substrate characteristics for the dependent biota.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The study approach uses generally accepted methodologies and practices and is consistent with recommended approaches presented in the noted study requests.

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study. A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

Desktop and field verification work will be performed prior to the summer field season in the first study year (2014). Field work will be performed under suitable conditions in 2014; initiated in early summer of 2014 and continue through the fall of 2014. A final report including relevant data from related studies will be prepared after data from those studies are available, analyzed and incorporated into this study's results.

LEVEL OF EFFORT AND COST

The estimated cost for the study is $175,000.

REFERENCES

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, and B. Popp (editors). 2005. Vermont's Wildlife Action Plan. Vermont Fish and Wildlife Department, Waterbury, VT.

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Study 9

INSTREAM FLOW STUDY

RELEVANT STUDY REQUESTS

FERC-06; FWS-02, -03; NHDES-05, -10; NHFG-05, -10; VANR-06, -07; CRWC-12, -14; TNC-02

STUDY GOALS AND OBJECTIVES

In their study requests, FERC, FWS, NHDES, NHFG, VANR, CRWC, and TNC identified issues regarding the potential effects of current project operations on fish and aquatic resources in the riverine sections downstream of Wilder and Bellows Falls Projects and in the Bellows Falls bypassed reach. Specifically, requesters are interested in answering the following questions:

- are current minimum flows adequate to protect aquatic resources downstream of Project dams; and
- what is the effect of current project operations on fish and aquatic resources.

The goal of this study is to assess aquatic resources and habitat in the project-affected areas, and in the Bellows Falls bypassed reach under flow conditions affected by project operations.

The overall objective of this study is to assess the relationship between stream flow and resultant habitat of key aquatic species in riverine reaches downstream of Project dams. The specific objectives of this study are to:

- compute a habitat index versus flow relationship for key aquatic species in each project reach; and
- use the habitat index versus flow relationship to develop a habitat duration time series analysis over the range of current operational flows.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

Federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS	• General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives; and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects. • General goals related to aquatic resources including protection, enhancement, or restoration of aquatic and riparian habitats;

providing instream flows to meet the requirements of diadromous and resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.

NHDES	• State water quality standards and designated uses for Class B waters including aquatic life, biological and aquatic community integrity, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.
NHFG	• General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet fish and wildlife objectives; and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.
	• Specific goals include protecting, enhancing, or restoring aquatic and riparian habitats, providing flows appropriate for resident fish and wildlife including freshwater mussels and benthic invertebrates and minimizing project effects on water quality and aquatic habitat.
	• General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).
VANR	• State water quality standards for designated uses of Class B waters relative to flow alteration, water level fluctuation, and anti-degradation provisions. The Connecticut River below Wilder dam is listed as impaired waters on the Section 303(d) due to flow alterations.
	• General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.

ASSOCIATION WITH OTHER STUDIES

The Aquatic Habitat Mapping Study (Study 7) must be completed prior to commencement of this study. This study will use information from the aquatic habitat mapping as a basis for selecting study sites and establishing transect locations in riverine reaches relative to overall habitat type distribution, and will assist in identifying potential 2-D study sites. Potential 2-D study sites for this study may be selected based on results of early field work related to the Dwarf Wedgemussel and Co-Occurring Mussel Study (Study 24), the Riverbank Erosion Study (Study 3) and others.

Studies that could be performed in conjunction with this study include the Bellows Falls Aesthetic Flow Study (Study 32) and the Whitewater Boating Flow Assessment (Study 31), reducing duplication of flow releases necessary to complete those studies. Incorporating cross-sectional data collected for the Hydraulic Modeling Study (Study 4) HEC-RAS transects, or vice-versa, would add to or supplement 1-D transects for this study.

Completion of this study is dependent on hourly time-step hydrology of project operations and alternatives from the Operations Modeling Study (Study 5) that will be part of the habitat time series evaluation.

Results of this study will assist in determining effects of downstream flow and water level fluctuations on fish spawning (Studies 15, 16, and 19) by assessing the relationship between flows and water levels on spawning habitat suitability in riverine reaches.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Little information exists pertaining to aquatic habitat or aquatic resources within flowing reaches downstream of project dams or the Bellows Falls bypassed reach. TransCanada is not aware of any previously conducted instream flow studies. Agency requests note there is no indication how current minimum flow requirements were established or what specific ecological resources they are intended to benefit. As described in the existing licenses for each Project the minimum flows equate to 0.2 cubic feet per second per square mile (cfsm) of drainage area, as was then recommended by the Coordinating Committee of the Connecticut River Basin Comprehensive Water and Related Land Resources Study, to reestablish historic low flow levels. The New England River Basin Commission, VANR, and EPA recommended the same minimum flow, with which FERC concurred. The Technical Committee for Fisheries Management of the Connecticut River Basin, NHFG, and FWS favored a minimum flow of 0.25 cfsm.

The Bellows Falls Project bypasses a 3,500-foot-long section of the Connecticut River. Presently this bypassed reach only receives flow when inflow exceeds the hydraulic capacity of the Bellow Falls station, or through leakage. The bypassed reach receives excess flow less than 30 percent of the time on an annual basis. In summer (July-September) the bypassed reach receives excess flow less than 10 percent of the time based upon analysis of 40 years of data as indicated in the Bellows Falls PAD. No information exists on the adequacy of the existing bypass flow regime to protect water quality and aquatic life.

This empirical study will provide information on the relationship between flow and habitat in the Connecticut River riverine sections of the project-affected areas.

PROJECT NEXUS

The projects are currently operated with minimum flow releases dating from issuance of the existing FERC licenses, and have not been reviewed since that time. Further, the projects generate power in a daily peaking mode resulting in potential within-day flow fluctuations between the minimum and the maximum capacity of each station. While the current licenses require a continuous minimum flow from the powerhouses of 675, 1,083, and 1,250 cfs, for the Wilder, Bellows Falls, and Vernon Projects, respectively, to what extent these flows protect aquatic resources is unknown in these reaches, especially in the context of the magnitude, frequency, and duration of flow changes. This study will help to establish a baseline condition of effects of licensed project operations on the spatial and temporal aspects of aquatic habitat and aquatic species below the dams and in the Bellows Falls bypassed reach.

STUDY AREA AND STUDY SITES

The study areas consist of an approximately 17-mile river segment downstream of Wilder dam, a 6-mile river segment downstream of the Bellows Falls Project, and the Bellows Falls bypassed reach.

METHODS

A standard approach to instream flow analysis since 1980 has been the Instream Flow Incremental Methodology (IFIM). The IFIM is a structured habitat evaluation process initially developed by the Instream Flow Group of FWS in the late 1970s to allow comparison of alternative flow regimes for water development projects (Bovee and Milhous, 1978; Bovee et al., 1998). The IFIM involves multiple scientific disciplines and stakeholders, in the context of which hydraulic habitat simulation studies are usually designed and implemented.

Critical stakeholder concurrence on study design elements, and overall adequacy for decision-making is one of the principal objectives of IFIM scoping, one of the first identified steps of the methodology (Bovee et al., 1998). Depending on the desires of the participants, the IFIM can be completely comprehensive for all aquatic aspects of flow regulation or tightly focused on topics of specific concern. This study plan utilizes hydraulic habitat modeling with 1-D and 2-D models as one aspect of the IFIM process and is directed at the evaluation of instream flow needs as related to aquatic habitat.

Specific elements of the Instream Flow Study are:

- Habitat Mapping
- Study Reach, Study Site, and Transect Selection
- Identify Key Aquatic Species and Life Stages
- Select Habitat Suitability Criteria

- Hydraulic Data Collection
- Hydraulic and Habitat Modeling
- Hydrology Development
- Time Series Analysis

Habitat Mapping

An instream flow study begins with a representative sample of hydraulic and physical habitat conditions within the study reaches. Generally, the samples are represented by cross sections for 1-D models or a topographic grid for 2-D models. This study will use data derived from the Aquatic Habitat Mapping Study (Study 7) to assist in determining the appropriate hydraulic modeling method, the placement of 1-D transects needed to adequately represent habitat in proportion to that found in a reach, and the location of any 2-D study sites.

Study Reach, Study Site, and Transect Selection

Preliminary river reaches to be studies are based on hydrology and channel morphology and include:

- Wilder dam to White River (1.5 miles), Wilder tailwater;
- White River to upper extent of the Bellows Falls impoundment (15.5 miles);
- Bellows Falls bypassed reach (3,500 feet); and
- Bellows Falls dam to upper extent of the Vernon impoundment (6 miles).

Evaluation of the tailwater section below Vernon dam is not proposed pending a more thorough analysis of the FirstLight study, and if necessary, any follow-up modified study that addresses concerns raised by TransCanada and potentially other stakeholders. While TransCanada acknowledges that discharges from the Vernon Project fluctuate, observations, monitoring, and measurements suggest there is no effect from Vernon Project discharge into an impounded reach managed for dual purposes by both downstream projects.

Study sites for 1-D transects will be based on the least available habitat type as derived from habitat mapping. For example, if riffle habitat accounts for the lowest percentage of all types in a reach, study sites would be selected to ensure that riffle habitat type is included in the sample by randomly selecting a riffle habitat unit. If deemed modelable, a transect would be established across that particular mesohabitat unit. Transects will then be placed across other meoshabitat types in the vicinity in proportion to the overall mesohabitat distribution. Depending on the number of samples needed, other riffle units would be selected through the same process. This process has the advantage of using randomization for selection without precluding the use of professional judgment for sites that are unrepresentative or unworkable. It also establishes a systematic approach and results in clusters of transects, minimizing the time required to travel between transects in the field.

The number of 1-D transects in a specific reach depends on the overall mesohabitat distribution and projected representation. Generally each transect should represent no more than 10 percent of a reach, meaning at minimum, 10 transects should be placed to represent a reach. The final study sites and number of transects will be agreed upon during consultation with agency representatives. 1-D transects will be located in all reaches except the Bellows Falls bypassed reach.

A 2-D study site may be selected to represent river channel areas or habitat too complex to be adequately modeled using 1-D transects. 2-D study sites are independent and not necessarily representative of all available habitat types. Potential 2-D modeling sites located within the reach between White River and the upper extent of Bellows Falls impoundment could include one of the major islands or an area of bedrock ledges known as Sumner Falls. The Bellows Falls bypassed reach, a complex series of bedrock and large substrate components, is also a candidate for a 2-D study. Actual sites will be decided during consultation with agency and stakeholder representatives prior to the commencement of field studies.

Select Key Aquatic Species and Life Stages To Be Assessed

Study requests indicate target species for the instream flow study will include, but are not limited to:

- American shad
- Fallfish
- White sucker
- Yellow perch
- Smallmouth bass
- Walleye
- Dwarf wedge mussel

Select Habitat Suitability Criteria

Substrate size and cover classifications can vary greatly depending on the source of Habitat Suitability Criteria (HSC). Preferably, HSC should be determined prior to field data collection if substrate and/or cover are a major component of the curves. This allows field personnel to document the specific information needed rather than try to collect an extensive amount of information to cover all possible data needs.

Selection of HSC will be completed in conjunction with agency consultation. No HSC are proposed at this time. Prior to commencement of the field portion of the

Instream Flow Study, a list of candidate HSC curves will be compiled based on the above species and any others identified through agency consultation. This will be distributed to agencies and stakeholders for review and approval. Additional HSC may be added during the consultation process.

Hydraulic Data Collection

1-D Transects

Calibration flows (discharge and related water levels) are used to develop stage-discharge rating curves for each transect. The range of calibration flows depends on project operations and the agreed upon modeling range among TransCanada and stakeholders. For this study it is anticipated that calibration flow measurements will take place near the base minimum flow, at ½ to ¾ the maximum operational flow and at an intermediate flow. The basic rule-of-thumb for 1-D hydraulic models is they are most reliable between 0.4 times the low calibration flow and 2.5 times the high calibration flow. A minimum of three sets of calibration flow measurements will be acquired for each transect. When feasible, middle flow levels will be estimated based on rating curves from Hydraulic Modeling Study (Study 4) HEC-RAS transects, thus reducing field time.

One complete set of depths and velocity measurements will be collected at each transect at the target high flow or the flow level that can be effectively and safely measured. Velocity data will be collected using an Acoustic Doppler Current Profiler (ADCP) mounted on a boat or encased in a rigid 4-foot trimaran hull that can be tethered to the side of a boat or other type of vessel. In areas that cannot be effectively measured using the ADCP such as shallow areas or areas inaccessible to a boat, velocity measurements will be acquired by wading techniques using electromagnetic or mechanical flow meters attached to top-set rods. Mean column velocity will be determined by a single measurement at six-tenths of the water depth in depths less than 2.5 feet, and a two-tenths and eight-tenths measurement for depths between 2.5 feet and 4.0 feet. All three points will be measured where depths exceeded 4.0 feet, if possible. The number of verticals (depth, velocity, and substrate points) across each transect will depend on ADCP settings and boat speed. In most instances data is collected at intervals of between 1 to 2 feet.

Substrate and/or cover information will be collected across each transect at low flow or when visibility is best. For deep areas where the bottom is not visible, an underwater camera may be deployed to discern substrate and cover. Classification of substrate and cover will be determined based on agency consultation in the selection of HSC.

Field data collection and the form of data recording will basically follow the guidelines established in the IFG field techniques manuals (Trihey and Wegner, 1981; Milhous et al., 1984; Bovee, 1997). Additional quality control checks that have been found valuable during previous applications of the simulation models will be employed. Basic field measurement protocols are as follows:

- Staff gages are established and continually monitored throughout the course of collecting data at each study site.

- Headpins and tailpins consisting of either rebar or spikes will be established for each transect.

- An independent benchmark, an immovable object or additional rebar, will be established for each transect or set of transects.

- All elevation surveying will be done using auto-level and telescoping stadia rod. Upon establishment of headpin and tailpin elevations, or during calibration flow surveys, a level loop will be shot to check the auto-level measurement accuracy or field errors. Allowable error tolerances on level loops will be set at 0.02 foot.

- Water surface elevations will be measured on both banks on each transect. If possible, on more complex transects such as riffles with uneven water surface elevations, additional measurements may be taken across a transect.

- Pin elevations and water surface elevations will be calculated during field measurement and compared to previous readings to confirm accuracy.

- Photographs will be taken of all transects at the three calibration flows. An attempt will be made to shoot each photograph from the same location at each flow level.

Field Data Collection (2-D)

The 2-D model requires a detailed topographic and bathymetric map of the study site. Bathymetry data will be collected using an ADCP or depth transducer and a Real Time Kinematic (RTK) GPS. Out-of water topography will be acquired with a stationary and/or robotic total station also tied to an RTK-GPS. In the event LiDAR data are available, this may also be incorporated, which would reduce the amount of field time needed. Bathymetry will be acquired at the highest flow possible to reduce the amount of time needed to survey bank areas. In addition to topography, substrate and cover information will be collected by identifying and surveying substrate and/or cover breaks in enough detail to be incorporated into the model.

Upstream and downstream boundaries of a 2-D study site require rating curves that cover the range of flows that may be modeled. A single calibration flow with associated water surface elevations is required for a 2-D site, although additional flows and elevations can assist with model calibration. Water surface elevation measurements can take place independent of the topographic mapping.

ANALYSIS

Hydraulic Modeling and Habitat Modeling

For 1-D applications in this study, the hydraulic models and habitat index simulations will be derived from the computer program SEFA (System for Environmental Flow Assessment, http://sefa.co.nz/). This program was developed jointly by originators of the primary models used in instream flow studies, Tom Payne (RHABSIM), Bob Milhous (PHABSIM), and Ian Jowett (RHYHABSIM) and merges and expands on the capabilities of these older software packages.

For 2-D applications in this study, the River2D model will be used (Steffler and Blackburn, 2001). River2D is a two-dimensional, depth-averaged hydrodynamic and fish habitat model developed for use in natural streams and rivers. The fish habitat module is based on the PHABSIM habitat index approach, adapted for a triangular irregular spatial grid network. Habitat analysis uses habitat suitability inputs like those used by PHABSIM.

Time Series and Hydrology

The major basis for habitat time series analysis is that habitat is a function of stream flow and that stream flow varies over time. A habitat time series displays the temporal habitat change for a particular species and life stage during selected seasons or critical time periods under various flow scenarios. Typically, results are represented by habitat duration curves indicating the quantity of habitat that is equaled or exceeded over the selected time period. Hydrology and flow scenarios to be assessed will be determined with input from agency personnel.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The study methodology using IFIM is consistent with generally accepted practices and was identified by resource agencies as the preferred method.

DELIVERABLES

Upon completion of the Aquatic Habitat Mapping Study (Study 7), TransCanada will produce and distribute a pre-selection package of potential study sites and transect locations for agency review, discussion, and approval.

A report will be prepared that presents methods, analysis, and results of the study. It will also include summary of data collected, hydraulic modeling results and calibration details, and habitat and time series modeling results. A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

Field work for this study will commence in spring 2014. Most field work will be completed in 1 year, though additional data collection may be necessary depending on the results of initial modeling runs and identification of additional study needs.

LEVEL OF EFFORT AND COST

The preliminary estimated cost of this study is dependent upon on the number of 2-D study sites, and on the number of 1-D transects used. Estimated study costs for three 2-D sites and as many as 50 1-D transects is $350,000 to $500,000. This estimate does not include costs for additional 2-D sites identified as sites of interest in other studies (e.g., Dwarf Wedgemussel and Co-Occurring Mussel Study (Study 24) and Riverbank Erosion Study (Study 3).

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Study 10

Fish Assemblage Study

RELEVANT STUDY REQUESTS

FERC-07; FWS-15; NHDES-13; NHFG-13; VANR-13; CRWC-15; TNC-04

STUDY GOALS AND OBJECTIVES

In their study requests, FERC, FWS, NHDES, NHFG, VANR, CRWC, and TNC requested a baseline fish assemblage study for the Wilder, Bellows Falls, and Vernon Projects. As stated in the project PADs, a thorough and comprehensive assessment of the fish assemblage present in the project-affected areas of the Bellows Falls and Wilder Projects is limited.

Study requests submitted by the resource agencies indicated that previous surveys conducted by Vermont Yankee in the Vernon impoundment relied on sampling techniques and objectives that differ from those requested for this study. It is TransCanada's opinion that the surveys previously conducted by Vermont Yankee in the Vernon impoundment will provide a valuable source of information related to the occurrence, distribution, and relative abundance of fish species present in the Vernon Project-affected area because they have relied on a variety of sampling methods (boat electrofishing, trap nets, and beach seining) and have been conducted on a seasonal basis over an extended period of years.

The goal of this study is to determine the occurrence, distribution, and relative abundance of fish species present in the project-affected areas. Specific objectives include:

- documentation of fish species occurrence, distribution, and relative abundance within the project impoundments, tailwaters, and downstream riverine sections;

- comparison of historical records of fish species occurrence in the project-affected areas to the results of this study; and

- description of the distribution of resident/riverine and diadromous fish species within the reaches of the river and in relationship to data gathered by related studies, state agencies' surveys, and other information as available (e.g., surveys conducted by Vermont Yankee in the Vernon impoundment).

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS

- General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives; and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.

- General goals related to aquatic resources including protection, enhancement, or restoration of aquatic and riparian habitats; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.

NHDES

- State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.

NHFG

- General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).

VANR

- State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat.
- General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.
- VFWD general goals related to resource conservation, fish and wildlife recreation and use, and human health and safety. Goals reference Vermont Fish and Wildlife Strategic Plan (VFWD, 2006), including fish SGCN.

ASSOCIATION WITH OTHER STUDIES

Resident/riverine and diadromous fish species sampled from the project impoundments, tailwaters, and downstream riverine sections during this study will be combined in GIS with habitat information collected during the Aquatic Habitat Mapping Study (Study 7) to examine the relationship between species occurrence, distribution, and relative abundance as it relates to habitat types. Species occurrence, distribution, and relative abundance data collected during this study may also be used in a supportive role to augment aspects of species-specific studies (e.g., the Sea Lamprey Spawning Assessment [Study 16], American Eel Survey [Study 11], and American Eel Upstream Passage Assessment [Study 18]). In particular, detection of sea lamprey and American eel during this study may provide valuable insight on particular aspects of those studies such as lamprey spawning areas or eel congregation areas.

Information collected on the presence and relative abundance of small-bodied benthic fish species during the Tesselated Darter Survey (Study 12) will be used to augment findings related to this study and will enhance the knowledge of species occurrence, distribution, and relative abundance in the project areas. Where habitat and sampling gears are appropriate (e.g., backpack electrofish sampling in the Bellows Falls bypassed reach), sampling for both this study and Study 12 will be conducted concurrently.

Information collected during this study will also be used in the development of a target species list for the Fish Impingement, Entrainment, and Survival Study (Study 23). The determination of that target species list is dependent on the findings of this study.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Some site-specific data on general species presence/absence was provided in the Wilder and Bellows Falls PADs, and only minimal additional information on fisheries resources is available. Therefore, fishery agencies and other stakeholders have requested additional fisheries abundance data to assess potential effects of project operations on this resource.

The most relevant fish study related to the Wilder and Bellows Falls Project-affected areas is a Connecticut River electrofish survey conducted during 2008 (Yoder et al., 2009). Whereas some sampling was conducted in project-affected areas during the 2008 survey, the total number of sample locations was limited, and each location was sampled only a single time during the later summer-early fall. Similarly, although considerable fish data has been collected by Vermont Yankee for many years in the vicinity of Vernon dam, objectives for those surveys differ from those requested for this study. NHFG also conducts periodic surveys in the Connecticut River near the projects, but those surveys also have not been extensive and do not meet the objectives of this study.

PROJECT NEXUS

Operations at the Wilder, Bellows Falls, and Vernon Projects potentially affect the availability of instream habitat on which fish species depend. Habitat for fish species may be related to project operations in terms of flow (water depth and velocity and their timing, duration, frequency, and rate of change), as well as the interactions of flow with other habitat variables such as substrate, vegetation, and cover. Operations both upstream (i.e., impoundment levels) and downstream (i.e., flow fluctuations) may affect habitat, which may consequently lead to changes in the distribution, abundance, and behavior of fish species.

This study will help to establish a baseline condition on the extent of the fishery of the Connecticut River in the project-affected areas under current operations. The baseline condition assessed during this survey will not only represent current project operations but will also represent the extent of available habitat for resident and diadromous fish populations. When combined with Aquatic Habitat Mapping (Study 7), results from this study will allow for the contribution of both factors (project operations and available habitat) to the baseline fisheries conditions to be examined for limiting or non-limiting influences.

Furthermore, several fish species considered to be an SGCN in New Hampshire and/or Vermont have been documented in the project-affected areas, and this study will assist in identifying those populations.

STUDY AREA AND STUDY SITES

Sampling will be conducted to determine the baseline fish assemblage within project-affected areas from the upper extent of the Wilder impoundment downstream to Vernon dam, as well as in the Bellows Falls bypassed reach. Approximately 10 sample stations (4 shoreline electrofish transects (set up in a paired-bank design) and 4 to 6 netting locations) will be established within each of the upper, middle, and lower portions of the impoundments. Between 4 and 12 sample stations will be established in each of the riverine sections downstream of the Wilder and Bellows Falls Projects, including the tailraces, setbacks, and the Bellows Falls bypassed reach, to the extent safe conditions allow for necessary access. The final number of sampling locations will be proportional to reach length and will depend on suitability of the selected sampling gears for habitat conditions present in those reaches.

METHODS

Sampling techniques for this study, which have been selected based on recommendations and information provided in the study requests, include electrofishing (boat, pram, and backpack) and gill netting with experimental nets. Exact sampling locations that are representative of the full extent of habitat types within the study area will be established prior to the first sampling event and provided to the fisheries stakeholder interest community prior for discussion and review. Sampling locations will uniquely keyed by an identification code, and a more precise location will be identified using GPS such that lattitude/longitude coordinates of the locations or limits of the sampling areas can be used to present the information in a GIS dataset. Sampling will be conducted across multiple seasons including spring (May-June as flow conditions permit), summer (July-August), and fall (September-October), and sampling stations will be maintained during all three seasons to allow for comparison of seasonal catches.

Study requesters recommended conducting replicate sampling in accordance with methods described in MacKenzie et al. (2006). Pending detailed review of that source document and agency consultation, a limited number of replicate samples may be conducted to provide estimates of species detection probability. Pending detailed review of references cited in agency study requests, sample replicates may be gathered temporally, using different methods, by independent observers, by randomly sampled spatial replicates, or by other means (MacKenzie et al., 2006).

Boat Electrofish

Boat electrofish stations will be established in the boatable study reaches including the project impoundments, tailraces, and downstream riverine sections between the

Wilder and Vernon Projects. Electrofish transects will use a 500-meter (1,640-foot) paired shoreline design. Each shoreline transect will be sampled once seasonally, and sampling will consist of a single pass along the shoreline and out to water depths of about 6 to 8 feet and in an upstream direction. Scap netters on the bow of the electrofish boat will net and place stunned fish in an onboard livewell for processing once the full transect is complete.

Following completion of the full transect, biological data will be collected from captured fish. All individuals will be identified to the species level and enumerated. Total length and wet weight will be recorded for each individual. If there are more than 50 individuals for any one species within a particular sample, then a representative subsample of 50 individuals will be measured and weighed and the rest of that species will be counted.

The date, start and end time, water quality parameters (temperature, DO, pH, and conductivity), weather, cloud cover, water depth; and velocity will be recorded for each full transect. Habitat and substrate types along the sampled transect will be obtained following the integration of sampling coordinates and available habitat (as determined by aquatic habitat mapping (Study 7)) in GIS.

Pram / Backpack Electrofish

In cases where access is limited and does not permit boat electrofishing (e.g., Bellows Falls bypassed reach), pram and/or backpack electrofish sampling will be conducted. Sampling will be conducted by anchoring a fine mesh seine at the downstream end of the sample station. A pram or backpack electrofish unit and two to three biologists will move in a downstream direction towards the seine while actively netting stunned individuals and kicking the substrate to drive additional stunned individuals towards the collection net. Field crews will record the start and end coordinates for each pram/backpack electrofish sample. In addition, the date, start and end time, water depth, velocity, water quality (temperature, DO, and conductivity), weather, and dominant substrate will be recorded. Factors such as the presence/absence of cover and proportion of available cover will also be recorded for shallow water samples. The total fish catch will be processed following the same methods as boat electrofish samples.

Experimental Gill Net

Gill net stations will be established in the boatable study reaches with appropriate water depths and flow conditions for effective use of the gear. Gill nets will be experimental and will be constructed using 4 to 5 panels of increasing mesh size (e.g., 0.75-, 1.0-, 1.5-, 2.0-, and 2.5-inch stretch mesh). Gill nets will be deployed perpendicular to the shoreline in areas where water depths are greater than the net height and capture area is maximized. Nets will be set and allowed to fish for a 24-hour period prior to pulling. Field crews will record the set coordinates for each sample. In addition, the set and pull date and time, water depth, velocity, water quality (temperature, DO, and conductivity), and weather conditions will be recorded. The total fish catch will be processed following the same methods as boat electrofish samples.

ANALYSIS

Data recorded for each sample will include the specific location (coordinates), collection date and time, gear type, and associated habitat/environmental variables including water quality parameters (temperature, DO, pH, and conductivity), weather, cloud cover, water depth and velocity as well as project operational information and conditions (upstream discharge and or impoundment elevation at the dam) at the time of sampling. These data will be reported in tabular format as well as included in the attributes table associated with the sampling location included in the GIS datasets.

Habitat and substrate information for each sample location will be obtained following the integration of sampling coordinates and available habitat, as determined by aquatic habitat mapping (Study 7), in GIS and will be also be presented in the attributes table associated with each unique sampling location. An appendix table of the biological data (i.e., length and weight) will be provided for all fish caught by location and season. Summary statistics will be calculated and included in the GIS dataset on a seasonal basis for each study reach and will include taxa richness, species composition, Shannon Diversity Index, relative abundance (i.e., catch-per-unit-of-effort), and condition factors for selected species. Relative abundance will be examined on a seasonal basis as it relates to habitat/environmental variables (e.g., water quality, habitat, velocity) and project operational information (e.g., discharge, impoundment elevation).

Finally, historical records of fish species occurrence in the project-affected areas including state agency surveys, and other information as available (e.g., surveys reported by Entergy for Vermont Yankee where publicly available) will be compared to the results of this study. The presence of invasive or introduced fish species will be noted during the analysis.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The study methodology is consistent with generally accepted practices. Previous relicensing efforts have relied on a seasonal combination of boat electrofishing and gill netting to collect baseline fisheries information (e.g., Yadkin Project, FERC No. 2197, and Tapoco Project, FERC No. 2169).

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of this 1-year study. A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

This study will be conducted during the first study year (2014). Sampling locations will be identified during late 2013 and shared with the fisheries interest community for discussion and review. The primary field effort associated with baseline fish assemblage sampling will be conducted during the spring (May-June), summer (July-August), and fall (September-October) seasons of 2014. It is anticipated that 9 to 12 days of boat electrofishing and approximately 12 days of gill net effort will be necessary to complete the number of proposed samples within each of the project impoundments (spring, summer, and fall sampling combined). An additional several days will be required seasonally to conduct general fisheries sampling within the tailraces and downstream riverine corridor study reaches.

LEVEL OF EFFORT AND COST

The preliminary estimated cost for this study is $220,000.

REFERENCES

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, and B. Popp (editors). 2005. Vermont's Wildlife Action Plan. Vermont Fish and Wildlife Department, Waterbury, VT.

MacKenzie, D.I., J.D. Nichols, J.A. Royle, K.H. Pollock, L.L. Bailey, and J.E. Hines. 2006. Occupancy Estimation and Modeling: Inferring Patterns and Dynamics of Species Occurrence. Elsevier, San Diego, CA.

NHFG (New Hampshire Fish and Game Department). 1998. New Hampshire Fish and Game Department Strategic Plan (1998–2010). Concord, NH.

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Yoder, C.O., L.E. Hersha, and B. Appel. 2009. Fish Assemblage and Habitat Assessment of the Upper Connecticut River: A Preliminary Result and Data Presentation. Final Project Report. Submitted to U.S. Environmental Protection Agency, Region 1, Boston, MA. Center for Applied Bioassessment & Biocriteria, Midwest Biodiversity Institute, Columbus, OH.

Study 11

American Eel Survey

RELEVANT STUDY REQUESTS

FWS-08, NHDES-07, NHFG-07, VANR-15, CRWC-25, TU-05

STUDY GOALS AND OBJECTIVES

In their study requests, FWS, NHDES, NHFG, VANR, CRWC, and TU identified potential issues related to Wilder, Bellows Falls, and Vernon Project operations on the distribution and relative abundance of American eels in mainstem habitat upstream of the project dams. In response to those requests, the goal of this study is to provide baseline data relative to the presence of American eel upstream in the project-affected areas.

The specific objectives of this study are to:

- determine the distribution of American eel in the project impoundments and riverine sections upstream of Wilder, Bellows Falls, and Vernon dams; and
- determine the relative abundance of American eel in the project impoundments and riverine sections upstream of the dams.

RELEVANT RESOURCE MANAGEMENT GOALS

In their study requests, federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS

- Specific goals related to American eel including protecting, enhancing, and restoring aquatic and riparian habitats; understanding the baseline condition of eel presence within and upstream of the projects; and minimizing project effects on eel in the projects and moving up and downstream. Goals reference the ASMFC Interstate Fishery Management Plan for American Eel (ASMFC, 2000); ASMFC Addendum II to the Fishery Management Plan for American Eel (ASMFC, 2008) and CRASC Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin (CRASC, 2005).
- General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives; and to conserve, protect and enhance habitats for fish, wildlife and plants affected by the projects.

NHDES	•	State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.
NHFG	•	American eel is a state SGCN. Specific goals including minimizing project effects on eel inhabiting the project area or moving through the area during upstream and downstream passage. Goals reference ASFMC 2000, ASMFC 2008 and CRASC 2005.
	•	General goals related to sustainable fish populations, habitats, recreational fishing and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).
VANR	•	American eel is a state SGCN. Specific goals related to American eel including protecting, enhancing, and restoring aquatic and riparian habitats; understanding the baseline condition of eel presence within and upstream of the projects; and minimizing project effects on eel in the projects and moving up and downstream Goals reference ASFMC 2000, ASMFC 2008 and CRASC 2005.
	•	State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat.
	•	General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.
	•	VFWD general goals related to resource conservation, fish and wildlife recreation and use, and human health and safety. Goals reference Vermont Fish and Wildlife Strategic Plan (VFWD 2006) and Vermont's Wildlife Action Plan (Kart et al., 2005).

ASSOCIATION WITH OTHER STUDIES

This study is part of a group of studies related to American eel in the project areas. Related studies include the American Eel Upstream Passage Assessment (Study 18), American Eel Downstream Passage Assessment (Study 19) and American Eel Downstream Migration Timing Assessment (Study 20). Together, these four studies will provide a more complete picture of American eel usage of the mainstem river and project areas and potential project effects.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

As described in the PADs, a limited number of American eels were collected during sampling for the Fish Assemblage and Habitat Assessment of the Upper Connecticut River study (Yoder et al., 2009). A single eel was collected from the Vernon impoundment upstream of Vernon dam. No eels were observed during sampling conducted within the Bellows Falls impoundment or upstream of Wilder dam. No eels have been collected since 2004 during Entergy's annual sampling in the vicinity of Vermont Yankee. However, as noted in the PAD for the Vernon Project, 262 immature American eels were documented moving upstream through the upstream fish ladder at Vernon during 2012 (Lael Will, Vermont Fish and Wildlife, personal communication). As stated in its study request, NHFG has documented the presence of American eel upstream of both the Bellows Falls and Wilder dams.

Although evidence exists that American eels are moving upstream of the Vernon, Bellows Falls, and Wilder dams, the distribution and relative abundance of American eels in the mainstem habitat upstream and in the project areas remains unknown.

PROJECT NEXUS

If eels are accessing and using habitat upstream of the projects in numbers sufficient to maintain species success and re-population in those areas, then current species distribution and abundance data are important to collect. When coupled with timing and route-specific survival estimates for outmigrating silver eels (Study 19), the distribution and relative abundance data collected for this study can help to determine the critical population sizes in each project area that might trigger the need for downstream eel passage.

STUDY AREA AND STUDY SITES

Surveys will be conducted for the presence and relative abundance of American eels in the project waters upstream of each dam from the upper extent of Wilder impoundment downstream to Vernon dam. Study requests indicated that the survey area for eel sampling conducted upstream of each dam should include lakes and ponds associated with tributaries (including but not limited to, Spofford Lake and Lake Morey). These areas are outside of the FERC designated project areas, however, have no nexus with project operations and, therefore, will not be included in this study.

Sampling locations will be distributed throughout the study area. A total of 29 sample stations will be established upstream of Wilder dam, and 17 sample stations will be established upstream of each the Bellows Falls and Vernon dams.

METHODS

Sampling techniques for the 1-year assessment of American eel distribution and relative abundance upstream of the projects are as presented in the study requests and include electrofishing and eel traps.

Electrofish Surveys

American eel will be surveyed using a boat-mounted Smith-Root electrofishing system. A total of 29, 0.6-mile (1-km) shoreline transects will be established upstream of Wilder dam, 17, 0.6-mile (1-km) shoreline transects will be established upstream of Bellows Falls dam, and 17, 0.6-mile (1-km) shoreline transects will be established upstream of Vernon dam. Shoreline electrofish transects will be spaced at approximately 2.0-mile (3.2-km) intervals over the full length of the reach. For each shoreline transect, the bank to be electrofished (east or west) will be randomly selected prior to sampling. Field crews will record the coordinates for the start and end points of each shoreline transect. Any setbacks or tributary confluence areas that lie within a shoreline transect will be sampled to the extent that conditions allow for sampling gear access. Sampling will occur during the evening and night hours (6:00 PM to midnight) when American eel are most active.

Each shoreline transect will be sampled one time, and sampling will consist of a single pass along the shoreline and out to water depths of approximately 6 to 8 feet and in an upstream direction. Scap netters on the bow of the electrofish boat will net and place stunned eels in an onboard livewell for processing once the full 0.6-mile (1-km) shoreline transect is complete. Any eels observed during electrofish sampling but not netted will be noted on the field data sheet for that particular sample. Non-target fish species will not be collected.

Following completion of the entire 0.6-mile (1-km) shoreline transect, biological data will be collected from captured eels. Each eel will be assigned a length class (0 to 6 inches, 6 to 12 inches, 12 to 18 inches, >18 inches). The first 10 individuals within each length class will be individually measured for total length and wet weight. Additional eels within a particular length class will be enumerated, and a batch weight will be recorded. In addition to length and weight, the first 10 individual eels in the >18-inch length class will also have eye diameter measurements recorded. To facilitate collection of length and weight data as well as prevent unnecessary injuries to the eels, it may be necessary to anesthetize individuals using an appropriate anesthetic for the species (i.e., ice, clove oil, MS-222). Following processing, and after full recovery from anesthesia, if used, all eels will be returned to the river.

The date, start and end time, water quality (temperature, DO, and conductivity), weather, cloud cover and dominant substrate will be recorded for each 0.6-mile (1-km) shoreline transect.

Eel Traps

Eel traps will be deployed at 29 locations upstream of Wilder dam and 17 locations upstream of each of the Bellows Falls and Vernon dams. Eel trap locations will be spaced at approximately 2.0-mile (3.2-km) intervals over the full length river upstream of each dam. Eel traps will consist of standard double-entry, galvanized wire mesh cylinders approximately 2.5-feet long. Eel traps will be weighted to remain on station for the duration of their soak time and will be retrievable via a float line. Traps will be baited using dead herring or other appropriate bait. At the time of deployment, field crews will record the coordinates for the sampling location as well as the set date and time. Traps will be checked after approximately 24 hours of soak time and then pulled after 48 hours of soak time.

Eel trap catch will be processed identically to catch for electrofish samples. All eels will be assigned a length class and enumerated. A subset of eels will be measured for length and weight to provide a representative sample of individuals from each length class represented in the total catch. The set, check and pull dates and times, water quality (temperature, DO, conductivity), weather, cloud cover, water depth and dominant substrate will be recorded for each sample.

ANALYSIS

Results of this study will be presented in graphical and tabular format. Species distribution data will be displayed on maps of the sampled study areas. Abundance data, in the form of raw catch and catch-per-unit-of-effort will be presented in tabular format. Length frequency data will be presented graphically. Occurrence of silver eels (as indicated by eye diameter measurements) will be presented in tabular format.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The study methodology is consistent with generally accepted practices. Previously conducted (Saluda Hydroelectric Project, FERC No. 516) and active (Eastman Falls Hydroelectric Project, FERC No. 2457) relicensing efforts have relied on a similar combination of electrofish and eel trap sampling for the purposes of describing eel distribution and relative abundance in hydroelectric project areas.

DELIVERABLES

A report will be prepared that presents methods, analysis and results of the study. A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

The field effort associated this study will be conducted during the summer months (July-September) of the first study year (2014). It is anticipated that a total of 15 nights of boat electrofishing will be necessary to survey all 63 shoreline transects. Total sampling time for each eel pot will be 48 hours, and the total number of days required to deploy and fish each station will depend on the number of eel traps available.

LEVEL OF EFFORT AND COST

The preliminary estimated cost for this study is $85,000.

REFERENCES

ASMFC (Atlantic States Marine Fisheries Commission). 2008. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

ASMFC. 2000. Interstate Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission.

CRASC (Connecticut River Atlantic Salmon Commission). 2005. A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin. Connecticut River Atlantic Salmon Commission. Draft.

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, and B. Popp (editors). 2005. Vermont's Wildlife Action Plan. Vermont Fish and Wildlife Department, Waterbury, VT.

NHFG (New Hampshire Fish and Game Department). 1998. New Hampshire Fish and Game Department Strategic Plan (1998–2010). Concord, NH.

VFWD (Vermont Fish and Wildlife Department). 2006. Vermont Fish and Wildlife Strategic Plan.

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Study 12

Tessellated Darter Survey

RELEVANT STUDY REQUESTS

FWS-14, NHDES-23, NHFG-23, VANR-16, CRWC-31, TNC-06

STUDY GOALS AND OBJECTIVES

In their study requests, FWS, NHDES, NHFG, VANR, CRWC, and TNC indicated that Wilder, Bellows Falls, and Vernon Project operations may affect the distribution and abundance of the tessellated darter within project-affected areas. The goal of the study requests is to assess the effects of project operations on populations of tessellated darter, a New Hampshire Species of Greatest Conservation Need and known host species for the federally listed endangered dwarf wedgemussel (DWM).

This study plan differs from that requested by resource agencies and NGOs. Those study requests sought to (1) determine the distribution and abundance of tessellated darter within the project-affected areas and (2) determine the effects of project operations on the distribution and abundance of tessellated darter. Determination of effects on tessellated darter due to project operations is not an achievable goal without a baseline data set for comparison. Based on the life history characteristics of tessellated darter, the collection of a baseline data set encompassing several generations to account for natural variability in the population in project-affected and nonproject-affected areas would require years of study and is not a realistic undertaking for the 2-year relicensing study period.

As a result, TransCanada's specific objective for this study is to characterize the distribution and relative abundance of tessellated darter within project-affected areas. With this information, some judgments on whether the DWM population is constrained due to distribution and abundance of tessellated darters may be feasible.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS

- Tessellated darter is one of three host species in the Connecticut River for the gloclidia of DWM, a federally listed endangered species. The goal for DWM is species recovery for removal under the Endangered Species Act in accordance with the FWS Dwarf Wedgemussel Recovery Plan (FWS, 1993) and Five Year Review Summary and Evaluation (FWS, 2007).
- General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives;

and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.

- General goals related to aquatic resources including protection, enhancement, or restoration of aquatic and riparian habitats; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.

NHDES

- State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.

NHFG

- Tessellated darter is a state SGCN.
- General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).

VANR

- Tessellated darter is a state SGCN.
- State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat.
- General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.
- VFWD general goals related to conserving, enhancing, and restoring natural communities, habitats, species, and the ecological processes that support them; and providing fish- and wildlife-based activities including viewing, harvesting, and utilization of fish, plant, and wildlife resources. Goals reference Vermont's Wildlife Action Plan (Kart et al., 2005).
- VFWD general goals related to resource conservation, fish, and wildlife recreation and use, and human health and safety.
- Goals reference Vermont Fish and Wildlife Strategic Plan (VFWD, 2006).

ASSOCIATION WITH OTHER STUDIES

Information collected during Aquatic Habitat Mapping (Study 7) will be used for determination of sample collection locations and may provide insight into species distribution and abundance. Likewise, areas targeted as most likely to provide appropriate habitat for DWM (Study 24) will aid in the location of sampling efforts to characterize the distribution and relative abundance of tessellated darter.

Information collected on the presence and relative abundance of small-bodied benthic fish species during this study will be used to augment findings related to the determination of the baseline fish assemblages (Study 10). Where habitat and sampling gears are appropriate (e.g., backpack electrofish sampling in the Bellows Falls bypassed reach), sampling for both resident fish spawning studies (Study 13, 15) will be conducted concurrently.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

As described in the PADs, the tessellated darter is a confirmed host for DWM (a federally listed as endangered freshwater mussel species) resident within the upper Connecticut River. As noted in the study requests, existing literature indicates that tessellated darters may be found in a variety of habitat types (Scott and Crossman, 1979; Hartel, 2002). Although tessellated darter has been confirmed both upstream and downstream of each project, previous fisheries sampling in those areas did not rely on collection techniques that specifically target small-bodied benthic fish species. Based on comments in the study requests, the resource agencies determined it is likely that results from previous investigations are biased and may have underrepresented the abundance.

PROJECT NEXUS

Operations at the Wilder, Bellows Falls, and Vernon Projects potentially affect the availability of instream habitat on which the tessellated darter and other lotic species depend. Habitat for tessellated darters may be related to the project operations in terms of flow (water depth and velocity, and their timing, duration, frequency, and rate of change), as well as the interactions of flow with other habitat variables such as substrate, vegetation, and cover. Operations both upstream (i.e., impoundment levels) and downstream (i.e., flow fluctuations) may affect habitat, which may consequently lead to changes in the distribution, abundance, and behavior of tessellated darter. Those changes could, in turn, potentially affect the federally listed as endangered DWM.

Results from this study will enhance the currently limited knowledge related to the distribution and abundance of tessellated darter in the project areas.

STUDY AREA AND STUDY SITES

The study area will encompass the upper extent of the Wilder impoundment to the Vernon tailrace. For sampling purposes, that portion of the Connecticut River will be broken down into six study reaches:

- Wilder impoundment (RM 217.4 – 262.4)
- Wilder tailrace and downstream riverine corridor (RM 217.4 – 199.7)
- Bellows Falls impoundment (RM 199.7 – 173.7)
- Bellows Falls tailrace and downstream riverine corridor (RM 173.7 – 167.9)
- Vernon impoundment (RM 167.9 – 141.9)
- Vernon tailrace (RM 141.9 - ~140.9)

Sampling locations will be distributed throughout each of the six study reaches. Ten sample stations will be established in each impoundment study reach, and five sample stations will be established in each of the tailrace and downstream riverine corridor study reaches included in the study area. As noted in the study requests, existing literature indicates that tessellated darters may be found in a variety of habitat types. Study requests included evaluation of habitat use within project-affected areas because it is not certain if habitat use infers preference, or if habitat use will be consistent from basin to basin. To accommodate that request, final placement of sample stations within each study reach will be determined following review of the literature and results from aquatic habitat mapping (Study 7). Stations will be distributed throughout each of the six study reaches proportional to the distribution of dominant substrate types (e.g., if 50 percent of the study reach is dominated by sand substrate then 50 percent of the sample locations will be placed in that habitat type). To ensure that a portion of tessellated darter sampling occurs in areas within the distribution of DWM, results from the population and habitat assessment for that species in the project areas downstream of Wilder and Bellows Falls (Study 24) will be used to place several sample stations.

METHODS

Collection techniques for tessellated darters were not specified in the study requests. Available peer-reviewed and gray literature dealing with the collection of small-bodied benthic fish species was reviewed, and several appropriate sampling techniques were identified.

- Electrified benthic trawl
- Snorkel survey
- Beach seine/backpack electrofish unit (where feasible)

An electrified benthic trawl (similar to that developed by Freedman et al., 2009) will be used at all non-wadeable sample stations. Each trawl sample will consist of a single 5-minute tow conducted with and slightly faster than the river current. Sampling will take place during the daylight hours. Field crews will record the start and end coordinates and track information for each trawl sample. In addition, the date, start and end time, water depth, velocity, water quality (temperature, DO, pH, and conductivity), weather, and dominant substrate will be recorded.

Snorkel and beach seine/backpack electrofish sampling will be used at all wadeable sample stations where boat access is limited or unavailable and the use of a deeper water trawl is inappropriate. These techniques have been successfully employed for the detection of benthic darter species during FERC relicensing processes at other hydroelectric facilities (e.g., at the Conowingo Project, FERC No. 405).

The determination of the shallow-water sampling technique to be used will be made on a case-by-case basis at each sampling station. In general, snorkel surveys will consist of a team of 2 to 5 biologists spread across a selected reach. The survey team will move from downstream to upstream and record the abundance of species based on visual observation. Beach seine/backpack electrofish sampling will be conducted by anchoring a fine mesh seine at the downstream end of the sample station. A backpack electrofish unit and 2 to 3 biologists will move in a downstream direction towards the seine while actively kicking the substrate to drive stunned individuals towards the collection net. Sampling will take place during the daylight hours. Field crews will record the start and end coordinates for each snorkel or beach seine/backpack electrofish sample. In addition, the date, start and end time, water depth, velocity, water quality (temperature, DO, and conductivity), weather, and dominant substrate will be recorded. Factors such as the presence/absence of cover and proportion of available cover will also be recorded for shallow water samples. Effort will be made during the shallow water sample collections to record the presence and abundance of DWM and the presence of other freshwater mussel species.

Following completion of each electrified benthic trawl or beach seine/backpack sample collection, total catch will be identified to species and enumerated. Tessellated darters will be measured for total length. Representative photographs will be taken of each collected fish species.

Sampling within each of the six study reaches will be conducted during a single year of study. A limited number of replicate samples may be conducted to provide estimates of species detection probability. Sample replicates may be gathered temporally, using different methods, by independent observers, by randomly sampled spatial replicates or by other means (MacKenzie et al., 2006).

ANALYSIS

Results of this study will be presented in graphical and tabular format and combined into a single report document with the results from the Fish Assemblage Study (Study 10). For each sample collected, date and time of sample, the specific location (coordinates), and unique habitat and environmental variables at the time of collection will be presented in tabular format and in GIS attribute tables. Distribution data will be displayed as GIS maps of the six sample reaches overlaid with habitat mapping from other studies, and abundance data in the form of raw catch and catch-per-unit-of-effort will be presented in tabular format within the attribute tables and or hardcopy report for each station and sample reach. The GIS layer attribute table for each tessellated darter sampling location will include information on the length frequency data for tessellated darters at that location as well as operational and environmental conditions at the time of sampling.

An examination of the distribution and relative abundance of tessellated darters as it spatially relates to the determined distribution and relative abundance of DWM (from Study 24) will be conducted in GIS, and results will be presented in the report.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The study methodology is consistent with generally accepted practices. Electrified benthic trawl sampling has been shown to be highly effective for the capture of small-bodied benthic fish species when compared to conventional survey methods (boat electrofish and gill net) and standard trawling (Freedman et al., 2009). Previous relicensing efforts (at the Conowingo Project) have relied on a similar combination of snorkel and beach seine/backpack electrofish sampling to describe the presence of benthic darter species.

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study. A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

This study will be conducted during the first study year (2014), following completion of aquatic habitat mapping (Study 7). Sampling locations will be identified by May 2014 and shared with the fisheries interest community for discussion and review. The primary field effort associated with tessellated darter surveys within the six defined study reaches will be conducted during the late-summer months (August-September, 2014). This will ensure that young-of-year individuals are large enough to recruit to the sampling gears and be represented in collected samples. It is anticipated that 5 to 7 days of trawl sampling will be necessary to complete the number of proposed samples within the three impounded study reaches. An additional several days will be required to conduct tessellated darter sampling within the tailraces and downstream riverine corridor study reaches.

LEVEL OF EFFORT AND COST

The expected cost for survey work is $75,000.

REFERENCES

Freedman, J.A., T.D. Stecko, B.D. Lorson, and J.R. Stauffer. 2009. Development and Efficacy of an Electrified Benthic Trawl for Sampling Large-River Fish

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MacKenzie, D.I., J.D. Nichols, J.A. Royle, K.H. Pollock, L.L. Bailey, and J.E. Hines. 2006. Occupancy Estimation and Modeling: Inferring Patterns and Dynamics of Species Occurrence. Elsevier, San Diego, CA.

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Scott, W.B. and E.J. Crossman. 1979. Freshwater Fishes of Canada. The Bryant Press Limited, Ottawa, Canada.

VFWD (Vermont Fish and Wildlife Department). 2006. Vermont Fish and Wildlife Strategic Plan.

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Study 13

Tributary and Backwater Area Fish Access and Habitats Study

RELEVANT STUDY REQUESTS

FWS-18; NHDES-17; NHFG-17; VANR-19; CRWC-19

STUDY GOALS AND OBJECTIVES

In their study requests, FWS, NHDES, NHFG, VANR, and CRWC identified issues related to water level fluctuations caused by Wilder, Bellows Falls, and Vernon Project operations that may impede fish movement in and out of tributaries and backwater areas in the project impoundments and riverine reaches.

The goals of this study are to:

- determine if water level fluctuations from project operations cause impediments to fish movement into and out of tributaries and backwater areas within the project-affected areas; and
- determine if water level fluctuations caused by project operations effect available fish habitat and water quality in the tributaries and backwater areas within the project-affected areas.

The objectives for this study are to:

- conduct a field study of tributaries and backwaters in the project-affected areas to assess potential effects of water level fluctuations on fish access to these areas in the impoundments and riverine reaches below the Wilder and Bellows Falls dams; and
- conduct a field study to examine potential effects of water level fluctuations on available habitat and water quality in tributaries and backwaters.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS

- General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives; and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.
- General goals related to aquatic resources including protection, enhancement, or restoration of aquatic and riparian habitats; providing instream flows to meet the requirements of resident

fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.

NHDES

- State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.

NHFG

- General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998) including two SGCN unidentified in the study request.

VANR

- State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat.
- General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.
- VFWD general goals related to conserving, enhancing, and restoring natural communities, habitats, species, and the ecological processes that support them; and providing fish and wildlife-based activities including viewing, harvesting, and utilization of fish, plant and wildlife resources. Goals reference Vermont's Wildlife Action Plan (Kart et al., 2005).
- VFWD general goals related to resource conservation, fish and wildlife recreation and use, and human health and safety.
- Goals reference Vermont Fish and Wildlife Strategic Plan (VFWD, 2006), including fish SGCN.

ASSOCIATION WITH OTHER STUDIES

This study depends on the results of the Aquatic Habitat Mapping Study (Study 7). The bathymetry data from that study will help identify tributaries and backwaters that may have access problems such as shallow areas in the inlets to backwaters or shallow areas in and around the tributary mouths that may impede fish movements in and out of these areas when water levels are low. For the riverine reaches, preliminary data will be collected on the tributaries and backwaters, including identifying those that may be affected by fluctuating water levels. These data will help in screening potential tributaries and backwaters that may need further investigation in this study.

Concurrent studies that will provide additional data are the Instream Flow Study (Study 9), Hydraulic Modeling Study (Study 4), and Operations Modeling Study (Study 5). Those studies will provide water level elevation data that can be incorporated into this study's analysis through the operations model.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

All five requestors stated that to their knowledge, no information exists related to effects on tributary and backwater area access and habitat due to project operations.

PROJECT NEXUS

In their study requests, stakeholders expressed concern that water level fluctuations due to project operations have the potential to create conditions that could impede the movement of fish between the Connecticut River and its tributaries and backwaters. These conditions, if present, could limit access to spawning habitat and growth opportunities. Additionally, water level changes have the potential to alter water quality and quantity in these areas, which could decrease productivity.

STUDY AREA AND STUDY SITES

The study area includes all tributaries and backwaters from the upper extent of the Wilder impoundment to Vernon dam and up to a point in tributaries and backwaters where project operations no longer have any effect under normal operating conditions.

METHODS

During habitat mapping of riverine reaches all tributaries and backwater areas in project-affected areas will be inspected and preliminary data collected to assess their potential for impeding fish movements during fluctuating water levels. The inlets to backwaters and the tributaries will be photographed and water depths at selected points will be collected. These preliminary data will be used to select sites that are most likely to impede fish movement and will be focus of field to assess effects on habitat, water quality, and access.

During the first study year (2014), selected sites will be studied further. Water level recorders (estimated 30 units total) will be placed in selected backwaters and tributary areas and will operate for an entire year to collect hourly depth changes and water temperature. Additional water quality data will be collected in these areas (temperature, DO, pH, conductivity, and turbidity) if it is found that access to the main river is impeded.

When low flow measurements are being collected for the Instream Flow Study (Study 9), these selected locations will be inspected, photographed and data collected on water depths at the backwater inlets and tributaries to document the conditions found during low flows. These areas will also be inspected during the fish spawning field work in Resident Fish Spawning in Impoundments (Study 14) and Resident Fish Spawning in Riverine Sections (Study 15) studies and during the Fish Assemblage Study (Study 10). Data collected at the tributary and backwater sites during these field efforts will include water quality data (temperature, DO, pH, conductivity and turbidity), photographs, downloading of water level recorders and field notes on access conditions.

ANALYSIS

Water level recorders will be downloaded every few weeks during spring through late fall when field crews are in the area, but they will not be downloaded during the winter months. They will be retrieved after 1 year of data collection. Water level data will be analyzed to develop a relationship between project operations and effects at the selected sites. Using the operations model (Study 5), project related effects on the habitat in these areas, including whether they become an impediment to fish access due to water level fluctuations will be determined. Water quality data collected during the study in the selected backwaters and tributary mouths will also be analyzed to see if water fluctuations affect water quality at the study sites.

Data from the water level recorders, bathymetry mapping, habitat mapping (both riverine and impoundment), and periodic field surveys for the instream flow and resident fish spawning assessments (Studies 9, 14, and 15) will assist in determining potential effects of project operations on fish access and habitat during water level fluctuations.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The methodologies presented above are consistent with accepted scientific practice and have been used at other hydroelectric projects in the Northeast, including the Brassua Hydroelectric Project.

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study. An interim study report will be prepared after the first year of study is complete. The report will be provided to stakeholders for review and comment. A draft final study report will be prepared after the study and analysis is complete in study year two. Stakeholder comments on the draft final report will be included in the final study report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

This study will be conducted during the first study year (2014). Based on the results of the 2013 Aquatic Habitat Mapping Study (Study 7) tributary and backwater sites will be selected for detailed survey in 2014. Water level recorders will be deployed in select locations in early spring 2014, and data will be collected at the sites selected during the related studies through spring of 2015.

LEVEL OF EFFORT AND COST

The preliminary estimated cost of this study is $50,000 including an estimated 30 Onset water level recorders @$15,000.

REFERENCES

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, and B. Popp (editors). 2005. Vermont's Wildlife Action Plan. Vermont Fish and Wildlife Department, Waterbury, VT.

NHFG (New Hampshire Fish and Game Department). 1998. New Hampshire Fish and Game Department Strategic Plan (1998–2010). Concord, NH.

VFWD (Vermont Fish and Wildlife Department). 2006. Vermont Fish and Wildlife Strategic Plan.

Study 14

Resident Fish Spawning in Impoundments Study

RELEVANT STUDY REQUESTS

FWS-17; NHDES-16; NHFG-16; VANR-18; CRWC-17

STUDY GOALS AND OBJECTIVES

In their study requests, FWS, NHDES, NHFG, VANR, and CRWC identified issues regarding the potential effects of impoundment fluctuation on resident fish spawning success in the Wilder, Bellows Falls, and Vernon Project impoundments.

The goal of this study is to assess whether project related water level fluctuation in the impoundments effect resident fish spawning. The target species identified for this study by VANR, NHDES, NHFG, and CRWC include smallmouth bass, largemouth bass, yellow perch, black crappie, pumpkinseed, bluegill, chain pickerel, northern pike, golden shiner, white sucker, spottail shiner, walleye, and fallfish. FWS did not specify the fish species that should be included in the analysis.

The objectives of this study are to:

- delineate, quantitatively describe (e.g., substrate composition, vegetation type and abundance) and map shallow water aquatic habitat types subject to inundation and exposure due to normal project operations, noting and describing additional areas where water depths at the lowest operational range are wetted to a depth less than one foot, such as flats, near shoal areas, and gravel bars with very slight bathymetric change;

- conduct analysis of the effects of the normal operation and the maximum licensed impoundment fluctuation range on the suitability of littoral zone habitats for all life stages of target species likely to inhabit these areas;

- conduct field studies to assess timing and location of fish spawning under existing conditions; and

- conduct field studies to assess potential effects of impoundment fluctuation on nest abandonment, spawning fish displacement, and egg dewatering.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS	•	General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives; and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.
	•	General goals related to aquatic resources including protection, enhancement, or restoration of aquatic and riparian habitats; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.
NHDES	•	State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.
NHFG	•	General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).
VANR	•	State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat.
	•	General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.
	•	VFWD general goals related to conserving, enhancing, and restoring natural communities, habitats, species, and the ecological processes that support them; and providing fish and wildlife-based activities including viewing, harvesting, and utilization of fish, plant and wildlife resources. Goals reference Vermont's Wildlife Action Plan (Kart et al., 2005).
	•	VFWD general goals related to resource conservation, fish and wildlife recreation and use, and human health and safety.
	•	Goals reference Vermont Fish and Wildlife Strategic Plan (VFWD, 2006), including fish SGCN.

ASSOCIATION WITH OTHER STUDIES

The Aquatic Habitat Mapping Study (Study 7) will be completed prior to this study. Data collected in that study will be used to identify preferred spawning habitat types and depths of the targeted fish species.

Data collected concurrently about fish spawning in the riverine sections (Resident Fish Spawning in Riverine Sections, Study 15) includes some of the same fish species being investigated in the impoundments and will provide data on spawning times for walleye, smallmouth bass, fallfish, and white sucker. The Fish Assemblage Study (Study 10) will also inform this study because collections made during the spring/early summer spawning period will provide potential location data for target species spawning grounds and nesting sites for this study..

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

All five requestors stated that, to their knowledge, no information exists related to the effects of project operations on resident fish spawning. This study, in conjunction with the referenced related studies, will provide information on resident fish spawning activity in relation to project operations.

PROJECT NEXUS

Project operations, specifically fluctuating water levels in the three impoundments, have the potential to affect fish spawning success and spawning habitat quality and quantity. The potential exists for either fish eggs or quality spawning habitat to be dewatered, and/or for some species of fish to abandon nests containing eggs. Data collected during this study will assist in determining whether spawning fish in the project impoundments are affected by fluctuating water levels due to project operations.

STUDY AREA AND STUDY SITES

The study area includes all impounded waters of the Wilder, Bellows Falls, and Vernon Projects including portions of tributaries and backwaters within the impoundments that are affected by project operations.

METHODS

To effectively delineate and map the shallow water habitat types and analyze the potential effects of fluctuating water levels on these areas, detailed bathymetry and side-scan sonar habitat mapping from the Aquatic Habitat Mapping Study (Study 7) will need to be conducted before this study can begin. The bathymetry mapping will be used to identify shallow water habitats that may be affected by fluctuating water levels in the impoundments. The side-scan sonar habitat mapping will provide the habitat types that occur in all three impoundments, including substrate types (sand/mud, gravel/cobble, boulder, riprap), woody cover and submerged vegetation. The habitat mapping will be post-processed to delineate and quantify the amount of the different habitat types found in each impoundment and at the depths they occur. The substrate types and locations will assist in identifying potential target fish spawning locations based on spawning habitat preferences, such as gravel or cobble areas. These data will help focus the field effort for the first year of this study to locate fish spawning sites based on habitat characteristics such as substrate and depth.

Water level in each of the impoundments during normal operations will be quantified using Onset continuous monitoring water level recorders. Recorders will be placed in selected locations along the length of each impoundment, including at selected backwater areas, potential spawning locations, in shoal areas and other sensitive locations to determine how, in terms of depth, frequency and duration daily water level changes affect these locations. The recorders will also collect water temperature data every 30 minutes, and field crews will download the data anytime they are in the area sampling or checking on the nest sites, which will occur at least twice per week at the spawning sites. Data will be compiled with corresponding project operational data from the downstream dam to create a dataset that can be used to analyze how project operations affect the spawning areas primarily in terms of elevation, frequency, and duration.

A literature review of spawning times, temperature, and habitat preferences with geographic relevance for the target fish species will be conducted. A field study will be conducted in each impoundment during each target species' spawning season to locate shallow water spawning areas and record spawning times for the target species. Five of the 13 target fish species spawn early in the early spring, including walleye, yellow perch, white suckers, northern pike, and chain pickerel when water temperatures are 42-52^{o}F. None of these fish are nest builders (they broadcast their eggs) but they prefer specific habitat types for spawning and this will help in locating their spawn sites. For instance, northern pike and chain pickerel require vegetated areas for spawning, so searches will focus on submerged aquatic beds in shoal water. Yellow perch spawn near rooted vegetation but also like to spawn near submerged brush, fallen trees, and sometimes over sand and gravel areas. Walleye spawn in rocky areas in white water, so we are not expecting to find them spawning in the impoundments. However, they could move up to the tailraces (riverine habitat) or in the tributaries in the faster water. Walleye egg traps will be set in the tailraces of the Wilder and Bellows Falls Projects to locate their spawning sites; that effort is detailed in the Resident Fish Spawning in Riverine Sections Study (Study 15).

Additional egg traps will be set in tributaries that enter the three impoundments, if they have the right conditions (white water, rocky bottom), to determine if walleye are spawning in those sites. White sucker typically move into tributary streams to spawn in shallow water with a gravel bottom, sometimes spawning in rapids. Egg traps will be set in some of the lower tributaries with the proper habitat that are influenced by project operations to attempt to locate their spawning sites. Using the habitat and bathymetry data collected from the Aquatic Habitat Mapping Study (Study 7), these preferred habitat types can be identified before going into the field, enabling the field crew to focus their efforts in the correct habitats. The time of spawning can also be narrowed down using literature-based water temperature preferences for each fish species. Field efforts to look for spawning sites for the five fish listed above will begin in April and will likely be completed by early May (dependent upon water temperatures).

The other eight target fish species (smallmouth bass, largemouth bass, pumpkinseed, black crappie, bluegill, spottail shiner fallfish, and golden shiner) spawn later in the season when water temperatures range from 61 to 68^{o}F (late spring/early summer). Most of these fish build nests and guard the eggs, with the exception of golden shiner and spottail shiner, which scatter their eggs. The preferred habitats, depth and temperature ranges of these fish will be used to locate the spawning sites/nests.

Sampling during the Fish Assemblage Study (Study 10) will assist with locating spawning sites and nest locations. Fish in spawning condition will be reported by the crew and all nest/spawning sites will be recorded with GPS. Sampling for the early spawners (April) will be conducted prior to the general fisheries surveys. This early sampling will include electrofishing in key habitat areas, such as off channel locations for chain pickerel, yellow perch and northern pike and in the tributary mouths for walleye and white suckers. Fish captured will be checked for spawning condition, released back to the water and their locations recorded with GPS. If targeted fish are found and they are spawning, a water level recorder will be set up to document water levels in the spawning sites to record depth and water temperature every 30 minutes. These data will determine if the area is dewatered during the spawning period, and if so, the time that it occurred so it can be determined if the fluctuating water levels may have been due to project operations. Data on the depth of the nesting site, fish species, water quality data (temperature, DO, pH, conductivity, turbidity) and habitat type (i.e., aquatic weed bed, gravel bar) will be recorded. Field crews will return to the spawning sites during the season to conduct visual observations on the spawning nests/sites and record instances of abandoned or dewatered nests.

ANALYSIS

Using data from the Aquatic Habitat Mapping Study (Study 7), water level recorders and field surveys, an analysis of the effects of project operations on spawning of target resident fish species will be conducted. The analysis will include data on fish spawning sites and fish species located during the field study and potential effects that may have occurred due to project operations, such as dewatered nests or spawning sites from peaking operations. This will be performed using the outputs from the Hydraulic Modeling and Operations Modeling studies (Study 4 and 5) in order to assess the full range of current project operating conditions.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The methodologies presented above are consistent with accepted scientific practice and have been used at other hydroelectric projects in the Northeast, including the Brassua Hydroelectric Project (FERC No. 2615). The side-scan sonar habitat mapping will follow the methods and analysis techniques developed by Kaeser and Litts, 2010.

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study. A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

The study will be conducted in the first study year (2014). Field work to locate spawning fish in the impoundments will be begin in late March/April 2014 and will continue into the summer months until all the targeted fish have completed spawning. The water level recorder data will be analyzed and correlated with project operations to determine if any effects on surveyed spawning fish were due to fluctuating water levels in the impoundments.

LEVEL OF EFFORT AND COST

This preliminary estimated cost for this study is $80,000.

REFERENCES

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, and B. Popp (editors). 2005. Vermont's Wildlife Action Plan. Vermont Fish and Wildlife Department, Waterbury, VT.

Kaeser, A. and T. Litts. 2010. A Novel Technique for Mapping Habitat in Navigable Streams using Low Cost Side Scan Sonar. Fisheries 35:4.

NHFG (New Hampshire Fish and Game Department). 1998. New Hampshire Fish and Game Department Strategic Plan (1998–2010). Concord, NH.

VFWD (Vermont Fish and Wildlife Department). 2006. Vermont Fish and Wildlife Strategic Plan.

Study 15

Resident Fish Spawning in Riverine Sections Study

RELEVANT STUDY REQUESTS

NHDES-11; NHFG-11; VANR-14; CRWC-18

STUDY GOALS AND OBJECTIVES

In their study requests, NHDES, NHFG, VANR, and CRWC identified issues related to potential effects of water level fluctuations on resident fish spawning in downstream riverine reaches of the Wilder, Bellows Falls, and Vernon Projects.

The goal of this study is to determine if project related water level fluctuations in the affected areas downstream of Wilder and Bellows Falls dams negatively affect resident fish spawning.

Based on the study requests, the resident target species included in this analysis are smallmouth bass, white sucker, walleye, and fallfish.

Objectives for this study are to:

- conduct field studies in the project-affected areas downstream of the Wilder and Bellows Falls dams. Nesting locations and spawning sites will be GIS located and mapped; and

- conduct field studies in the project-affected areas below Wilder and Bellows Falls dams to assess potential effects of operational flows and water level fluctuations on nest abandonment, spawning fish displacement and egg dewatering.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

NHDES	• State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.
NHFG	• General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).

VANR

- State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat.
- General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.
- VFWD general goals related to resource conservation, fish and wildlife recreation and use, and human health and safety. Goals reference Vermont Fish and Wildlife Strategic Plan (VFWD, 2006), including fish SGCN.

ASSOCIATION WITH OTHER STUDIES

Aquatic Habitat Mapping (Study 7) is a prerequisite study that should be completed prior to beginning this study, and is anticipated to be completed in 2013. The riverine habitat mapping that is included in Study 7 for the reaches below the Wilder and Bellows Falls Projects (for the purpose of this study plan, referred to as the projects) will assist in identifying and focusing the field efforts on potential spawning locations that may be used by the four target fish species. The Fish Assemblage Study (Study 10) is associated with this study since the electrofishing field work in the riverine reaches in that study will be used to help locate spawning smallmouth bass and fallfish nest sites; it will not help locate walleye and white sucker spawning locations since they spawn early, prior to the electrofishing surveys.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

All four requestors stated that to their knowledge, no information exists related to the effects of the project related water level fluctuations on spawning fish downstream of the projects. This study, in conjunction with the referenced related studies, will provide information on resident fish spawning activity in relation to project related water level fluctuations.

PROJECT NEXUS

Project related water level fluctuations downstream of the projects have the potential to affect resident fish spawning success and spawning habitat quality and quantity. Fish eggs or quality spawning habitat could potentially be dewatered, and/or some species of fish could abandon nests containing eggs. Data collected during this study will assist in determining whether fish spawning downstream of the Wilder and Bellows Falls Projects are affected by fluctuating water levels caused by project operations.

STUDY AREA AND STUDY SITES

The study area includes locations in the project-affected riverine areas downstream of the Wilder and Bellows Falls dams where the target fish species are likely to spawn.

METHODS

Data from the Aquatic Habitat Mapping Study (Study 7) will be analyzed to identify possible spawning sites for walleye, white sucker, fallfish, and smallmouth bass. A literature search and field surveys will be conducted to assess timing and location of fish spawning for the target species below each project. Smallmouth bass and fallfish are nest spawners, nest locations will be GIS located and mapped.

Egg traps will be deployed to find spawning sites for the broadcast spawning walleye and white sucker. Walleye spawn at night in fast water, and both species spawn in early spring when high flows and turbidity can make it difficult to locate them visually. Once spawning locations (walleye and white sucker) are identified by the egg traps, field surveys will be conducted in those spawning sites. Field surveys will also be conducted to assess effects of water fluctuations on potential spawning fish displacement and egg dewatering. This will include photographing the sites and monitoring water levels (water level recorders) to determine if eggs in these selected spawning locations are being dewatered.

For the two nesting species, smallmouth bass and fallfish, nest sites will be located by field surveys and from data collected from the electrofishing surveys conducted under the Fish Assemblage Study (Study 10). Field work will be conducted at selected nesting sites during the spawning season to determine if fluctuating water levels are causing nests to become dewatered. Water level recorders set in proximity to the nests along with field observations will be used to determine effects. Water quality data will be collected at the spawning sites during all field visits (for nesting and broadcast spawners) and will include DO, pH, and turbidity. Temperature data will be collected by the water level recorders every 30 minutes during the spawning season.

ANALYSIS

Data on the timing and location of fish spawning collected during field efforts will be summarized. The potential effects of project related water fluctuations on nesting and spawning fish, such as nest abandonment, egg dewatering and spawning fish displacement will be analyzed. This will include comparing water level fluctuation data from the recorders placed near the nesting sites to project operations data where spawning fish are documented. Data will include GPS mapped locations of fish nests (smallmouth bass, fallfish) and the location of the water level recorders. The walleye and white sucker spawning locations from egg trap data that were located during field surveys will be mapped with GPS along with the water level recorders set nearby. All egg trapping sites will be mapped, including those where no eggs are collected.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The methodologies presented above are consistent with accepted scientific practice and have been used at other hydroelectric projects in the Northeast, including the Brassua Hydroelectric Project (FERC No. 2615).

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study. A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

This study will be done in the first study year (2014). Field work to locate spawning fish downstream of the dams will be begin in late March/early April 2014 when egg traps will be set for walleye and white suckers. Field work will continue into June to capture the fallfish and smallmouth bass spawning periods. The final study report will be prepared after the field season and the lab effort to identify fish eggs collected is completed.

LEVEL OF EFFORT AND COST

The estimated cost of this study is $60,000.

REFERENCES

NHFG (New Hampshire Fish and Game Department). 1998. New Hampshire Fish and Game Department Strategic Plan (1998–2010). Concord, NH.

VFWD (Vermont Fish and Wildlife Department). 2006. Vermont Fish and Wildlife Strategic Plan.

Study 16

Sea Lamprey Spawning Assessment

RELEVANT STUDY REQUESTS

FWS-12, NHDES-19, NHFG-19, VANR-17, CRWC-29

STUDY GOALS AND OBJECTIVES

In their study requests, FWS, NHDES, NHDFG, VANR, and CRWC identified issues related to potential effects of operation of the Wilder, Bellows Falls, and Vernon Projects on sea lamprey spawning habitat and activity in the Connecticut River.

The goal of this study is to assess the level of spawning activity by sea lamprey (*Petromyzon marinus*) in the project-affected areas and to determine whether project operations are affecting the success (i.e., survival to emergence) of lamprey spawning. New Hampshire and Vermont have classified sea lamprey as an SGCN, thus, as stated in Vermont's Wildlife Action Plan (Kart et al., 2005), "research and monitoring needs for SGCN include monitoring and assessing populations and habitats for current conditions and future changes, and identifying and monitoring problems for species and their habitats." New Hampshire has listed the conservation status of sea lamprey as "vulnerable."

The objectives of this study are to:

- identify areas within the Wilder, Bellows Falls, and Vernon Project-affected areas and riverine reaches where suitable spawning habitat exists for sea lamprey;
- conduct a telemetry study of sea lamprey during their upstream migration period in the spring, focusing on areas of suitable spawning habitat, and areas of known spawning;
- conduct spawning ground surveys to observe the use of this habitat for spawning purposes, and hence, confirm suitability;
- obtain data on redd characteristics including location, size, substrate, depth and velocity; and
- determine if the operations at the Wilder, Bellows Falls, or Vernon Projects are adversely affecting these spawning areas, specifically if flow alterations are causing dewatering and/or scouring of sea lamprey redds.

Results of the study will provide information on sea lamprey spawning locations within the three project-affected areas, lamprey redds will be characterized and spawning success will be assessed. An analysis of the effects of project operations on spawning success, potential habitat degradation and larval viability will be presented.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS

- General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives; and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.
- General goals related to aquatic resources including protection, enhancement, or restoration of aquatic and riparian habitats; providing instream flows to meet the requirements of diadromous and resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.

NHDES

- State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.

NHFG

- Sea Lamprey is a state SGCN.
- General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).

VANR

- State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat.
- General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.
- VFWD general goals related to conserving, enhancing, and restoring natural communities, habitats, species and the ecological processes that support them; and providing fish and wildlife-based activities including viewing, harvesting and utilization of fish, plant and wildlife resources. Goals reference Vermont's Wildlife Action

Plan (Kart et al., 2005).

- VFWD general goals related to resource conservation, fish, and wildlife recreation and use, and human health and safety.
- Goals reference Vermont Fish and Wildlife Strategic Plan (VFWD, 2006), including SGCN.

ASSOCIATION WITH OTHER STUDIES

Analysis of data and conclusions in this study will be informed by data collected in several other studies, including: Instream Flow (Study 9), Aquatic Habitat Mapping (Study 7), Tributary and Backwater Fish Access and Habitats (Study 13), Operations Modeling (Study 5), Upstream Passage of Riverine Fish (Study 17), and Fish Assemblage (Study 10).

Studies 7, 9, and 13 will provide additional information on the availability or lack, of sea lamprey spawning habitat within the project-affected areas, and where suitable habitat is found (i.e., backwater areas, tributaries). The Operations Modeling Study, which will help discriminate between the effects from or associated with project and non-project flows, and Studies 10 and 17 will allow for a closer evaluation of the results of this study. For example, the upstream fish passage study and fish assemblage study will provide relative abundance data on sea lamprey and therefore, perspective relative to the quantity of spawning sites identified in the project area and their rated success. If some nests are not successful, river flow modeling will help to determine if project or non-project flows were a factor.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

The sea lamprey is known to spawn in the Connecticut River as far upstream as Wilder dam and in tributaries such as the West, Williams, Black, and White rivers (Kart et al., 2005). Sea lamprey typically spawn in areas of shallow rapid water conducive to their redds, and near sandy bottom, quiet water being preferred by larvae (Bigelow and Schroeder, 1953). FWS (2012) lists the current upstream extent of sea lamprey range as Bellows Falls dam, noting, however, that reproduction has been documented as far north as the White River, Vermont, in the Wilder Project area. In certain years hundreds to thousands of sea lamprey have been recorded passing upstream of Bellow Falls dam, and in at least one year (2008) sea lamprey were documented passing upstream via the Wilder dam fish ladder. In 2008 surveys, Yoder et al. (2009) documented sea lamprey just downstream of the confluence of the White River.

As reported in the project PADs (add cite here for the three PADs), 99 lamprey passed Bellows Falls dam in 2012, and 696 passed Vernon dam in that year. They also state that they know of no studies to date that address the identification of sea lamprey spawning habitat and activity within the three project areas and no studies of the effects of project operations on those activities.

PROJECT NEXUS

Agencies contend that Wilder, Bellows Falls, and Vernon Project operations have the potential to cause direct effects on spawning habitat and activity downstream of the projects in riverine portions of the river, from water releases during routine operations. If lampreys are actively spawning during operational changes, such as decreased or increased generation, assessing whether these changes adversely affect spawning activity will assist resource agencies in the management of the species. Results of this study should identify whether project operations affect spawning activity of sea lamprey.

STUDY AREA AND STUDY SITES

The study area will encompass the Wilder, Bellows Falls, and Vernon Project-affected areas. Specific sites of interest are likely to be riverine sections of the river downstream of Wilder dam and the stretch of river from Bellows Falls tailrace to about 6 miles downstream. Thus, the study area will extend from the upstream limit of the Wilder impoundment to the upstream limit of the Turners Falls Project impoundment (FERC No. 1889).

Sea lamprey typically spawn in areas of shallow rapid water with cobble/gravel substrate for their redds and sandy/muddy bottom quiet water for their larvae (Bigelow and Schroeder, 1953). Other areas of the projects, i.e., impoundments, will most likely not be suitable for lamprey spawning. Specific lamprey spawning sites within the study area will be determined via radio telemetry of individuals. Lamprey will be trapped at the Vernon fish ladder, radio tagged, and released just upstream of Vernon dam. If suitable numbers of lamprey arrive and pass the Bellows Falls fish ladder, they will be trapped, radio tagged, and released above Bellows Falls dam for migration upstream towards the Wilder Project. No lamprey will be double tagged. Tagged lamprey will be followed throughout the project impoundments, riverine sections and into project-affected tributary areas until they exhibit stationary behavior implying spawning activity.

METHODS

Methods to be used in this study generally follow those requested by stakeholders in their study requests, and are as described below.

If present, up to 20 sea lamprey will be collected at each of the Vernon and Bellows Falls fish ladders. It is expected that tracking tagged lamprey will reveal spawning locations and that these spawning locations, if suitable, will be inhabited by non-tagged lamprey as well. Lamprey will be collected and tagged as they enter and traverse the ladder, and released just upstream of the dam. If fewer than 20 fish are collected at the Bellows Falls fish ladder as the ambient water temperature approaches 15^{o}C, since lamprey spawn between 10 and 20^{o}C, additional fish may be taken from Vernon, tagged, and transported to above Bellows Falls dam for release to expedite arrival at spawning areas.

In the event that FirstLight conducts a similar study in the Turners Falls Project area, TransCanada will share radio frequency information with FirstLight, and expects FirstLight will share its frequencies as well, to ensure that tagged fish that move from the Turners Falls Project upstream into the Vernon Project or vice versa, will be monitored.

Lamprey will be radio tagged by techniques described in Hanson and Mather (2002). These techniques are very similar to those described in Noyes et al. (2011) and Mosher et al. (2002). Briefly, sea lamprey will be anesthetized, weighed, and measured for total length and girth and surgically implanted with a radio transmitter. Tagged lamprey will be allowed to recover in a flow through water bath for 4r to 5 hours before release. They will be placed in a truck mounted transport tank or live well on a boat for release mid-channel just upstream of Vernon dam, and just upstream of Bellows Falls dam. Releases will be made after sunset in adherence to widely accepted methodology.

Each transmitter will be of suitable size, weight not to exceed 3 percent of lamprey weight, and most likely all transmitters will operate on at least 20 different frequencies. Lamprey will be manually tracked by boat, car, or possibly aircraft if lamprey cannot be located otherwise, and locations recorded for each tracking event. Once tagged lamprey have reached suspected spawning grounds within the project-affected areas, the area in the immediate proximity of tagged fish will be visually inspected by scuba, snorkeling, and/or boat-mounted observation gear to discern if the habitat is suitable for spawning (i.e., shallow rapid water, sandy/ muddy bottom areas nearby). Fish that move outside of the project-affected areas will be noted as having left, followed until they exhibit stationary behavior indicating potential spawning, and will not be tracked further into nonproject-affected waters.

Once an area within project-affected areas is deemed suitable for lamprey spawning activity, it will be characterized for substrate, depth, and GPS location and monitored frequently, approximately once every 2 or 3 days, dependent upon how many spawning areas are found. Water quality (temperature, DO, relative clarity, pH), water velocity, and depth will be measured over the range of normal project operations. Once redds are established within the project’s affected areas and spawning activity commences, these redds will be monitored and a sample will be capped and emerging larvae enumerated following methods by Fox et al. (2010).

All spawning grounds within project-affected areas will be observed from the time of lamprey arrival to the time of larval lamprey departure, or until water temperature exceeds 22^{o}C because lamprey spawn between 10 and 20^{o}C (Bigelow and Schroder, 1953). Environmental variables including water velocity, depth, temperature, exposure, and relative condition of redds/area will be measured; and the grounds photographed if possible, over the range of normal ,project discharges in order to characterize operational effects. Any changes to the habitat and/or redds will be described and recorded.

It can be expected that some radio tagged sea lamprey will migrate to areas not affected by project operations, such as up into the White River or the West River. In that event, individuals will be monitored to a much lesser extent and gross observations (from shoreline or wading) of their activity will be conducted. Tagged lamprey may also move to locations in some tributaries that may be affected by project operations, such as near the confluence or just within the tributary in a location that may be affected by operations (e.g., just within the Saxtons River or the Cold River). In cases such as these, where tributary inflows or other nonproject-related variables may be a factor in lamprey behavior, all possible environmental variables will be measured and recorded, i.e., water depth, velocity, temperature, etc., so that normal project operations and other contributing effects can be isolated.

ANALYSIS

All radio transmitters will have a unique frequency or code, thus allowing discrimination by individual. All radio telemetry data will be compiled, reduced, and sorted by individual lamprey. Data from any related FirstLight study will be incorporated into this dataset. Locations of each tagged lamprey will be presented spatial-temporally in tabular and graphic form. Coordinates of spawning locations for all tagged fish that participate in spawning within project-affected areas will be identified graphically on maps. The last known location of each tagged fish that moves out of the project areas will also be identified. Congregation areas of radio tagged sea lamprey will be compiled and presented graphically on maps and with aerial photography. Additional non-tagged lamprey will be enumerated. Areas within the project-affected areas will be classified as follows:

1) non-suitable spawning habitat
2) suitable spawning habitat – no observed spawning
3) active spawning area
4) active spawning area with larval sampling

These classified areas will be described as to substrate composition, and for classes 2, 3, and 4, range and average depth, range and average temperature, range and average water velocity, and range and relative clarity over the course of spawning and rearing activity.

Success of spawning by sea lamprey within the project-affected areas will be characterized by emergence of larvae from capped redds, -if larvae emerge, spawning was successful. If eggs do not hatch, and no larvae emerge, spawning was not successful. Emerging larvae will be enumerated and timing of emergence relative to redd construction will be documented. Redds will be characterized as to location, range and average depth, general surrounding substrate, and range and average water velocity.

In order to gage the effects of project operations on the physical spawning habitat and success of spawning by sea lamprey within project-affected areas, collected data will be analyzed and compared to project operations. The date and time of all observed activities, water measurements, and any visual variations of the structural spawning habitat and redd characteristics will be related to the operational data (i.e., total generation, turbine operating, spill, etc.) of the particular project in question. Effects of the projects will be classified per operational regime observed as:

1) No effect - no observable difference to habitat/redd structure or lamprey activity – successful spawning documented.

2) Moderate effect – observable difference to habitat/redd structure and/or behavior noticeable but not enough to preclude normal spawning activity - successful spawning documented.

3) Large effect – observable structural differences to habitat/redds and observable decreased spawning activity – minimal to no successful spawning documented.

4) Severe effect – noticeable habitat/redd degradation, i.e. de-watered, scoured out, and conditions, depth, water velocity, preclude normal spawning activity – no successful spawning documented.

If radio tagged sea lamprey migrate to areas not affected by project operations, gross observations of their activity may reveal whether they spawned in those areas. These data will be presented as ancillary observations. If tagged lamprey move into locations in tributaries that may be affected by project operations, all data will be analyzed and to the extent possible, non-project effects will be compared to project operational effects to determine the extent of each contributing factor.

Other related studies (5, 7, 9, and 13) should provide additional information on available sea lamprey spawning habitat within the project-affected areas. Results of these studies will then enhance the analyses of this study when those studies data are available.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The study methodology is consistent with generally accepted practices. Radio telemetry of both Pacific and sea lampreys has been conducted and accepted for many years. Habitat descriptions and measurement of environmental variables as described above have also been widely conducted for years.

DELIVERABLES

A final study report will be prepared after the first year field season. This reporting period depends on analyses and reporting of related habitat studies. In addition, if project operations were not reasonably typical during the study year, a second year of study may be warranted.

Results and conclusions will be reported in either the PLP or draft license applications for the projects. Exhibit E of the final license applications will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license applications.

SCHEDULE

This study will be conducted in the first study year (2014). Lamprey collection and tagging would likely commence at Vernon fish ladder between mid-April and early May dependent upon water temperature. All specimens should be tagged and released by the end of May. Lamprey will be monitored during May and early June and, once all lamprey have arrived at suspected spawning sites in mid- to late-June, field observations will commence. The field observations will most likely end by mid- to late-July. Data compilation, reduction, and analysis will be conducted directly after the field season. A final report including relevant data from related studies will be prepared after data from those studies are available, analyzed, and incorporated into this study's dataset.

LEVEL OF EFFORT AND COST

The estimated cost for this study is $150,000 for one field season.

REFERENCES

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Study 17

Upstream Passage of Riverine Fish Species Assessment

RELEVANT STUDY REQUESTS

FWS-16; NHDES-20; NHFG-20; VANR-24; CRWC-20

STUDY GOALS AND OBJECTIVES

In their study requests, FWS, NHDES, NHFG, VANR, and CRWC identified issues related to upstream passage of riverine fish species at the Wilder, Bellows Falls, and Vernon Projects. Specifically, requesters indicated that no information exists to assess existing year-round fishway use by resident fish species, nor whether existing upstream passage at the projects is adequate for riverine and diadromous fish species. The goals of this study are to determine the use and temporal distribution of riverine fish passing upstream in the existing Wilder, Bellows Falls, and Vernon fish ladders during year-round fishway operation and to determine the appropriate operation period for these fishways to pass riverine and diadromous fish.

The objectives of this study are to:

- identify the use and temporal distribution of upstream passage through the Wilder, Bellows Falls, and Vernon fishways by riverine and diadromous fish species;
- operate and monitor the fishways year-round (or until otherwise infeasible) to assess fishway use over a longer period than the existing May-July time period;
- determine the appropriate operating windows for the fishways for riverine species; and
- determine the appropriate operating windows for diadromous species such as American eel and sea lamprey.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS

- General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives; and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.
- General goals related to aquatic resources including protection,

enhancement, or restoration of aquatic and riparian habitats; providing instream flows to meet the requirements of diadromous and resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.

NHDES
- State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.

NHFG
- General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).

VANR
- State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat.
- VFWD general goals related to conserving, enhancing, and restoring natural communities, habitats, species, and the ecological processes that support them; and providing fish and wildlife-based activities including viewing, harvesting, and utilization of fish, plant, and wildlife resources. Goals reference Vermont's Wildlife Action Plan (Kart et al., 2005).
- VFWD general goals related to resource conservation, fish and wildlife recreation and use, and human health and safety.
- Goals reference Vermont Fish and Wildlife Strategic Plan (VFWD, 2006).

ASSOCIATION WITH OTHER STUDIES

This study relates to two other requested studies. Data collected from the Sea Lamprey Spawning Assessment (Study 16) and American Shad Telemetry Study (Study 21) that will provide additional information on upstream fishway usage by these species. In those studies adult sea lamprey and adult American shad will be monitored as they approach and potentially attempt to pass the Bellows Falls and Wilder fishways, American shad will also be monitored at the Vernon fishway.

We expect that radio tagged shad and sea lamprey tagged downstream by FirstLight will also be monitored if they attempt upstream passage at any of the three project fishways.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

No information exists that will allow for a comprehensive assessment of existing year-round fishway use by resident fish species. The requesters provided some summary data in their study requests on passage numbers of resident fish at Vernon dam in 2012, but noted that those analyses were conducted during one year and did not include any monitoring outside of the May through July period. In their PADs for the Wilder and Bellows Falls Projects, TransCanada identified resident fish species recorded using the Wilder and Bellows Falls fishways and indicated that the data are available from VFWD. They also noted that VFWD has several years (2007-2012) of seasonal fish passage data not yet analyzed for the May through July period.

This study will fill the data gaps about potential upstream passage usage of the project fishways by resident and diadromous fish during the other 9 months of the year (August through April).

PROJECT NEXUS

The Wilder, Bellows Falls, and Vernon dams are a physical impediment to upstream fish passage for both resident and diadromous fish. The three dams have a direct effect on fish species attempting to move upstream and may prevent some fish from accessing aquatic habitat upstream of the dams. Operating the fishways beyond the normal May-July time period and documenting the usage by resident and diadromous fish species will provide the data needed to determine the level of riverine fish passage through the existing fishways. The data from this study will also provide information on the temporal distribution of riverine and diadromous fish passage.

STUDY AREA AND STUDY SITES

The study sites include the fish ladders at the Wilder, Bellows Falls, and Vernon Projects.

METHODS

The study methods will be similar to what was requested. Requesters indicated that the fishways should be operated year-round (or until otherwise infeasible), which is what this study plan includes. The only difference is that this plan proposes to operate the fishways until freezing temperatures cause severe icing, which could lead to damage to fishway components. The following methods will be used:

Video monitoring and recording equipment will be set up and maintained in the fishway windows of each of the three fish ladders. Fishways will be monitored year-round (or until freezing temperatures make it infeasible) to monitor fishway use by resident and diadromous fish. Video equipment will be checked weekly to ensure its operating properly and to retrieve video files for analysis.

Video files will be processed and reviewed throughout the study and monthly tables will be created that detail hourly fish passage results at each fishway. Data will include number of fish, species, water flow through the ,project, water temperature and time of passage.

Salmonsoft FishTick/FishRev digital video counting systems will be used at all three fishways to process the video files. The Salmonsoft counting systems will be quality control checked during the study to determine the accuracy of the counts. This will be accomplished by operating a second video camera on randomly selected days that is not using Salmonsoft and compare the results.

Hydraulic conditions in the fishways will be documented during weekly visits to download video files and from Project operational data. This will include recording attraction flow settings, inspection of the fishway entrances and exits to make sure they are not blocked with debris. Temperature monitors will be placed in each fishway to record hourly temperatures throughout the study period.

ANALYSIS

Results of this study will be presented in graphical and tabular format. The usage and temporal distribution of riverine and diadromous fish passage at each of the three fish ladders year-round (or until icing prevents fishway operation) will be documented after reviewing all the recorded digital files collected during the year-long study.

Radio telemetry data on upstream migrating shad and sea lamprey attempting upstream passage at any of the three fishways gleaned from the related sea lamprey and shad studies (Studies 16 and 21) will also be analyzed and summarized as part of this study.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The use of cameras to record upstream fishway use by resident and diadromous fish has been used at the Merrimack Hydroelectric Project (FERC No. 1893) and at other locations in the Northeast, including the fishway monitoring conducted annually by Vermont DFW since 1985.

DELIVERABLES

A report will be prepared that presents methods, analysis and results of the study. A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

This study will be conducted during the first study year (2014). Cameras and recording equipment will be setup in the count windows at each of the three fishways during April 2014 and will be operated until icing in the fishways makes sampling prohibitive during the winter of 2014/2015. A final report will be prepared after the study field season and data analysis is completed.

LEVEL OF EFFORT AND COST

The preliminary estimated cost for this study is approximately $40,000 per fishway, or $120,000 total.

REFERENCES

NHFG (New Hampshire Fish and Game Department). 1998. New Hampshire Fish and Game Department Strategic Plan (1998–2010). Concord, NH.

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, and B. Popp (editors). 2005. Vermont's Wildlife Action Plan. Vermont Fish and Wildlife Department, Waterbury, VT.

VFWD (Vermont Fish and Wildlife Department). 2006. Vermont Fish and Wildlife Strategic Plan.

Study 18

American Eel Upstream Passage Assessment

RELEVANT STUDY REQUESTS

FWS-09, NHDES-24, NHFG-24, VANR-22, CRWC-27, TU-08

STUDY GOALS AND OBJECTIVES

In their study requests, FWS, NHDES, NHFG, VANR, CRWC, and TU identified potential issues related to upstream American eel passage at the Wilder, Bellows Falls, and Vernon Projects. TU only requested upstream eel studies for the Bellows Falls and Vernon Projects; the other five requestors also included the Wilder Project. Specifically, requesters indicated that the dams may increase residency time of upstream migrating American eels trying to access historical rearing habitat and information is needed on where and at what concentrations American eels are congregating downstream of the projects.

The goal of this study is to provide baseline data on the presence of American eels attempting to move upstream of the projects and the locations where they congregate while attempting upstream passage.

The objectives of this study are to:

- conduct systematic surveys of eel presence/abundance at tailrace and spillway locations at the Wilder, Bellows Falls, and Vernon Projects to identify areas of concentration of eels staging in pools or attempting to ascend wetted structures; and

- collect eels with temporary trap/pass devices from areas identified from the surveys as locations of eel concentrations to assess whether eels can be collected and passed in substantial numbers.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS	• Specific goals related to American eel include minimizing project effects that could hinder management goals; and minimizing project effects on upstream passage, injury, and stress to facilitate access to historical rearing habitat. Goals reference ASMFC Interstate Fishery Management Plan for American Eel (ASMFC, 2000); ASMFC Addendum II to the Fishery Management Plan for American Eel (ASMFC, 2008); and CRASC Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin (CRASC, 2005).

	• General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives; and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.
NHDES	• State water quality standards and designated uses for Class B waters, including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.
NHFG	• American eel is a state SGCN. Specific goals include minimizing project effects on upstream passage, injury, and stress to facilitate access to historical rearing habitat. Goals reference ASMFC (2000), ASMFC (2008), and CRASC (2005).
	• General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).
VANR	• American eel is a state SGCN. Specific goals include minimizing project effects that could hinder management goals; and minimizing project effects on upstream passage, injury, and stress to facilitate access to historical rearing habitat. Goals reference ASMFC (2000), ASMFC (2008), and CRASC (2005).
	• General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives; and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.
	• VFWD general goals related to conserving, enhancing, and restoring natural communities, habitats, species, and the ecological processes that support them; and providing fish- and wildlife-based activities including viewing, harvesting, and utilization of fish, plant, and wildlife resources. Goals reference Vermont's Wildlife Action Plan (Kart et al., 2005), including SGCN.
	• VFWD general goals related to resource conservation, fish and wildlife recreation and use, and human health and safety.
	• Goals reference Vermont Fish and Wildlife Strategic Plan (VFWD, 2006), including SGCN.

ASSOCIATION WITH OTHER STUDIES

This study is part of a group of studies related to American eel in the project areas. Related studies include the American Eel Survey (Study 11), American Eel Downstream Passage Assessment (Study 19), and American Eel Downstream Migration Timing Assessment (Study 20). Together, these four studies will provide a more complete picture of American eel usage of the mainstem river in project-affected areas and the potential project effects.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

No information currently exists about where upstream migrating American eels might be concentrating below the three dams as they seek upstream passage, or the annual numbers of eels attempting to ascend the dams.

While eels have been documented ascending the Bellows Falls and Vernon fishways, fishway efficiency for passing eels is also unknown. The existing upstream fishways were designed to pass Atlantic salmon and American shad, the primary species of concern when fishery agencies were considering fish passage at the projects. Although some eels ascend the fishways, agencies are concerned that smaller eels may encounter velocity barriers within the fishways that increase their residency time below the dams.

PROJECT NEXUS

The three project dams create impediments to upstream migrating eels. The dams directly affect some of the eels' ability to pass upstream due to dam height; the existing fishways were not designed for eel passage and may present a velocity barrier for some smaller eels. The results from this study will provide information on specific locations where eels attempting to move upstream may concentrate downstream of project facilities.

STUDY AREA AND STUDY SITES

The study area includes the tailrace and spillway locations at the Wilder, Bellows Falls, and Vernon dams and the Bellows Falls bypassed reach. Systematic surveys will be conducted at each site to document the presence and relative abundance of eels. Surveys will be conducted in the spillway areas, especially where there is significant spill or leakage flow where eels may attempt to climb. Visual searches and eel pot trapping will also be conducted around the fish ladders and in the Bellows Falls bypassed reach.

METHODS

Systematic Surveys

Visual surveys will be conducted at night, once per week, downstream of each dam on foot (wading) or from a boat from May 1 through October 15 (or when water temperature exceeds 50°F), preferentially during precipitation events. Visual surveys will be done in likely areas where eels may congregate below each dam, such as spillways, places where there is significant leakage or overflow points along the dams, the Bellow Falls bypassed reach, and in areas near the upstream fish ladders. Data collected will include location (GPS coordinates), observation of eels (presence, absence, numbers, estimated sizes), time and date of observation, field notes on weather conditions, and moon phase. Other data that will be recorded include notes on project operations during sampling such as spill gates that may be open and/or spill conditions during high flows.

Up to 10 baited eel pots per project will be fished once per week (overnight sets) from May 1 through October 15 below the spillways, Bellows Falls bypassed reach, near fish ladders, and in locations that upstream migrating eels may congregate. Data collected will include location, numbers captured (or recorded as none captured), relative sizes, and time and date of observation. Each eel will be assigned a length class (0 to 6 inches, 6 to 12 inches, 12 to 18 inches, and >18 inches). The first 10 individuals within each length class will be individually measured for total length (nearest mm) and wet weight (nearest gram). The first 10 individual eels in the >18-inch length class will also have eye diameter measurements recorded. To facilitate collection of length and weight data as well as prevent unnecessary injuries to the eels, it may be necessary to anesthetize individuals using an appropriate anesthetic for the species (i.e., ice, clove oil, or MS-222).

All eels collected from baited eel pots will be released at their point of capture. Eel pots will be moved to different locations below the dams if no eels are captured in a particular location after 3 weeks of fishing. GPS coordinates will be taken for all eel pot locations.

Temporary/Portable Eel Trap Passes

Temporary eel trap passes will be installed and operated at each of the three projects if concentrations of eels are identified during systematic surveys. If concentrations of eels are not located due to low abundance below a project, then eel trap passes will not be fished at that site.

If eel concentrations are located below a project during the systematic surveys, then up to two portable, temporary eel trap passes will be set below each of those dams in the locations where the eels congregated. These eel trap passes will be operated throughout the upstream migration season for eels (May 1 to October 15, or when river temperature exceeds 50^{o}F). The eel trap passes will be operated daily, with catches quantified every 2 to 3 days. GPS coordinates will be taken at all the locations the eel trap passes are fished.

One of the temporary eel trap passes may be installed in the lower sections of fishways supplied with minimal attraction flow (0.5 to 1.0 cfs); however, this will only occur if the fishway is dewatered. In another study request, the Upstream Passage of Riverine Fish Species Assessment (Study 17), agencies have asked for year-round operation of the three fishways to assess resident fish passage at the projects.

Data recorded from the temporary eel trap passes will include location, trapping interval, number of eels trapped, length, weight, and hydrologic and environmental conditions (water temperature, DO, pH and conductivity, weather conditions, moon phase) encountered during trapping. Project operations data for such spill events, including gates that may be open, will also be recorded. Each eel will be assigned a length class (0 to 6 inches, 6 to 12 inches, 12 to 18 inches, >18 inches). The first 10 individuals within each length class will be individually measured for total length (nearest mm) and wet weight (nearest grams). The first 10 individual eels in the >18-inch length class will also have eye diameter measurements recorded. All eels collected from the eel trap passes will be transported and released into the impoundment upstream of where they were collected.

ANALYSIS

Study results will include an analysis of where eels congregate during the visual night surveys and eel pot survey, including GPS coordinates of places where eels were captured or visually seen during night surveys and photos of the locations and eels found during the surveys, if possible. Additional data will include the number of eels captured (in traps); number (or relative number) of eels observed during night surveys; relative sizes, weight, behaviors noted during the survey (visual surveys); and the time, date, and environmental and hydrologic conditions (as described above) encountered during the surveys.

For the eel trap/pass collections, recorded data will include location, trapping interval, number of eels trapped, relative sizes, weights, and hydrologic and environmental conditions (as described above) encountered during the trapping period.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The methodologies presented above are consistent with accepted scientific practice and have been used at other hydroelectric projects in the Northeast, including the Merrimack River Hydroelectric Project (FERC No. 1893).

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study. A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

Systematic surveys will begin at all three dams during the first study year (2014) on May 1 and continue through October 15, including weekly eel pot trapping and visual night surveys. Temporary eel trap passes will be installed below the dams if concentrations of eels are found. Two eel trap passes will be set in locations where eels were found congregating by May 1, and traps will be fished through October 15. The field effort will cover 22 weeks of sampling, with the traps being fished every 2 to 3 days during that time period. The study report will be prepared after all field work and data analysis is completed.

LEVEL OF EFFORT AND COST

The estimated cost of this study is approximately $65,000 per dam or $195,000 total.

LITERATURE CITED

ASMFC (Atlantic States Marine Fisheries Commission). 2000. Interstate Fishery Management Plan for American Eel.

ASMFC. 2008. Addendum II to the Fishery Management Plan for American Eel. Approved October 23, 2008. 8pp.

CRASC (Connecticut River Atlantic Salmon Commission). 2005. A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin. Draft.

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, and B. Popp (editors). 2005. Vermont's Wildlife Action Plan. Vermont Fish and Wildlife Department, Waterbury, VT.

NHFG (New Hampshire Fish and Game Department). 1998. New Hampshire Fish and Game Department Strategic Plan (1998–2010). Concord, NH.

VFWD (Vermont Fish and Wildlife Department). 2006. Vermont Fish and Wildlife Strategic Plan.

Study 19

American Eel Downstream Passage Assessment

RELEVANT STUDY REQUESTS

FWS-11, NHDES-09, NHFG-09, VANR-21, CRWC-28, TU-06

STUDY GOALS AND OBJECTIVES

In their study requests, FWS, NHDES, NHFG, VANR, CRWC, and TU identified a potential issue related to potential effects of operations of the Wilder, Bellows, and Vernon Projects on American eel during the silver phase. Specifically, the issue is whether project operations negatively affect emigration of American eels.

The study goals are to identify project-related effects on downstream passage timing, injury, stress, and survival in order to maximize the number of American eels migrating to their spawning grounds.

The specific objectives of this study are to:

- quantify the movement rates (including timing) and relative proportion of eels passing via various routes at the projects including through the turbines, the Bellows Falls bypassed reach, the current downstream passage facilities, and spillways; and

- assess instantaneous and latent mortality and injury of eels passed via each route.

This study will assess whether project operations are adversely affecting American eel migration timing and survival.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS	• Specific goals related to American eel include minimizing project effects that could hinder management goals; and minimizing project effects on passage timing, injury, stress, and mortality to maximize the number of silver eels migrating to spawning grounds. Goals reference ASMFC Interstate Fishery Management Plan for American Eel (ASMFC, 2000); ASMFC Addendum II to the Fishery Management Plan for American Eel (ASMFC, 2008) and CRASC Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin (CRASC, 2005).

	• General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives; and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.
NHDES	• State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.
NHFG	• American eel is a state SGCN. Specific goals include minimizing project effects on eel passage, injury, stress, and mortality to maximize the number of silver eels migrating. Goals reference ASMFC (2000), ASMFC (2008), and CRASC (2005).
	• General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).
VANR	• American eel is a state SGCN. Specific goals include minimizing project effects that could hinder management goals; and minimizing project effects on passage timing, injury, stress, and mortality to maximize the number of silver eels migrating to spawning grounds. Goals reference ASMFC (2000), ASMFC (2008), and CRASC (2005).
	• State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat.
	• General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.
	• VFWD general goals related to conserving, enhancing, and restoring natural communities, habitats, species, and the ecological processes that support them; and providing fish and wildlife-based activities including viewing, harvesting, and utilization of fish, plant, and wildlife resources. Goals reference Vermont's Wildlife Action Plan (Kart et al., 2005), including SGCN.
	• VFWD general goals related to resource conservation, fish and

wildlife recreation and use, and human health and safety.

- Goals reference Vermont Fish and Wildlife Strategic Plan (VFWD, 2006), including SGCN.

ASSOCIATION WITH OTHER STUDIES

This study is part of a group of studies related to American eel in the project areas. Related studies include the American Eel Survey (Study 11), American Eel Upstream Passage Assessment (Study 18), and American Eel Downstream Migration Timing Assessment (Study 20). Together, these four studies will provide a more complete picture of American eel usage of the mainstem river and project areas and potential project effects.

EXISTING INFORMATION

American eels have been collected both upstream and downstream of the Vernon Project and also have been counted passing the upstream fish ladder. Eels have been documented upstream of the Bellows Falls Project by NHFG (unpublished data) and Yoder et al. (2009), and although passage into the Wilder Project area is available (based on their presence upstream of Bellows Falls), American eels were not documented in the Wilder Project area during the most recent survey (Yoder et al., 2009). To date, no directed studies of eel entrainment or mortality have been conducted at any of the projects.

Within the past 7 years, FWS has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005, FWS issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007, with a finding that listing was not warranted. The second petition was filed on April 30, 2010, by the Council for Endangered Species Act Reliability. On September 29, 2011, FWS issued a substantial 90-day finding and initiated a 12-month status review. FWS is still accepting new American eel information for the ongoing status review. The date for completion of the 12-month finding on the latest petition is uncertain.

PROJECT NEXUS

The Wilder, Bellows Falls, and Vernon Projects operate as daily peaking facilities, except during periods when inflow exceeds the hydraulic capacities of generation. Silver phase American eels emigrate during the mid-summer through late fall, a time of year when flows are generally within the operating capacities of the projects except during periodic high water events. Therefore, eels would likely pass the projects through either the turbines, open fish passage facilities or spill gates. Since little information exists and eels are known to be present upstream of Vernon and Bellows Falls projects, and potentially in the Wilder Project, it is necessary to understand how eels move downstream through the projects and to determine what level of injury or mortality caused by passage during emigration may occur.

STUDY AREA AND STUDY SITES

The study areas associated with assessing movement rates and passage through the dams encompass the Wilder, Bellows Falls, and Vernon Project forebays, tailraces, turbines, downstream fish bypass routes, and spillways.

METHODS

American eel downstream passage will be assessed by radio tagging and systematically monitoring fish movements and passage through each of routes through the projects. The methods in this study incorporate the use of radio telemetry and balloon tag methodology as requested by the agencies, but do not include the use of passive-integrated transponder (PIT) tags because PIT tags would provide little additional information for determining passage route selection or passage survival, and only the open fish passage facilities would be conducive to installing PIT tag readers so the remaining potential passage routes would not be monitored by that method.

American eel downstream passage survival will be assessed by using HI-Z Turb'N Tag mark/recapture methodology. In their study requests, resource agencies proposed evaluating survival at all potential passage routes at each project; however, TransCanada believes that passage survival through the fish passage facilities and over the spillways is likely to be high. Therefore, the focus of the survival study is on turbine passage, and this portion of the study will use the total number of silver eels (150) requested by the resource agencies. In addition, resource agencies proposed testing 50 eels at each of the three projects. However, this study will proportionally allocate the number of eels tested at each project by the number of different turbine types. This approach will provide more reliable survival estimates because the sample size for each test will be increased.

Route Selection

American eel downstream passage will be assessed by radio tagging and systematically monitoring their movements and passage through each of the projects.

Silver phase American eels for the study will be collected at either the Turners Falls or Holyoke bypass samplers, or as suggested by the resource agencies, from out-of–basin if needed to meet the sample size requirements. All collections will occur from late August to mid-October to coincide with the expected natural emigration period. Following collections or acquisition, eels will be transported and retained in appropriate holding facilities in a secure location at the Vernon Project.

Only eels that meet the morphometric criteria (eye diameter relative to body size as described in Pankhurst, 1982) will be used to ensure they are silver phased migrants. It is expected that any eels obtained from an out-of-basin source will be of similar size to those collected at the Turners Falls or Holyoke bypass samplers.

Remote telemetry monitoring will occur at the project forebays, log booms, fish passage routes, turbines, tailraces, and spillways. Additionally, monitoring will occur in the power canal at Bellows Falls and the fishway attraction water intake at Vernon if it is operational during the course of this study.

Radio receivers and/or Digital Spectrum Processors capable of monitoring multiple radio channels simultaneously at each location will be coupled with appropriate antennas and calibrated to ensure adequate coverage of the individual sites to be monitored while minimizing overlap between the sites. It is expected that at a minimum, 18 monitoring sites will be installed. Data collection from the remote telemetry monitoring stations will occur at a minimum of three times per week. Periodic manual monitoring by vehicle or boat will also occur at least two times per week to assist in data collection and analysis.

Radio transmitters of a suitable size and weight and having a minimum calculated life of 90 days will be used. Each transmitter will contain a unique pulse code to allow for individual fish identification and be compatible with Digital Spectrum Processors. The radio tag channel/code set will be designed to ensure tagged eels released upstream of Wilder and Bellows Falls will subsequently be able to be monitored at the TransCanada facilities downstream, thus increasing the sample size at those facilities. In the event that FirstLight conducts a similar study within the Turners Falls Project area, TransCanada will share radio frequency information, and expects that FirstLight will share its frequencies as well, to ensure that tagged fish that may move from the Turners Falls Project upstream into the Vernon Project or vice versa, will be monitored.

For testing, 50 silver phase eels will be radio tagged following procedures established in Welsh et. al. (2009) and released approximately 5 kilometers (3 miles) upstream of each project in five separate groups of 10 fish each, for a total of 150 eels. If possible, releases will occur during spill and non-spill conditions and under low, moderate, and high generation conditions. If spillage from the Bellows Falls dam occurs, an additional 50 eels will be released directly into the power canal so an adequate number of eels are exposed to the turbines and fish passage facilities.

During the course of the study, air temperature, water temperature, turbidity, rainfall, river flow, and project operations will be continually collected and retained. Lunar phase will also be noted.

Survival / Injury Studies

American eel passage survival will be assessed by using HI-Z Turb'N Tag mark/recapture methodology at the powerhouse turbines at each of the three projects.

Silver phase eels for this portion of the study will be collected at either the Turners Falls or Holyoke bypass samplers or (as suggested by the resource agencies) out-of–basin if needed to meet the sample size requirements. All collections will occur from late August to mid-October to coincide with the expected natural outmigration period. Following collections or acquisition, eels will be transported and retained in appropriate holding facilities in a secure location at the Vernon Project.

Only eels that meet the morphometric criteria (eye diameter relative to body size as described in Pankhurst, 1982) will be utilized to ensure they are silver phased migrants. It is expected that eels that may come from an out-of-basin source will be of similar size to those collected at the Turners Falls or Holyoke bypasses.

A minimum 50 HI-Z Turb'N Tagged eels will be released for testing at each of the three projects using methodologies outlined in Normandeau (2010). The exact breakdown of the number of eels released at each turbine type at each project and the number of control eels released will be determined following agency consultation. Turbine survival tests will be conducted by injecting tagged eels into turbines at or near full generation. Following release through each turbine tested, the eels recovered alive downstream will be held for 48 hours for observation of injury and latent mortality. Unrecovered balloon tagged eels will be censored from the sample for survival analysis.

During the course of the study, air temperature, water temperature, turbidity, rainfall, river flow, and project operations will be continually collected.

ANALYSIS

Route Selection

The radio telemetry data will be analyzed to determine the number and timing of eels using each passage route at each of the three projects. A comparative analysis of passage routes with environmental and physical variables that occur during the study period will be conducted. The analysis will include 2-D maps of movement and passage for each individual eel.

Survival / Injury Studies

Immediate and latent survival and classification of injuries will be estimated for the turbines at each project using generally accepted practices (Normandeau, 2010). The results will be assessed in conjunction with the physical and environmental conditions that occur during the study. At Wilder and Vernon where multiple turbine types are tested, a survival estimate will be derived individually for each turbine type as well as a composite survival estimate for the project.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The study methodology, data collection, and analysis techniques to complete this study are consistent with generally accepted practices (Normandeau and FPLE, 2007a, b; Normandeau, 2010, 2011a, b; Normandeau and Gomez and Sullivan, 2012).

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study. A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license applications for the projects. Exhibit E of the final license applications will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license applications.

SCHEDULE

This study will occur in the fall of the first study year (2014). If environmental conditions (i.e., high flows) compromise the route selection study findings, a second year of study may be warranted; however, the timing of a second year study in the fall of 2015 precludes filing of a final study report by the current ILP study report deadline. A final report will be provided after completion of the field study.

LEVEL OF EFFORT AND COST

The preliminary estimated cost for this 1-year study is $200,000-$250,000 but is dependent on the effort required to obtain test specimens through field collections.

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Study 20

American Eel Downstream Migration Timing Assessment

RELEVANT STUDY REQUESTS

FWS-10; NHDES-03; NHFG-03; VANR-20; CRWC-26; TU-04

STUDY GOALS AND OBJECTIVES

In their study requests, FWS, NHDES, NHFG, VANR, CRWC, and TU identified a potential issue related to the lack of understanding about the outmigration timing of silver phase American eels in relation to environmental factors and operations of mainstem hydropower projects on the Connecticut River, including the Wilder, Bellows Falls, and Vernon Projects, although the TU study request only included the Bellows Falls and Vernon Projects.

The goal of the requested studies was to assess the timing of American eels migrating from the Connecticut River to their spawning grounds. The specific objective is to characterize the general migratory timing and presence of silver phase American eels in the Connecticut River compared to environmental factors including air and water temperature, turbidity, rainfall, river flow, lunar phase and flow-related operations of mainstem river hydroelectric projects.

TransCanada is interested and willing to contribute to a more in-depth understanding of the timing and cues that initiate the downstream migration of American eel in the Connecticut River. However, it finds that a field study is premature at this time. There are few American eel upstream of the TransCanada projects, as indicated by annual electrofishing conducted in the lower portion of Vernon impoundment by Entergy Nuclear Vermont Yankee and as summarized in the Vernon PAD, and collections made by Yoder et al. (2009) above the Bellows Falls and Wilder dams. A robust evaluation of the timing of downstream migration necessarily requires collecting fish through the migration period, as they emigrate. The effort required to catch a reasonable proportion of the few eels that currently emigrate through the projects would be cost prohibitive. Even then, the number of eels collected would likely be too small to draw reasonable conclusions. Therefore, TransCanada proposes to conduct a thorough review of existing eel downstream migration literature. It appears that such a review has not been completed, particularly with an emphasis on the Connecticut River watershed. The review would augment any field data collected at Cabot Station by FirstLight if such a study is conducted.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS	•	Specific goals related to American eel include minimizing project effects that could hinder management goals and minimizing project effects on passage timing, injury, stress, and mortality to maximize the number of silver eels migrating to spawning grounds. Goals reference ASMFC Interstate Fishery Management Plan for American Eel (ASMFC, 2000); ASMFC Addendum II to the Fishery Management Plan for American Eel (ASMFC, 2008) and CRASC Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin (CRASC, 2005).
	•	General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.
NHDES	•	State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.
NHFG	•	American eel is a state SGCN. Specific goals include minimizing project effects on eel passage, injury, stress, and mortality to maximize the number of silver eels migrating. Goals reference ASMFC (2000), ASMFC (2008), and CRASC (2005).
	•	General goals related to sustainable fish populations, habitats, recreational fishing and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).

VANR	• American eel is a state SGCN. Specific goals include minimizing project effects that could hinder management goals and minimizing project effects on passage timing, injury, stress, and mortality to maximize the number of silver eels migrating to spawning grounds. Goals reference ASMFC (2000), ASMFC (2008), and CRASC (2005). • State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat. • General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat. • VFWD general goals related to conserving, enhancing, and restoring natural communities, habitats, species, and the ecological processes that support them and providing fish and wildlife-based activities including viewing, harvesting, and use of fish, plant, and wildlife resources. Goals reference Vermont's Wildlife Action Plan (Kart et al., 2005), including SGCN. • VFWD general goals related to resource conservation, fish and wildlife recreation and use, and human health and safety. • Goals reference Vermont Fish and Wildlife Strategic Plan (VFWD, 2006), including SGCN.

ASSOCIATION WITH OTHER STUDIES

This study (Study 20) is part of a group of studies related to American eel in the project areas. Studies related to this study include American Eel Upstream Passage Assessment (Study 18), American Eel Survey (Study 11), and American Eel Downstream Passage Assessment (Study 19). Together, these four studies will provide a more complete picture of American eel usage of the mainstem river and project areas and potential project effects. In addition, other concurrent studies may provide supplemental information for this study, including the Fish Assemblage Study (Study 10), Upstream Passage of Riverine Fish Species Assessment (Study 17), and Aquatic Habitat Mapping (Study 7).

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Some information is available about the timing of downstream migration of American eel in the Connecticut River watershed and in other basins. Monitoring of the downstream bypass at the Holyoke dam (canal louver array) was performed in 2004 and 2005 (Kleinschmidt, Inc., 2005, 2006; Normandeau, 2007).

Results of the 2004 study indicated outmigration occurred at night, between the hours of 1700 to 0400 with peak activity (70 percent) between the hours of 1900 to 2100. Most eels were collected between October 13 and November 7. In 2005, sampling occurred almost every night from October 5 through November 9. The nightly emigration activity occurred between the hours of 1900 and 2400.

PROJECT NEXUS

Currently the TransCanada projects have little, if any, direct effect on the overall outmigration of Connecticut River American eel because so few eels exist upstream of the TransCanada projects. With increased passage at the Turners Falls Project, a greater number of American eels may penetrate farther up the basin, and ultimately, there may be a need to consider specific downstream passage effects at one or more of the TransCanada projects. Because of the potential for a significant number of eels at some time in the future, TransCanada recognizes that there is a nexus between the projects and the American eel resource.

As stated above, an understanding of the dynamics and triggers for downstream migration would be helpful in developing reasonable plans to address safe downstream passage. Results of this study will be used to contribute to the overall knowledge about the American eel downstream migration in the basin. This approach differs from those requested by the resource agencies. The agencies requested continual systematic monitoring of the Holyoke or the Turners Falls bypass facilities via video or DIDSON surveys and a hydroacoustics survey in the Turners Falls intake canal. Because the same request for study has been made to FirstLight, it is not plausible for TransCanada to conduct a field study at the FirstLight Project. If FirstLight conducts a field study at Cabot Station, the field data request to characterize run timing will be fulfilled, obviating the need for TransCanada to request permission of Holyoke Gas & Electric to conduct a study related to TransCanada's projects at the Holyoke Project.

STUDY AREA AND STUDY SITES

The literature review will focus on existing Connecticut River Basin primary publications, reports, and data (as made available). In addition, existing information from basins in the Northeast will be included to compare and contrast with specific information for the Connecticut River Basin. A broader search for information specific to cues that instigate migration will be included. Regardless of basin or even region, such information on migratory cues may be helpful for developing downstream passage plans in the Connecticut River Basin.

METHODS

The method to be used for this study is to conduct a thorough review of currently available literature for the Connecticut River Basin and other rivers in the Northeast to characterize the general timing of the Connecticut River American eel downstream migration.

Specifically, a review of both peer-reviewed and grey literature related to American eel downstream migration on the Connecticut River and other river systems in the Northeast and general eel migration biology will be conducted to quantify and characterize the expected outmigration of silver phase American eels with a particular focus on environmental cues that stimulate migration.

ANALYSIS

Results of the literature review along with results of related studies and any field surveys that may be conducted at Turners Falls and shared by FirstLight within this study's report timeline will be compiled, summarized, and presented to the agencies and FERC for review and comment.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The study methodology is consistent with generally accepted practices.

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study.

If FirstLight conducts field studies at Turners Falls in study year one, it is assumed those results will be available to be incorporated into the review (or a report supplement for study year two if field study results are not available prior to the due date of TransCanada's report).

A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

This study will occur in early 2014, the first study year.

LEVEL OF EFFORT AND COST

The preliminary estimated cost for this study is $30,000.

LITERATURE CITED

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Study 21

American Shad Telemetry Study - Vernon

RELEVANT STUDY REQUESTS

FERC-09; FWS-04, -05; NHDES-02, -04; NHFG-02, -04; VANR-11, -12; CRWC-22, -23; TU-02, -03

STUDY GOALS AND OBJECTIVES

In their study requests, FERC, FWS, NHDES, NHFG, VANR, CRWC, and TU identified two issues related to potential project effects relative to adult American shad (*Alosa sapidissima*). One issue concerned upstream and downstream adult American shad passage success on the Connecticut River, leading agencies and NGOs to request a study of shad migration from FirstLight's Cabot Station to upstream of Vernon dam. The second issue pertains to American shad spawning behavior, spawning habitat use, areal extent and quality of those spawning areas, and spawning activity in terms of egg deposition in those areas.

Additionally, agencies and NGOs included a request for TransCanada and FirstLight to complete analyses of data collected by USGS on the migration of radio-tagged shad from Turners Falls Project to Vernon dam and passage efficiency of the Vernon fish ladder. They have requested the analyses be completed as soon as possible so that these analyses can be used as a basis to design subsequent field studies.

This study will include analyses of the USGS and FWS 2011 and 2012 data and an assessment of effects on migration and spawning of shad between Bellows Falls dam and the tailwaters below Vernon dam.

The goals of this study are to:

- assess behavior, approach routes, passage success, survival, and residency time by adult American shad as they encounter the Vernon Project during both upstream and downstream migrations; and
- determine if project operations affect American shad spawning site use and availability, spawning habitat quantity and quality, and spawning activity in the river reaches downstream and upstream of Vernon dam and in the area downstream of the Bellows Falls Project.

The objectives of the study are to:

- assess near field, attraction to and entrance efficiency of the Vernon fish ladder;
- assess internal efficiency of the Vernon fish ladder;

- assess upstream passage past Vermont Yankee's thermal discharge located on the west bank of the river 0.45 mile upstream of the Vernon fish ladder exit;

- assess upstream migration from Vernon dam in relation to the peaking generation operations of the Bellows Falls Project;

- determine post-spawn downstream migration route selection, passage efficiency, downstream passage timing and survival related to the Vernon Project, including evaluation of the effect of the Vermont Yankee's heated water discharge plume on downstream passage route, migrant residence/timing of migration, efficiency, and survival;

- identify areas that American shad use for spawning;

- assess and quantify effects (e.g., water velocity, depths, inundation, and exposure of habitats) of project operations on identified spawning areas over the complete period of spawning activity under a range of current operational conditions; and

- quantify spawning activity.

This study will provide information about American shad route selection, efficiency, and survival during upstream and downstream passage at the Vernon Project. In addition, American shad spawning areas between the Bellows Falls and Vernon dams will be identified and spawning activity will be determined. The effects of project operations on upstream passage, spawning, and downstream passage of American shad will be assessed.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS	•	Specific goals related to American shad include minimizing project effects on shad spawning and recruitment, and shad passage effectiveness and survival. Goals reference ASMFC Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (ASMFC, 2010) and CRASC Management Plan for American Shad in the Connecticut River (CRASC, 1992).
	•	General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.
NHDES	•	State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.
NHFG	•	Specific goals related to American shad include minimizing project effects on shad spawning and recruitment; and shad migration, false attraction, entrainment, impingement, and survival. Goals reference ASMFC (2010) and CRASC (1992).
	•	General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).

VANR	• VFWD specific goals related to American shad include minimizing project effects on shad spawning and recruitment, and shad passage effectiveness and survival. Goals reference ASMFC (2010) and CRASC (1992). • State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat. • General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat. • General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects. • VFWD general goals related to conserving, enhancing, and restoring natural communities, habitats, species, and the ecological processes that support them and providing fish and wildlife-based activities including viewing, harvesting, and use of fish, plant and wildlife resources. Goals reference Vermont's Wildlife Action Plan (Kart et al., 2005). • VFWD general goals related to resource conservation, fish and wildlife recreation and use, and human health and safety. Goals reference Vermont Fish and Wildlife Strategic Plan (VFWD, 2006).

ASSOCIATION WITH OTHER STUDIES

The Aquatic Habitat Mapping Study (Study 7) may assist in identifying suitable spawning areas. In addition, this study may relate directly to similar shad studies requested of FirstLight. The resource agencies requested shad migration studies related to the Turners Falls and Northfield Projects. Part of those studies, specifically, migration of radio-tagged shad past the Northfield Project to Vernon dam, may directly add to the sample size of this study, and this study may inform any FirstLight study conducted.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

American shad are known to migrate upstream as far as the Bellows Falls Project. In 2011, FWS and USGS began, and TransCanada partially funded, a whole-river study of radio-tagged shad migration. This study continued through 2012, but the plethora of data has precluded analyses of overall performance of the fish ladder to pass shad. The 2011 study identified problems with the Vernon fish ladder that prevented efficient upstream passage (Castro-Santos, 2011). Subsequently TransCanada repaired the fish ladder, and passage in 2012 was vastly improved in terms of numbers passed and efficiency of the ladder (personal communication, Melissa Belcher, Vermont Fish and Wildlife Department, and Ted Castro-Santos, USGS). In 2012, more than 10,000 shad passed upstream through the Vernon fish ladder compared with fewer than 100 in 2011. Data are lacking for ladder efficiency in 2011 because so few shad passed, and data for 2012 have not yet been analyzed.

Resource agencies and NGOs state in their requests that they know of no studies or data available to identify or describe shad spawning areas downstream of Bellows Falls dam or in the vicinity of the Vernon Project.

PROJECT NEXUS

Vernon Project operations have the potential to affect water velocity and depth in the shad migration corridors of the Connecticut River. Project flow releases at Vernon dam could affect passage route selection and entry into fishways, increasing tailrace residence time. Inefficient downstream bypasses could increase forebay residence times and possibly result in higher turbine passage. If normal project operational changes, such as decreased or increased generation, occur during active shad spawning, it is important to determine if these changes adversely affect the spawning activity. Results of this study should identify effects of project operations on upstream and downstream passage of shad at Vernon and spawning activity in the project-affected areas.

STUDY AREA AND STUDY SITES

The study area will encompass the immediate near-field area of Vernon dam for passage evaluations and the area between Bellows Falls and Vernon dams for the spawning evaluation. The specific study site for upstream passage efficiency will be the immediate Vernon tailrace, fish ladder entrance, and fish ladder proper.

The Connecticut River upstream of Vermont Yankee and to about 5 river miles upstream of Vernon dam will be monitored to assess timing through Vermont Yankee's effluent. During the downstream passage of post-spawned shad phase, the immediate Vernon forebay area, turbine intakes, bypass fishpipe entrance and exit, and spillway areas will be monitored. An area of the Connecticut River approximately 10 miles downstream of Vernon dam near Northfield, MA, will be monitored for survival of downstream passage. This site was used during the USGS shad study and is a relatively secure site for the monitoring equipment.

Specific sites of interest for the spawning phase of the study will be areas identified as potential spawning sites between Bellows Falls dam and Vernon dam. Specific shad spawning sites will be determined via radio telemetry of individuals, and because this determination is a result of the study, it is not specifically known yet. Some shad will also be trapped at the Vernon fish ladder, radio tagged, and released just upstream of Vernon dam for the spawning phase of the study.

METHODS

Analysis of the 2011 and 2012 data will be discussed with the stakeholder interest community. Critical modifications in the field work described below for the upstream passage assessment in this study will be discussed based upon this consultation.

Methods used for this study will generally follow those requested by the agencies and NGOs and are provided below with the level of detail requested. Using methods similar to those used in the 2011 and 2012 whole-river shad migration studies for this study will aid in making comparisons between years and enhance the overall dataset. Use of radio telemetry with PIT telemetry, which is widely accepted as the best method to assess fish migratory behavior and passage success, has been used extensively to assess migration and passage issues at Connecticut River projects.

Prior to any releases of tagged individuals, radio-monitoring equipment and PIT readers will be set up at the Vernon Project. Similarly to the 2011 USGS radio telemetry study, monitoring stations will be installed to monitor the fish ladder entrance, the immediate tailrace area, and a location just downstream of the tailrace (approximately 1.5 miles downstream of Vernon dam). In addition, two monitoring stations will be deployed to discretely monitor the dam spillway and turbine discharge areas of the tailrace.

All monitor stations will be configured to discretely monitor tagged individuals: to within 30 feet of the fish ladder entrance, in areas of the turbine discharges within 50 feet downstream, in the spillway within 100 feet downstream, and within the entire tailrace area to approximately 800 feet downstream of the dam. The monitor station located 1.5 miles downstream of the dam will be configured to detect tagged individuals within 400 feet downstream and upstream of that station over the entire width of the river. An additional receiver will be installed in the counting house of the Vernon fish ladder to confirm presence within the ladder via radio telemetry. A monitor station will also be installed approximately 5 miles upstream to monitor continued upstream migration and determine the timing of passage past the Vermont Yankee effluent.

PIT readers will be installed at five locations within the fish ladder. An antenna will be installed in the first bay of the ladder to denote the entrance of an individual. Other antennas will be deployed at the first bend of the ladder, near the counting house window, just upstream of the window where the ladder becomes vertical slot, and at the exit.

The immediate upstream area of Vernon dam will be monitored with three dedicated receivers. They will be configured to discretely monitor the intakes, the fishpipe, and the spillway area of the dam. Post-spawned, radio-tagged shad will be monitored emigrating past the dam and route selection will be determined. A PIT antenna will be installed on the bypass fishpipe exit to monitor PIT-tagged (nonradio-tagged) shad that may exit.

Radio receivers will be Lotek SRX_400 and SRX_600 datalogging units. Radio transmitters will be coded VHF transmitters supplied by Lotek Wireless Inc. (Lotek), Newmarket, Ontario, Canada. The radio tags (model number MCFT-3EM) are digitally encoded and will transmit signals on two frequencies (channels), yet to be determined, within the 150- to 151-megahertz band. Each radio tag will contain a unique pulse train to allow for individual fish identification (codes). Each cylindrical radio tag measures 11 mm in diameter, 49 mm in length, weighs 4.3 g in water, and has a 455-mm-long whip antenna. The radio tags will propagate a signal every 2.5 seconds and will have a minimum battery life of approximately 206 days.

PIT readers to be used will be half-duplex units identical to those used for the 2012 USGS study. PIT tags will be 32 mm half-duplex Model RI-TRP-WR2B-30 read/write, Texas Instruments, Austin, TX.

American shad will be collected at the Holyoke fishlift and Vernon fish ladder for radio tagging. Twenty specimens will be taken at Holyoke, radio and PIT tagged, and transported to an area of the Connecticut River approximately 10 miles downstream of Vernon dam for release. The release site is located outside of the Vernon Project area, but it was selected to give radio-tagged shad sufficient area in which to recover from handling and continue volitional upstream migration. The sample size of 20 was chosen to facilitate monitor-station reception of radio-tagged individuals. If too many signals are present simultaneously, reception may be hindered by “collisions,” i.e., signals overlapping and making it difficult or impossible to decode a given signal.

Specimens will be tagged by inserting the radio tag through the mouth and esophagus and placing it in the stomach. They will be PIT tagged by placing the tag through a small incision made on the lower flank of the fish. Another 50 shad will be PIT tagged at the Holyoke fishlift, transported upriver, and released at the same area of the Connecticut River 10 miles down from Vernon dam. Fifty fish should be sufficient to monitor fish ladder efficiency, and this sample size is likely to be supplemented with radio-tagged shad released by First Light under a similar study.

Another 20 shad (not previously PIT or radio tagged) will be taken from the Vernon fish ladder, radio tagged, and released just upstream of Vernon dam. For the same reason above, 20 radio-tagged shad should be sufficient to follow to spawning areas, while limiting the number of individuals to track.

In the event that FirstLight conducts a similar study in the Turners Falls Project area, TransCanada will share radio-frequency information with FirstLight and expects that FirstLight will share its frequencies to ensure that tagged fish that move from the Turners Falls Project upstream into the Vernon Project or vice versa will be monitored.

Radio-tagged American shad upstream and downstream (if present) of Vernon dam will be manually tracked using a boat, car, and/or aircraft if shad cannot be located otherwise, and their locations will be recorded for each tracking event. Once the tagged fish appear to be congregating and holding around areas that appear suitable for spawning and once water temperatures are conducive, nighttime observation periods will commence.

Observation trips will take place every night, alternating between the downstream areas of Bellows Falls dam and the downstream areas of Vernon dam (i.e., one night below Vernon dam and the next night below Bellows Falls dam). Nighttime visual observation of spawning activity will include identifying and defining areas geospatially and obtaining data about physical habitat conditions and project operations (e.g., water depth, velocity, discharge, substrate, exposure, and inundation of habitats). If observations suggest that shad are spawning, ichthyoplankton nets will be set and towed downstream of the suspected spawning activity to collect eggs. All sampling events will be documented with date/time, location, water temperature, substrate type, average depth, water velocity, and pertinent comments.

ANALYSIS

After all telemetry data (radio and PIT) collected by USGS and/or FWS during their studies in 2011 and 2012 that is pertinent to the Vernon Project are made available to TransCanada, the data will be compiled, reduced, sorted by individual, and analyzed to provide, to the extent the agency data allows, a concise representation of migrating shad movement and behavior in the tailrace area of Vernon dam. Depending on the quality of the data, migration routes, residency times, ladder efficiencies, and effects of project operations on passage efficiency will be ascertained if the data allow. If data are conducive to determining downstream passage of post-spawned shad, they will be analyzed to discern success of downstream passage.

All radio transmitters for the study will have a unique frequency or code, thus allowing discrimination by individual. All radio-telemetry data from each monitor station at Vernon dam will be combined, compiled, reduced, and sorted by individual shad. Pertinent data from any related FirstLight study will be incorporated into the TransCanada dataset associated with this study. Resultant refined data will illustrate individual shad movement about Vernon dam tailwater areas and indicate holding areas, if any, and timing of upstream passage. PIT readers within the fish ladder will supply information as to the efficiency of the ladder to pass shad. Locations of each tagged shad will be presented spatial-temporally in tabular and graphic form, both in and around Vernon dam and upstream in the Vernon impoundment and Bellows Falls downstream reach. Project operational data will be presented and compared to shad movement to determine effects on shad movement and passage at the dam. The spawning location of each fish within the study area, if applicable, will be identified.

Congregation and spawning areas of radio-tagged American shad will be compiled and presented graphically on maps and with aerial photography. Quantification and qualification of shad egg collections will be presented in tabular form.

Emigration timing, residence time, passage route selection, and survival of passage for each post-spawned shad will be presented in tabular form. Shad presence and timing of passage will be related to project operations data to determine what effects, if any, project operations had on downstream passage.

In order to gage the effects of project operations on shad spawning, collected data will be analyzed and compared to project operational data. The times and dates of all observed spawning activities, substrate description, water measurements (i.e., velocity, temperature, dissolved oxygen, pH, conductivity, and relative clarity), and observational characteristics or anomalies (e.g., extensive water roiling or turbulence that impedes spawning) will be recorded and related to the operational data (e.g., total generation, turbine(s) operating, and spill of the particular project in question—Bellows Falls or Vernon).

Observed effects of the projects will be classified per operational regime observed as:

1. no effect – no observable effect on spawning, viable eggs were collected;

2. moderate effect – observable possible effect on normal spawning activity; spawning may have been hindered but viable eggs were collected; and

3. adverse effect – project operations likely to have prevented successful spawning of shad; no viable eggs collected.

Effects classified as 2 or 3 will be correlated to data in the HEC-RAS model in the Hydraulic Modeling Study (Study 4) specific to that location in an attempt to discern the project effects from non-project effects that contribute to potential adverse effects on the specific sites. To the extent possible and based on the assessment of the entire spawning dataset, attempts will be made to identify and characterize if any of these effects are likely to be persistent throughout available shad spawning habitats.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The study methodology is consistent with generally accepted practices. The radio telemetry of American shad has been conducted and accepted for many years. Shad spawning observations and egg collections during and after spawning follow acceptable practices and also have been widely conducted for years.

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study, as well as results of the passage efficiency at Vernon fish ladder and an assessment of normal project operations on spawning success. A final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report, and an explanation of any stakeholder comments not incorporated will be provided.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

Analyses of all data from FWS and USGS American shad migration study conducted in 2011 and 2012 and related to the Vernon Project is expected to be completed by the end of 2013, prior to the first year of study.

Field work for this study will occur in the first study year (2014). American shad collection and tagging would likely commence at the Holyoke fishlift from mid-April to early May, depending on water temperature. All specimens should be tagged and released by the end of May. Shad will be monitored at Vernon dam and tailwaters during May and early June, and once most specimens have passed upstream and have arrived at suspected spawning sites by mid- to late-June, field observations and egg collections will commence. The field observations will likely end in early to mid–July when specimens should begin to emigrate. Most post-spawned shad can be expected to pass downstream of Vernon dam by late July. Data compilation, reduction, analyses, and report preparation will be conducted after the end of the field season.

LEVEL OF EFFORT AND COST

The preliminary estimated cost for this study is $150,000.

REFERENCES

ASMFC (Atlantic States Marine Fisheries Commission). 2010. Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management). ASMFC, Washington, D.C.

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NHFG (New Hampshire Fish and Game Department). 1998. New Hampshire Fish and Game Department Strategic Plan (1998–2010). Concord, NH.

VFWD (Vermont Fish and Wildlife Department). 2006. Vermont Fish and Wildlife Strategic Plan.

Study 22

Downstream Migration of Juvenile American Shad - Vernon

RELEVANT STUDY REQUESTS

FWS-06; NHDES-26; NHFG-26; VANR-09; CRWC-24; TU-09

STUDY GOALS AND OBJECTIVES

In their study requests, FWS, NHDES, NHFG, VANR, CRWC, and TU identified a potential issue related to the Vernon Project's operations on downstream passage of juvenile shad. The issue identified is whether or not project operations affect juvenile shad outmigration and production.

The study goal is to determine whether project operations affect juvenile American shad outmigration, survival, production, and recruitment.

The specific objectives of this study are to:

- assess project operation effects on the timing, route selection, migration rates, and survival of juvenile shad migrating past the project;
- determine the proportion of juvenile shad using all possible passage routes at Vernon over the period of downstream migration under normal operational conditions; and
- determine empirical survival rates for juvenile shad entrained into one of Vernon Station's vertical Kaplan units.

This study, in conjunction with a previous juvenile American shad turbine survival study of Unit 10 (Normandeau, 1996) and calculated estimates of turbine survival (Franke et al., 1997) for Units 1–4, will assess whether project operations adversely affect juvenile survival and migration timing. A route selection study found that only 10% of Atlantic salmon smolts passed via the smaller Francis turbines (Units 1–4) (Normandeau, 1996). It is anticipated that similar results will be found for juvenile American shad; consequently, total project mortality by this route will be minimal.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS	•	Specific goals related to American shad including minimizing project effects on juvenile shad survival, production, and recruitment. Goals reference ASMFC Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (ASMFC, 2010) and CRASC Management Plan for American Shad in the Connecticut River (CRASC, 1992).
	•	General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.
NHDES	•	State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.
NHFG	•	NHFG specific goals related to American shad including minimizing project effects on juvenile shad survival, production, and recruitment. Goals reference ASMFC (2010) and CRASC (1992).
	•	General goals related to healthy ecosystems to support fish and wildlife. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).

VANR

- VFWD specific goals related to American shad including minimizing project effects on juvenile shad survival, production, and recruitment. Goals reference ASMFC (2010) and CRASC (1992).
- State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat.
- General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.
- General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.
- VFWD general goals related to conserving, enhancing, and restoring natural communities, habitats, species and the ecological processes that support them and providing fish and wildlife-based activities including viewing, harvesting, and utilization of fish, plant, and wildlife resources. Goals reference Vermont's Wildlife Action Plan (Kart et al., 2005).
- VFWD general goals related to resource conservation, fish and wildlife recreation and use, and human health and safety. Goals reference Vermont Fish and Wildlife Strategic Plan (VFWD, 2006).

ASSOCIATION WITH OTHER STUDIES

This study does is not directly associated with any other studies.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Adult shad are counted annually as they pass above Vernon dam. Juvenile American shad production has been monitored upstream and immediately downstream of Vernon dam by Vermont Yankee as part of an annual monitoring program, using both boat electrofishing (since 1991) and beach seining (since 2000). A seasonal average annual index of juvenile American shad standing crop in the portion of the Vernon impoundment included in the Vermont Yankee study area (from river mile 141.9 at Vernon dam to the West River confluence at river mile

149.3) has been calculated since 2000. Estimates of juvenile shad growth rates in that study have been calculated annually beginning in 2004 and ranged from 0.38 to 0.7 mm per day. Additionally in a study conducted in 1995 (Smith and Downey, 1995) in the Vernon reservoir and upper Turners Falls impoundment, the combined average growth rate observed was 0.75 mm per day.

Studies of American shad passage were conducted in 1991 and 1992 with tests of a high frequency sound field to guide fish to the fish pipe, the primary downstream fishway (RMC Environmental Services, Inc., 1993). Although the high-frequency sound studies were deemed incomplete, the technology indicated some level of response by juvenile shad. An attempt to determine passage routes of juvenile shad using hydroacoustics occurred in 2009 following the replacement of Units 5 through 8 (Normandeau, 2010). The hydroacoustic study was deemed unsuccessful, but no follow-up assessment was made due to the limited viable assessment tools available at that time.

Passage survival of juvenile shad through Vernon's Unit 10 (a Francis turbine) was conducted in the fall of 1995. All recaptured fish were alive, and the immediate (1-hour after passage) estimate of survival compared to controls was 94.73%. The long-term (48-hour) survival estimate was 94.61%. The precision on the estimates was within $\pm$10% for 95% of the time (Normandeau, 1996).

PROJECT NEXUS

Upstream migrating adult American shad that use the Vernon fish ladder or are trucked from Holyoke dam to the Vernon impoundment may spawn in the river reach upstream of Vernon. Shad production also occurs in this reach, which is thought to be the historical upstream limit of the shad migration in the Connecticut River. Juvenile shad require safe and timely downstream passage to contribute to the restoration target population size. Little information is available regarding the total effect of the Vernon Project on downstream migration of juvenile shad. Project operations may influence the timing of outmigration, increase predation and mortality of juvenile during passage, and change route selection under different flow conditions. Effective juvenile downstream passage and production are necessary to help achieve shad management restoration goals for the Connecticut River, particularly in the upstream reaches.

STUDY AREA AND STUDY SITES

The study area encompasses the Vernon Project forebay, tailrace, turbines, bypass fishways, and dam.

METHODS

The methods used in this study include radio telemetry and HI-Z Turb'N tag methodology as requested by the agencies, but they do not include the use of PIT tags or passive hydroacoustics. The use of PIT tags would provide little additional information for determining passage route selection or passage survival and would only provide information on the proportion of shad using the fish bypass because they would not be recovered or monitored downstream following passage. Only the fish bypass would be conducive to installing a PIT-tag reader, so the remaining potential passage routes would not be monitored. The use of hydroacoustics also has limitations based on a previous study conducted in 2009 (Normandeau, 2010).

Route Selection

Juvenile shad downstream passage will be assessed by radio tagging and systematically monitoring juvenile shad movement and passage through the project. Fish for this study will be collected at either the Turners Falls bypass sampler via seining upstream of Turners Falls dam near Barton Cove or via seining in a backwater known as Cersosimo Pond (a backwater located approximately 4.7 miles upstream of Vernon dam). All collections are expected to occur in late September to early October to coincide with the expected natural downstream migration period. Following collections, shad will be transported and retained in appropriate holding facilities in a secure location at the Vernon Project.

Remote telemetry monitoring will occur at the Vernon forebay, log boom and diversion boom, bypass fish tube, turbines, tailrace, and spillway. Radio receivers and/or digital spectrum processors (DSP) capable of monitoring multiple radio channels simultaneously at each location will be coupled with appropriate antennas and calibrated to ensure adequate coverage of the individual sites to be monitored while minimizing overlap between the sites. It is expected that at a minimum, seven monitoring sites will be installed. Data downloading from the remote telemetry monitoring stations will occur at a minimum of three times per week. Periodic manual monitoring by boat will also occur at least twice per week to assist in data collection and analysis.

Radio transmitters for this study will be no more than 5 mm wide x 3 mm high x 14 mm long in size, weigh ≤0.5 g in air, have a calculated life of 8 days, and will propagate a signal via a flexible whip antenna. Each transmitter will contain a unique pulse code to allow for individual fish identification and be DSP compatible. The transmitters will be constructed or modified to allow for reliable secure external attachment to the back of each fish.

For testing, 10 groups of 10 shad will be externally radio tagged, transported by boat, and released approximately 1.5 miles upstream of Vernon dam over the course of the downstream migration season. It is expected that this release scenario will allow for monitoring over a range of environmental and project operating conditions. Only shad >100-mm total length will be used for the study. Additionally, each group of tagged shad will be released with a group of untagged shad to encourage schooling behavior.

During the course of the study, air temperature, water temperature, turbidity, rainfall, river flow, and project operations will be continually collected and retained. Lunar phase will also be noted.

In the event that FirstLight conducts a similar study in the Turners Falls Project area, TransCanada will share radio-frequency information with FirstLight and expects that FirstLight will share its frequencies to ensure that tagged fish that move from the Turners Falls Project upstream into the Vernon Project or vice versa will be monitored.

Turbine Survival/Injury

Juvenile shad passage survival will be assessed by using mark/recapture methodology at one of the vertical Kaplan units (Units 5–8) installed in 2008.

A minimum 150 HI-Z Turb'N tagged shad will be released into the turbine for testing and an additional 150 will be released into the tailrace as controls to accomplish this objective. This sample size will yield a survival estimate with a precision of $\pm$10% for 95% of the time. Survival tests will be conducted by injecting tagged shad into a Kaplan turbine at or near full generation. Following release of test and control fish, they will be recovered from the tailrace, examined for injuries, and held for 48 hours for observation and latent mortality. Unrecovered tagged shad will be censored from the data.

ANALYSIS

Route Selection

The radio telemetry data will be analyzed to determine the number and timing of shad using each potential downstream passage route at the Vernon Project. A comparative analysis of passage routes with environmental and physical variables that occur during the study period will then be conducted. The analysis will include two-dimensional (2-D) maps of movement and passage for each individual shad.

Turbine Survival/Injury

Immediate and latent survival and classification of injuries will be estimated for the Kaplan turbine at the project using generally accepted practices (Normandeau, 1996). The results will be assessed in conjunction with the physical and environmental conditions that occur during the study.

An estimate of passage survival for the project in total will be calculated using route selection and survival data from this study and previous studies. As discussed above, one of the two large Francis turbines (Unit 10) was assessed for juvenile shad passage survival (Normandeau, 1996), and a calculated estimate of juvenile American shad survival through the smaller Francis turbines will be used.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The study methodology, data collection, and analysis techniques to complete the study objectives are consistent with generally accepted practices (Normandeau, 1996, Normandeau and Gomez and Sullivan, 2012).

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study. A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and

comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

This study will be conducted in the fall of the first study year (2014). The study report will be prepared after all field work and data analysis are completed.

LEVEL OF EFFORT AND COST

The preliminary estimated cost for this study is $125,000 to $150,000 and is dependent on the effort required to obtain test specimens, based on the year-class success.

LITERATURE CITED

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Study 23

Fish Impingement, Entrainment, and Survival Study

RELEVANT STUDY REQUESTS

FERC-08; NHDES-18; NHFG-18; VANR-23

STUDY GOALS AND OBJECTIVES

In their study requests, FERC, NHDES, NHFG, and VANR identified potential issues related to Wilder, Bellows Falls, and Vernon Project operations on fish impingement, entrainment, and survival. The goal of this study is to assess the adequacy of the intakes at the projects to minimize fish mortality resulting from impingement and entrainment of fishes residing in the Connecticut River.

The objectives of this study are to:

- provide a description of physical characteristics of the Wilder, Bellows Falls, and Vernon Projects (including forebay characteristics, intake location and dimensions, approach velocities, and rack spacing);
- identify current routes of fish movement past each project and the risk of injury/mortality associated with each route (considering seasonality, flow direction and velocity, existing management regimes);
- analyze target species for factors that may influence vulnerability to entrainment and mortality;
- assess the potential of and estimate mortality rates for target species impingement;
- estimate entrainment rates and numbers of target species;
- estimate turbine passage survival rates and numbers;
- estimate total project survival considering all passage routes for American shad and river herring at the Vernon Project; and
- estimate total project survival considering all passage routes for American eel, Atlantic salmon, and sea lamprey at the Wilder, Bellows, and Vernon Projects.

As requested by FERC, these objectives will be accomplished through desktop analysis, not through field study as requested by other entities. Supporting data for that desktop analysis will be obtained through review of previously conducted and currently proposed species-specific passage and survival studies at the Vernon, Bellows Falls, and Wilder Projects.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

NHDES	• State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.
NHFG	• General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).
VANR	• State water quality standards for designated uses of Class B waters relative to high levels of water quality that support healthy aquatic communities and associated uses such as fishing.
	• General goals relative to aquatic natural resources including providing for healthy, self-sustaining fish communities and minimizing potential effects of project operations on resident fish populations.

ASSOCIATION WITH OTHER STUDIES

This study will rely on fish community data collected during the Fish Assemblage Study (Study 10). Fish community data from that study will be used to identify the target species list that will be assessed to identify potential impingement and entrainment effects. In addition, findings from the two American shad studies at the Vernon Project (Studies 21 and 22) and from the two American eel downstream assessments (Studies 19 and 20) may provide useful insight into the determination of survival for diadromous fish species.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

No information for rates of fish impingement or entrainment of resident species at the projects is available. However, numerous studies of passage route entrainment for anadromous fish are available (Hanson, 1999; Normandeau, 1995a, 1996a, 1996c, 1996d, 2009a; RMC, 1990, 1992b, 1993, 1994a). Previous mark-recapture balloon tag studies have assessed survival of Atlantic salmon smolts passing via downstream bypasses at the Wilder (RMC, 1992a), Bellows Falls (RMC, 1991) and Vernon (Normandeau, 1995b) Projects and through turbine units at the Wilder Project (RMC, 1994b) and Vernon Project (Normandeau, 1996b, 2009b). Exclusion and guidance of Atlantic salmon smolts by a fish diversion structure at Bellows Falls has also been assessed (Normandeau, 1995a). In addition, survival and injury rates have been assessed for turbine passed juvenile American shad at the Vernon Project (Normandeau, 1996a). Information on impingement, entrainment, and survival will assist in assessing project effects on fisheries resources.

PROJECT NEXUS

Potential effects of project operations and facilities include fish impingement on the trashracks and entrainment through the generating units. Fish moving downstream as part of their life cycle, encounter the project dams and intakes on the Connecticut River. Similarly, fish species resident to the project impoundments may enter forebays and come in proximity to the intakes. These actions may result in exposure of fish to impingement or entrainment.

This study will help establish a baseline condition to assist in evaluating the number of fish entrained or impinged and the expected survival of those fish at each of the projects.

STUDY AREA AND STUDY SITES

This desktop assessment will examine fish impingement, entrainment, and passage through the Wilder, Bellows Falls, and Vernon Projects' dams and powerhouse structures, including spillways, downstream bypasses, and turbine units.

METHODS

The assessment of impingement, entrainment, and survival will be conducted as a desktop analysis. A list of target fish species representing species of conservation interest and all fish guilds will first be developed based in the baseline fish community data collected as part of the Fish Assemblage Study (Study 10).

The probability of impingement will be determined based on the relationship of site-specific intake characteristics along with swim speed and life history characteristics of target fish species and guilds. Site-specific intake characteristics (including configuration, rack spacing, and intake velocities) will be assessed for each project. This assessment will rely on intake velocities calculated using the velocity equation $Q = V*A$ where Q = flow rate (cfs), V = velocity (feet per second) and A = area (square feet). Life history characteristics and species-specific swim speed information for target fish species will be obtained from peer-reviewed literature.

A review of entrainment studies conducted at other hydroelectric projects with similar characteristics (i.e., EPRI, 1997) will be conducted to derive entrainment rates for target fish species. Literature-obtained entrainment rates will be combined with project-specific discharge data to generate estimates of entrainment for target species at each of the projects. Entrainment survival for target fish species will be estimated using data from survival studies conducted at the projects (Normandeau, 1995a, 1995b, 1996b, 1996e, 2009b; RMC, 1991, 1992a, 1994b), other hydroelectric facilities with similar characteristics (e.g., EPRI, 1997; Winchell et al., 2000) and the Franke blade strike probability equation (Franke et al., 1997).

In addition to literature-based and calculated passage survival rates, results from studies conducted for this relicensing will be used, including concurrent site-specific mark-recapture studies—Downstream Migration of Juvenile American Shad at the Vernon Project (Study 22) and the American Eel Downstream Passage Assessment (Study 19). Survival rate estimates for target fish species will then be combined with estimated entrainment numbers to estimate fish survival through the turbine units at the projects.

Total project survival will be determined for American eel, Atlantic salmon, and sea lamprey at the Wilder and Bellows Falls Projects and for American eel, American shad, Atlantic salmon, river herring, and sea lamprey at the Vernon Project. With the exception of species and life stages with known distributions among downstream passage routes (data to be collected from Studies 19 and 22, estimates of total project survival will be obtained based on the assumption that fish passage will be equal to the distribution of flow through all downstream passage routes at a particular project. Using available site-specific, literature-based, or calculated survival estimates for each downstream passage route, an estimate of total project survival for each applicable species-life stage combination will be calculated.

ANALYSIS

Results of this study, including probability of impingement, estimates of entrained fish survival through the project turbines and total project survival will be summarized in tabular format. All data used in the development of those estimates will be provided in an appendix to the study report.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

A desktop approach has been previously used and is a widely accepted technique for the assessment of impingement, entrainment and turbine survival as part of FERC relicensing. Examples include the Claytor Hydroelectric Project (FERC No. 739), Brassua Hydroelectric Project (FERC No. 2615), and the Santee Cooper Hydroelectric Project (FERC No. 199).

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study

A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the project. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

This desktop assessment of impingement, entrainment, and turbine survival will be conducted during the second study year in the spring of 2015. It will rely on results the Fish Assemblage Study (Study 10), which will be conducted during study year one and will allow for proper identification of the target fish species. In addition, findings from the associated studies referenced above (Studies 19, 20, 21, and 22) may provide useful insight into the determination of survival for diadromous fish species.

LEVEL OF EFFORT AND COST

The preliminary estimated cost this study is $65,000.

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Normandeau. 1996b. Estimation of Survival and Injuries of Atlantic Salmon Smolts in Passage through two Francis Turbines at the Vernon Hydroelectric Station, Connecticut River, VT. Prepared for New England Power Company.

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Study 24

Dwarf Wedgemussel (*Alasmidonta heterodon*) and Co-occurring Mussel Study

RELEVANT STUDY REQUESTS

FWS-13; NHDES-12; NHFG-12; VANR-27; CRWC-30; TNC-05

STUDY GOALS AND OBJECTIVES

In their study requests, FWS, NHDES, NHFG, VANR, CRWC, and TNC requested a study of the effects of the Wilder and Bellows Falls Project operations on the dwarf wedgemussel (*Alasmidonta heterodon*). Five objectives were stated in each study request: three were related to baseline population studies and long-term monitoring and two were focused specifically on the potential effects of flow regime/water level fluctuations on mussel behavior or habitat. This study includes an adaptive, two-phase plan that meets the objectives of the study requests and will benefit from collaboration with resource agencies throughout the design and implementation of the study. The goals of this study are to:

Goal 1: Assess the distribution, population demographics, and habitat use of dwarf wedgemussels in the Wilder and Bellows Falls Project areas. This goal has three specific objectives:

- **Objective 1 (Phase 1):** Conduct an initial survey of the 17-mile-long reach of the Connecticut River from Wilder dam to the upstream end of the Bellows Falls impoundment to determine the distribution, relative abundance, and habitat of the dwarf wedgemussel;

- **Objective 2 (Phase 1):** Determine the best sites for quantitative mussel sampling in areas where dwarf wedgemussels are known to occur in the Wilder and Bellows Falls Project areas and the reach surveyed for Objective 1; and

- **Objective 3 (Phase 2):** At sites identified in Objective 2, collect statistically sound and repeatable data, using quantitative methods, to estimate density and age-class structure for dwarf wedgemussels and co-occurring mussel species.

Goal 2: Assess the influence of flow regime (which includes water-level fluctuations) on dwarf wedgemussels and co-occurring mussel species. This goal has two specific objectives:

- **Objective 4 (Phase 2):** Observe and record behavior of dwarf wedgemussels and co-occurring mussel species *in situ* during varying flow conditions; and

- **Objective 5 (Phase 2):** Assess the effects of flow regime on dwarf wedgemussels and their habitat.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS	• Dwarf wedgemussel is a federal endangered species. The goal is species recovery for removal under the Endangered Species Act in accordance with the U.S. Fish and Wildlife Service Dwarf Wedge Mussel Recovery Plan (FWS, 1993) and Five Year Review Summary and Evaluation (FWS, 2007).
NHDES	• State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.
NHFG	• General goals related to sustainable fish populations, habitats, recreational fishing and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).
VANR	• Dwarf wedgemussel is a state-listed endangered species. Specific goals for rare, threatened and endangered species include maintaining or increasing populations and maintaining, restoring, providing stewardship for, and conserving habitats and natural communities that support rare, threatened, and endangered species.

ASSOCIATION WITH OTHER STUDIES

Several other studies have objectives and methods that overlap with, or complement, this study. They will contribute toward a greater understanding of the effects of flow regime on aquatic resources in the study area. Related studies include the Tessellated Darter Study (Study 12), Aquatic Habitat Mapping (Study 7), Instream Flow Study (Study 9), Hydraulic Modeling (Study 4), and Operations Modeling (Study 5).

Phase 1 of this study can be completed independent of other studies. Phase 1 results may assist with site selection or the selection of which parameters to measure, map, analyze, or model for Studies 4, 5, 7, 9, and 12. Likewise, those studies may also provide important information regarding site selection, measured parameters, and analysis to meet Phase 2 objectives of this study.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

The Connecticut River is thought to contain the largest populations of the dwarf wedgemussel in the world; they occur in three distinct areas of the river that have been referred to as the Southern, Middle, and Northern Macrosites (Nedeau, 2008, 2009). The Southern Macrosite is bounded by Bellows Falls dam to the south and Wilder dam to the north, a distance of approximately 42 miles within which dwarf wedgemussels are thought to occur in a 35-mile-long reach from Charlestown to Plainfield with one tributary population in the Black River. The Middle Macrosite occurs in the reach between the Wilder dam and Monroe, NH. Based on studies conducted from 1999 to 2011, it appears that no tributary populations exist along the Middle Macrosite and that dwarf wedgemussels are confined to a 16-mile-long reach from the Orford/Piermont line to Haverhill. The Northern Macrosite occurs in areas upstream from Moore dam to the now breached Wyoming dam.

In 2011, Biodrawversity conducted a freshwater mussel survey throughout the Wilder, Bellows Falls, and Vernon Project areas (Biodrawversity and LBG, 2012). This survey was semi-quantitative; the main goal was to assess the distribution, relative abundance, demographics, and habitat of the dwarf wedgemussel in the project areas. Dwarf wedgemussels were generally found in the same areas where they had been found during previous studies. The 2011 survey did not include the 17-mile-long reach of the Connecticut River downstream from Wilder dam, where dwarf wedgemussels have been documented to occur (Nedeau, 2008). This is the longest reach in the Connecticut River from the Holyoke dam (MA) to Fifteen Mile Falls (NH) that has not been surveyed in the last 15 years.

Most of the dwarf wedgemussel studies conducted in the last 20 years in the Connecticut River were either qualitative or semi-quantitative. Therefore, there is no basis for determining population estimates or trends. In addition, very little quantitative data exist about age-class structure, and therefore recruitment, of the population. Data on population distribution, size, density, age-class structure, and habitat use and availability are essential for determining the status and viability of the dwarf wedgemussel population. Resource agencies want to gain a better understanding of potential effects of hydropower operations on dwarf wedgemussels.

The biggest knowledge gaps include lack of a repeatable, quantitative mussel monitoring program that can allow for an assessment of population trends, and a general lack of understanding of how flow regime and water level fluctuations affect individual mussels, populations, and the quality and quantity of habitat.

PROJECT NEXUS

The federally endangered dwarf wedgemussel occurs in the Wilder and Bellows Falls Project areas, and the species may also occur in the 17-mile-long reach of the Connecticut River between the Wilder and Bellows Falls Projects. Project operations may influence dwarf wedgemussel population viability and habitat suitability in these areas. This study plan will document the distribution and status of dwarf wedgemussel populations in these areas and allow for a better understanding of how flow regime may influence dwarf wedgemussel distribution, density, behavior, and habitat use.

STUDY AREA AND STUDY SITES

The study area includes the Wilder Project, Bellows Falls Project, and the 17-mile-long reach from Wilder dam downstream to the upper end of the Bellows Falls impoundment (approximately to Chase Island). Survey sites in the Wilder impoundment will occur within the 14-mile-long reach (from 27 to 41 miles upstream from Wilder dam) where dwarf wedgemussels were documented in 2011. Survey sites in the Bellows Falls impoundment will occur within the upper 17 miles (approximately from the Black River confluence to Chase Island) where dwarf wedgemussels were documented in 2011. In the 17-mile-long reach from Wilder dam to Chase Island, a minimum of one site per mile will be surveyed; sites will be selected in the field as described in the Methods section.

METHODS

This study will use a two-phase, adaptive, and collaborative approach to achieve the same basic goals and objectives stated in each of the study requests. The study plan focuses on objectives that can be met within a 2-year period, but specific methods are described for only Phase 1 tasks. The primary reason for a two-phase approach is that additional surveys are needed to determine where dwarf wedgemussel densities are high enough to permit quantitative sampling, behavioral studies, or habitat studies. Another reason for a two-phase approach is that the goals and objectives of the dwarf wedgemussel study align with those of several other studies, and the planning and implementation of those studies would benefit by having better information on where, at what density, and in what habitat dwarf wedgemussels occur. The 2011 survey did provide some of these data, but none of the sites appeared to have dwarf wedgemussel populations high enough for quantitative sampling.

- **Phase 1:** Addresses study objectives 1 and 2, which both relate to baseline mussel studies and an evaluation of potential areas where more intensive quantitative sampling and flow-related studies may be conducted. Specific methods for a Phase 1 study are outlined in this study plan, under Task 1 and Task 2.

- **Phase 2**: Addresses study objectives 3 through 5 and will rely on Phase 1 data and agency input to determine where and how the necessary data may be collected. Therefore, this study plan provides only general details on methods for Phase 2 studies, under Tasks 3 through 5.

Task 1. Semi-quantitative Survey from the Wilder Dam to Chase Island

Methods for this task are similar to those used in the 2011 survey of the Wilder, Bellows Falls, and Vernon Project areas (Biodrawversity and LBG, 2012) but with the flexibility to spend additional time in high-quality habitat to simultaneously accomplish Task 2 objectives.

A minimum of 17 sites will be surveyed in this reach. Survey sites will be selected based on prior mussel survey data and the presence of habitat conditions likely to support dwarf wedgemussels. Further, sites will be selected to ensure adequate spatial coverage of survey sites within the study reach.

Survey methods may vary according to habitat conditions at each survey site, but generally, surveys will be conducted by SCUBA diving. Snorkeling may be used in shallow areas. A minimum 1-hour, timed search will be conducted at all survey sites with more time spent in high-quality habitat where dwarf wedgemussels are found.

The following information will be recorded at each survey site:

- Species richness;
- Precise counts of target species (dwarf wedgemussel) and uncommon non-target species;
- Abundance estimates of non-target common species and size ranges of live animals;
- Shell lengths and shell condition (i.e., degree of shell erosion) for each dwarf wedgemussel and also for a subsample of other species;
- Microhabitat (water depth, substrate, flow conditions, submerged aquatic vegetation, woody debris, and distance to shore) for each dwarf wedgemussel;
- General habitat descriptions will be recorded for each survey site and also for the broader areas near each survey site (i.e., a reach or segment);
- GPS locations for each survey site; and
- Digital photographs of habitat, live animals or shells, and other features.

Task 2. Assess and Select Sites for Quantitative Mussel Surveys and Flow-Related Mussel Studies

This step will examine data collected during the 2011 surveys in the Bellows Falls and Wilder impoundments (Biodrawversity and LBG, 2012), data collected from 1990 to 2010 for these same reaches (Nedeau, 2008, and references therein), and the mussel survey from Wilder dam to Chase Island.

Based on these data, sites likely to have the largest dwarf wedgemussel populations and the most available suitable habitat will be determined and assessed as to the degree of flow regime alteration at each site.

These survey sites and/or nearby reaches will be revisited to gain a better understanding of the following: 1) spatial extent of the dwarf wedgemussel population, 2) population densities of dwarf wedgemussels and other species, 3) habitat use by dwarf wedgemussels, 4) habitat suitability for dwarf wedgemussels, 5) environmental conditions (especially sampling constraints), 6) accessibility (including potential property rights issues), and 7) any other factors that may influence whether a site could be used for further study.

Items 1–4 above will be determined by SCUBA diving or snorkeling both cross-channel and longitudinal transects; the number of transects will vary according to conditions at each site. For each transect, the following data will be recorded:

- Precise counts of target species (dwarf wedgemussel) and uncommon non-target species;

- Abundance estimates of non-target common species;

- Shell lengths and shell condition (i.e., degree of shell erosion) for each dwarf wedgemussel and also for a subsample of other species;

- Microhabitat (water depth, substrate, flow conditions, submerged aquatic vegetation, woody debris, and distance to shore) for each dwarf wedgemussel, and for the entire transect; and

- GPS locations for stopping and starting locations of each transect.

A written summary will include the following: 1) complete rationale for the initial screening process, 2) summary of mussel data and habitat data gathered at each of the sites, 3) summary of environmental and logistical constraints to accessing or surveying each site, and 4) recommendations for monitoring sites. The goal will be to establish three monitoring sites: one in the Wilder impoundment, one in the Bellows Falls impoundment, and one in the 17-mile-long reach between the Wilder and Bellows Falls Project areas.

Task 3. Quantitative Mussel Survey at Selected Sites

Quantitative sampling using a statistically sound and repeatable study design, with the goal of estimating mussel density and population size with a measure of variance, was an objective of all six study requests. A mussel study should be guided by five considerations: 1) what are the objectives, 2) what is the target population, 3) what resources are available, 4) what is known about the study site, and 5) what is known about the mussel population (Strayer and Smith, 2003). Objectives should be defined in quantitative terms to help inform specific details of methods, such as sampling size.

Based on currently available information, it is premature to propose a specific study design or methods for quantitative monitoring. First, objectives need to be more explicit and quantitative. The target population (e.g., where, when, and what) needs to be better defined. Currently, there is no way to select study sites because the qualitative and semi-quantitative studies performed to date have not provided adequate data. In fact, based on currently available data, dwarf wedgemussel population densities in the project areas may be too low for effective quantitative monitoring. Lastly, environmental conditions and other sampling or access constraints need to be assessed before survey sites can be selected. TransCanada will work with resource agencies to address these considerations.

A variety of quantitative study designs have been proposed and tested on dwarf wedgemussel populations and other riverine mussel species (Strayer and Smith, 2003). Study requests specifically mentioned a systematic sampling with multiple random starts and double sampling (i.e., substrate excavation); this was described in Strayer and Smith (2003) and used in the Ashuelot River (NH) for long-term monitoring of dwarf wedgemussel populations (Nedeau, 2004, 2006; Biodrawversity, 2012, 2013a). Variations of this approach have also been used in lakes (Biodrawversity 2009) and large rivers (Biodrawversity 2013b) in the Northeast. It is very likely that some variation of this study design will be most appropriate for Phase 2 of this study. Concurrent with this type of quantitative sampling, the shell length, age estimates, shell condition (degree of shell erosion), and gender of mussels can be recorded to document age/size structure, recruitment success, individual condition, and sex ratios.

Task 4. Observe and Record Mussel Behavior *In Situ* at Varying Flow Levels

In situ observations of mussel behavior at varying flow levels were included in each of the study requests. As described in the study requests, biologists could "measure changes in shell position (open/closed), siphoning rate, lure display, horizontal migration (movement across the substrate), and vertical migration (burrowing) due to flow fluctuations" by observing individual mussels. There are a myriad of challenges to this type of monitoring, and very few case studies provide guidance on where and under what conditions *in situ* observations might be effective, how to collect data, how to minimize observer effects, how to separate natural behavior from behavior related to a stressor of interest, how to interpret the data, and what conclusions can be drawn about individual mussels or populations from short-term observations of behavior.

Due to these challenges, this study plan includes a pilot study to observe a mussel bed, preferably with dwarf wedgemussels present, during the rising and falling limbs of the daily hydrograph. Behavior will be observed, and recorded with an underwater video camera. The mussel bed will occur in relatively shallow water in an area of the river where peaking flows are more acute, probably in the upper Bellows Falls impoundment or the reach downstream from Wilder dam. A summary of observations, along with an assessment of whether this type of monitoring might be feasible at a larger scale, will be developed and shared with stakeholders. Even if this type of monitoring appears to have merit, TransCanada will wait until Task 1 and Task 2 are complete to determine if there are sites within the project areas where this type of monitoring might be more effective, and if so, it will then discuss ideas for a study plan with agencies.

Task 5. Assess the Effects of Flow Regime on Dwarf Wedgemussel and Their Habitat

All six study requests expressed interest in an assessment of potential effects of flow regime (which includes water-level fluctuations) on dwarf wedgemussel populations and on the availability of dwarf wedgemussel habitat. Study requests cited a publication on the effects of flow and substrate parameters on dwarf wedgemussel habitat persistence in the Delaware River (Maloney et al., 2012), suggesting that this could be a model for the Connecticut River studies. Several other studies might also help to guide study plan development and offer alternate analyses (Hardison and Layzer, 2001; Howard and Cuffey, 2003; Morales et al., 2006; Gangloff and Feminella, 2007; Allen and Vaughn, 2010; Daraio et al., 2010). Regardless of the study design or analysis, TransCanada feels it is premature to plan this specific study for all of the reasons described under Task 3. Once Phase 1 studies are complete, TransCanada will work with resource agencies, discuss the feasibility of the study, and develop a study plan.

ANALYSIS

Task 1 will follow the same level of analysis and mapping used to develop the 2011 report. Task 2 will rely on descriptive statistics, written summaries, maps, photographs, and clearly presented data to convey how sites were assessed and why certain sites were selected for more detailed studies. Analyses are not yet defined for Tasks 3 through 5.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

Overall, a two-phase approach is a widely accepted, highly recommended practice to refine key study considerations and provide preliminary data (i.e., Phase 1) to help plan more detailed studies (i.e., Phase 2). This approach will ensure that resource agency goals and objectives are adequately addressed, time is used efficiently, and studies serve their intended purpose. As recommended by resource agencies, methods for Task 1 match those used for the 2011 survey. Task 2 methods are widely accepted for evaluating populations and habitats and for informing the development of suitable study designs and methods. Methods and analyses are not yet defined for Tasks 3 through 5, but TransCanada feels that the best path forward is an open, collaborative approach with resource agencies with an awareness of the relevant publications and case studies to guide development of study plans.

DELIVERABLES

Task 1 results will be integrated into the 2012 mussel survey report, and an updated version of that report will be provided to resource agencies. Results from Task 2 and the pilot study for Task 3 will be compiled into a separate written report. Key topics for the Task 2 report will include the following: 1) complete rationale for the initial screening process, 2) summary of mussel data and habitat data gathered at each of the sites, 3) summary of environmental and logistical constraints to accessing or surveying each site, 4) recommendations for monitoring sites. The report for the Task 3 pilot study will include a summary of methods, parameters measured, locations where observations were made, summary of observations, underwater photographs, and underwater video (on DVD). Additional deliverables will depend on the outcomes of the Phase 1 studies and consultation with resource agencies and other stakeholders on Phase 2 studies.

Results and conclusions will be reported in either the PLP or draft license application for the project. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

Task 1, Task 2, and the pilot study for Task 3 can be completed in the 2013 or 2014 field season, any time from mid-May to early October. Ideally, fieldwork would be completed early in that potential time frame, results will be summarized and provided to resource agencies, and a plan and timeline for Phase 2 studies can be developed.

LEVEL OF EFFORT AND COST

Phase 1

The preliminary estimated cost for Phase 1 is $30,000, and Phase 2 could range from $50,000 to $100,000, depending upon agency consultation.

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Study 25

Dragonfly and Damselfly Inventory and Assessment

RELEVANT STUDY REQUESTS

VANR-29

STUDY GOALS AND OBJECTIVES

In its study request, VANR requested a baseline inventory of odonates (dragonflies and damselflies) and collection/synthesis of key life history, ecology, and habitat data to help assess the effects of current project operations on habitat and survival in the Wilder, Bellows Falls, and Vernon Project-affected areas. The study request emphasized SGCN but generally outlined objectives, methods, and analyses that would effectively target the all odonate species that use riverine habitat for larval stages.

This study plan has two related goals: 1) inventory the river-dependent odonate assemblages in the project-affected areas, including life history, ecology, and behavior information for each species; and 2) assess the potential influence of project operations on river-dependent odonate larval emergence/eclosion and habitat. The four specific objectives are to:

1. conduct a baseline inventory and habitat assessment that builds on prior surveys in the project areas;

2. collect field data on the emergence and eclosion behavior of river-dependent odonates in the project areas;

3. review and synthesize available information on the life history, ecology, and behavior of river-dependent odonates that occur in the project areas; and

4. use information gathered in Objectives 1–3, combined with data and analyses from other studies, to develop an overall assessment of the potential effects of project operations on odonate emergence/eclosion and habitat.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

VANR

- State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat.

- General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.

- VFWD general goals related to conserving, enhancing and restoring natural communities, habitats, species and the ecological processes that support them and providing fish and wildlife-based activities including viewing, harvesting and utilization of fish, plant and wildlife resources. Goals reference Vermont's Wildlife Action Plan (Kart et al., 2005), including three odonate SGCN.

ASSOCIATION WITH OTHER STUDIES

At least five other studies have objectives and methods that complement this study and that will contribute to a greater understanding of the effects of project operations on aquatic resources in the study area. These include Aquatic Habitat Mapping (Study 7); Instream Flow (Study 9); Hydraulic Modeling (Study 4); Floodplain, Wetland, Riparian, and Littoral Vegetation Habitats (Study 27); and Riverbank Erosion (Study 3). Because odonates use aquatic habitats as larvae, riverbanks and riparian habitats for emergence/eclosion, and upland habitats as adults, studies within and across these habitats will help provide a more comprehensive assessment of odonate usage in the study area.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Thirty-three species were found in the most recent odonate survey in the Connecticut River in New Hampshire and Vermont (Hunt et al., 2010); seven of the species are SGCN in Vermont, and an eighth species was newly reported in Vermont and possibly rare. All eight of these species are riverine dragonflies in the Family Gomphidae. These include:

- Gomphus abbreviates,
- Gomphus quadricolor,
- Gomphus vastus,
- Gomphus ventricosus,
- Ophiogomphus rupinsulensis,
- Stylurus amnicola,
- Stylurus scudderi, and
- Progomphus obscurus.

Hunt et al. (2010) sampled 13 sites in the Connecticut River from Northumberland to Hinsdale, NH. Ten of these sites were in areas influenced by the Wilder, Bellows Falls, and Vernon Projects. Pfeiffer (2009) reported four Vermont SGCN species downstream from Vernon dam. These reports provide valuable baseline information on the odonate species that occur in the project-affected areas; however, site selection, species data, and habitat parameters collected at each survey site do not provide enough information to fully achieve the objectives of this study.

The effects of water-level fluctuations stemming from project operations on the emergence and eclosion success of odonates is not well understood. Aquatic larvae crawl out of the water (i.e., "emerge") when they are mature and ready to metamorphose into the adult phase of their lives. They crawl onto the riverbank, or onto emergent vegetation or woody debris, to find a suitable location to eclose, which is the process by which the adult sheds the larval exoskeleton before taking flight. For a short period after eclosion, the adult wings and exoskeleton are soft and the adults cannot yet fly, making them susceptible to fluctuating water levels and predators during this period. Species with a propensity to crawl farther up the streambank and gain a greater vertical distance from the water's surface are at lesser risk from fluctuating water levels. One of the key information gaps this study will address is how the magnitude and timing of project-related, water-level fluctuations may affect odonate species with different emergence and eclosure behaviors.

PROJECT NEXUS

Seven of Vermont's SGCN odonates occur in the Connecticut River in the Wilder, Bellows Falls, and Vernon Projects, yet the distribution and habitat of these and other odonate species is not well understood. Project operations may influence odonate assemblages in these areas, primarily via effects on habitat use/suitability, or survival during emergence/eclosion due to water-level fluctuations. This study will document the distribution, relative abundance, habitat, and behavior emerging and eclosing larvae of both SGCN odonates and the entire river-dependent odonate assemblage found in project areas and use these data and other studies to assess the potential effects of project operations, particularly water-level fluctuations.

STUDY AREA AND STUDY SITES

The study area includes the Wilder, Bellows Falls, and Vernon impoundments and the two riverine reaches downstream from the Wilder dam and Bellows Falls dam. Seven of the sampling sites from Hunt et al. (2010) that occur within these areas will be used as study sites to maintain continuity with that study. These include two in the Wilder impoundment, one downstream from Wilder dam, two in the Bellows Falls impoundment, and two in the Vernon impoundment. Three additional sites will be selected to provide wider geographic and habitat diversity: one toward the middle of the Wilder impoundment, one additional site downstream of Wilder dam, and one downstream of Bellows Falls dam based on the considerations below. Overall, this results in a total of 10 sampling sites: three in riverine reaches and seven in the impoundments.

In general, study sites will be 100 meters (m) in length, and will be selected primarily based on two considerations: 1) is habitat suitable for odonates, and 2) is habitat representative of conditions within that reach. Field reconnaissance and results of Aquatic Habitat Mapping (Study 7) and the Floodplain, Wetland, Riparian, and Littoral Vegetation Habitats (Study 27) will help with site selection.

METHODS

Timing

Each site will be surveyed three times during the summer: mid-June, mid-July, and early August. These times generally cover the peak emergence periods of most odonates, particularly SGCN species. Surveys will be conducted when weather and flow conditions are conducive to collecting larvae and exuviae and when larvae are more likely to be emerging. Optimal sampling conditions include warm, sunny days when river discharge is near or below average.

Field Data Collection

Odonate sampling methods will target mature larvae, pre-flight adults (called tenerals), and exuviae. The focus will be on those individuals that have emerged from the water, but there will also be an effort to collect pre-emergent mature larvae by sampling in nearshore shallow water. Basic methods will generally follow Morrison et al. (2006) and Hunt et al. (2010), but with a more quantitative approach. These methods briefly described below:

- Randomly placed transects will be established within each of the ten 100-m-long survey sites. The long axis of each transect will be perpendicular to the shoreline with the lower end at the estimated low waterline and the upper end terminating 1 m into dense vegetation or at the top of the riverbank, whichever is less. The upper and lower ends of each transect will be recorded with GPS.

- Within each transect, biologists will thoroughly search for larvae, tenerals, and exuviae. Each individual that is found will be either identified in the field (if possible) or put into its own uniquely numbered vial. The following information will be recorded for each individual:

  - Species;
  - Exact time when collected;
  - Surface from which it was collected;
  - Horizontal, vertical, and straight-line distance from the waterline.

- For each transect sampled on each date, the following habitat information will also be collected:

  - Types and percent coverage of soil/substrate;
  - Types and percent coverage of vegetation;

- Percent coverage of large woody debris or other types of cover;
- The height, slope, and stability of the streambank;
- Evidence of recent versus current water levels; and
- Representative photos.

- In addition to the transect-specific data, biologists will also describe and photograph aquatic, riparian, and upland habitat along the entire length of the 100-m sampling sites.
- At each site and each sampling date, an aquatic D-net will be used to capture larval odonates from a representative range of microhabitats, and the first 50 larvae captured will be preserved in alcohol.
- In the laboratory, all specimens will be identified to species.

Literature Review

Existing books, manuals, peer-reviewed journal articles, unpublished technical reports, and other case studies will be reviewed to compile key life history, ecology, and behavior data for each of the odonate species found in the project areas, and particular emphasis will be placed on SGCN odonates.

ANALYSIS

Field data will allow for a quantitative analysis of odonate density and abundance at each sampling site, an analysis of the variability in density and abundance within and among sampling sites and sampling dates, and an analysis of the influence of measured habitat parameters on odonate density and abundance. In addition, the field data will include key species-specific information such as emergence times, distances and heights that larvae travel before eclosion and preferred substrates for emergence and eclosion. These field data will be supplemented with the literature review to provide a comprehensive database on when, in what conditions, and how odonates emerge and eclose, as well as the susceptibility of each species to water-level fluctuations.

The results of the Aquatic Habitat Mapping (Study 7), Hydraulic Modeling (Study 4), Operations Modeling (Study 5), Instream Flow (Study 9), Riverbank Erosion Study (Study 3) and Floodplain, Wetland, Riparian, and Littoral Habitats Study (Study 27) will then be used to assess the potential influence of project operations on river-dependent odonates.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The methods outlined for site selection, field data collection, and analysis are consistent with other studies that seek to understand the odonate assemblages in large rivers, habitat use, emergence and eclosion behavior, and potential effects of water-level fluctuations. VANR requested methods similar to Morrison et al. (2006), and this study plan uses these basic methods (minus the river bottom transects) but also uses methods that will allow for better quantitative analyses, which will be a more effective way of integrating results of the water-level fluctuation study, and expressing results in quantitative terms.

DELIVERABLES

A final study report will be prepared after the first year field season. The report will follow a standard scientific format and will include appendices for raw field data, field notes, and species information. Voucher specimens will be retained and made available to resource agencies.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

This study will occur in the first study year (2014). Potential sampling sites may be assessed in late 2013 for planning purposes. In 2014, field studies will occur from June to August, laboratory identification of specimens will occur throughout the summer and fall, and a draft report will be prepared in late fall.

LEVEL OF EFFORT AND COST

The preliminary estimated cost for this study is $96,000.

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STUDY 26

COBBLESTONE AND PURITAN TIGER BEETLE SURVEY

RELEVANT STUDY REQUESTS

VANR-30

STUDY GOALS AND OBJECTIVES

In its study request, VANR identified potential issues associated with Wilder, Bellows Falls, and Vernon Project operations on two species of tiger beetle listed as Vermont SGCN. One of these species, the Puritan tiger beetle, is federally listed as threatened. Specifically, potential habitat disturbance, alteration, and loss as well as sedimentation due to project operations could negatively affect these species.

The goal of this study is to conduct a survey to detect and gather information on known and new cobblestone tiger beetle (*Cicindela marginipennis*) and Puritan tiger beetle (*Cicindela puritana*) populations along the Connecticut River throughout the project-affected areas, including the impoundments and downstream on the riverine reaches, and to determine the potential effects of project operations on tiger beetles.

The objectives of this study are to:

- obtain baseline distributional and abundance data and map occurrences of cobblestone and Puritan tiger beetle populations along the Connecticut River throughout the three project-affected areas;
- define the particular habitat requirements of each species;
- assess the vulnerability of each species to disturbances such as siltation, flow fluctuations, and changes in shoreline composition and vegetation;
- identify areas where suitable habitat may exist for tiger beetles and the portions of those habitats affected by project operations; and
- determine if project operations are adversely affecting the survival success of adult tiger beetles and tiger beetle larvae.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In its study request, VANR described various jurisdictional resource management goals for this study, as summarized below.

VANR		• Cobblestone tiger beetle is a state-listed threatened species. Specific goals for rare, threatened, and endangered species include maintaining or increasing populations; and maintaining, restoring, providing stewardship for, and conserving habitats and natural communities that support rare, threatened, and endangered species. • State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat. • VFWD general goals related to conserving, enhancing, and restoring natural communities, habitats, species, and the ecological processes that support them; and providing fish and wildlife-based activities, including viewing, harvesting, and utilization of fish, plant, and wildlife resources. Goals reference Vermont's Wildlife Action Plan (Kart et al., 2005), including two beetle SGCN.

ASSOCIATION WITH OTHER STUDIES

This study should be conducted after the Aquatic Habitat Mapping Study (Study 7) and with preliminary mapping from the Floodplain, Wetland, Riparian, and Littoral Habitats Study (Study 27), both of which will help in identifying likely beetle habitats. Field work for this study could be conducted in conjunction with the Dragonfly and Damselfly Inventory and Assessment (Study 25).

In addition, results from the Hydraulic Modeling Study (Study 4), Operations Modeling Study (Study 5), Instream Flow Study (Study 9), Channel Morphology and Benthic Habitat Study (Study 8), and the Riverbank Erosion Study (Study 3) may also provide information on project operations that could affect these species.

EXISTING INFORMATION

The Puritan tiger beetle is a federally listed as threatened species only known historically from several New Hampshire sites in the project areas and a single Vermont site in Hartland, VT, within the Bellows Falls Project. The historical distribution of Puritan tiger beetles included locations in the Connecticut River that extended from Claremont, NH, to Cromwell, CT. Nine of these populations were extirpated in the early 1900s, with the latest collection records in the 1930s (Knisley, 1987, cited in Hill and Knisley, 1993).

The distribution of Puritan tiger beetle, both historical and current, is restricted to two disjunct regions, Chesapeake Bay in Maryland and the Connecticut River in New England. Vogler et al. (1993) performed a genetic analysis of individuals from the two regions and concluded that the occurrences on the Connecticut River "have to be considered as independent units." Historically, there are records of Puritan tiger beetles from New Hampshire and Vermont but despite intense searching by tiger beetle experts over the last 25 years, no occurrences have been found upstream of Hadley, MA.

Impoundments along the Connecticut River are believed to have contributed to the extirpation of this species. Riverside recreational use has had a significant effect on populations at other New England sites, although in some cases recreational activity provides surrogate disturbance that delays vegetative succession. Historically found along the Connecticut River in Hartland, VT, and nearby New Hampshire sites, larval density of this species is highest along big rivers in sparsely vegetated patches of fine to medium sand (particles predominantly 0.125 to 0.5 mm [Omland, 2002]); in some instances, suitable habitat may be embedded in wide beaches (e.g., Northampton, MA) but in other instances, the beach may be quite narrow (e.g., 4 to 6 m in Cromwell, CT). Given their genetic distinctness, the species' association with clay banks in Maryland may not be relevant to habitat preferences in New England.

The cobblestone tiger beetle is a Vermont state-listed as threatened species and has been studied in Vermont to a greater degree than other *Cicindela* species. According to VANR in its study request, habitat losses along the Connecticut River and possibly along other rivers have been significant due to impoundments. The cobblestone tiger beetle is found in the vicinity of the projects on the Connecticut River, West River, and White River. This species has an extremely restricted habitat and is found on cobble and gravel beaches on medium and large rivers. Adults inhabit areas of cobble, gravel, and sand where vegetation is sparse. Larvae are thought to occupy burrows in the sand along the edges of or interspersed with cobblestones.

PROJECT NEXUS

Project operations and land uses have the potential to cause direct adverse effects on tiger beetle populations through effects on the egg, larval, and pupal stages; effects on adult beetles are unlikely. Threats to larval habitat are primarily due to vegetative succession mediated by diminished erosion dynamics. Inundation per se is unlikely to affect buried life stages because tiger beetles have adapted to tolerate frequent and/or prolonged submersion (Brust and Hoback, 2009), and it is likely that larvae dwell higher on banks than the daily inundation zone (Omland, 2002). However, if the daily inundation cycle or recreational activity on the riverbanks causes larval burrows to collapse frequently, then there may be an energetic cost of re-excavating burrows, which would divert resources from growth and reproduction. Knowing whether larvae of the two focal species are present in the project-affected areas and how they may be affected by vegetative succession, inundation, or recreational activity will enable us to assess whether project operations are having adverse effects on the populations.

Vernon dam discharges into a reach that has no riverine habitat due to impoundment fluctuations associated with a combined operational effect from Turners Falls Project (FERC No. 1889) and Northfield Mountain Pumped Storage

Project FERC No. 2485). As a result, TransCanada does not propose to include this area in this study.

STUDY AREA AND STUDY SITES

The study area encompasses the Wilder, Bellows Falls, and Vernon impoundments and riverine reaches below Wilder and Bellows Falls dams that are identified to be likely habitat for tiger beetles, as described below. Having identified likely habitat patches from historical records and inspection of orthophotos, only specific patches will be included in this study.

Cobblestone tiger beetles and Puritan tiger beetles occupy distinct habitats along the Connecticut River as larvae and adults. Larval habitat is more specific than adult habitat. Puritan tiger beetle larvae are found at highest density in fine to medium sand, which is associated with slow-moving water. Adults may be found foraging near larval habitat on a variety of substrates ranging from mud to coarse sand. Puritan tiger beetles inhabit fine-to-medium sand beaches along bends of big rivers. For instance, the beach in Massachusetts where they have been found is dry, wide, free of vegetation, and located on a bend of the river (MA NHESP, 2010), while the beaches in Connecticut where they have been found are wet, narrow, and sparsely vegetated and located on a straight reach. Larvae live in burrows along the upper margin of the beaches.

In contrast, cobblestone tiger beetles are associated with cobble and gravel bars and beaches that have a mixture of coarse sand. Larval biology of cobblestone tiger beetles is poorly known but it is presumed they dig burrows in sand in such places. Cobblestone tiger beetles are found on the edges and islands of small to medium sized rivers with swiftly flowing water. They are restricted to scour areas along these rivers where the substrate is composed of wet pebbles, cobblestone, sand, and sparse vegetation. The larvae dig burrows in wet sand found interspersed among cobblestones (Pearson et al., 2006).

METHODS

Orthophotos taken in summer low flow conditions (if available) will be examined for patches of potentially suitable habitats for cobblestone and Puritan tiger beetles based on lack of vegetation and substrate composition. Areas of apparently suitable habitat will be visited by boat or on foot to confirm habitat suitability. In addition, historical areas where cobblestone and Puritan tiger beetles were found will be examined for larval burrows and adult specimens. Areas where tiger beetles were found during previous studies (Dunn, 1978; Dunn, 1986; Omland, 2004) will be searched in each project. Coordinates of previous records will be requested from the Vermont and New Hampshire natural heritage programs. Three separate searches (Hudgins, 2012) will be conducted during the adult flight period in early July, late July, and August.

Searches will be conducted by walking along each beach or cobble bar from access point to end in a serpentine pattern until the area has been completely searched (Hudgins et al., 2011). Searches will be conducted under sunny, humid conditions when adult tiger beetles are most active. The searchers will primarily look for adults but will opportunistically flag larval burrows during the search. Two biologists equipped with close-focus binoculars and aerial nets will search each survey location for a minimum of 30 minutes. Survey time will be recorded to calculate an index of relative abundance for each species. Beetles may be captured using the aerial net and marked with a sharpie or paint spot on their pronotum to reduce double counting individuals. In addition to the two focal species, the common shore tiger beetle (*Cicindela repanda*) will be counted as will other tiger beetles that may occur on the beaches. Representative photographs of adult tiger beetles will be taken to document identification.

Clasping pairs or individuals probing the sand with the tip of the abdomen will be noted as possible evidence of reproduction. The field biologists will attempt to net any individuals seen probing the sand with the abdomen to determine sex; males exhibiting such behaviors will not be construed as evidence of reproduction.

Following the active search for adult beetles the biologists will search the survey location for larval burrows for 30 minutes. Tiger beetle larval burrows may be recognized as neat, nearly perfectly round holes often with a distinct pile of excavated soil pellets nearby (burrows of wasps, spiders, and other arthropods are not like that). Grass stems will be used to probe any larval tiger beetle burrows found. Depth of burrows will be recorded, and angle relative to vertical will be noted. Larval burrows of the common shore tiger beetle are expected to be numerous; they may be recognized by being 5 to 10 cm deep and angled. In contrast, burrows of Puritan tiger beetle larvae are vertical and deep (50 to 100 cm). Larval biology of cobblestone tiger beetles is poorly known but it is likely that they are different than those of the common shore tiger beetle either in being deeper or vertical. If a distinct class of tiger beetle burrows is found at a site where adult cobblestone tiger beetles are known, their locations relative to the water level during the survey will be recorded; if at least 10 such burrows are found, then one or two of those larvae will be excavated, preserved in alcohol, and sent to a taxonomic expert for identification. However, if the burrows are similar to those described for Puritan tiger beetles in Connecticut (50 to 100 cm deep, vertical; Omland, 2002), then FWS personnel will be notified of the possible presence of the listed species, and no specimens will be collected.

Substrate, vegetative cover, land use and other pertinent habitat information will be recorded on field data sheets. Field staff will use professional judgment to take 3 to 5 representative samples for particle size classification either screening sand through sieves or estimating the b-axis of gravel or cobble particles typical of the site.

ANALYSIS

Data collected will be used to qualitatively assess the distribution of cobblestone and Puritan tiger beetles in the study area. Survey results will include presence, relative abundance, evidence of reproduction, and information on habitat used by each tiger beetle species, including potential habitat. The location of survey areas will be identified on a map of each project as well as a description of habitat conditions at each location. A list of all adult tiger beetles identified from each survey location and their relative abundance for each location and sample trip will be developed.

Project operations schedules, results from related studies, and river discharge data will be compared to determine river discharge levels that may affect tiger beetle populations. The portion of the habitat that is affected by project operations will also be determined using information from the Instream Flow Study (Study 9) to develop an estimated frequency of inundation of each survey location.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

Larval sampling will follow one of several methods described by Leonard and Bell (1999) including the recommended procedures of Brust et al. (2010). Adult sampling will use a standard timed search by two biologists searching with close-focus binoculars and aided by aerial nets. Survey distance and time will be recorded to provide an index of relative abundance.

DELIVERABLES

A study report will be prepared that presents methods and results of the survey after this 1-year study. A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

The tiger beetle survey will be conducted during the first study year (2014) in July and August to coincide with adult emergence of both focal species. Identification of adults will occur in the field. Some larvae may be collected to be sent to taxonomic experts with determination expected in the fall of 2014 or winter of 2015. The study report will be prepared after the field season.

LEVEL OF EFFORT AND COST

The preliminary estimated cost for this study is $45,000.

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Study 27

Floodplain, Wetland, Riparian, and Littoral Habitats Study

RELEVANT STUDY REQUESTS

FWS-19; NHDES-15a; NHFG-15; NHNHB-01; VANR-25, -26; CRWC-16; TNC-03; Rock-02, -03

STUDY GOALS AND OBJECTIVES

In their study requests, FWS, NHDES, NHFG, NHNHB, VANR, CRWC, TNC, and the Town of Rockingham, Vermont, indicated that Wilder, Bellows Falls, and Vernon Project operations may affect the distribution, plant species composition, and structure of riparian, floodplain, wetland, and littoral habitats, and the wildlife that utilize these areas. The goal of this study is to provide baseline mapping and characterization of riparian, floodplain, wetland, and littoral vegetation and their habitats within the Wilder, Bellows Falls, and Vernon Project-affected areas and to determine the potential effects of water level fluctuations on those habitats.

The objectives of this study are to:

- quantitatively describe (e.g., substrate composition, vegetation type, and abundance with a focus on invasive species) and map riparian, floodplain, and wetland habitats within 200 feet of the river's edge and the extent of this habitat if it extends beyond 200 feet;

- quantitatively describe (e.g., substrate composition, vegetation type, and abundance) and map shallow water aquatic habitat types within the zone of daily water level fluctuations and where water depths at the lowest operational range are wetted to a depth of less than 1 foot (flats, nearshore area, gravel bars, with very slight bathymetric change);

- qualitatively describe associated wildlife (e.g., bald eagle nesting, waterfowl nesting); and

- assess potential effects of project operations on riparian, floodplain, wetland, and littoral habitats, and associated wildlife.

RELEVANT RESOURCE MANAGEMENT GOALS

In their study requests, federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

FWS	• General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives; and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.

	• General goals related to aquatic resources including protection, enhancement, or restoration of aquatic and riparian habitats and minimizing project effects on water quality and aquatic habitat.
NHDES	• State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.
NHFG	• General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).
NHNHB	• Goals of the NHNHB include developing information about indigenous plants and natural communities and to determine protective measures and requirements necessary to their survival. Goals reference New Hampshire's Native Plant Protection Act (RSA 217:A).
	• Goals of the NHDES Wetlands Bureau include protecting and preserving submerged lands and wetlands from unregulated alteration that would adversely affect wetlands structure and function, and that would depreciate or obstruct the commerce, recreation and aesthetic enjoyment of the public. Goals reference New Hampshire Fill and Dredge in Wetlands statute (RSA 482-A).
VANR	• State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat.
	• Specific goal to identify and protect significant wetlands and their values and functions.
	• General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.
	• VFWD general goals related to conserving, enhancing, and restoring natural communities, habitats, species, and the ecological processes that support them; and providing fish and wildlife-based activities including viewing, harvesting, and utilization of fish, plant, and wildlife resources. Goals reference

Vermont's Wildlife Action Plan (Kart et al., 2005).

- VFWD general goals related to resource conservation, fish and wildlife recreation and use, and human health and safety. Goals reference Vermont Fish and Wildlife Strategic Plan (VFWD, 2006).

ASSOCIATION WITH OTHER STUDIES

This study will rely on several other studies for supplemental information. The Aquatic Habitat Mapping Study (Study 7) in the project impoundments and riverine sections will provide bathymetric and littoral habitat delineation for aquatic vegetation beds below 2 feet water depth. The results of Hydraulic Modeling and Operations Modeling studies (Studies 4 and 5) will provide site-specific detailed data on water level fluctuations and river flows. The riverbank erosion studies (Studies 1, 2, and 3) will inform the vegetation community and wildlife findings.

Goals associated with mapping vegetative types and wildlife species composition will be supported by specific studies including: Northeastern Bulrush Survey (Study 29); Cobblestone and Puritan Tiger Beetle Survey (Study 26); Dragonfly and Damselfly Inventory and Assessment (Study 25); and Fowler's Toad Survey (Study 28).

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Existing habitat information in the PADs is based primarily on state or regional mapping efforts including the USGS land use cover maps (Homer, 2007), the Wildlife Action Plans for New Hampshire and Vermont, National Wetland Inventory mapping, and limited local data on floodplains and wetlands. Results from a 2012 TransCanada study of rare, threatened, and endangered plants and listed natural communities (Normandeau, 2013) will be used in combinations with existing records and locations of rare plant species and communities from VANR and NHNHB. General descriptions of those habitats and communities are available in Sperduto and Kimball (2011) and Thompson and Sorenson (2000). Other relevant studies that have been recently completed, ongoing, or sponsored by TransCanada include eagle nesting studies and mussel surveys. These studies are yet to be released as final reports, but their results and findings will inform the study of riparian, floodplains, wetland, and littoral habitats. To date, no detailed existing data set for wildlife or wildlife habitat has been identified in the project areas.

This study will provide more detailed mapping and characterization of riparian, floodplain, wetland, and littoral habitats, and supplement wildlife observations. The potential effects of project operations on those habitats and wildlife will be assessed using data from other studies of hydrology, erosion, and aquatic habitats.

Data for reference wetlands will not be collected, as proposed in an agency study request. On a large system such as the Connecticut River it is unrealistic for several reasons: few if any reaches of the river are not affected by water management; the river changes character rapidly north and south of the project areas; and lastly, the natural variability of any potential reference habitats would require a very large data set for effective comparisons to project habitats, of questionable value and at significant expense.

PROJECT NEXUS

The Connecticut River provides habitat for vegetation communities ranging from upland to submerged aquatic systems. Groundwater and surface water close to the river are potentially influenced by daily and seasonal project operations, which in turn may affect the substrates, species composition, and structure of the vegetation communities bordering the river, particularly those in lower topographic settings such as wetlands and floodplains. Intact, natural riparian habitat is valuable wildlife habitat providing river access and travel corridors.

A more detailed understanding of the distribution and character of the existing habitats will allow an analysis of the potential effects of project operations on those habitats. Coincidental wildlife observations will better inform the analysis of wildlife species that rely on the river for part of their life cycle.

STUDY AREA AND STUDY SITES

The study area will extend from the top of Wilder impoundment to Vernon dam. including the Wilder, Bellows Falls, and Vernon impoundments and the riverine sections downstream of Wilder and Bellows Falls dams, as well as project lands downstream of Vernon. All of the shorelines in Vermont and New Hampshire, including the river's edge, islands, sand and gravel bars and impounded portions of the tributaries, will be mapped. The terrestrial extent of the study will encompass 200 feet from the river's edge, except where wetlands and floodplains extend further. In those areas, the study will extend within to the inland limits of the wetland or floodplain, or to where the topography or site features indicate the river is no longer a significant influence on the habitat.

This study scope accommodates most study requests, which asked for riparian and wetland studies within 200 feet of the river or the extent of this habitat if it extends beyond 200 feet. The TNC study request asked for surveys to extend to the 100-year floodplain, which in some areas could result in extensive mapping of terrestrial habitats far from the river. This will not contribute significantly to the information needed to study the areas influenced by project activities. The littoral zone will extend from the river's edge to a depth of 1 foot below the lowest limit of water level fluctuation along the shorelines, islands, sand and gravel bars, and the impounded tributaries.

METHODS

Methods will include habitat mapping and field verification of riparian, floodplain, wetland, and littoral habitats, and observations for river-dependent wildlife. The methods will follow commonly accepted protocols, and will meet the components of the study requests, except where noted. For this study, the following definitions will apply:

- Riparian – all areas within 200 feet of the shoreline that are not classified as floodplain, wetland, or littoral. While 50 feet or 100 feet is more commonly used in a classic definition of riparian buffer (Williams, 2008; VANR, 2005), expanding the area to 200 feet, as requested by agencies, will allow a complete mapping of all land cover types within the study area.

- Floodplain – Floodplains are ecologically defined as occurring in the regularly flooded valleys of major rivers or the floodplains of lakes. The soils in floodplain habitats are variable based on the exact location, but they tend to be exposed mineral soils, minerotrophic, and of alluvial origin (NHFG, 2005; Kart et al., 2005). A unique suite of flood-tolerant plant species characterizes this habitat type. When associated with large, high-gradient rivers like the Connecticut, the most common canopy cover is silver maple or sugar maple with a sparse shrub layer and a lush herbaceous layer dominated by either ostrich fern or sensitive fern depending on the gradient of the river (NHFG, 2005; Kart et al., 2005).

- Wetland - Palustrine wetlands include all non-tidal freshwater wetlands dominated by trees, shrubs, persistent emergent vegetation, emergent mosses or lichens (Cowardin et al., 1979). Riverine wetlands include all wetlands and deepwater habitats within the river channel dominated by non-persistent emergent and aquatic vegetation.

- Littoral zone - For this study, the littoral zone will include all habitat within 1 foot below the lower limit of the water level fluctuation zone, and all submerged aquatic vegetation.

Habitat Mapping

Aerial maps of the study area will be obtained in either LiDAR, true color, or infrared stereo format. LiDAR has the advantage of including topography at 1-foot contour intervals, but is more expensive than aerial stereo imagery. Aerial photointerpretation allows more accurate vegetation community mapping, but does not have the ability to “see” into areas obscured by dense vegetation or shadows generated by river banks. The mapping will occur at a scale sufficient for 0.5-acre minimum map unit size. Aerial photos, if used, will be flown during leaf off, snow- and ice-free periods, and coordinated, to the extent practicable, with TransCanada to capture low water conditions on the impoundments.

The images will be used to digitally delineate riparian, floodplain, wetland, and littoral habitats within the study area as described above. Additional publicly available maps of the study area will be used in conjunction with the aerial imagery to increase confidence in the delineation, including topographic maps, NRCS soils maps, National Wetland Inventory maps, and recent leaf-on orthophotos. Each resource area will be cover typed by the dominant cover class, using the FWS

Wetland Classification system (Cowardin et al., 1979), where appropriate. The three-tier Vermont wetland classification system specified under the Vermont Wetland Rules will be applied on wetland cover types mapped in that state. Polygons of the various cover types will be compiled in GIS for mapping and analysis.

The accuracy of mapping submerged aquatic vegetation is poor using either of the remote methods because it is virtually undetectable on LiDAR and during the leaf-off aerial photography season. Submerged aquatic vegetation will be best mapped using a combination of the results from the Aquatic Habitat Mapping Study (Study 7) and field verification.

Field Verification

A subset of the cover type maps will be field verified during the height of the growing season to confirm the accuracy of the delineation and cover typing. Representative sites for the cover types will be selected to encompass the geographic and hydrologic variability of each cover type. For access reasons, the representative areas will be confined to suitable sites within TransCanada fee owned lands and publicly accessible lands. The selected sites will be visited to characterize the following habitat components: vegetation structure; species composition and abundance by structural layer, with a focus on invasive and rare species; soil type; hydrology; and other relevant aspects, including evidence of recent or historic disturbance, flooding or scour, and wildlife usage. GPS coordinates will be collected at distinct wildlife features such as bank nests, concentration of species or evidence of browse, large stands of invasive species, and other important site features. Photo-documentation will occur at each representative cover type.

Cover type boundaries will be field verified where either accessible or visible from the river or a public road. Wetland boundaries will not be delineated on the ground using the USACE 1987 delineation manual, as requested by VANR because 1) much of the land is in private ownership, not TransCanada fee-owned land, 2) jurisdictional boundaries are not necessary to verify cover types for baseline mapping, or for the effective evaluation of potential project effects, and 3) the cost of the delineation would be excessive relative to the minor additional information it would provide.

Wetland functions and values will be assessed at all field verified wetland cover types using the New England Division USACE Highway Methodology (USACE, 1995). This method is a descriptive, non-quantitative method which can be used to determine the degree to which a wetland provides a set of 13 functions and values: groundwater recharge/discharge; flood flow alteration; fish and shellfish habitat; sediment/toxicant/pathogen retention; nutrient removal/transformation; production export; sediment/shoreline stabilization; wildlife habitat; recreation; education/scientific value; uniqueness/heritage; visual quality and aesthetics; and threatened or endangered species habitat. The rationale for evaluating the performance of each function is developed from a series of criteria, and is supplemented by professional judgment. From this evaluation, the principal (most important) functions are identified. While this method is less rigorous than the methods proposed by the NHNHB and TNC, it allows a more rapid assessment of wetland functions and values while documenting the rationale and maintaining consistency between sites and users. Given the combined approximate 120-mile length of the three projects, the USACE highway methodology assessment method provides a reasonable balance between efficiency and effectiveness. As with all evaluation methods, it must be conducted by a qualified wetland scientist to maintain its intended quality and consistency.

Wildlife Observations

All observations of wildlife and their sign will be noted during field verification, both at the representative cover type locations and during travel between sites. Particular emphasis will be placed on river-dependent species, including bald eagle, waterfowl, wading birds, shorebirds, bank nesting birds (e.g., kingfisher, bank swallow), breeding amphibians, basking reptiles, nesting turtles, and mammals (river otter, beaver, muskrat). All other wildlife sign and observations will be recorded as encountered. Coordination with TransCanada, Vermont FWD, NHFGD, and other organizations with local knowledge will provide additional search areas and likely habitats. The times of day for best capturing specific species (evening for chorusing frogs, early morning for breeding birds) will be utilized to maximize the chance of encountering desired species.

ANALYSIS

The results of the cover type mapping will be compiled into site maps and summaries of the acreages of the various cover types within each project and project-affected area. Descriptions of the representative cover types will be developed, and the relative functions and values of each discussed. Unique conditions or findings will be highlighted, including invasive species concentrations, rare species, and disturbance. Notable differences of habitats among the projects will be analyzed and if appropriate, compared to the results of the rare species studies (Study 29 and Normandeau [2013]), hydrologic studies (Studies 4 and 5), and erosion studies (Studies 1, 2, and 3). The potential effects of project operations on the mapped riparian, floodplain, riparian, and littoral habitats, and wildlife usage areas will be assessed using the results of hydraulic and operations modeling (Studies 4 and 5).

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The methodologies for mapping, delineation, field verification, and analysis presented above are consistent with accepted scientific practice and have been used at other hydroelectric projects in the Northeast, including the Brassua Hydroelectric Project (FERC No. 2615).

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study. A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and

comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application**.**

SCHEDULE

The aerial imagery will be collected in late 2013 after FERC's study plan approval and/or early 2014, followed by delineation and mapping. The resulting cover type map will be field verified in the 2014 growing season. The final report will be produced at the end of 2014, after completion of analysis for this study and other relevant studies (Studies 1, 2, 3, 4, 5, 25, 26, 28, and 29).

LEVEL OF EFFORT AND COST

The preliminary estimated cost for this study is $198,000 excluding the costs for LiDAR and/or aerial photos (See study 4).

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Study 28

FOWLER'S TOAD SURVEY

RELEVANT STUDY REQUESTS

VANR-31

STUDY GOALS AND OBJECTIVES

In its study request, VANR identified potential issues associated with operations of the Wilder, Bellows Falls, and Vernon Projects on Fowler's toad (*Anaxyrus fowleri*), mapped in Vermont's Wildlife Action Plan (Kart et al., 2005) as a high priority SGCN and listed as an S1, Very Rare species. The goal of this study is to conduct a survey to obtain baseline distributional and abundance data on Fowler's toad along the Connecticut River in the Bellows Falls and Vernon Project-affected areas.

The objectives of this study are to:

- develop additional information regarding the distribution and relative abundance of Fowler's toad;
- develop additional information regarding the distribution and condition of suitable habitat within the study area; and
- determine if project operations are likely to have affect suitable Fowler's toad habitat, and if those effects are likely to be positive or negative.

RESOURCE MANAGEMENT GOALS

In its study request, VANR described various jurisdictional resource management goals for this study, as summarized below.

VANR	• Fowler's toad is a state SGCN. State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports aquatic biota and habitat. • General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat. • VFWD general goals for conserving, enhancing, and restoring natural communities, habitats, species, and the ecological processes that support them; and providing fish and wildlife-based activities including viewing, harvesting, and utilization of fish, plant, and wildlife resources. Goals reference Vermont's Wildlife Action Plan (Kart et al., 2005), including SGCN.

ASSOCIATION WITH OTHER STUDIES

Surveys for the distribution and abundance of Fowler's toads are a stand-alone activity. They do not require support from any other study, nor can they be efficiently combined with any other study effort. The assessment of Fowler's toad habitat distribution and condition within project-affected areas, however, will benefit greatly from data collected for other studies regarding the soil type, cover type, and the distribution and condition of wetlands.

The results of the *2012 Rare, Threatened, and Endangered Plant and Exemplary Natural Community Assessment* (Normandeau, 2013), and other related studies including Floodplain, Wetland, Riparian, and Littoral Habitats Study (Study 27), Hydraulic Modeling (Study 4), Operations Modeling (Study 5), and the erosion studies (Study 1, 2, and 3) will assist in identifying suitable habitat, interpreting the toad data collected and in drawing conclusions about preferred habitat characteristics, and whether project operations affect this habitat.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

To date, no studies have been conducted to identify the location or size of Fowler's toad populations within the project-affected areas, or to determine if project operations could affect toad populations, if present. The 2012 Species Status Review (provided as Appendix B to VANR's study request document dated March 1, 2013) for Fowler's toad by the State of Vermont Endangered Species Committee indicates that Fowler's toad has been recorded in the vicinity of the Connecticut River in both Vermont and New Hampshire. Fowler's toad was first reported and photographed in Vermont in 1983 in the Town of Hartford where it was reported as numerous. There was one 1985 report from Westminster, and a population in Vernon was well documented from 1994 through 2007. Additionally, there was one 2002 report from along the Saxton's River in Rockingham, VT.

In New Hampshire, Fowler's toad has been documented in Hinsdale (2002) and Westmoreland (2001) along the Connecticut River in Cheshire County (NHFG, 2010). No studies have been conducted to quantify the habitat occupied by Fowler's toad in the vicinity of the Connecticut River, or to identify apparently suitable habitat along the river, based on the literature.

PROJECT NEXUS

Project operations have the potential to affects Fowler's toad habitat that may be present. This species has specialized habitat requirements that benefit from shoreline disturbance as a result of flooding and/or wave action. Hydraulic regimes that deposit sand and gravel along the shoreline and clean away vegetation may help to create appropriate breeding, aestivation, and hibernation habitat. Fowler's toad also undergoes regular short-term population fluctuations. Hydraulic regimes that promote habitat fragmentation, e.g., reduced flooding allowing substantial plant growth, may disrupt this species' ability to move between breeding and terrestrial sites as well as recolonize appropriate habitats. Results of this study could be used to identify important breeding habitats for Fowler's toad, and to define the riverine processes that affect these habitats.

STUDY AREA AND STUDY SITES

The study area includes the shorelines and terrestrial lands of the Bellows Falls impoundment, the Bellows Falls riverine project-affected area, and the Vernon impoundment. The Wilder impoundment and Wilder riverine project-affected area are unlikely to support this species, as it is north of the northernmost Vermont record for Fowler's toad, and that report is the northernmost record in the Northeast, with the exception of a disjunct population in Canada. The precise study sites within the study area are to be determined, based on the results of the first stage of this study, a desktop assessment of potential habitat. Surveys will be conducted on lands owned by TransCanada, or lands that are publicly accessible by boat or by foot.

METHODS

This study will begin with a desktop analysis of existing data regarding the habitat available to Fowler's toad within the study area. Information that will be considered will include soil types, vegetation and cover type, and the locations and condition of existing wetlands in and directly adjacent to the project-affected areas. Sources of data that will be considered include relevant reports and maps created from concurrent studies as well as existing maps and aerial photos.

Records of historic and recent locations and extent of Fowler's toad in Vermont and New Hampshire will be requested from the relevant agencies. Fowler's toads require temporary pools for breeding, and loose sandy or gravelly soils above the waterline but below the frost line, for aestivation and hibernation burrows. Dense vegetation impedes the ability of this species to borrow into suitable soils. The results of the desktop analysis will be ground truthed by field-checking a subsample of the areas identified as suitable.

As requested by VANR, standard call surveys will be used to identify and map species occurrence. The methods describe below are based on Droege (undated) and Tupper et al. (2007):

- Likely breeding locations will be identified based on historic and recent records and the results of the desktop habitat suitability analysis. Of those likely breeding locations, a determination as to whether or not they are potentially affected by project operations will be conducted. Those outside the project boundary and those that are not likely to be affected by project operations will be identified as potential habitats but eliminated from further survey and analysis.

- A survey route based on results of the first step will be created and field-checked to verify that breeding areas identified with the desktop appear suitable (ground truthing).

- Suitable breeding locations will be surveyed three times, 2 weeks apart, during the survey period, which is late May through early July.

- Surveys will be conducted within 3 hours after sunset, with light winds, and water temperature of potential breeding ponds above 17.8°C. Light rain that does not interfere with listening is also a suitable survey condition.

In the study request, VANR also suggested several additional methodologies that are not included in this study plan. VANR suggested that surveys could be conducted using nighttime wet road surveys, nearshore boat surveys, FrogLoggers, and environmental DNA sampling.

The call surveys may be conducted in part by boat if necessary to reach remote areas. Nighttime wet road surveys will not be used because call surveys can be conducted under a greater range of conditions and are more efficient, allowing a greater area to be surveyed. FrogLoggers will also not be used because the call of Fowlers' toad is distinctive and easily perceived, making direct listening a more efficient option for surveying a large area. The time it would take to deploy FrogLoggers and analyze the results would be better spent listening in likely breeding habitat. Environmental DNA (eDNA) sampling is relatively new and an apparently effective method for detecting rare species in aquatic ecosystems (Ficetola et al., 2008; Goldberg et al., 2011). However, because it is a technique still undergoing development, there is not yet good data on how eDNA is transported and distributed by surface or groundwater flow and how long eDNA persists under varying conditions (Goldberg et al., 2011). Therefore, its value for identifying occupied habitats in riverine systems is uncertain and will not be included in this study.

ANALYSIS

The analysis will combine the results of the desktop study with the second phase results of the call survey to determine the suitability of the project-affected areas for Fowler's toad, and the likelihood that the species is currently present in the study area. The analysis will define habitat requirements based on literature and survey results; document/map currently suitable habitats based on results of the study's first step; and ascertain whether the habitat is affected, positively or negatively, by project-related flows or otherwise.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

Call surveys are generally accepted as an efficient, accurate method for determining habitat occupancy by amphibians that vocalize as part of their breeding activities. Standard methodologies have been developed by the USGS (Droege, undated), and call surveys are used by the North American Amphibian Monitoring Program (USGS, 2013) and by many states to inventory vocal amphibians.

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study. The report will summarize the desktop and field results, including maps of potential habitat, survey locations, and survey results showing whether operations of the projects are likely to have effects on suitable Fowler's toad habitat, and if those effects are likely to be positive or negative. A final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

This study will be conducted in the first study year (2014). As noted in the methods section, suitable habitats will be determined through a desktop analysis prior to the summer 2014; field surveys will be conducted during the month of June, under appropriate weather conditions. Analysis of field data and potential model application to determine project effects will occur in Fall 2014 and into 2015.

LEVEL OF EFFORT AND COST

The preliminary estimated cost for the study is $49,000.

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Study 29

Northeastern Bulrush Survey

RELEVANT STUDY REQUESTS

FWS-19; NHDES-15a, NHFG-15; NHNHB-01, -04; VANR-26; CRWC-16; Rock-03

STUDY GOALS AND OBJECTIVES

In their study requests relative to aquatic vegetation and habitats within the Wilder, Bellows Falls, and Vernon Project-affected areas, stakeholders specifically requested a survey for northeastern bulrush (*Scirpus ancistrochaetus*), a federally listed as endangered species known to occur in one location within the Bellows Falls Project on a beaver flowage in Rockingham, VT.

The goal of this study is to determine the potential effects of project operations on northeastern bulrush within the Wilder, Bellows Falls, and Vernon Project boundaries.

The objectives of this study are to:

- document the presence or absence and status of previously documented populations of northeastern bulrush in the study area;
- survey for additional locations of populations of northeastern bulrush in likely habitats;
- estimate the elevation of identified populations of northeastern bulrush to daily operational flows and impoundment levels to assess the potential influence of project operations on those populations; and
- assess effects on populations from non-flow related project operations within the project boundaries (e.g., recreation, agricultural leases).

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

Federal and state resource agencies described various jurisdictional resource management goals for this study in their requests, as summarized below:

FWS

- Northeastern bulrush is a federally listed endangered species. The goal for northeastern bulrush is species recovery for removal under the Endangered Species Act in accordance with the FWS' Northeastern bulrush (*Scirpus ancistrochaetus*) Recovery Plan (FWS, 1993).
- General goals for relicensing including to ensure that protection, mitigation, and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives;

and to conserve, protect, and enhance habitats for fish, wildlife, and plants affected by the projects.

- General goals related to aquatic resources including protecting, enhancing, or restoring aquatic and riparian habitats; and minimizing project effects on water quality and aquatic habitat.

NHDES
- State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.

NHFG
- General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).

VANR
- General goals related to aquatic resources including protecting, enhancing, and restoring habitats necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirements of resident fish and wildlife including invertebrates; and minimizing project effects on water quality and aquatic habitat.

- VFWD general goals related to conserving, enhancing, and restoring natural communities, habitats, species, and the ecological processes that support them; and providing fish and wildlife-based activities including viewing, harvesting, and utilization of fish, plant, and wildlife resources. Goals reference Vermont's Wildlife Action Plan (Kart et al., 2005).

- VFWD general goals related to resource conservation, fish and wildlife recreation and use, and human health and safety. Goals reference Vermont Fish and Wildlife Strategic Plan (VFWD, 2006).

ASSOCIATION WITH OTHER STUDIES

Other studies addressing other federally listed species have been completed or are proposed including Jesup's milk vetch (*Astragalus robbinsii* var *jesupii*) in Normandeau (2013a); dwarf wedgemussel (*Alismodonta heterodon*) in Biodrawversity and LBG, 2012) and in the Dwarf Wedgemussel and Co-Occurring Mussel Study (Study 24); and Puritan tiger beetle (*Cicindela puritana*) in the Cobblestone and Puritan Tiger Beetle Survey (Study 28).

The bald eagle (*Haliaeetus leucocephalus*) is no longer listed under the Endangered Species Act, but continues to receive federal protection under the Bald and Golden Eagle Act. Ongoing studies of bald eagle nesting activity in the project area are conducted by the New Hampshire Audubon Society with financial support from TransCanada.

The aerial photographs collected for the Floodplain, Wetland, Riparian, and Littoral Habitats Study (Study 27) will be reviewed to identify possible locations of new populations of northeastern bulrush, and to determine the land use in and adjacent to identified populations of this species. The Recreation Facility Inventory and Use & Needs Assessment (Study 30) will be reviewed in the event that northeastern bulrush populations appear to be affected by a recreational activity. Additional studies that will be used during the northeastern bulrush study will include the Instream Flow (Study 9), Hydraulic Modeling (Study 4), and Riverbank Erosion (Study 3) studies to assess the potential for water level fluctuations to affect populations of northeastern bulrush within the project boundaries.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

One record of northeastern bulrush is known to occur within the Bellows Falls Project boundary. While the specifics of its habitat preferences are poorly understood, northeastern bulrush, like other sedges, grows in wet areas – small wetlands, sinkhole ponds or wet depressions with seasonally fluctuating water levels. It may be found at the water's edge, in deep water or in just a few inches of water, and during dry spells there may be no water visible where the plant is growing (FWS, 1993b). The species appears to flourish in small ponded areas with full light availability, and relatively stable water levels, although many seemingly suitable habitats are unoccupied by northeastern bulrush.

The results of this study will establish baseline information on the distribution and habitat characteristics of northeastern bulrush populations within the project boundaries, and will assess the effects of project operations on the species. The assessment will consider the potential for existing project operations to influence surface and groundwater conditions at the northeastern bulrush sites.

PROJECT NEXUS

One record of northeastern bulrush is known to occur within the Bellows Falls Project boundary, but outside of the flow-related influence of operations. The northeastern bulrush was not found during the 2012 TransCanada study of rare, threatened and endangered plant species (Normandeau, 2013b); however, that study did not include a survey specific to northeastern bulrush because FWS indicated that it was unlikely to be found within the geographic scope of that study, which was focused on habitats immediately adjacent to the river and were directly affected by the projects' flow-related operating range. This study will include surveys for northeastern bulrush within the project boundaries that are not subject to river and impoundment fluctuations. This approach will provide information that supports the two recovery strategies recommended in the FWS recovery plan for the species: 1) provide protection for known populations, and 2) survey for new populations (FWS, 1993).

STUDY AREA AND STUDY SITES

The study area includes areas within the Wilder, Bellows Falls, and Vernon Project boundaries, including fee-owned properties and lands with flowage rights held by TransCanada. Although northeastern bulrush is only known to occur in the Bellows Falls Project area outside of the range of project operational flows, additional information will be sought from agencies and botanists who are expert in this species to identify possible new populations and habitats in other locations within the study area.

METHODS

Information on existing populations of northeastern bulrush and the habitats known to support the species will be gathered from state databases and botanical specialists for this species. Aerial photographs, soil survey data, and other remote sources of data will be reviewed to identify locations in which to search for new populations.

Field surveys will include site visits to known and likely locations during the fruiting season when the species is best identified (late June through August). Found populations will be documented according to VANR and NHNHB protocols. The limits of the population and approximate elevation of each location will be collected with GPS with 3-D, submeter capabilities. Visual observations of land use in the vicinity of found populations will be noted.

ANALYSIS

The results of the habitat and population surveys will be mapped and analyzed in GIS. The findings will be assessed relative to activities within the project boundaries (both flow-related and non-flow related such as recreation, agriculture, development, and other land uses) that have the potential to affect the species or its habitat.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The methods of rare, threatened, and endangered plant data collection, survey, and analysis are consistent with generally accepted scientific practice.

DELIVERABLES

A stand-alone confidential report will be provided to FWS, NHNHB, and VANR. The report will include maps of locations, documentation of findings, and an assessment of project operational effects.

A draft study report summary will be provided after the research and analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in a final report with an explanation of any stakeholder comments not incorporated.

Results and non-confidential conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

The field work for this study will be conducted during the northeastern bulrush growing season of the first study year (2014). Preliminary research and mapping will occur in the spring with field surveys conducted between late June and August. A study report will be provided after the research and analysis is complete and the results are available.

COST ESTIMATE

The preliminary estimated cost for this study is approximately $23,000.

REFERENCES

Biodrawversity and LBG (Biodrawversity and The Louis Berger Group, Inc.). 2012. Freshwater Mussel Survey in the Connecticut River for the Vernon, Bellows Falls, and Wilder Hydroelectric Projects. Prepared for TransCanada Hydro Northeast Inc.

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NHFG (New Hampshire Fish and Game Department). 1998. New Hampshire Fish and Game Department Strategic Plan (1998–2010). Concord, NH.

Normandeau (Normandeau Associates, Inc.). 2013a. Jesup's Milk Vetch Assessment: Agency Draft Report. Prepared for Transcanada Hydro Northeast, Inc. February 8, 2013. 49 pp.

Normandeau. 2013b. Rare, Threatened, and Endangered Plant and Exemplary Natural Community Assessment, Wilder Hydroelectric Project No.1892, Bellows Falls Hydroelectric Project No.1855, Vernon Hydroelectric Project No.1904: Agency Draft Report. Prepared for TransCanada Hydro Northeast Inc. February 8, 2013. 61 pp.

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Study 30

Recreation Facility Inventory, Use & Needs Assessment

RELEVANT STUDY REQUESTS

FERC-10; NPS-01; NHDES-01a, -01b, -01c; NHFG-01a, -01b, -01c; VANR-32; AMC-VRC-FRs-01; NEF-AW-01, -02; NEF-AW-AMC-02a, -02b, -02c; NEF-AW-AMC-05, Rock-04, -05; TwoRiv-01

STUDY GOALS AND OBJECTIVES

Public comments during scoping meetings and input from FERC, NHDES, NHFG, VANR, NPS, recreational user groups, the Town of Rockingham, VT, and Two Rivers Ottauquechee Regional Commission indicate a strong public interest in recreation access and opportunities, and a belief that there may be undocumented or underrepresented user groups and recreation opportunities available in the projects. This study will address recreation resource opportunities, uses, and needs within and also in the vicinity of the Wilder, Bellows Falls, and Vernon Projects.

The goals of this study are to:

- obtain information about the condition of existing recreation facilities and access sites at the projects;
- obtain information about existing recreation use and opportunities, access, and present and future demand within the vicinity of the projects;
- conduct an assessment of the need to enhance recreation opportunities and access at the projects;
- photograph views from public recreation facilities to document existing aesthetic conditions; and
- lay the foundation for preparation of a Recreation Management Plan (RMP) for the projects that will be included in the license applications.

Key objectives associated with the various components of this study are summarized as follows:

A. Recreation Facility Inventory

1. Identify existing information on recreation resources adjacent to and within the projects, and update existing data through site assessment and consultation with public and private recreation providers.

2. Provide a general characterization of the white water-oriented recreational opportunities within the region.

3. Provide an inventory of informal and formal public and private waterfront recreational sites/facilities within and adjacent to each project boundary including within the Bellows Falls bypassed reach.

4. Create detailed GIS-based map layers denoting recreation sites/facilities, and populate the database with information identified in 1-3 above.

5. Prepare a recreation sites/facilities inventory summarizing the information collected, and categorize it by recreation type or interest; distinguish whether or not facilities are project facilities and if not identify the site manager.

6. Photodocument representative views of each project to capture current aesthetic resources.

B. Recreation Use and Needs Assessment

1. Collect visitation levels, activities, and trip frequencies related to recreational use (including active and passive recreation types) and user preferences and perceptions (e.g., adequacy of facilities, crowding) at existing formal and informal public access sites within the project boundaries.

2. Collect information (e.g., activity type and resource needs, visitation levels and trip frequency, obstacles to recreation in vicinity of the projects) regarding recreational use and user preferences of uncommon user groups.

3. Characterize existing and potential recreational uses in the projects by season and activity.

4. Characterize current user preferences and any identified needs.

5. Summarize parking lot utilization, identify area capacity, and identify sites that receive heavy use. If areas are recorded at maximum capacity or are likely to be within the term of a new license, examine opportunities for that site that can be met through repair or upgrading at the site or elsewhere within the projects.

6. Summarize recreation use and demand from the information collected.

C. Future Recreational Use Assessment

1. Collect information regarding local and regional population trends and trends in recreation activities throughout the Connecticut River Valley.

2. Document current trends in recreation, and use available accepted literature to make future use estimates.

3. Estimate future demand (by activity) at each project.

4. Identify if changes in the public access facilities would be needed and where those facilities would be beneficial.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In their study requests, federal and state resource agencies described various jurisdictional resource management goals for this study, as summarized below.

NPS

- The Connecticut River has been designated a National Blueway, part of the America's Great Outdoors Initiative. Among the stated goals are "to advance a whole-river, water-based approach to conservation, outdoor recreation, education, and sustainable economic opportunities in the watersheds in which we live, work, and play."

NHDES

- State water quality standards and designated uses for Class B waters including aquatic life, fish consumption, drinking water supply after treatment, primary and secondary contact recreation, and wildlife.

NHFG

- General goals related to sustainable fish populations, habitats, recreational fishing, and healthy aquatic ecosystems. Goals reference New Hampshire Fish and Game Department Strategic Plan 1998–2010 (NHFG, 1998).

VANR

- State water quality standards for designated uses of Class B waters relative to levels of water quality that fully supports all recreational uses.
- General policy related to protection of the quality of state waters with scenic, recreational, cultural, and natural values; balance competing uses; provide improved public access for water-based recreational opportunities. Policy references the 1993 Vermont Recreation Plan (VANR, 1994).

Not included in agency study requests, but included in the project PADs, the states of New Hampshire and Vermont have published Statewide Comprehensive Outdoor Recreation Plans (New Hampshire, 2007; Vermont, 2005) containing goals related to recreation resource management throughout each state.

ASSOCIATION WITH OTHER STUDIES

This study will supply context and background for the Whitewater Boating Flow Assessment -- Bellows Falls and Sumner Falls (Study 31), and the Bellows Falls Aesthetic Flow Study (Study 32).

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Section 3.10.3 of the PAD for each project provides a summary of FERC Form 80 Recreation Use Report annual visitation estimates for 2008. Section 3.10.2 provides a general description of public recreation facilities, activities, and demand at the projects. However, the PADs do not provide detailed information regarding the condition of existing facilities or type or location of various uses. Site-specific information regarding visitor perceptions and identified needs at the projects, current use, and whether existing access facilities in the area are meeting current and expected future recreation demand has not been collected.

PROJECT NEXUS

The projects include impoundments, tailwater areas, and a bypassed reach at Bellows Falls, some of which are inherently attractive recreation features. An analysis of existing recreation use and access at the projects would help form the basis for determining the projects' ability to provide public recreation access opportunities. Also, an assessment of the current level of recreation use would provide information necessary to develop an RMP for efficient management of the recreational components of the projects over the term of new licenses.

STUDY AREA AND STUDY SITES

The study area includes Wilder, Bellows Falls, and Vernon Projects (lands and waters). Figures 3.10-1 of the Wilder, Bellows Falls, and Vernon PADs show the publically accessible recreation sites in proximity to the projects. Specifically, the study area includes the project impoundments within the project boundaries and existing formal and informal public recreation areas including TransCanada access areas, state and municipal lands and access areas, and commercial recreation areas (marinas) located adjacent to the projects that provide water and land based recreation opportunities for the general public. The study will draw on information gathered from public recreation area visitors; residents from neighboring communities, and less common user groups (e.g., snowmobile clubs, whitewater boaters).

METHODS

Several methods will be used to collect current and estimate future recreation use and needs for the Wilder, Bellows Falls, and Vernon Projects lands and waters potentially affected by project operations. The study will assess data on recreational use and needs gathered during the 2014 peak recreation season (May 1 through September 30, 2014).

A. Recreation Facility Inventory

The recreation facility inventory will be developed through site visits to each publicly accessible site within and adjacent to the project boundaries to document existing facilities and resources. All sites that will be inventoried are shown in the PAD figures referenced above and summarized in the following table.

Table 30-1. Publicly Accessible Recreation Areas within the Wilder, Bellows Falls, and Vernon Projects

Wilder Project	Bellows Falls Project	Vernon Project
Newbury-Haverhill Bridge Access	Andrews Road	Putney Boat Landing
Bedell Bridge State Park	Wilgus State Park	Dummerston Landing
Bugbee Landing Access Point	Ashley Ferry Boat Landing	River Road Access
Orford Boat Landing	Hoyts Landing	Old Ferry Road Access
Richardson Conservation Land	Patch Park	Retreat Meadows Boat Launch
North Thetford Landing	Charlestown Boat Launch and Picnic Area	West River Marina
Hewes Brook Boat Launch	Herrick's Cove Boat Launch and Picnic Area	Norm's Marina
Ompompanoosuc Launch	Pine Street Boat Launch and Portage Trail Take-Out	Hinsdale Island
Fullington Landing	Bellow Falls Fish Ladder Visitor Center	Prospect Street Launch
Ledyard Canoe Club	Bellows Falls dam portage put-in	Fisherman Access Area
Norwich Landing	Bellows Falls bypassed reach	Vernon Canoe Portage
East Wilder Boat Launch		Vernon Glen
Hartford (Wilder) Picnic Area at Kilowatt Park		Vernon (Governor Hunt) Recreation Area & Boat Launch
Wilder dam (Olcott Falls) Boat Launch		Vernon Neck Open Space
Fishladder and Angler Parking		
Lebanon (Wilder dam) Picnic Area Vista and hiking trails		
Wilder dam portage and downstream natural areas		
Connecticut River Trail Campsites		
Harkdale Farm	Wilgus State Park	Windyhurst
Vaughn Meadows	Student Conservation Association	Wantastiquet - Hinsdale Canoe Rest Area
Bugbee Landing	Lower Meadow	Stebbins Island Canoe Rest Area

Wilder Project	Bellows Falls Project	Vernon Project
Underhill Camp		
Pastures Campground		
Birch Meadow		
Roaring Brook		
Gilman Island		
Gilman Island -Titcomb Cabin		

Amenities at each site, such as number and type of boat ramps, the presence and type of restrooms, types of activities supported, parking spaces, and parking surface, will be recorded along with digital photos and GPS points. This inventory will identify and characterize the public facilities and resources, as well as identify any barrier-free sites/facilities, and the conditions of those facilities. At Bellows Falls, the facility inventory will include characterization of the suitability of the bypassed reach for whitewater boating (e.g., gradient, length, character of potential flows) and the feasibility of incorporating a shorter and safer portage (i.e., a path that reduces boaters proximity and time near NH State Route 12) around Bellow Falls dam.

The results of the inventory will provide baseline information regarding existing recreation facilities and resources at the projects. The inventory information will be assessed in conjunction with the information obtained through the visitor demand survey (see below).

The expected results of the inventory effort will be:

- inventory of recreation sites and opportunities within and adjacent to each project;
- digital photographs of each of the recreation sites; and
- GIS map layers with links to digital photos and inventory information.

B. Recreation Use and Needs Assessment

The use and needs assessment will attempt to document all recreation activity types known to occur or potentially occurring at each project. Use assessments will be based on three components to collect existing and potential (future) recreational visitor use data. These components are: 1) existing public use (traffic counters, spot counts, and visitor interviews); 2) potential visitors (mailed and/or online questionnaire); and 3) use from other shoreline operators (e.g., publicly accessible marinas, and state parks [interviews and/or shared recreation data]).

Existing Public Use

Traffic counters, spot counts, and visitor exit interviews from the public access points listed above will be used to estimate current recreation use and activity levels at each project's public access sites.

Traffic counters capable of recording the time of each vehicle count will be installed at public access sites within the project boundaries that are conducive to this form of data collection. These are sites where there is a clearly designated entrance and exit to the recreation site. An assessment will be made in the field regarding the suitability of using a traffic counter at each site.

Spot counts and interviews will be conducted at all public access sites listed in table 30-1 above. Spot counts will collect data on the amount of occupied parking spaces, recreational activities and use numbers, and general climate conditions.

Intercept surveys will be conducted with visitors to collect data on people's use of recreation sites, their attitudes concerning recreation needs and opportunities, safety concerns, and perceptions on site aesthetics. Survey questions will ask the visitors about group size, activities participated in, duration of and frequency of visits, primary activity, satisfaction, perceptions related to operation of the projects, and insight into site or project needs. The date and time of the interviews and the information collected on the public's perceptions of impoundment levels or flows will be correlated to the actual levels during the interviews. Key aesthetic places and areas will be identified through the interview process and will be photographed. The goal of each site visit is to capture use numbers from traffic counts, characterize them with spot counts, and obtain as many interviews as possible to get a representative sample of the recreating public and characterize their uses, opinions, attitudes, and experiences.

A stratified random sampling scheme, such as by month, time of day, and location, will be used to gain representative responses from the visitors. Within the project boundaries, a sampling day will begin either ½ hour after sunrise or end ½ hour before sunset and will focus either on the AM or PM time period. The number of sampling days each month will be developed with the agencies and other interested stakeholder participants (e.g., a Recreation Resources Work Group). Route direction and schedules for spot counts and interviews will be randomly selected each month. The details of the survey tool questions and site stratification will be discussed with the agencies and other interested stakeholder participants (e.g., a Recreation Resources Work Group) prior to the beginning of field work.

Potential and Uncommon Visitors

On-site interviews generally capture common activity types and potentially miss stakeholder groups with unique recreation resource needs. These uncommon user groups (e.g., adjacent residential land owners, snowmobile clubs, rock climbers, hunters) will be surveyed using a mixed mode (mail and internet) approach inquiring about their recreational uses and needs of the Connecticut River within the projects as well as reasons for not visiting the projects. Adjacent residential land owners and seasonal clubs (adjacent land owners, snowmobile clubs, etc.) will be identified and targeted to randomly receive a recreation survey. The mixed mode survey will follow the Dillman Method or modified Dillman Method (Dillman, 1978), and include items such as frequency and duration of visits to the projects, qualitative ratings of existing public access and recreation facilities in the project area, and reasons for visiting or not visiting the projects for recreation.

Needs Assessment

The needs assessment will include the demand for whitewater boating in the bypassed reach of Bellow Falls, existing boating opportunities within the project areas (including at the impoundments and immediately downstream of the dams), feasibility of providing additional public access at the impoundments and riverine reaches (potential locations, type of facilities and access, and any associated costs), identifying visitor perceptions regarding the adequacy of recreation facilities, and access in the project areas, and assessing future recreation demand and facility needs at each project.

Expected results of the use and needs assessment will be:

- annual recreation use estimates by activity type and season, for all sites;
- visitor profile information including results of interviews and mixed mode surveys;
- characterization of existing recreational visitation based on the assessment of information gathered via spot counts, traffic counter information, and available use information of recreation facility providers;
- characterization of existing recreational use and user preferences based on exit interviews and survey information; and
- assessment of visitor perceptions of the effects of project operations and management (including fluctuating reservoir levels, and minimum flow releases) on recreation and recreation opportunities at the projects.

C. Future Use Assessment

Future recreation demand at each project will be assessed by assessing future demand for recreation activities and population trends for the expected term of new licenses (to year 2050). Population estimates for the communities surrounding the projects will be obtained from the respective state agencies. Growth in recreation activities and the recreation use projections for the anticipated growth in recreational use through 2050 will be developed using *Outdoor Recreation in American Life: A National Assessment of Demand and Supply Trends* (Cordell et al., 1999). Current use estimates will be projected with indexed values of expected changes in the number of recreation days for given activities at the projects to estimate future recreation use in the project for 10-year increments out to 2050.

The expected results will be:

- data tables of expected population growth surrounding the projects in 10 year increments to 2050; and
- data tables of expected activity use levels for each project in 10-year increments to 2050.

ANALYSIS

The information acquired would be used to characterize and quantify recreation opportunities and conditions of recreation facilities, activity types, and levels of use by season, parking lot use through peak and weekend periods, visitor perceptions and recommendations, estimate future activity levels, and lay the ground work for a draft RMP. Results from the Bellows Falls inventory and suitability work will inform the Whitewater Boating Flow Assessment Study (Study 31).

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The methods to be used in this study are consistent with professional practices. The overall approach is commonly used in FERC relicensing proceedings and is consistent with generally accepted methods used by federal and state agencies for conducting recreation inventory, use, and needs studies. In addition, the methods are consistent with FERC study request under the ILP.

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study. A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

This will be a 1-year study conducted during the first field season (2014). Desktop and pre-field work will begin in late 2013, after FERC's study plan approval. Field work will focus on the peak recreational season with exact start and stop dates to be determined in consultation with stakeholders, and is anticipated to start May 1 through September 30, 2014.

LEVEL OF EFFORT AND COST

The estimated budget for the study is approximately $350,000.

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Study 31

Whitewater Boating Flow Assessment

Bellows Falls and Sumner Falls

STUDY REQUESTS

FERC-11; NPS-02a, -02b; AMC-VRC-FRs-02; NEF-AW-AMC-03

STUDY GOALS AND OBJECTIVES

Public comments during scoping meetings and study requests received from FERC, NPS, AMC-VRC-FRs, and NEF-AW-AMC indicate a strong public interest in evaluating the suitability of whitewater boating opportunities at the bypassed reach below Bellows Falls dam and studying the effects of operations of the Wilder Project on paddling opportunities at Sumner Falls.

The goal of this whitewater flow study is to assess the presence, quality, access, flow information, and flow ratings for paddling opportunities in a stepwise manner.

The objectives of the study are to:

- identify recreational paddling opportunities at Sumner Falls and the suitability of the Bellows Falls bypassed reach for whitewater boating;
- describe flow-quality relationships at each location, and identify acceptable and optimal ranges for each. Information will be organized independently for Sumner Falls and the Bellows Falls bypassed reach;
- describe potential effects of operations on paddling at each location, and identify boater's sensitivity to current operations regimes (e.g., project discharges ranging from minimum flow to full generation);
- broadly characterize recreational paddling-relevant hydrology of the existing operating regime, and qualitatively describe the relationship between paddling opportunities and project operations;
- determine whether current or future demand exists for whitewater boating in the Bellows Falls bypassed reach within the context of regional opportunities and those provided through current operation;
- determine the number of days flows for whitewater boating are available under the projects' current operation at both locations;
- identify resource needs (e.g., aquatic habitat) and competing recreational uses (e.g., canoeing, climbing, or fishing) that are or would be affected by flows suitable for whitewater boating;

- identify all safety issues associated with whitewater boating and further development of opportunities for such at both locations;
- identify public access obstacles at Sumner Falls and Bellows Falls bypassed reach; and
- characterize effects on current project operations associated with providing various flows for recreational paddling.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

In its study request, NPS identified the following resource management goals related to this study.

NPS	• The Connecticut River has been designated a National Blueway, part of the America's Great Outdoors Initiative. Among the stated goals are "to advance a whole-river, water-based approach to conservation, outdoor recreation, education, and sustainable economic opportunities in the watersheds in which we live, work, and play."

Also as included in the project PADs, the states of New Hampshire and Vermont have published Statewide Comprehensive Outdoor Recreation Plans (New Hampshire, 2007; Vermont, 2005) containing goals related to recreation resource management throughout each state.

ASSOCIATION WITH OTHER STUDIES

Study results from this effort will help characterize the whitewater boating opportunities; however, conducting the study and interpreting the results will need to be done in a comprehensive manner. Results from other studies will help provide the context in which to assess the results of this study so agencies, stakeholders, and regulators can properly balance the resources. Similarly, the study can be coordinated with other studies to achieve efficiencies associated with mobilized staff and operational requirements and so that study components are implemented in a stepwise manner so any potential conflicts in resource needs are identified and avoided.

Sumner Falls

TransCanada conducted investigations into the federally listed Jesup's milk vetch (*Astragalus robbinsii* var *jesupii*) (Normandeau, 2013), which resulted in the development of stage flow relationships in the reach below Wilder dam to assess the relationship between flows and Jesup's milk vetch. The area surrounding Sumner Falls also serves as critical habitat for state-listed Cobblestone Tiger Beetle, which will be studied in Study 26.

This location would also likely be studied in further detail under the Instream Flow Study (Study 9) with analysis of minimum and operational flows related to various aquatic habitats. Results from the Hydraulic Modeling (Study 4) and Operations Modeling (Study 5) studies will contribute to the understanding of the potential effects on operations of whitewater flows. Sumner Falls access, uses, and user interviews (among other data) will be documented with the Recreation Facility Inventory and Use & Needs Assessment (Study 30). This information will help characterize the social and human dimensions related to recreational use of the site, which will provide a richer context for understanding the relationship between the Wilder Project and natural and recreational resources.

Bellows Falls Bypassed Reach

Similar to the Sumner Falls section above, results from this study will provide inputs into the comprehensive understanding of the relationships between operations and natural, recreation, and aesthetic resources. Results from the Instream Flow Study (Study 9) will help describe flow habitat relationships. Flow effects from operations will also be assessed through the Hydraulic Modeling (Study 4) and Operations Modeling (Study 5) studies. The American Eel Upstream Passage Assessment (Study 18) will provide insights into eel passage needs and flow relationships.

This study will also draw on the documentation of the bypassed reach described in Study 30, Recreation Facility Inventory Use & Needs Study (e.g., gradient, access, length).

This study is dependent on controlled releases from the Wilder Project and from Bellows Falls dam into the Bellows Falls bypassed reach, and the timing and magnitude of those releases could be scheduled to accommodate various studies. Controlled flows provided for the Instream Flow Habitat Study (Study 9) could be used in lieu of separate flows for this study. That study would also produce hydraulic modeling (2-D) outputs that could provide additional information about flows (e.g., depths, water velocity, direction) and be used to supplement this study. The Bellows Falls Aesthetic Flow Study (Study 32) is similarly dependent on controlled flows and would most likely be coordinated around scheduled releases.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

The Bellows Falls PAD does not include information on the suitability of boating in the bypassed reach because that is not part of the project's current operation. Currently there is no information available to analyze whether flows could be provided to enhance whitewater boating opportunities or whether there is demand for whitewater boating in the bypassed reach. Furthermore, there is no reasonably available information on the characteristics or boating suitability of the Bellows Falls bypassed reach, or the range of boatable flows.

In terms of physical capability to release water into the Bellows Falls bypassed reach, the PAD indicates that no minimum flow is required in the bypassed reach under the current project license, and the amount of flow present is determined by the amount of spillage and leakage. When flows exceed project capacity the excess water is spilled into the bypassed reach through two 115-foot long roller gates that discharge water 15 to 18 feet below the impoundment surface. Flows over the stationary flash boards would occur when inflows exceed roller gate capacities combined with generator discharge (approximately 40,000 cfs). The minimum gate opening for these gates is 1 foot to prevent river debris from damaging the submerged seals or getting lodged and preventing the closure of the gate. Considering the overall 3-foot range of operation of the impoundment, a 1-foot opening discharges 3,000 to 3,300 cfs into the bypassed reach.

There have been historical instances of personal injury and accidents, including at least one fatality, due to public use or attempts at boating spill related flow in the bypassed reach. The level of danger requires safety considerations to be a key component of all studies and demonstration flows. This should apply to both the demonstrations if evaluators require presence in the bypassed reach itself and potential for future requirements for flow in the bypassed reach with respect to instream public use.

The Wilder PAD recognizes Sumner Falls (also known as Hartland Rapid) for its whitewater characteristics and summarizes some basic information about the site; however, the PAD does not include information about the relationship between flow releases from Wilder and the characteristics, boating suitability, or other flow-dependent recreation effects of those releases.

Existing Wilder and Bellows Falls operations data can provide baseline information about opportunities for boating and flow dependent recreation under current operations.

PROJECT NEXUS

Operation of the Wilder Project regulates the level of flow downstream of the dam. Recreational paddling opportunities at Sumner Falls can be affected by the timing, duration, and magnitude of those releases. A better understanding of operations and recreational paddling opportunities for this location is needed.

Bellows Falls Project operation diverts flows from the bypassed reach of the Connecticut River that could, in theory, provide whitewater boating opportunities. Other than leakage from the dam, flows into the bypassed reach only occur during high flow events when inflow exceeds station capacity and the excess is spilled at the dam. An analysis of project operations relative to a range of boatable flows would help form the basis for assessing how often boatable flows occur in the bypassed reach under existing conditions and the quality of those flows.

STUDY AREA AND STUDY SITES

This study focuses on two specific locations: Sumner Falls, which is downstream of the Wilder Project but affected by project discharge, and the Bellows Falls bypassed reach directly downstream of Bellows Falls dam. Sumner Falls is a series of ledges sprawled across a wide section of the Connecticut River about 7 miles downstream of Wilder dam creating a quarter mile stretch of rapids as the river drops 7 vertical feet. The Bellows Falls bypassed reach comprises natural river bed approximately 3,500-feet long that receives minimal flow from dam leakage, and high flow events or powerhouse outages.

METHODS

The methods used in this study are designed to gather information to assess flow ranges for recreational paddling in a stepwise, or phased, manner. Specific protocols related to study components will follow accepted practices outlined by Whittaker et al. (1993, 2005).

A phased approach encourages advancing the level of effort needed to quantify specific opportunities and flow needs for a reach only if less intensive work is unable to provide that information. For example, whitewater boating already exists at Sumner Falls, but the relationship to Wilder Project operations and the quality of the recreational paddling is less well documented. This approach is even more important for Bellows Falls because it is currently unknown if the bypassed reach is suitable for whitewater boating. The basics of the reach and any insurmountable risks should be documented and assessed prior to committing to on-water flow reconnaissance or controlled flow evaluations.

Study phases will progress according to the levels prescribed by Whittaker et al. (2006). Study information acquisition will begin with “Level 1” methods (a review of existing information and limited reconnaissance of river segments at a single flow), and will also include “Level 2” (structured interviews with experienced recreation users for target opportunities and on-land boating feasibility assessment). Decisions about whether or not to proceed will be made at the conclusion of each task (level) working towards “Level 3” methods (e.g., on-water single-flow reconnaissance or multiple flow controlled flow study). Taken together, this level of precision/study intensity is expected to provide sufficient quantification of flow ranges or flow fluctuation tolerances to assess broad project effects from current operations.

Review of Existing Documents (Level 1)

A review of relevant resource documents (e.g., guidebooks) and operational data is an important first step in a flow assessment for recreation. This study component will include a directed assessment of existing project hydrology data and operational constraints relative to recreational paddling opportunities. These materials will help clarify existing or potential opportunities and flow issue and allow researchers to become familiar with operations and resulting recreation-relevant hydrology of the river reaches.

Existing available hydrology information will be used to generally describe the range of flows available in reaches during specified recreation seasons; this provides context for conducting field work, interviews, and controlled flow study components.

Resource Reconnaissance (Level 1)

Field work is planned for spring/summer 2014. This time frame allows researchers to identify potential study participants and observe recreation opportunities at common flow levels (assuming normal conditions are available). It also provides sufficient time to develop preliminary hydrology information, become familiar with the resource via interviews and existing information, and define logistics with local recreational paddlers who may help guide reconnaissance.

Interviews and Land-Based Feasibility Assessment (Level 2)

Interviews with key resource experts or recreation users offer complementary information about recreational paddling and the system's hydrology. Interviews are proposed with a minimum of two to four experienced recreation users (or agency staff) for each recreational paddling opportunity.

Interviews will be semi-structured with specific topic areas, and questions will focus on how people boat at Sumner Falls or if the bypassed reach could provide whitewater opportunities. The goal is to describe the character of the recreational paddling opportunities and identify flow-dependent attributes while recognizing any insurmountable risks. A second series of questions will focus on the effects of flows on those attributes and whether interviewees can identify specific flows or fluctuation levels that affect the quality of opportunities (e.g., acceptable and optimal ranges and fluctuation tolerances).

The land-based feasibility assessment will include visually evaluating Sumner Falls and the bypassed reach and having open discussion with interview participants related to the recreational paddling opportunities (and specifically the feasibility of boating within the bypassed reach), possible flow ranges, and potential risks. An evaluation form will be developed that address issues identified in the interviews and land-based assessment. The results from these activities will help determine and inform the next steps, which may include Level 3 on-water assessment(s).

Controlled Flow Study (Level 3)

If whitewater boating is deemed feasible and safe in the Bellows Falls bypassed reach, expert boaters will be allowed to boat the reach and respond to predetermined rating questionnaires. Initially this would be a single flow reconnaissance study to better understand the whitewater characteristics within the reach. Photos and video will also be used to document the runs. If the single trip is successful and more information is required to quantify acceptable and optimal flow ranges, multiple boat trips will be made either as stand-alone study releases or in coordination with controlled flows scheduled for the Instream Flow Study (Study 9). Hydrological flow modeling (2-D) conducted as part of that study could be used and show current direction, water velocity, and depth patterns in the bypassed reach and linked with boater criteria or observational data as a supplement to the qualitative approaches.

Similarly, various flows released downstream of Wilder will be used at Sumner Falls to assess recreational paddling opportunities and rate the quality of the flows at this location. Paddlers will participate in a controlled flow study. Participants will complete a pre-fieldwork survey on their experience and boating preferences, paddle the river at each flow and assess flows and participate in a focus group after each flow. After all flows have been observed, participants will provide their overall evaluations using a "flow comparison" format." Photos and video footage of key rapids, pools, or other features and conditions with different user types will be taken and will provide useful documentation, particularly in combination with qualitative focus group notes, quantitative data from surveys, and relevant hydraulic modeling outputs.

ANALYSIS

Results from each level of the stepwise approach will be documented and will inform the process as the study progresses. Results from the literature review and field-based reconnaissance will be used in determining if and at what flow, a single reconnaissance flow trip should be made in the bypassed reach. Successful completion of a single flow trip would inform the flow levels and types of watercraft that would be appropriate for a multiple flow controlled flow study. Similarly, results from interviews and observations at Sumner Falls will help to determine the flows needed for the multiple flow assessments. Quantitative ratings will be made for whitewater boating opportunities and conditions. Results will incorporate hydrology, project operations, interview results, and quantitative data collected from the rating forms (questionnaires) that would be completed by study participants. An overall flow preference curve for paddlers will be provided.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The methods used in this study are consistent with professional practices. The overall approach is commonly used in FERC relicensing proceedings and is consistent with generally accepted methods used by federal and state agencies for conducting recreational flow assessments. In addition, the methods for the study are consistent with FERC study requirements under the ILP.

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study. The report will 1) describe the whitewater boating attributes of the range of flows examined, including level of difficulty, play spots, safety and portage requirements, etc.; 2) identify the acceptable and optimal flows for the reach and the frequency of availability of the identified flows under current project operations; and 3) incorporate relevant results from the Recreation Facility Inventory and Use & Needs Assessment (Study 30), including characterization of the access or suitability of the bypassed reach for whitewater boating (e.g., gradient, length, character of potential).

A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and

comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the projects. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

This will be a 1-year study conducted during the first study year (2014). Desktop and pre-field work will begin in late 2013 after FERC's study plan approval. Because this is a flow study, the field work could be coordinated to occur with spring run-off and distinct controlled releases or those provided for the Instream Flow Assessment (Study 9). Controlled flows may be required over the course of 3 to 4 consecutive days during which the multiple flow on-water trips would occur.

LEVEL OF EFFORT AND COST

The estimated budget for the study is approximately $86,000.

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Study 32

BELLOWS FALLS AESTHETIC FLOW STUDY

RELEVANT STUDY REQUESTS

VANR-34

STUDY GOALS AND OBJECTIVES

In their study requests, VANR and the Rockingham Conservation Commission indicate a need to characterize the aesthetic attributes of the Bellows Falls bypassed reach.

The goals of this study are to:

- characterize the aesthetic conditions in the bypassed reach at various levels of flows; and
- provide a range of aesthetic ratings that can be used to assess conditions relative to Vermont's water quality standards.

The primary objectives of this study are to:

- collect videography and still photography to document the appearance of the bypassed reach under existing and various controlled flows conditions;
- identify user groups potentially affected by the aesthetic conditions in the bypassed reach and determine how the interests of these user groups relate to the aesthetic conditions;
- identify flow ratings and timing preferences across the full range of potential user groups; and
- estimate the costs to provide different levels of flow and assess the trade-offs of the various flows among the different user groups.

RELEVANT RESOURCE MANAGEMENT GOALS

In its study request, VANR described jurisdictional resource management goals for this study, as summarized below.

VANR	• State water quality standards for designated uses of Class B waters relative to aesthetic values including water character, flows, water level, and bed and channel characteristics.

Note that the Bellows Falls bypassed reach is located primarily in New Hampshire. New Hampshire water quality standards do not include aesthetics as a parameter for Class B waters.

ASSOCIATION WITH OTHER STUDIES

This study requires observations of specific, measured flow releases into the bypassed reach for rating by study participants. Similarly, ranges of controlled flows may also require a level of observation as a component of the Instream Flow Study (Study 9) and the Whitewater Boating Flow Assessment (Study 31). At this time it is unclear how and what level demonstration flows would be necessary in those studies to meet those study objectives. If it is feasible, it would make sense to incorporate the elements of an aesthetic flow assessment analysis to the range of flows associated with those studies.

Furthermore, there may be preliminary, non-flow assessment criteria and information that is required to determine what, if any, flows are suitable for those interests. All of this associated study determination should be completed before conducting a series of controlled flows specifically to address this study's aesthetic analysis. Alternatively, a series of controlled releases could be attempted solely for the purposes of this study should either of the associated flow demonstrations not prove feasible or adequate to meet the needs of this study's objectives. To the extent possible, aesthetic evaluations could also include naturally occurring spill events.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

No information is available to characterize the aesthetic conditions in the Bellows Falls bypassed reach. No minimum flow is required in the bypassed reach, and the amount of flow present is determined by the amount of spillage and leakage from the dam. When flows exceed project capacity, the excess water is spilled into the bypassed reach through two, 115-foot long roller gates that discharge water 15 to 18 feet below the impoundment surface. Flows over the stationary flashboards would occur when inflows exceed roller gate capacities combined with generator discharge (approximately 40,000 cfs). The minimum gate opening for these gates is 1 foot to prevent river debris from damaging the submerged seals or getting lodged and preventing the closure of gate. Considering the overall 3-foot range of operation of the impoundment, a 1-foot opening discharges 3,000 to 3,300 cfs into the bypassed reach.

There have been historical instances of personal injury and accidents, including at least one fatality, due to public use or attempted use of spill-related flow in the bypassed reach. The level of danger requires that safety must be a consideration for all studies and demonstration flows. This should apply to both the demonstrations should evaluators require presence in the bypassed reach itself, and potential future requirements for flow in the bypassed reach with respect to instream public use.

PROJECT NEXUS

Lack of consistent flow passing the dam and into the bypassed reach directly affects aesthetic resources associated with the dam and the bypassed reach itself. VANR requests a study of alternative flows released from Bellows Falls dam. This information will be needed to characterize existing and potential aesthetic conditions before VANR can determine whether the project would meet Vermont water quality standards.

STUDY AREA AND STUDY SITES

The study area includes the Bellows Falls bypassed reach from the base of the dam to a point below the fish barrier dam at the confluence of the tailrace. The fish barrier dam will be considered an element associated with the bypassed reach for the purposes of this study. It will be assessed under different flow conditions from publicly accessible and representative observation points. Review of site conditions suggests direct views into the bypassed reach are limited, and there is no public access. The specific number of sites and exact locations will be determined in consultation with agency representatives and interested stakeholders. Likely observation points include the now-closed Vilas Bridge (Bridge Street), along New Hampshire Route 12 (River Street or Main Street), and potentially near the dam from the intersection of River Street and Church Street (north side of the Arch Bridge in New Hampshire).

METHODS

The conditions of the bypassed reach during a range of flow releases will be recorded (digital videography and photographs) and rated using the comparative method. Representative study (survey) participants will be identified and asked to rate conditions under the specified flow releases using a predefined rating form. A seven-point Likert acceptability scale ranging from -3 (labeled "totally unacceptable") to +3 (labeled "totally acceptable") with a 0 midpoint (labeled "marginal") will serve this purpose. Researchers have advocated the use of this type of metric for assessing recreation and aesthetic flows (Shelby et al., 1992; Whittaker et al., 1993, 2005). The overall process will be as follows:

- Develop background materials (e.g., hydrographs, photos, videos).
- Develop survey tool/rating form.
- Assess project operations and existing hydrological conditions in the bypassed reach (e.g., frequency and duration of spills, amount of leakage, ability of spillway gates to make controlled releases).
- Identify potentially affected user groups and representative study (survey) participants.
- Identify 3 to4 key, common observation points to record flows though photography and videography.
- Document existing aesthetic conditions (i.e., with only leakage flow and periodic high flows) and the conditions present under at least three controlled flows associated with other studies to the extent possible using photography and videography.

- Administer surveys and collect responses provided in the structured rating forms for each flow that is assessed. Participants will complete a form to rate the leakage flow, a seasonal spill event, and each of the controlled flows released in the bypassed reach.

- If flows demonstrated under other studies are not adequate once completed and assessed (for some unspecified reason) to meet the goal of this study, specific aesthetic resource demonstration flows and on-site evaluation teams will assess flows similar to those described above.

ANALYSIS

Survey responses will be summarized, and results from each user group will be tallied to identify whether each assessed flow creates acceptable, marginal, or unacceptable conditions for each user group. Survey responses will be assessed to determine preferred times for making flow releases and to identify trade-offs that would exist between user groups and the different flows. This information will be correlated with operational data to estimate the costs to provide different levels of flow. Safety-related effects for all flows represented will be included in the analysis.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The methods for the study are consistent with professional practices. The overall approach is commonly used in FERC relicensing proceedings and is consistent with generally accepted methods used by federal and state agencies for conducting aesthetic flow assessments. Photographing and videotaping the bypassed reach when it contains each of the alternative flows and using these recordings to survey a group of individuals using the comparative method is an equivalent and efficient methodology to the on-site demonstration flow approach.

DELIVERABLES

A report will be prepared that presents methods, analysis, and results of the study and will include photos and short videos of the various flows assessed in the study. A draft final study report will be provided after the study analysis is complete and the results are available. The report will be prepared for stakeholder review and comment. Stakeholder comments on the draft final report will be included in the final report with an explanation of any stakeholder comments not incorporated.

Results and conclusions will be reported in either the PLP or draft license application for the project. Exhibit E of the final license application will include modified results and conclusions, as appropriate, in response to stakeholder comments on the PLP or draft license application.

SCHEDULE

Timing for this 1-year study will depend on the associated study schedules. Background and survey tool materials will be prepared in advance of the evaluation phase. Because this is a flow-dependent study, the timing of field work depends on the controlled flow releases to be provided for the associated flow studies (Studies 9 and 31). Evaluations of all flows will be done collectively after both associated demonstration flows have been recorded in summer 2014. An alternative approach is to release a range of controlled flows intended to address this study alone, which would also be performed in 2015 should the associated study flow demonstrations prove incapable of meeting the goals of this study.

LEVEL OF EFFORT AND COST

The estimated budget for the study is approximately $40,000.

REFERENCES

Shelby, B., T.C. Brown, and J.G. Taylor. 1992. Streamflow and Recreation. U.S. Forest Service, General Technical Report RM-209. Revised. March 1992.

Whittaker D., B. Shelby, and J. Gangemi. 2005. Flows and Recreation: A Guide to Studies for River Professionals. October 2005.

Whittaker, D., B. Shelby, W. Jackson, and R. Beschta. 1993. Instream Flows for Recreation: A Handbook on Concepts and Research Methods.

Study 33

CULTURAL AND HISTORIC RESOURCES STUDY

RELEVANT STUDY REQUESTS

FERC-12; VT SHPO-01, -02, -03; Nolumb-01; additional information requests from FERC, and comments from the New Hampshire Division of Historical Resources (NH SHPO)

STUDY GOALS AND OBJECTIVES

In their study requests, FERC, the VT SHPO, NH SHPO, and The Nolumbeka Project, Inc. identified existing additional information needs and study requests related to the Wilder, Bellows Falls, and Vernon Project operations in relation to historic and archaeological resources located within the Area of Potential Effects (APE) defined for each project. This study addresses those information needs. The goal of this study is to determine the potential effects of the projects on archaeological and historic resources that are listed in, or eligible for, inclusion in the National Register of Historic Places (National Register).

The objectives of this study are to:

- define the APE for archaeological resources in both written and graphic form for the three projects; and

- present the proposed treatment of cultural resources including archaeological sites beyond the previously completed Phase IA archaeological reconnaissance surveys.

More specific objectives and requirements were specified as requests for additional information from FERC, and comments and study requests from the VT and NH SHPOs and The Nolumbeka Project, Inc., in Greenfield, MA. They are indicated below:

FERC

FERC requested additional information but specified that the response be included in the form of a study plan.

Phase IA archaeological reconnaissance surveys have been conducted to identify known sites and to identify areas of archaeological sensitivity where documented and previously unrecorded sites are likely to exist within the Wilder, Bellows Falls, and Vernon Project APEs. FERC requests additional information regarding the definition of the project APEs used in the Phase IA archaeological surveys as well as information regarding further proposed identification and evaluation surveys for archaeological sites within the project APEs. Specifically, FERC requests including the following elements in the study plan for cultural resources:

- Provide documentation that the APE defined for each project would include all lands enclosed by the project boundary including both in-water and on-shore project lands and facilities, and lands or properties outside the project boundary where project operations or other project-related activities may directly or indirectly cause changes in the character or use of historic properties, if any historic properties exist. Include a record of consultation with the Vermont and New Hampshire SHPOs, including SHPO concurrence with the APE, and other interested parties, including Native American tribes or organizations that may attach religious and cultural significance to the project lands regarding the APE or a proposal to complete such consultation as a component of the study. Include the APE definition and a detailed map showing all aspects of the APE, including designations of land ownership.

- Include the techniques for carrying out the Phase IB investigation, in addition to any other methods (if needed) by which other cultural resources that may be directly or indirectly affected by the projects will be inventoried. Include methods for inventorying all archaeological and historic resources that may lie within the APE, including project facilities, non-project architectural resources, and properties of traditional religious or cultural significance.

- Develop and include a process for evaluating the National Register eligibility of all cultural resources identified during the field inventory stage, and afterwards, through additional second season field investigations (if necessary), including a strategy for examining, testing, or excavating cultural resources. This process should take into account applicable guidelines and standards promulgated by the Vermont and New Hampshire SHPOs. Include follow-up site evaluations to determine National Register eligibility in the Historic Properties Management Plan (HPMP) if determinations cannot be made in the first or second field season.

- Elaborate on the methods that will be used to identify any existing project-related effects (both direct and indirect) on historic properties recorded during the field inventory, and determine how project operations may affect or potentially affect them.

- Include in any study report:

    - a background section on previous work in and around the APE;

    - a culture history of the research area;

    - definition and map of the APE;

    - methods used for the archival research and field pedestrian survey and how the APE was systematically inventoried;

    - the results of the survey and detailed descriptions of the cultural resources found (including a table depicting type of cultural resources, age, property location and ownership, associated artifacts, existing and potential effects, and National Register eligibility status);

  - results of National Register evaluations for all cultural resources located within the APE; and

  - site or resource specific descriptions of existing and potential project-related effects on cultural resources considered to be eligible for inclusion in the National Register. Consult with involved parties and submit National Register evaluations to the Vermont and New Hampshire SHPOs for concurrence.

- Put a statement that an HPMP will be prepared in consultation with the involved parties and a draft HPMP will be filed along with the preliminary licensing proposal, and a final HPMP with the final license application. Among other things, the HPMP should provide site-specific measures to resolve any potential project-related adverse effect to historic properties located within the project's APE. The HPMP will be prepared in accordance with the Guidelines for the Development of Historic Properties Management Plans for FERC Hydroelectric Projects, developed by the Advisory Council on Historic Preservation and Commission in May 2002. The final HPMP will be attached to the Programmatic Agreement(s) to be prepared for the project by FERC.

- Provide a schedule for carrying out all of the various tasks involving the cultural resources study, including the filing of draft and final reports and HPMPs.

- Provide estimated costs associated with the various tasks in the study, along with the costs of report production and crafting the HPMP.

VT SHPO

The VT SHPO has the following comments and study requests for cultural resources.

- Provide the Phase IA archaeological reconnaissance survey reports prepared for the Wilder and Bellows Falls projects for their review and comment as soon as possible.

- Provide clarification on the delineation of the project APE, specifically in regard to the projects' operation on the destabilization of the riverbank, which is sufficient to bring all terrace margins and adjacent areas within the APE.

- Conduct Phase IB site identification within all archaeologically sensitive areas and potential site locations that are activity eroding in the Wilder and Bellows Falls Projects.

- Conduct Phase II site evaluations of all currently recorded archaeological sites in the Wilder and Bellows Falls Project APEs to determine their boundaries and eligibility for inclusion in the National Register.

- Conduct Phase II site evaluation of any other archaeological site identified in the Wilder and Bellows Falls Project APEs as a result of the Phase IB survey to determine their boundaries and eligibility for inclusion in the National Register.

- Provide a National Register Evaluation Report for the Wilder Project Hydroelectric Components.

- Submit 2013 archaeological monitoring study report for Vernon Project, in accordance with the 2008 Vernon HPMP.

- Conduct Phase IB site identification within all archaeologically sensitive areas and potential site locations that are actively eroding in the Vernon Project APE based on the 2013 Monitoring Report.

- Conduct Phase II site evaluation of all known archaeological sites in the Vernon Project APE to determine their boundaries and eligibility for inclusion in the National Register.

NH SHPO

The NH SHPO has the following comments and study requests related to cultural resources:

- Provide paper copies of the Phase IA archaeological reconnaissance survey reports prepared for the Wilder and Bellows Falls Projects for their review and comment as soon as possible.

- Provide documentation that the identification and evaluation of above-ground historical resources has been and will be performed by qualified architectural historian(s) including the completion of survey and National Register eligibility submissions.

The Nolumbeka Project, Inc.

The Nolumbeka Project, Inc. has the following study request specific to cultural resources:

- Perform additional comprehensive investigations, document searches, and other research and field studies and inventory and formal archaeological digs to address the project areas north up to and around the Wilder and Vernon Falls (dam) on the New Hampshire, Vermont, and Massachusetts side of the river. Organize the resultant data from these studies in a central location and make it digitally available.

RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS

The relevant resource management goal related to this study is to ensure the protection of cultural resources in compliance with Section 106 of the National Historic Preservation Act (NHPA), as amended, and its implementing regulation 36 C.F.R. § 800.

ASSOCIATION WITH OTHER STUDIES

For all three projects, the effects of project operations on historical resources that might lead to revisions to the presently defined APE, as well as an understanding of the contribution of non-project effects on the same, will rely upon the results of hydraulic modeling and operations modeling studies (Study 4 and 5), and the three erosion studies (Study, 1, 2, and 3). These studies will help to understand the spatial extent of project effects on riparian resources including historic resources typically associated with active erosion that ultimately defines the APE.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Phase IA archaeological reconnaissance surveys were conducted within the three project APEs to identify known archaeological sites and additional areas of archaeological sensitivity where documented and previously unrecorded sites are likely to exist. The APEs for all three projects are defined as all land owned in fee simple by TransCanada and the land privately owned by others within the project boundary, upon which flowage rights are retained, that are directly affected by the operation at full pond under normal flow conditions. For the Wilder Project, the extent of project boundary is based upon full pond elevation of 385.0 feet above mean sea level (msl) at the dam; for the Bellows Falls Project, it is based upon full pond elevation of 291.61 feet msl at the dam; and for the Vernon Project, it is based upon full pond elevation of 220.13 feet msl at the dam. The Phase IA surveys were conducted for all lands within the APE as described above.

The Phase IA survey for the Wilder Project (report forthcoming) identified a total of 48 archaeological sites within the project boundary: 28 sites on flowage lands including river shoreline and 3 sites within fee-owned lands in Vermont; and 16 sites on flowage lands including river shoreline and 1 site within fee-owned lands in New Hampshire. These sites are summarized in Table 3.12-1 in the Wilder PAD (pages 3-146 through 3-153). The Phase IA survey also documented 56 locations that could contain additional archaeological sites (27 in Vermont, 29 in New Hampshire) based on archival research (i.e., historical maps), five of which were identified during the Phase IA survey and assigned archaeological site numbers. The other 51 documented sites were not field-verified during the Phase IA survey. The documented sites are summarized in Table 3.12-2 (Vermont) and Table 3.12-3 (New Hampshire) in the Wilder PAD (pages 3-154 through 3-161). Of the 48 sites identified in the project APE, two are potentially eligible for listing in the National Register and one is ineligible. The National Register eligibility of the other 45 identified sites within the APE has not been determined.

The Phase IA survey for the Bellows Falls Project (report forthcoming) identified a total of 43 archaeological sites within the project boundary: 16 sites on private flowage lands, 8 sites on fee-owned lands and adjacent private flowage, and 2 sites on fee-owned lands in Vermont; and 6 sites on private flowage lands, 5 sites on fee-owned lands and adjacent private flowage, and 6 sites on fee-owned lands in New Hampshire. These sites are summarized in Table 3.12-1 in the Bellows Falls PAD (pages 3-157 through 3-165). The Phase IA survey also documented 26 locations that could contain additional archaeological sites (12 in Vermont, 14 in New Hampshire) based on archival research (i.e., historical maps), three of which were identified during the Phase IA survey as corresponding to previously recorded archaeological sites. The other 23 documented sites were not field-verified during the Phase IA survey. The documented sites are summarized in Table 3.12-2 (Vermont) and Table 3.12-3 (New Hampshire) in the Bellows Falls PAD (pages 3-166 through 3-169). Of the 43 sites identified in the project APE, three are currently listed on the National Register, and three are eligible for listing on the National Register. The National Register eligibility of the other 36 identified sites within the APE has not been determined.

The Phase IA survey for the Vernon Project (Cherau and O'Donnchadha, 2008) identified a total of 37 archaeological sites within the project boundary: 28 on fee-owned and private flowage lands in Vermont; and 9 on fee-owned and private flowage lands in New Hampshire. These sites are summarized in Table 3.12-1 in the Vernon PAD (pages 3-182 through 3-188), and include potential site locations documented through archival research (i.e., historical maps). Of the 37 sites identified in the project APE, two are eligible for listing in the National Register, and one of these may also be an unlisted National Historic Landmark. One site is potentially eligible for listing in the National Register. The National Register eligibility of the other 34 identified sites within the APE has not been determined.

The Phase IA archaeological field investigations at the Wilder and Bellows Falls Projects documented erosion along the impoundment shorelines, upstream of Bellows Falls dam and immediately below Wilder dam. The Phase IA surveys were conducted in the months immediately following Tropical Storm Irene (August 2011), and the high flow-related erosion may have been a result of flooding associated with the storm. No high flow-related erosion was observed in the Vernon Project during the Phase IA survey, which was conducted 4 years earlier (August 2007). The archaeological investigations were not designed to ascertain the causation, extent, and mechanics of the observed erosion at the Wilder or Bellows Falls Projects.

Although developed to specifically address historic resource effects associated with the 2006 Vernon license amendment for replacement of Units 5–8, a Memorandum of Agreement stipulated:

1. historic documentation of the Vernon powerhouse;

2. video documentation of the historic equipment removal;

3. development of an HPMP for the project that includes:

    a. steps to determine the extent of any project-related potential effects and further measures to manage identified sites and sensitive areas within the project APE.

    b. measures may include Phase IB site identification; and

    c. Phase II site evaluation for sites and sensitive areas identified through monitoring as undergoing active effects from project operations and/or maintenance or threatened by proposed project activities including recreational enhancements and uses.

    The HPMP also includes measures for the treatment of unanticipated cultural materials and human remains that could be discovered within the APE over any new license term.

4. Phase 1A archaeological investigations of the entire APE, similarly described above as all lands within the project boundary, both fee-owned and land owned by others affected by the project;

5. salvage of historic generating equipment; and

6. dispute resolution process

All the above have been completed except for 3.c, which is an ongoing requirement. The next cycle of monitoring is scheduled for 2013.

PROJECT NEXUS

Activities related to the operation and maintenance of the Wilder, Bellows Falls, and Vernon Projects over the license term may adversely affect cultural resources that are eligible for listing in the National Register. Phase IB archaeological site identification and Phase II archaeological site evaluation studies would identify National Register eligible archaeological sites that may be directly or indirectly affected by project operations and maintenance activities. Similarly, a National Register evaluation of the historic hydroelectric components of the Wilder Project will complete the identification of historic above ground properties. The information obtained from archaeological site and above ground historic property identification and evaluation studies will be used to assess the potential effects of the relicensing of the three projects on historic properties.

In the event that FERC, in consultation with the VT and NH SHPOs, determines that the relicensing has the potential to cause adverse effects on historic properties, the information will form the basis of continued consultation to resolve the effects. The product of that consultation will likely be a Programmatic Agreement (PA) developed for each of the projects that stipulates actions that will be taken to avoid, minimize, or mitigate the adverse effect. One of the key provisions of the

PAs will be the development of new HPMPs for the Wilder and Bellows Falls Projects and the revision of the existing Vernon HPMP.

STUDY AREA AND STUDY SITES

The study area is defined as the cultural resources project APE for the Wilder, Bellows Falls, and Vernon Projects. The APEs for all three projects are defined as all land owned in fee simple by TransCanada and the land privately owned by others within the project boundary, upon which flowage rights are retained, that are directly affected by the operation at full pond under normal flow conditions. For the Wilder Project the extent of project boundary is based upon full pond based upon elevation 385.0 feet msl at the dam; for the Bellows Falls Project, it is based upon full pond based upon elevation 291.61 feet msl at the dam; and for the Vernon Project it is based upon full pond elevation 220.13 feet msl at the dam.

Phase I APE mapbooks included as for Wilder and Bellows Falls (AIR B.2.a and B.3.a, respectively) are included as Attachment E to the document "Responses to Commission Staff's Identification of PAD Deficiencies, Requests for Additional Information and Status of Study Reports" which is being filed simultaneously with FERC. Those maps depict the project APE boundaries as defined for the Phase IA archaeological surveys of the Wilder, Bellows Falls, and Vernon Projects.

METHODS

Relicensing of the Vernon, Bellows Falls, and Wilder Projects constitutes a federal undertaking that is subject to review under Section 106 of the NHPA, and its implementing regulation 36 C.F.R. § 800. As such, the following methodologies for supplying requested information and studies are devised to facilitate the Section 106 consultation process that must be concluded prior to the issuance of the licenses.

Establishment of the APE Completion and Submittal of Phase 1A Reports (FERC AIR (a), (e); VT SHPO (a), (b)

The proposed APE for Vernon Project relicensing was described in the Vernon Phase IA archaeological report submitted to the VT SHPO and NH SHPO on April 10, 2008. The proposed Vernon APE was also described in the Vernon HPMP submitted to the VT SHPO and NH SHPO on October 21, 2008. The NH SHPO concurred with both the Phase IA report findings and recommendations and the HPMP for Vernon in letters dated May 22, 2008, and December 2, 2008. No responses were received from the VT SHPO. The APE defined through consultation with state SHPOs and Vernon Project's HPMP cover all aspects of current and future potential project effects on cultural and historic resources within the project boundary. TransCanada believes that the present APE, together with the HPMP, including the ongoing monitoring and management responsibilities, adequately addresses project effects.

The proposed APE for Wilder and Bellows Falls Project relicensing was described in the Phase IA archaeological reconnaissance survey methodologies submitted to the NH SHPO on September 29, 2011, as part of the NH SHPO's Request for Project Review. On October 11, 2011, the NH SHPO concurred with the project APE definition and the survey methodologies provided in the Phase IA methodology Request for Project Review Forms prepared prior to the Phase IA survey fieldwork. The VT SHPO was notified similarly of the proposed APE in the Phase IA archaeological reconnaissance survey methodologies on November 9, 2011. No response or comments were received. The proposed APE for Wilder and Bellows Falls will be confirmed in consultation with the VT SHPO as part of the submittal of the Phase IA archaeological reconnaissance survey reports. The APE will be included in the HPMPs to be prepared for the Wilder and Bellows Falls Projects and in the revised Vernon HPMP as well as in the PA for each project.

Based upon the results from the hydraulic modeling and operations modeling studies (Study 4 and 5), together with the erosion studies (Studies 1, 2, and 3), a revision in the APE is possible. However, based upon the fact that the current APE recognizes the potential for project effects associated with bank erosion and includes such active areas, there does not appear to be an overwhelming argument to reconsider the APE at the present time and until a more definitive determination is made relative to project effects on erosion and historic resources.

Phase 1A reports for the Wilder Project and Bellows Falls Project will be submitted to VT and NH SHPOs before May 15, 2013. Phase 1A reports for these projects together with the 2008 Phase 1A report for the Vernon Project will also be submitted to FERC before May 15, 2013. They will include copies of all SHPO consultation. The 2013 historic resources monitoring report for the Vernon Project will be provided to the SHPOs and FERC before December 31, 2013.

Phase 1B and Phase 2 Investigations (FERC AIR (b-d), VT SHPO (c), (d), (e); NH SHPO (a-b)

No Phase IB site identifications and/or Phase II site evaluations are proposed at this time for any of the three projects. Current project operations are not identified as resulting in effects on the identified archaeological sites and sensitive areas. The observed erosion at the Wilder and Bellows Falls Projects is identified as being the likely result of high flow from flooding associated with Tropical Storm Irene in August 2011. The Phase IB site identification surveys requested by the VT SHPO along all terrace margins and adjacent areas above the 385.0-foot contour line at Wilder, above the 291.63-foot contour line at Bellows Falls, and above the 220.13-foot contour line at Vernon are for the most part outside the project APE on private properties where TransCanada does not have permission to access or conduct intrusive subsurface investigations.

The archaeological monitoring program of the project APE areas as presently defined (see above) for all three projects is deemed sufficient to identify and manage effects that future project operations that may have on significant archaeological resources within the project APE. Archaeological monitoring programs for identified sites and sensitive areas have been successfully used following Phase IA archaeological reconnaissance surveys at both the TransCanada Hydro Northeast Deerfield Hydroelectric Project in Vermont and Massachusetts and the Fifteen Mile Falls Hydroelectric Project on the Connecticut River in Vermont and New Hampshire.

Should Phase IB site identifications and/or Phase II site evaluations be determined necessary at the Wilder, Bellows Falls, or Vernon Projects as a result of the archaeological monitoring program in consultation with the VT SHPO and NH SHPO (as applicable), the investigations will be conducted according to the applicable federal and state regulations and guidelines. The archaeological surveys in Vermont will be conducted in accordance with the Vermont Division for Historic Preservation (VDHP)/SHPO's *Guidelines for Conducting Archeology in Vermont*, dated June 2007, final adoption). In New Hampshire, the archaeological surveys will be conducted in accordance with the New Hampshire Division of Historical Resources (NHDHR) *Archaeological Standards and Guidelines*. In addition all surveys will meet the standards and guidelines set forth by the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation* and Section 106 of the NHPA.

National Register Evaluation Report for the Wilder Project Hydroelectric Components

The evaluation of the National Register eligibility of the Wilder Project's above-ground hydroelectric facilities will be conducted by a qualified architectural historian. Project facilities will be assessed in accordance with the National Register criteria (36 C.F.R. § 63) and integrity. The findings of the evaluation will be forwarded in a report that will be sent to FERC, VT SHPO, and NH SHPO for concurrence.

Development of Historic Property Management Plans (FERC AIR (g)

HPMPs will be developed for the Bellows Falls and Wilder Projects and the existing HPMP for the Vernon Project will be updated prior to the issuance of the new FERC license. The HPMPs will govern future actions as they relate to historic properties, including standing structures and archaeological sites, within the boundaries of the projects. The HPMPs will identify the nature and significance of historic properties within the project boundaries that may be affected by project-related maintenance and operation, proposed improvements to project facilities, and public access. The HPMPs will identify goals for the preservation of historic properties; establish guidelines for routine maintenance and operation; and establish consultation procedures. They will identify the responsible TransCanada officer in charge of executing the plan and establishing procedures for training plant operators, maintenance staff, and other employees in its implementation. The HPMPs will be integrated with existing management plans, as appropriate.

The HPMP for each project will be developed according to the following principles and procedures:

- **Consultation.** The HPMPs will be prepared through a process that will involve consultation with, and input from FERC, VT SHPO, NH SHPO, Native American tribes, historic preservation experts, and other interested parties that may be identified.

- **Identification of Historic Properties.** The HPMPs will identify known historic properties within the projects and include mechanisms for the completion of identification and evaluation tasks for previously unidentified historic properties within the projects, as necessary.

- **Routine Project Operations.** The HPMPs will include a description of how historic properties, including known and predicted archaeological resources, are or could be affected by routine project operations. This discussion will include the suspected or known cause of an effect on each site or feature. The HPMPs will identify and prioritize preservation issues associated with routine project operations.

- **Protection of Historic Properties.** The HPMPs will address the continuation of routine project operations in relation to the protection of the integrity of historic properties. These operations include, but are not limited to: continued use and maintenance that affects historic properties, shoreline erosion caused by routine operations, recreational developments, other project-related ground-disturbing activities, and vandalism.

- **Mitigation of Adverse Effects.** The HPMPs will include a process for determining and mitigating unavoidable adverse effects on historic properties.

- **Discovery of Human Remains.** The HPMPs will include mechanisms for the treatment and disposition of any human remains that may be discovered, taking into account applicable Vermont and New Hampshire state laws and the Advisory Council on Historic Preservation's *Policy Statement Regarding Treatment of Human Remains and Grave Goods*.

- **Discovery of Previously Unidentified Properties During Project Operations.** The HPMPs will include a plan to deal with previously unidentified properties discovered during project operations.

- **Public Interpretation.** The HPMPs will specify the implement a program to provide interpretation of the historic and archaeological values of the projects to the general public.

Vernon Project 2013 Monitoring Report

The archaeological monitoring program, as described in the Vernon HPMP (Olausen and Cherau, 2008:25-26), will be implemented by a team comprising a qualified archaeologists assisted as needed by a geologist, soil scientist, forester, and/or engineer with physical, geotechnical, or hydraulic experience pertinent to riverine hydraulics, reservoir operation and erosion, depending on the condition of the sites and locales to be visited. The monitoring program will include a physical inspection of all identified sites reported during the Phase IA archaeological surveys. Should project-related erosion or other threats to identified sites be identified during the monitoring, a Phase IB identification survey of the affects areas will be conducted. For the known National Register eligible sites or other sites subsequently identified as eligible for listing in the National Register, any identified threats will be addressed through controls or other measures designed to preserve their integrity. Threats that cannot be checked or otherwise resolved may require mitigation through the implementation of a Phase III archaeological data recovery program. The findings of the monitoring effort will be presented in a report that will be forwarded to FERC, VT SHPO, and NH SHPO for review and concurrence by September 30, 2013.

ANALYSIS

No new cultural resources data analyses are proposed as part of this study plan. The treatment of archaeological resources will be conducted separately as part of 2013 and future archaeological monitoring programs (see discussion below).

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

The archaeological monitoring as well as any subsequent Phase IB, II, or III investigations that may be necessary will be conducted according to the applicable federal and state regulations and guidelines. The archaeological surveys in Vermont will be conducted in accordance with VDHP/SHPO *Guidelines for Conducting Archeology in Vermont*, dated June 2007 (final adoption). In New Hampshire, the archaeological surveys will be conducted in accordance with the NHDHR *Archaeological Standards and Guidelines*. In additional, all surveys will meet the standards and guidelines set forth by the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation* and Section 106 of the NHPA.

DELIVERABLES

Cultural resource reporting deliverables for the Wilder, Bellows Falls, and Vernon Projects are as follows.

- Draft and Final Phase IA archaeological reconnaissance survey reports for the Wilder and Bellows Falls Projects.
- Draft and Final Vernon 2013 archaeological monitoring program report.
- National Register Evaluation report for the Wilder Project.

SCHEDULE

The draft Phase IA archaeological reconnaissance reports for Wilder and Bellows Falls will be submitted by May 15, 2013, to the VT and NH SHPOs, and other interested parties, including Native American tribes or organizations that may attach religious and cultural significance to the project lands. The final reports will follow the draft review.

The Vernon archaeological monitoring program is scheduled to be conducted in 2013. A draft report of the 2013 monitoring program findings will be prepared and filed with the VT and NH SHPOs and other interested parties within 30 days following the fieldwork. The final report will follow the draft review and be submitted before December 31, 2013.

The National Register DOE for the Wilder Project facilities will be prepared and filed with FERC and the VT and NH SHPOs by June 30, 2014.

LEVEL OF EFFORT AND COST

The preliminary estimated cost for the study broken down by major tasks is as follows:

- Submittal of Wilder and Bellows Falls Phase 1A reports and SHPO and stakeholder consultation: $3,000
- National Register Evaluation Report for the Wilder Project Hydroelectric Components: $7,500
- Phase 1B investigations: unknown pending water resource and erosion project effects analyses and Vernon 2013 monitoring
- Development of new HPMPs for Wilder and Bellows Falls and revised HPMP for Vernon: $50,000 to $55,000

REFERENCES

Cherau, S.G. and B. O'Donnchadha, PAL. 2008. Phase IA Archaeological Reconnaissance Survey, Vernon Hydroelectric Project (FERC No. 1904), Windham County, VT, and Cheshire County, NH. 119 pp.

Olausen, S.A. and S.G. Cherau, PAL. 2008. Historic Properties Management Plan, Vernon Hydroelectric Project, FERC Project No. 1904, Vermont and New Hampshire. 34 pp.