Groton Wind Farm Upper Bridge Replacement

Groton, NH

PREPARED FOR

Groton Wind, LLC
c/o Iberdrola Renewables, Inc.
1125 NW Couch Street, Suite 700
Portland, OR 97209
610.230.0356

PREPARED BY

2 Bedford Farms Drive Suite 200
Bedford, NH 03110
603.391.3900

May 2015

www.vhb.com

May 20, 2015

Laura Hauser, Town Clerk
Town of Groton
754 North Groton Rd
Groton, NH 03241

Re: NHDES Wetlands Bureau Standard Dredge and Fill Application
Groton Wind Farm, Replacement of Upper Bridge

Dear Ms. Hauser:

VHB is submitting the enclosed Standard Dredge and Fill Application on behalf of Groton Wind, LLC (the applicant) for the proposed replacement of the "Upper Bridge," a stream crossing over Clark Brook located on Groton Hollow Road at the Groton Wind Farm. The proposed project consist of removing the existing bridge and all its components entirely. A new precast concrete bridge with wingwalls will be installed in its place. The current bridge was damaged by high flows in late 2014 and requires replacement to maintain safe access to the wind farm. The proposed replacement bridge has been designed in accordance with NHDES stream crossing guidelines, and would reduce the risk of future stream bank erosion and potential damage to the new bridge.

The proposed project will result in approximately 430 square feet of impacts to the bed and banks of Clark Brook and a small forested wetland adjacent to the bridge. An additional impact of approximately 600 square feet is proposed for a temporary stream diversion to allow for the work to occur in the dry, which will help limit potential impacts to Clark Brook. Refer to the attached Wetland Permit Application for additional information.

In accordance with recent changes in the procedure of submitting a wetlands application to NHDES (as of June 17, 2014), we are submitting four copies of the Application for internal distribution to the Town of Groton's select board, planning board, and conservation commission. You must also retain one copy of the permit application form and attachments to be made accessible to the public. VHB will hand deliver a fifth copy to the NHDES Wetlands Bureau once you have signed the application form.

Please do not hesitate to contact me if you have questions at (603) 391-3900 or pwalker@vhb.com.

Sincerely,

Peter J. Walker
Director of Environmental Services

PJW/SEP/as

Attachments

cc: Doren Emmett, Iberdrola

Engineers | Scientists | Planners | Designers

2 Bedford Farms Drive
Suite 200
Bedford, New Hampshire 03110
P 603.391.3900
F 603.518.7495

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NHDES-W-06-012

WETLANDS PERMIT APPLICATION

Water Division/ Wetlands Bureau
Land Resources Management

Check the status of your application: http://des.nh.gov/onestop

RSA/Rule: Env-Wq 100-900

Administrative Use Only	*Administrative Use Only*	*Administrative Use Only*	File No.:
			Check No.:
			Amount:
			Initials:

1. REVIEW TIME:
Indicate your Review Time below. Refer to Guidance Document A for instructions.

☒ Standard Review (Minimum, Minor or Major Impact) ☐ Expedited Review (Minimum Impact only)

2. PROJECT LOCATION:
Separate applications must be filed with each municipality that jurisdictional impacts will occur in.

ADDRESS: **Groton Hollow Road** TOWN/CITY: **Groton**

TAX MAP: **9** BLOCK: **N/A** LOT: **2** UNIT: **N/A**

USGS TOPO MAP WATERBODY NAME: ☒ NA STREAM WATERSHED SIZE: **531 acres** ☐ NA

LOCATION COORDINATES (If known): **946034.53 457290.58 Feet** ☐ Latitude/Longitude ☐
UTM ☒ State Plane

3. PROJECT DESCRIPTION:
Provide a brief description of the project outlining the scope of work. Attach additional sheets as needed to provide a detailed explanation of your project. DO NOT reply "See Attached" in the space provided below.

The proposed project will permanently impact approximately 430 sq ft (30 lin ft) of the bed of Clark Brook to replace an existing bridge that crosses over Clark Brook. The existing bridge will be removed entirely and replaced with a precast concrete frame and new decking. Temporary impacts of 600 sq ft (60 lin ft) in the stream bed would occur to install a temporary dewatering area so work on the bridge can be completed. Additional details are provided in the attached application narrative.

4. RELATED PERMITS, ENFORCEMENT, EMERGENCY AUTHORIZATION, SHORELAND, ALTERATION OF TERRAIN, ETC…

An emergency authorization was issued November 25, 2015 (NHDES file number: 2014-03346)

5. NATURAL HERITAGE BUREAU & DESIGNATED RIVERS:
See the Instructions & Required Attachments document for instructions to complete a & b below**.**

a. Natural Heritage Bureau File ID: NHB **15** - **1470** .

b. ☐ Designated River the project is in ¼ miles of: _____ ; and
date a copy of the application was sent to Local River Advisory Committee: Month: __ Day: __ Year: ____
☒ NA

6. APPLICANT INFORMATION (Desired permit holder)			
LAST NAME, FIRST NAME, M.I.:			
TRUST / COMPANY NAME: **Groton Wind, LLC c/o Iberdrola Renewables, Inc.**	MAILING ADDRESS: **1125 NW Couch Street, Suite 700**		
TOWN/CITY: **Portland**		STATE: **OR**	ZIP CODE: **97209**
EMAIL or FAX: **Doren.Emmett@iberdrolaren.com**	PHONE: **610.230.0356**		
ELECTRONIC COMMUNICATION: By initialing here: _____, I hereby authorize DES to communicate all matters relative to this application electronically			

7. PROPERTY OWNER INFORMATION (If different than applicant)			
LAST NAME, FIRST NAME, M.I.:			
TRUST / COMPANY NAME: **Green Acre Woodlands, Inc. c/o Foreco, LLC**	MAILING ADDRESS: **PO Box 597**		
TOWN/CITY: **Rummey**		STATE: **NH**	ZIP CODE: **03266**
EMAIL or FAX: **(603) 786 9545**	PHONE: **(603) 786 9544**		
ELECTRONIC COMMUNICATION: By initialing here _____, I hereby authorize DES to communicate all matters relative to this application electronically			

8. AUTHORIZED AGENT INFORMATION			
LAST NAME, FIRST NAME, M.I.: **Walker, Peter, J.**	COMPANY NAME: **VHB**		
MAILING ADDRESS: **2 Bedford Farms Drive, Suite 200**			
TOWN/CITY: **Bedford**		STATE: **NH**	ZIP CODE: **03110**
EMAIL or FAX: **pwalker@vhb.com**	PHONE: **(603) 391-3900**		
ELECTRONIC COMMUNICATION: By initialing here _____, I hereby authorize DES to communicate all matters relative to this application electronically			

9. PROPERTY OWNER SIGNATURE:
See the Instructions & Required Attachments document for clarification of the below statements

By signing the application, I am certifying that:

1. I authorize the applicant and/or agent indicated on this form to act in my behalf in the processing of this application, and to furnish upon request, supplemental information in support of this permit application.
2. I have reviewed and submitted information & attachments outlined in the Instructions and Required Attachment document.
3. All abutters have been identified in accordance with RSA 482-A:3, I and Env-Wt 100-900.
4. I have read and provided the required information outlined in Env-Wt 302.04 for the applicable project type.
5. I have read and understand Env-Wt 302.03 and have chosen the least impacting alternative.
6. Any structure that I am proposing to repair/replace was either previously permitted by the Wetlands Bureau or would be considered grandfathered per Env-Wt 101.47.
7. I have submitted a Request for Project Review (RPR) Form (www.nh.gov/nhdhr/review) to the NH State Historic Preservation Officer (SHPO) at the NH Division of Historical Resources to be reviewed for the presence of historical/ archeological resources.
8. I authorize DES and the municipal conservation commission to inspect the site of the proposed project.
9. I have reviewed the information being submitted and that to the best of my knowledge the information is true and accurate.
10. I understand that the willful submission of falsified or misrepresented information to the New Hampshire Department of Environmental Services is a criminal act, which may result in legal action.
11. I am aware that the work I am proposing may require additional state, local or federal permits which I am responsible for obtaining.
12. The mailing addresses I have provided are up to date and appropriate for receipt of DES correspondence. DES will not forward returned mail.

⇨ Property Owner Signature	Print name legibly	Date
	DOREN EMMETT for	5/19/2015

MUNICIPAL SIGNATURES

10. CONSERVATION COMMISSION SIGNATURE

The signature below certifies that the municipal conservation commission has reviewed this application, and:

1. Waives its right to intervene per RSA 482-A:11;
2. Believes that the application and submitted plans accurately represent the proposed project; and
3. Has no objection to permitting the proposed work.

⇨	Print name legibly	Date

DIRECTIONS FOR CONSERVATION COMMISSION

1. Expedited review ONLY requires that the conservation commission's signature is obtained in the space above.

2. Expedited review requires the Conservation Commission signature be obtained **prior** to the submittal of the original application to the Town/City Clerk for signature.

3. The Conservation Commission may refuse to sign. If the Conservation Commission does not sign this statement for any reason, the application is not eligible for expedited review and the application will reviewed in the standard review time frame.

11. TOWN / CITY CLERK SIGNATURE

As required by Chapter 482-A:3 (amended 2014), I hereby certify that the applicant has filed four application forms, four detailed plans, and four USGS location maps with the town/city indicated below.

⇨ Town/City Clerk Signature	Print name legibly	Town/City	Date

DIRECTIONS FOR TOWN/CITY CLERK:

Per RSA 482-A:3,I

1. For applications where "Expedited Review" is checked on page 1, if the Conservation Commission signature is not present, NHDES will accept the permit application, but it will NOT receive the expedited review time.
2. IMMEDIATELY sign the original application form and four copies in the signature space provided above;
3. Return the signed original application form and attachments to the applicant so that the applicant may submit the application form and attachments to NHDES by mail or hand delivery.
4. IMMEDIATELY distribute a copy of the application with one complete set of attachments to each of the following bodies: the municipal Conservation Commission, the local governing body (Board of Selectmen or Town/City Council), and the Planning Board; and
5. Retain one copy of the application form and one complete set of attachments and make them reasonably accessible for public review.

DIRECTIONS FOR APPLICANT:

1. Submit the original permit application form bearing the signature of the Town/ City Clerk, additional materials, and the application fee to NHDES by mail or hand delivery.

12. IMPACT AREA:
For each jurisdictional area that will be/has been impacted, provide square feet and, if applicable, linear feet of impact
Permanent: impacts that will remain after the project is complete.
Temporary: impacts not intended to remain (and will be restored to pre-construction conditions) after the project is complete.

JURISDICTIONAL AREA	PERMANENT Sq. Ft. / Lin. Ft.		TEMPORARY Sq. Ft. / Lin. Ft.	
Forested wetland	140	☐ ATF		☐ ATF
Scrub-shrub wetland		☐ ATF		☐ ATF
Emergent wetland		☐ ATF		☐ ATF
Wet meadow		☐ ATF		☐ ATF
Intermittent stream		☐ ATF		☐ ATF
Perennial Stream / River	290 / 30	☐ ATF	600 / 60	☐ ATF
Lake / Pond	/	☐ ATF	/	☐ ATF
Bank - Intermittent stream	/	☐ ATF	/	☐ ATF
Bank - Perennial stream / River	/	☐ ATF	/	☐ ATF
Bank - Lake / Pond	/	☐ ATF	/	☐ ATF
Tidal water	/	☐ ATF	/	☐ ATF
Salt marsh		☐ ATF		☐ ATF
Sand dune		☐ ATF		☐ ATF
Prime wetland		☐ ATF		☐ ATF
Prime wetland buffer		☐ ATF		☐ ATF
Undeveloped Tidal Buffer Zone (TBZ)		☐ ATF		☐ ATF
Previously-developed upland in TBZ		☐ ATF		☐ ATF
Docking - Lake / Pond		☐ ATF		☐ ATF
Docking - River		☐ ATF		☐ ATF
Docking - Tidal Water		☐ ATF		☐ ATF
TOTAL	430 / 30		600 / 60	

13. APPLICATION FEE: See the Instructions & Required Attachments document for further instruction

☐ Minimum Impact Fee: Flat fee of $ 200

☒ Minor or Major Impact Fee: Calculate using the below table below

Permanent and Temporary (non-docking) **1030** sq. ft. X $0.20 = $ **206**

Temporary (seasonal) docking structure: _____ sq. ft. X $1.00 = $ _____

Permanent docking structure: _____ sq. ft. X $2.00 = $ _____

Projects proposing shoreline structures (including docks) add $200 = $ _____

Total = $ **206**

The Application Fee is the above calculated Total or $200, whichever is greater = $ **206**

WETLANDS PERMIT APPLICATION – ATTACHMENT A
MINOR AND MAJOR - 20 QUESTIONS

Water Division/ Wetlands Bureau/ Land Resources Management

Check the Status of your application: http://des.nh.gov/onestop

RSA/ Rule: RSA 482-A, Env-Wt 100-900

Env-Wt 302.04 Requirements for Application Evaluation - For any major or minor project, the applicant shall demonstrate by plan and example that the following factors have been considered in the project's design in assessing the impact of the proposed project to areas and environments under the department's jurisdiction. Respond with statements demonstrating:

1. The need for the proposed impact.

The proposed replacement of "Upper Bridge" over Clark Brook at the Groton Wind is needed to replace the existing deficient bridge. The existing bridge consists of precast slab superstructure supported by stacked "waste-block" concrete blocks. The abutment foundations are completely undermined from scour. The precast concrete footing sections (approximately 1 ft. thick) are completely exposed with a significant loss of foundation soil support along the entire length of each abutment. Several concrete blocks have shifted and fallen out of place at the upstream and downstream end leading to a loss of roadway embankment along the guardrails behind the abutments. No channel armament or riprap along the abutments or at the inlet and outlet of the bridge is present.

The existing crossing is undersized and constricts the natural bankfull channel and floodplain. The constriction of stream flows has likely resulted in the observed scour that has moved and/or loosened several of the abutment blocks.

Emergency authorization for a temporary repaid of the existing bridge was issued to Groton Wind, LLC on November 25, 2014. (NHDES File Number: 2014-03346) Based on the emergency authorization, temporary stabilization was completed, consisting of:

- Installing temporary erosion/sedimentation control measures.
- Remove concrete abutment block that had become disengaged from the bridge support structure.
- Inserted boulder to act as temporary support for bridge structure.
- Attach chain from top of concrete block(s) to guard rail to hold in place.
- Remove temporary erosion/sedimentation control measures.

After repairs were completed to the bridge, a follow up report was submitted to NHDES in early January 2015 to fulfill the requirements of Condition #2 of the Emergency Permit. It was noted in the report that Groton Wind was in the process of designing a new bridge crossing for which they plan to submit a standard dredge and fill application in the future.

The emergency repairs were conducted as a temporary measure, and the bridge is still not adequately stable and continues to represent a geomorphic constriction. The replacement is necessary to ensure allow access to the Groton Wind Farm and for forest management activities, and to allow for the stream to flow naturally. If the bridge is not replaced, the stability of the existing bridge will continue to decline which would lead to eventual failure of the existing bridge.

2. That the alternative proposed by the applicant is the one with the least impact to wetlands or surface waters on site.

One alternative to the proposed project would be to repair or rehabilitate the current crossing. This alternative was rejected because the existing bridge opening was determined to be constricted under certain flow conditions, which in turn therefore increases stream velocity and scour conditions, and limits aquatic organism passage. This option would leave a high risk for collapse or failure of the bridge during a storm event. A second alternative would be to leave the bridge in its current state, with no further repairs. This alternative is not viable. The bridge is currently failing and if nothing were done to it, then there is a high risk for it to collapse.

The proposed alternative allows for a permanent and necessary solution for the deteriorating bridge and also addresses the issue of the restrictive opening. The proposed crossing has a larger culvert opening that will allow the stream to flow without

constriction and allow for adequate space for water to flow in a storm event.

3. The type and classification of the wetlands involved.

The proposed project activities will impact the bed of Clark Brook. Under the Cowardin classification system Clark Brook is designated as Riverine, Lower Perennial, Unconsolidated Bottom, Cobble-Gravel, and Permanently Flood (R2UB1H) in this area. A portion of a nearby wetland (GH8) will also be impacted; Wetland GH8 is classified as Palustrine, Forested, Broad-Leaved Deciduous, and Seasonally Flooded/Saturated (PF01E).

4. The relationship of the proposed wetlands to be impacted relative to nearby wetlands and surface waters.

Clark Brook is a tributary of the Baker River, into which it flows approximately 3.5 river miles downstream. Two small wetlands are near the project area as well: There will be a small impact to the Wetland GH8, a small forested wetland seep (PFO1E) less than 0.1 acres in size. Wetland GH9 (PFO1C) is located approximately 50 feet downstream of the project area; no impacts to Wetland GH9 are proposed.

5. The rarity of the wetland, surface water, sand dunes, or tidal buffer zone area.

Clark Brook is a high energy perennial stream with many large boulders, pools, riffles and waterfalls of small drops in elevation. Its clear, cold and rapid waters provide habitat for the brook trout which inhabit these waters. The river is not designated under the New Hampshire River Management and Protection act and is not considered rare or unusual. The river exhibits common characteristic of a perennial stream in this areas of New Hampshire.

6. The surface area of the wetlands that will be impacted.

Permanent impacts to the bed of Clark Brooke are proposed to be 290 square feet (30 linear feet), for the construction and installation of the new bridge. There is also expected to be a permanent impact of 140 square feet to the adjacent wetland, GH8, due to gravel backfill used for streambed restoration. The proposed project will also result in 600 square feet (60 linear feet) of temporary impact on the streambed, due to installation of cofferdams and flumes to allow for temporary dewatering. Stream flow will be diverted through a flume or multiple pipes and will be removed upon the completion of the project.

7. The impact on plants, fish and wildlife including, but not limited to:
   a. Rare, special concern species; b. State and federally listed threatened and endangered species; c. Species at the extremities of their ranges; d. Migratory fish and wildlife; e. Exemplary natural communities identified by the DRED-NHB; and f. Vernal pools.

A search for the occurrence of rare plant, animal, or natural communities within the vicinity of the proposed project was completed using the New Hampshire Natural Heritage Bureau's (NHB) online DataCheck tool. The report generated from the DataCheck tool, dated April 27, 2015, indicated there were no known record of rare and exemplary natural communities near the project location. No further consultation with this agency is necessary.

A comprehensive survey for vernal pools was conducted in 2010 as part of the field work for the wind farm construction. While several vernal pools were identified at that time, there are no vernal pools within the Upper Bridge project area. (The closest known pool is approximately 2,000 feet from the project site. See Figure 2.)

8. The impact of the proposed project on public commerce, navigation and recreation.

The proposed project will not impact public commerce, navigation or recreation as the project leased parcel is privately owned and public access is limited. Groton Hollow Road within the project area is currently gated to restrict access by the general public.

9. The extent to which a project interferes with the aesthetic interests of the general public. For example, where an applicant proposes the construction of a retaining wall on the bank of a lake, the applicant shall be required to indicate

the type of material to be used and the effect of the construction of the wall on the view of other users of the lake.

Since the site is privately owned and the project location cannot be seen for public right of ways, the aesthetics of the projects will not affect the general public.

10. The extent to which a project interferes with or obstructs public rights of passage or access. For example, where the applicant proposes to construct a dock in a narrow channel, the applicant shall be required to document the extent to which the dock would block or interfere with the passage through this area.

The site is privately owned and public access is by written permission of the landowner. Gates restrict public access to the site. The proposed project will not have any effect on the manner in which the landowner allows public access to the site.

11. The impact upon abutting owners pursuant to RSA 482-A:11, II. For example, if an applicant is proposing to rip-rap a stream, the applicant shall be required to document the effect of such work on upstream and downstream abutting properties.

There would be no impacts to abutting property owners as a result of the proposed bridge replacement. Since the project proposes to allow the stream to flow unrestricted, there is potential for less erosion and sedimentation of Clark Brook, which could provide a benefit to properties downstream. The project is leased by Groton Wind, LLC and is located on a parcel that is owned by Green Acre Woodlands Inc. c/o Foreco, LLC. There are no other abutting properties within ¼ mile from the project location. An abutter's location map can be found in **Appendix A.**

12. The benefit of a project to the health, safety, and well being of the general public.

The proposed project is improving the safety of the Upper Bridge. The bridge is located on the main access to the wind turbines located on the east ridge and its current state it susceptible to failure and collapse. These turbines are a critical infrastructure system and providing improved and safe access to them will benefit health, safety and well being of the public.

13. The impact of a proposed project on quantity or quality of surface and ground water. For example, where an applicant proposes to fill wetlands the applicant shall be required to document the impact of the proposed fill on the amount of drainage entering the site versus the amount of drainage exiting the site and the difference in the quality of water entering and exiting the site.

No negative impacts to the quality and quantity of surface and ground water are anticipated as a result of the proposed project. The project is anticipated to improve water quality of the stream by reducing sedimentation and erosion at the crossing and downstream, since the proposed crossing has a larger span of the existing one.

14. The potential of a proposed project to cause or increase flooding, erosion, or sedimentation.

The proposed project is not anticipated to cause or increase flooding, erosion, or sedimentation. The construction of the bridge will provide a wider opening to allow the stream not be non-constricted which would prevent erosion, flooding and sedimentation. A hydraulic analysis was conducted in support of the proposed project, which demonstrates compliance with the NH Wetlands Bureau Stream Crossing Guidelines. See Appendix D.

15. The extent to which a project that is located in surface waters reflects or redirects current or wave energy which might cause damage or hazards.

The proposed project will have a temporary effect on the current of Clark Brook. A temporary water diversion and foundation dewatering is planned to allow for the construction of the new bridge. The water diversion will be removed at the completion of the project.

16. The cumulative impact that would result if all parties owning or abutting a portion of the affected wetland or wetland complex were also permitted alterations to the wetland proportional to the extent of their property rights. For example,

an applicant who owns only a portion of a wetland shall document the applicant's percentage of ownership of that wetland and the percentage of that ownership that would be impacted.

Abutting properties largely consist of undeveloped land and residential land. It is difficult to predict future development or alterations of these properties and their current relationship to the subject wetlands and streams beyond the boundaries delineated in relation to the proposed reconstruction work. However, it can be determined based on the small amount of permanent impact proposed (430 square feet), and the distance between the proposed work and these properties, that this project would not be of significant contribution to any future cumulative impacts

17. The impact of the proposed project on the values and functions of the total wetland or wetland complex.

Due to the fact the impacts proposed within the project are confined to one area of the streambed that has already seen disturbance, the new bridge is not expected to result in measurable impacts to the functions and values of Clark Brook. It is proposed that with the completion of the project, the streambed in the area will also be restored using a cobble-gavel-sand mix, which will help simulate a natural streambed habitat and limit erosion and sedimentation.

18. The impact upon the value of the sites included in the latest published edition of the National Register of Natural Landmarks, or sites eligible for such publication.

There would be no impact to Registered Landmarks as a result of the project since none are located within or near the project. The nearest Landmark to the project is Franconia Notch, which is located approximately 32 miles north of the project site.

19. The impact upon the value of areas named in acts of congress or presidential proclamations as national rivers, national wilderness areas, national lakeshores, and such areas as may be established under federal, state, or municipal laws for similar and related purposes such as estuarine and marine sanctuaries.

There would be no impact to these national resources as none of them are located within the project area. The nearest named national resource area to the project site is the Sandwich Range Wilderness, located approximately 50 miles north of the project site.

20. The degree to which a project redirects water from one watershed to another.

No water shall be redirected from one watershed to another as a result of the proposed project.

Application Narrative

Application Narrative

On behalf of Groton Wind, LLC, this Standard Dredge and Fill Application is submitted to the New Hampshire Department of Environmental Services (NHDES) Wetlands Bureau pursuant to the New Hampshire Revised Statutes Annotated RSA 482-A, Fill and Dredge in Wetlands, and Wetland Bureau Code of Administrative Rules, Chapters Env-Wt 100 through Env-Wt 900.

1.0 Introduction

The application narrative describes the proposed replacement of the "Upper Bridge," which carries the private portion of Groton Hollow Road over Clark Brook in Groton, New Hampshire. Clark Brook is a Tier 2 stream with a watershed of approximately 531 acres.

The Upper Bridge was installed and maintained as a forestry crossing by the property owner, Green Acre Woodlands, as part of its forestry management activities. The bridge was used during the construction of the Groton Wind Farm in 2011-2012, and is located within an area currently leased by Groton Wind, LLC. The bridge provides the primary means of access to the 24 turbine array located on the adjacent ridgelines. The bridge has since been damaged by high flow events, with severe scouring at the abutments.

In assessing solutions to damaged bridge, Groton Wind has determined that complete replacement of the bridge is appropriate. ***The proposed project therefore consists of permanently dredging and filling 290 square feet (30 linear feet) in the bed and banks of Clark Brook to entirely replace the Upper Bridge with a new 19-foot span consisting of a precast concrete open bottom bridge frame with new footings and wingwalls. Approximately 140 square feet of a forested wetland (Wetland GH8) will be impacted to stabilize the northwestern bank of Clark Brook to prevent potential future damage to the bridge. Additionally, approximately 600 square feet (60 linear feet) of Clark Brook will be temporarily impacted for a construction-phase stream diversion.*** The proposed crossing will simulate the natural stream channel and fully meet Tier 2 stream crossing regulations. Compensatory mitigation is not required since the new crossing fully meets the requirements of both Env-Wt 904.03 and Env-Wt 904.05.

Attached appendices include project site plans showing existing conditions and proposed improvements, evidence of agency coordination and representative site

photographs. Additionally, demonstration that the project complies with the provisions contained in the NHDES Wetland Rules is documented in further detail within this narrative.

2.0 Site Description and Existing Conditions

The proposed project involves replacing the "Upper Bridge" that crosses over Clark Brook located on Groton Hollow Road at the Groton Wind Farm. The proposed project is located on Tax Map 9 Lot 2, which is owned by Green Acre Woodlands, Inc. c/o Foreco, LLC. Groton Wind, LLC leases a portion of this lot on which it operates a 48-MW wind farm. Refer to **Figure 1** and **Appendix A** for property plans and abutter information**.**

The existing bridge consists of a precast slab superstructure supported by stacked "waste-block" concrete blocks. The minimum clear span is approximately 8.5 feet over Clark Brook and the roadway grade is between eight (8) and nine (9) feet above the average elevation of the brook. The bridge is approximately 16.6 feet wide measured between guardrail faces and approximately 18 feet wide measured from the outside face of slab.

The abutment foundations are completely undermined from scour. The precast concrete footing sections (approximately 1 ft thick) are completely exposed with a significant loss of foundation soil support along the entire length of each abutment. Several concrete blocks have shifted and fallen out of place at the upstream and downstream end leading to a loss of roadway embankment along the guardrails behind the abutments. No channel armament or riprap along the abutments or at the inlet and outlet of the bridge is present.

The existing crossing appears to be undersized and constricting the natural bankfull channel and floodplain. The constriction of the stream flow has likely resulted in the observed scour that had moved/or loosened several of the abutment blocks.

Emergency authorization for dredging and filling approximately 225 square feet (30 linear feet) of Clark Brook at the Upper Bridge crossing was given to VHB and Groton Wind, LLC on November 25, 2015 (NHDES File Number: 2014-03346) to temporarily repair the crossing. The bridge was compromised due to a storm event which dislodged and moved several abutment blocks. The work that was completed at that time consisted of:

- Installing temporary erosion/sedimentation control measures
- Remove concrete abutment block that had become disengaged from the bridge support structure
- Inserted boulder to act as temporary support for bridge structure
- Attach chain from top of concrete block(s) to guard rail to hold in place

- Remove temporary erosion/sedimentation control measures

These measures were only taken to provide a temporary fix since the abutment blocks had been compromised to such a large degree.

3.0 Proposed Project Description

The proposed project consist of carefully removing the existing bridge in its entirety including concrete blocks, footings, substructure slabs, and railings. The existing components will be removed and stockpiled at a suitable location on the property approved by Iberdrola Renewables. The guardrail end units and beam shall be salvaged and incorporated into the replacement bridge.

Once the existing bridge has been removed, a new precast concrete frame for the proposed bridge will be put in place. Based on analysis performed by VHB, the new bridge has been designed with a longer span, to allow for the stream to be less constricted. The height of the crossing will stay the same, but the span will increase to 19 feet. The precast frame will be placed on precast concrete footings. The wing wall and frame footings will be placed on crushed stone, at least 12 inches thick, wrapped in non-woven geotextile.

The proposed crossing will simulate, to the extent predictable, the natural stream channel, stream process and satisfy stream crossing regulations. The increased hydraulic opening will allow the stream to flow without restriction. This will have a positive impact on the stream at the crossing and downstream from the crossing. It will help reduce the risk for erosion and sedimentation since the stream will have adequate space to flow through the crossing.

Following the construction of the bridge, the scoured portions of the streambed will be restored using a cobble-gravel-sand mix which will be placed approximately 1 foot thick at the bridge replacement site. The final elevation of the streambed shall blend into the upstream and downstream elevations. The cobble-gravel-sand mix shall consist of natural field stone, bank run gravel or natural river rock. Crushed stone from a quarry or other sources will not be permitted.

To reconstruct the Upper Bridge, water diversion and foundation dewatering is anticipated. The construction will be scheduled for periods when the flows of Clark Brook are at a minimum. A sandbag cofferdam or similar structure will be placed upstream and downstream of the project site, and the stream will be diverted through the worksite via a flume or multiple pipes. A 10 ft x 10 ft steel splash plate or temporary stone fill apron will be installed downstream of the flume outlet to prevent erosion. Once the reconstruction has been completed the temporary water diversion controls will be removed.

Refer to **Appendix B – Project Plans** for further information.

4.0 Natural Resource Descriptions

Jurisdictional resources associated with the proposed project include the bed of Clark Brook. Below is a general description of the river and function and values with the surrounding landscape. Photographs of the referenced resources are found in **Appendix C**.

4.1 Clark Brook

Clark Brook is a high energy perennial stream with many large boulders, pools, riffles and waterfalls of small drops in elevation. The brook is not impaired for surface water quality (per NHDES Impaired Waters data) despite the potential for sedimentation to its tributaries from logging operations. Groton Hollow Road runs roughly parallel to the stream valley and the brook flows into the Baker River at the northerly end of Groton Hollow Road. There are many other tributaries that flow into Clark Brook along Groton Hollow Road.

Clark Brook and its associated tributaries provide habitat which can support native brook trout (*Salvelinus fontinalis*) due to its clear and cold water temperatures, riffles, deep pools, a forested canopy, and associated feed sources. Biologists observed brook trout within the Clark Brook main stem. The brook trout are not expected to be impacted by the proposed project.

VHB completed a geomorphic assessment and developed a hydraulic model of Clark Brook at the location of the Upper Bridge. The field assessment determined that Clark Brook in the project area has an average bankfull width (BFW) of approximately 14 feet. This technical analysis is included as **Appendix D**.

4.2 Wetland GH8

A small forested wetland seep, designated "Wetland GH8" (PFO1E), approximately 0.1 acre in size, is located along the southern side of Groton Hollow Road, to the west of Clark Brook. Dominant vegetation includes red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), yellow birch (*Betula allegheniensis*), cinnamon fern (*Osmunda cinnamomea*) and sensitive fern (*Onoclea sensibilis*). A portion of Wetland HG8 was previously impacted by the improvements to Groton Hollow Road during the construction of the wind farm. (Permitting plans indicate an impact of 420 square feet.) Additional impacts to this wetland would be required to stabilize the embankment at the Upper Bridge.

4.3 Vernal Pools

A comprehensive survey for vernal pools was conducted in 2010 as part of the field work for the wind farm construction. While several vernal pools were identified at that time, there are no vernal pools within the Upper Bridge project area. (The closest known pool is approximately 2,000 feet from the project site. See **Figure 2**.)

4.4 Floodplains and Floodways

According to the Federal Emergency Management Agency (FEMA) National Flood Insurance Program, Flood Insurance Rate Maps (FIRM), produced for Grafton County, the project does not lie within a mapped 100-year floodplain or regulatory floodway.

4.5 Rare, Threatened and Endangered Species

A search for the occurrence of rare plant, animal, or natural communities within the vicinity of the proposed project was completed using the New Hampshire Natural Heritage Bureau's (NHB) online DataCheck tool. The report generated from the DataCheck tool, dated April 27, 2015, indicated there were no known record of rare and exemplary natural communities near the project location. No further consultation with this agency is necessary.

Documented correspondence with the agency listed above has been provided in **Appendix E**.

5.0 Impact Analysis and Best Management Practices

The wetland impacts for the proposed project are limited to the bed of Clark Brook and adjacent Wetland GH8. The project will result in 290 square feet (30 linear feet) of permanent impact to the streambed and 140 square feet of permanent impact to Wetland GH8. The total permanent impact as a result of the project would be 430 square feet. Due to the small impact of the project, according to NHDES Wetland Rule [Env-Wt 904.03(e)], compensatory mitigation is not required for this project since the crossing meets the requirements for a tier 2 crossing and its design features.

An additional 600 square feet (30 linear feet) will be temporarily impacted for the installation of the temporary water diversion and foundation dewatering. The cofferdam and flumes that will be installed will allow water to continue to move past the project site but will also allow work crews to get the bridge built efficiently with minimal potential water quality impacts.

To successfully complete the proposed project the following construction steps and best management practices for erosion control are planned:

- All reconstruction will be performed in the dry, the work will be done during an anticipated period of low water in Clark Brook.
- A cofferdam and flumes will be installed to divert water away from the work area. The cofferdam will be constructed at an appropriate height and width that will allow the work area to remain dry. The cofferdam will be maintained watertight.
- Debris containment, sediment and turbidity controls shall be employed at all times to ensure water quality of Clark Brook.
- Excavation to bearing surfaces shall be completed with a smooth-edged bucket to minimize the disturbance of sensitive glacial till. Disturbed areas that become yielding shall be further dewatered, excavated and backfilled with controlled lifts of compacted gravel backfill.
- Control of water within the excavation site shall be conducted in such a manner as to prevent disturbance of the bearing soil. Well points/sumps shall be located outside the footing limits and properly filtered to prevent pumping of the soil materials below the excavation subgrade.
- Upon completion, water diversion structures will be removed.

6.0 Stream Crossings (Env-Wt 900)

The proposed Upper Bridge replacement over Clark Brook must address the stream crossing standards outlined in the New Hampshire Administrative Rule Env-Wt 900. Under this rule, stream crossings are classified as Tier 1, Tier 2, or Tier 3 based on the location of the project. This site meets the requirements for a Tier 2 classification as defined by Env-Wt 904.03(a): A Tier 2 stream crossing must have a watershed area greater than 200 acres and less than 640 acres. The drainage area to the site is 531 acres (0.83 square mile). The site does not satisfy any of the other Tier 3 requirements as defined in Env-Wt 904.04.

The required Tier 2 stream crossing design criteria are provided below in italics. Responses on how the proposed crossing meets each requirement are provided below the pertinent regulations.

Env-Wt 904.03 <u>Tier 2 Stream Crossings.</u>

(a) A tier 2 stream crossing shall be a crossing located on a watercourse where the contributing watershed is greater than 200 acres and less than 640 acres.

The proposed project has a drainage area of 531 acres.

(b) Subject to (c), below, any new tier 2 stream crossing and any replacement tier 2 stream crossing that does not meet the criteria specified for in-kind replacement in Env-Wt 904.07 shall be a span structure, pipe arch embedded with stream simulation, open-bottom culvert with stream simulation, or closed-bottom culvert embedded with stream simulation.

The proposed structure will be full span, open-bottom bridge structure, which allows for natural streambed characteristic.

(c) The applicant shall use an alternative design only if a request is submitted and approved as specified in Env-Wt 904.09.

The proposed project fully complies with the rules for Tier 2 crossings; an alternative design is not proposed.

(d) An existing legal crossing that would be classified as tier 2 under (a), above, may be repaired or rehabilitated pursuant to Env-Wt 904.06 or replaced in kind pursuant to Env-Wt 904.07.

The project proposes to replace an existing deficient crossing with a new fully compliant span.

(e) Compensatory mitigation shall not be required for:

> ***(1) Any new tier 2 stream crossing that meets the requirements of this section and Env-Wt 904.05; or***
> ***(2) Any tier 2 stream crossing that is repaired or rehabilitated pursuant to Env-Wt 904.06 or replaced in kind pursuant to Env-Wt 904.07.***

Compensatory mitigation is not required since the new crossing fully meets the requirements of both Env-Wt 904.03 and Env-Wt 904.05.

(f) Plans for a tier 2 stream crossing shall be stamped by a professional engineer who is licensed under RSA 310-A to practice in New Hampshire.

The enclosed plans (**Appendix A**) have been stamped by Steven Hodgdon, PE, a professional engineer licensed to practice in New Hampshire.

(g) Construction involving in-stream work shall be limited to low flow conditions.

Given the damage to the existing bridge, Groton Wind, LLC wishes to construct the replacement bridge as soon as possible. However, the period of in-stream construction is anticipated to be relatively brief – perhaps a few weeks - and every effort will be made to schedule construction during low flow.

(h) Crossings that require excavation in flowing water shall use best management practices, such as temporary by-pass pipes, culverts, or cofferdams, so as to maintain normal flows and prevent water quality degradation.

Sandbag cofferdams and flume pipes or similar devices will be installed temporarily to divert water away through the project site such that excavation in flowing water is not required during construction. The water diversion structures will be removed after construction

Env-Wt 904.05 <u>Design Criteria for Tier 2 and Tier 3 Stream Crossings.</u>

New tier 2 stream crossings, replacement Tier 2 stream crossings that do not meet the requirements of Env-Wt 904.07, and new and replacement Tier 3 stream crossings shall be designed and constructed:

(a) In accordance with the NH Stream Crossing Guidelines, University of New Hampshire, May 2009, which can be downloaded for free at http://www.streamcontinuity.org/pdf_files/nh_stream_crossing_guidelines_unh_web_rev_2.pdf/;

The proposed crossing will meet the requirements outlined in the NH Stream Crossing Guidelines, including:

- Maintaining a similar crossing slope to the natural channel
- Installing an open bottomed spanning structure
- Creating natural channel geometry with banks to accommodate low flows
- The proposed span of 19 feet meets the guideline of spanning at least BFW (14-ft) x 1.2 + 2-ft = 18.8-ft
- The proposed span would have an openness ratio of approximately 0.48, which exceeds the recommended ratio of 0.25.

(b) With the bed forms and streambed characteristics necessary to cause water depths and velocities within the crossing structure at a variety of flows to be comparable to those found in the natural channel

The proposed structure will be open-bottom which allow for establishment of natural streambed characteristics. The crossing will have a natural channel geometry which will maintain comparable water depths and velocities to the natural channel.

(c) To provide a vegetated bank on both sides of the watercourse to allow for wildlife passage;

The recommended crossing span of 19-feet is 5 feet beyond the measured BFW to allow for creation of natural banks through the crossing.

(d) To preserve the natural alignment and gradient of the stream channel, so as to accommodate natural flow regimes and the functioning of the natural floodplain;

The proposed crossing will maintain a channel slope similar to the natural stream slope at the Site. The larger 19-foot span will mitigate impacts to stream flow regimes and floodplain functions compared to existing conditions.

(e) To accommodate the 100-year frequency flood, to ensure that:
(1) There is no increase in flood stages on abutting properties; and
(2) Flow and sediment transport characteristics will not be affected in a manner which could adversely affect channel stability;

The proposed crossing will pass the entire 100-year frequency flood with freeboard, and will not increase flood stage on any abutting property, and will maintain flow and sediment transport characteristics to avoid adversely affecting channel stability.

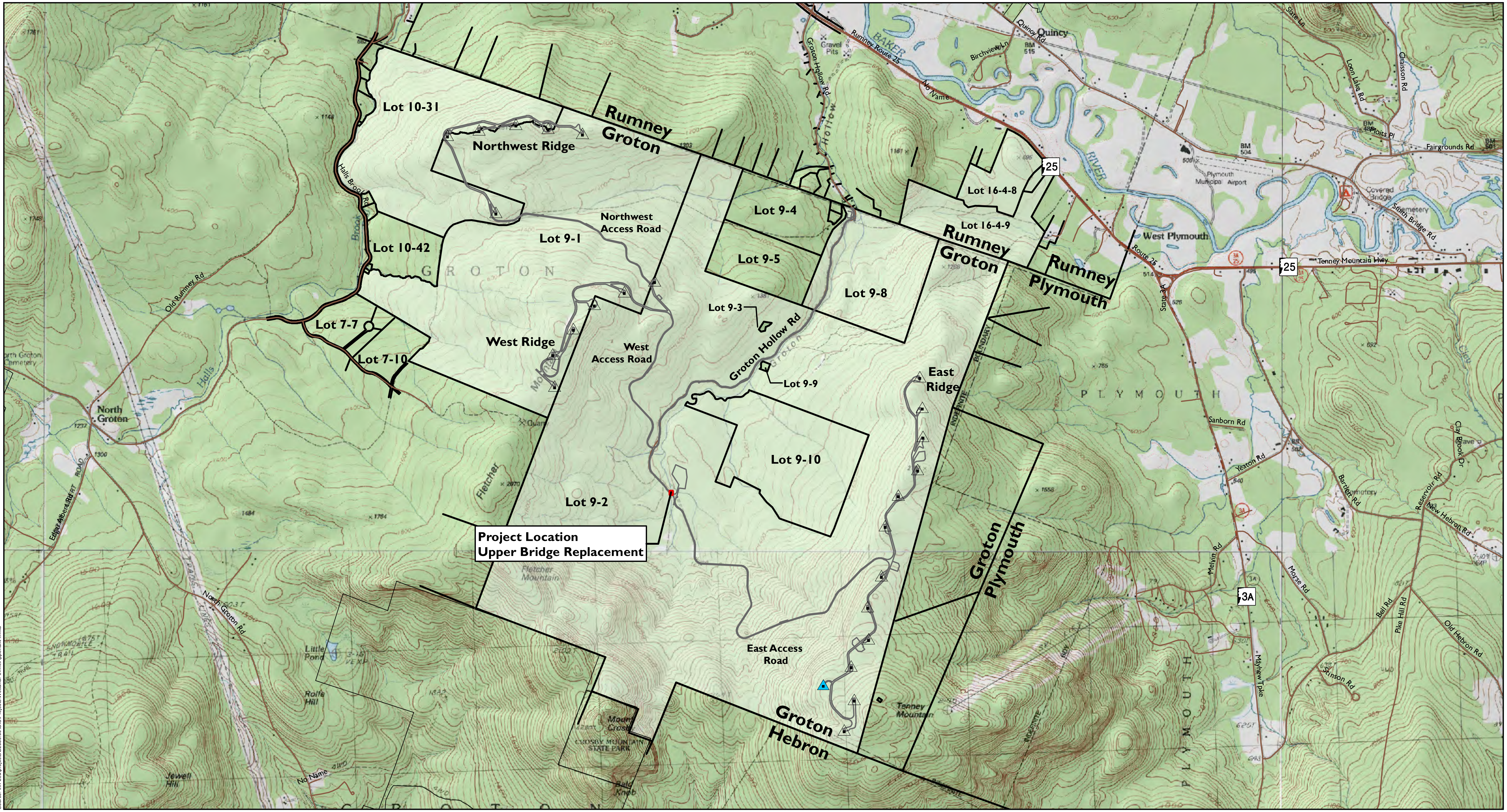
(f) To simulate a natural stream channel; and

The proposed structure will be open-bottom which allow for establishment of natural streambed characteristics. Following installation of the new bridge, the streambed will be stabilized using a cobble-gravel-sand mixture which simulates the natural streambed and will ensure bed stability at the crossing location.

(g) So as not to alter sediment transport competence.

The proposed crossing will simulate, to the extent practicable, the natural stream channel and stream processes.

Figures



Legend

- Upper Bridge Site
- Turbine
- Permanent Met Tower
- Project Location (Shaded White)
- Gravel Areas
- Lake/Pond
- Property Line
- River/Stream
- Roads (NHDOT)
- Project Location (Shaded White)

0 2,500 5,000 Feet

Source: USGS Quadrangle: Ashland, Mt. Cardigan, Newfound Lake, Plymouth, Rumney, Wentworth
Property Lines based on multiple sources of data including ground survey, and assessing tax maps.
Conservation Lands, Roads, and hydrography data taken from the archives on NHGRANIT.

VHB Vanasse Hangen Brustlin, Inc.

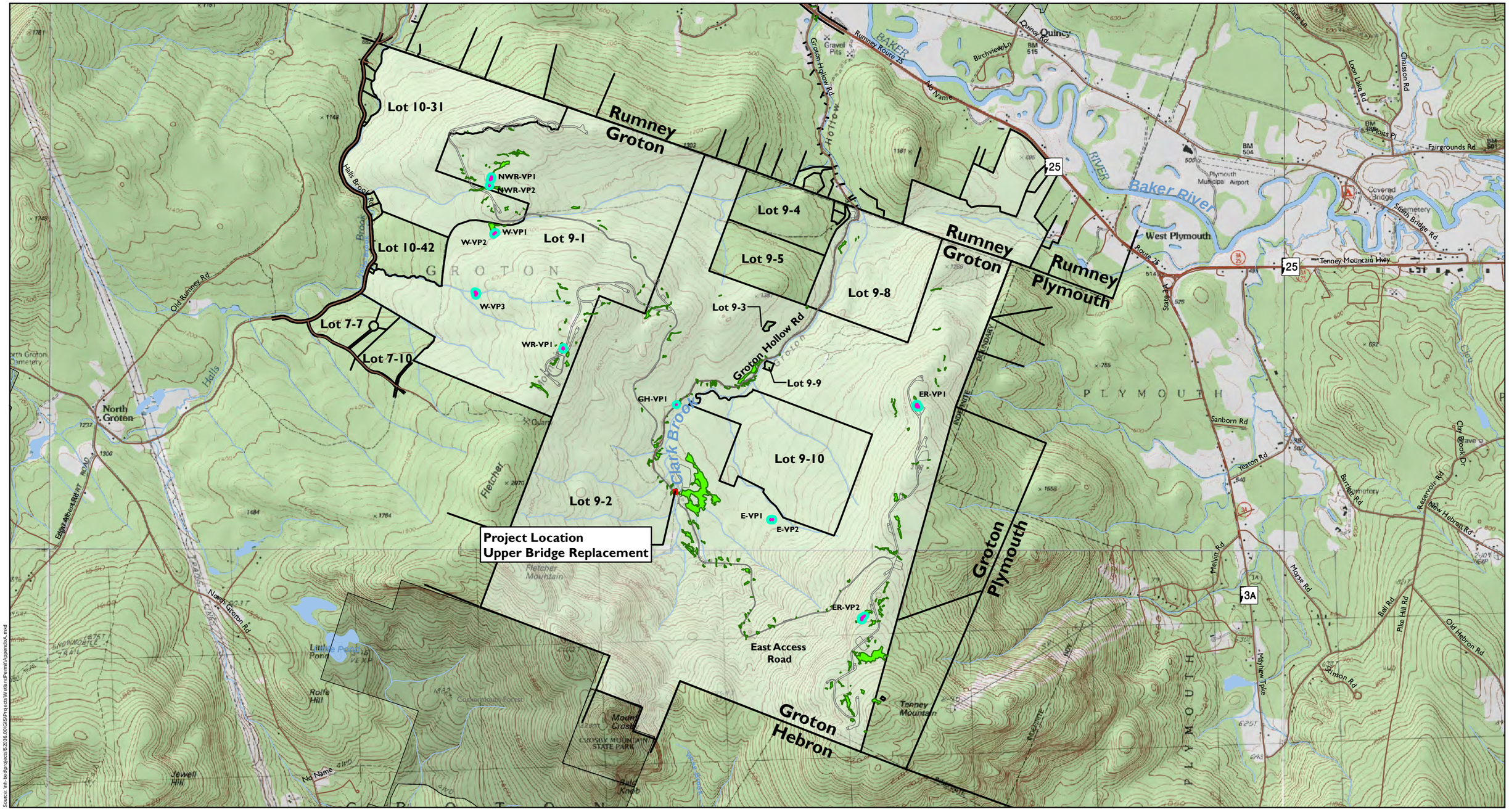
Figure 1

Site Location Map

Upper Bridge Replacement

Groton Hollow Road
Groton, NH

IBERDROLA RENEWABLES



Source: \vhb-fs\projects\K2036.00\GIS\Projects\WetlandPermit\AppendixA.mxd

Legend

- Upper Bridge Site
- Gravel Areas
- Property Line
- River/Stream
- Roads (NHDOT)
- Lake/Pond
- Vernal Pool (VHB Delineation)
- Vernal Pool Buffer (100')
- Wetland Boundary (VHB Delineation)
- Project Location (Shaded White)
- Conservation/Public Land

Source: USGS Quadrangle: Ashland, Mt. Cardigan, Newfound Lake, Plymouth, Rumney, Wentworth Property Lines based on multiple sources of data including ground survey, and assessing tax maps. Conservation Lands, Roads, and hydrography data taken from the archives on NHGRANIT.

0 2,500 5,000 Feet

Vanasse Hangen Brustlin, Inc.

Figure 2

Vernal Pool and Wetland Resources

Upper Bridge Replacement

Groton Hollow Road
Groton, NH

IBERDROLA RENEWABLES

Appendices

Appendix A

Plans of Leased Premises, Tax Map and Abutters Information

IBERDROLA
RENEWABLES

15th of May, 2015

Green Acre Woodlands, Inc.
PO Box 334
450 Main Street
Rumney, New Hampshire 03266

Subject: Groton Wind Farm Upper Bridge Replacement Project, NH NHDES Wetlands Permit Application, File No. 2014-03346 Abutter Permission, per Env-Wt 304.04

Dear Green Acre Woodlands,

Per NHDES Administrative Rule Env-Wt 304.04, this letter requests written confirmation that Green Acre Woodlands, Inc. supports and has no objections to the replacement of the Upper Bridge on Groton Hollow Road in Groton, NH.

DES Rule: Env-Wt. 304.04 Setback from Property Lines

> *(a) The department shall limit the location of a project at least 20 feet from the abutting property line or imaginary extension thereof over surface water unless it receives written agreement from the affected abutter concurring with any impact that may result relative to the abutter's interest.*

The project will occur on property (Groton Tax Map 9, Lot 2) which is leased to Groton Wind, LLC. and a small section of the work may be required on Green Acre Woodlands, Inc. land as shown on the attached Wetland Impact Plan, dated April 24, 2015. Green Acre Woodlands, Inc. understands that the project will be conducted in accordance with the plans submitted to the NHDES and is in full support of the Groton Wind, LLC's permit application for the bridge replacement, and understands that NHDES may impose design modifications or permit conditions which may modify the impacts to the design and property.

By signing below Green Acre Woodlands provides permission to proceed with the bridge replacement as submitted and approved by NHDES and has no objections, as neither abutter nor land owner. Please return a countersigned copy of this letter to NH Department of Environmental Services at the address provided below at your earliest convenience. Thank you for your time and consideration of this matter.

IBERDROLA RENEWABLES, LLC.
2 Radnor Corporate Center
Suite 200
Radnor, PA 19087
Telephone (610) 254-9800
www.iberdrolarenewables.us

GROTON WIND, LLC.

By: _____

Name: Ryan Haley

Title: Plant Manager

ACKNOWLEDGED AND AGREED:

GREEN ACRE WOODLANDS, INC.

By: _____

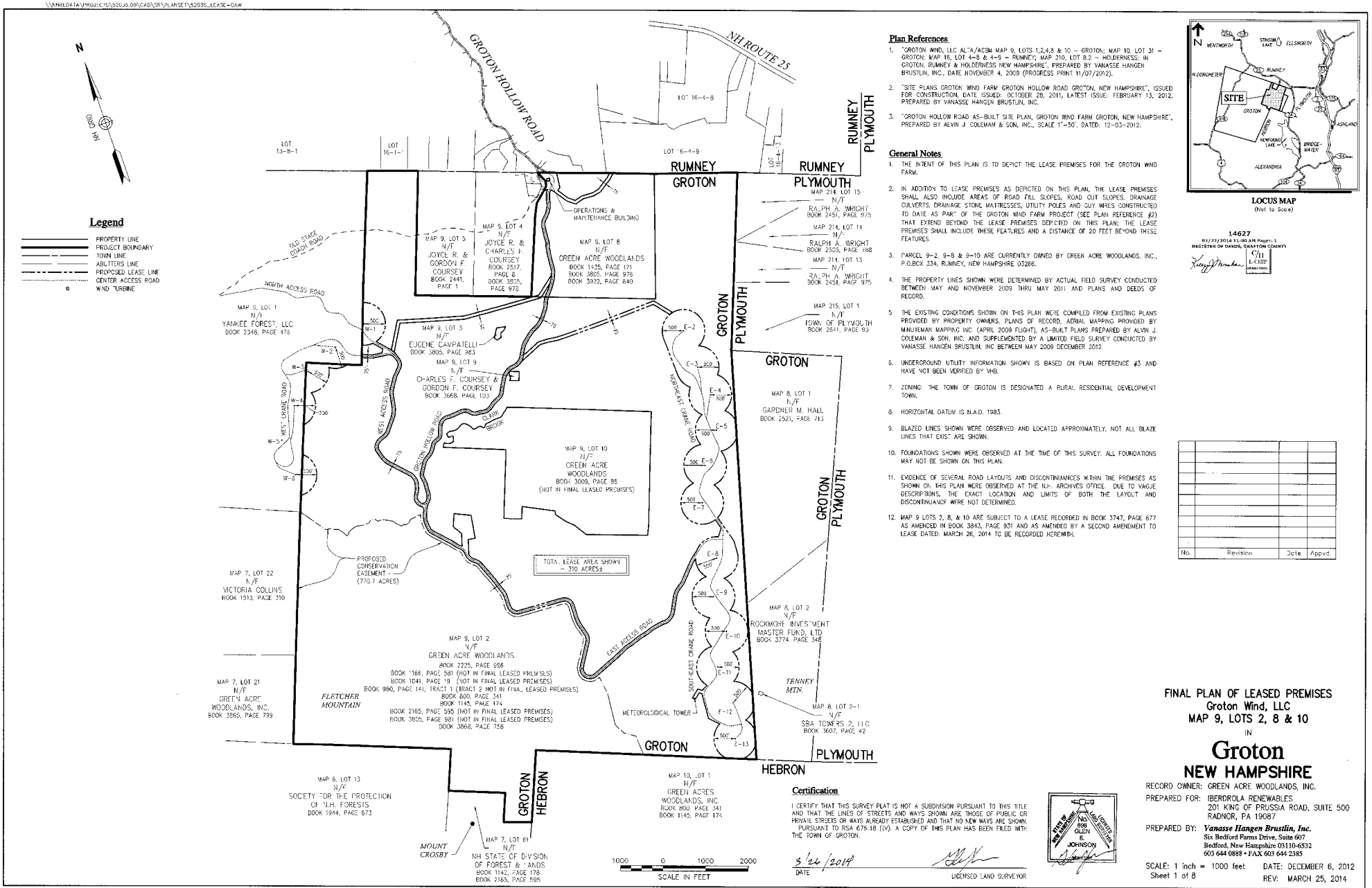
Name: _____

Title: _____

Executed copy to:

NH Department of Environmental Services
Wetlands Bureau
PO Box 95
29 Hazen Drive
Concord, NH 03302-0095

\\NHBEDATA\PROJECTS\52035.00\CAD\SR\PLANSET\52035_LEASE-GAW



Legend

- PROPERTY LINE
- PROJECT BOUNDARY
- TOWN LINE
- ABUTTERS LINE
- PROPOSED LEASE LINE
- CENTER ACCESS ROAD
- WIND TURBINE

Plan References

1. "GROTON WIND, LLC ALTA/ACSM MAP 9, LOTS 1,2,4,8 & 10 – GROTON; MAP 10, LOT 31 – GROTON; MAP 16, LOT 4-8 & 4-9 – RUMNEY; MAP 210, LOT 8.2 – HOLDERNESS; IN GROTON, RUMNEY & HOLDERNESS NEW HAMPSHIRE", PREPARED BY VANASSE HANGEN BRUSTLIN, INC., DATE NOVEMBER 4, 2009 (PROGRESS PRINT 11/07/2012).
2. "SITE PLANS GROTON WIND FARM GROTON HOLLOW ROAD GROTON, NEW HAMPSHIRE", ISSUED FOR CONSTRUCTION, DATE ISSUED: OCTOBER 28, 2011, LATEST ISSUE: FEBRUARY 13, 2012, PREPARED BY VANASSE HANGEN BRUSTLIN, INC.
3. "GROTON HOLLOW ROAD AS-BUILT SITE PLAN, GROTON WIND FARM GROTON, NEW HAMPSHIRE", PREPARED BY ALVIN J. COLEMAN & SON, INC., SCALE 1"=50', DATED: 12-03-2012.

General Notes

1. THE INTENT OF THIS PLAN IS TO DEPICT THE LEASE PREMISES FOR THE GROTON WIND FARM.
2. IN ADDITION TO LEASE PREMISES AS DEPICTED ON THIS PLAN, THE LEASE PREMISES SHALL ALSO INCLUDE AREAS OF ROAD FILL SLOPES, ROAD CUT SLOPES, DRAINAGE CULVERTS, DRAINAGE STONE MATTRESSES, UTILITY POLES AND GUY WIRES CONSTRUCTED TO DATE AS PART OF THE GROTON WIND FARM PROJECT (SEE PLAN REFERENCE #2) THAT EXTEND BEYOND THE LEASE PREMISES DEPICTED ON THIS PLAN; THE LEASE PREMISES SHALL INCLUDE THESE FEATURES AND A DISTANCE OF 20 FEET BEYOND THESE FEATURES.
3. PARCEL 9-2, 9-8 & 9-10 ARE CURRENTLY OWNED BY GREEN ACRE WOODLANDS, INC., P.O.BOX 334, RUMNEY, NEW HAMPSHIRE 03266.
4. THE PROPERTY LINES SHOWN WERE DETERMINED BY ACTUAL FIELD SURVEY CONDUCTED BETWEEN MAY AND NOVEMBER 2009 THRU MAY 2011 AND PLANS AND DEEDS OF RECORD.
5. THE EXISTING CONDITIONS SHOWN ON THIS PLAN WERE COMPILED FROM EXISTING PLANS PROVIDED BY PROPERTY OWNERS, PLANS OF RECORD, AERIAL MAPPING PROVIDED BY MINUTEMAN MAPPING INC. (APRIL 2009 FLIGHT), AS-BUILT PLANS PREPARED BY ALVIN J. COLEMAN & SON, INC. AND SUPPLEMENTED BY A LIMITED FIELD SURVEY CONDUCTED BY VANASSE HANGEN BRUSTLIN, INC BETWEEN MAY 2009 DECEMBER 2012.
6. UNDERGROUND UTILITY INFORMATION SHOWN IS BASED ON PLAN REFERENCE #3 AND HAVE NOT BEEN VERIFIED BY VHB.
7. ZONING: THE TOWN OF GROTON IS DESIGNATED A RURAL RESIDENTIAL DEVELOPMENT TOWN.
8. HORIZONTAL DATUM IS N.A.D. 1983.
9. BLAZED LINES SHOWN WERE OBSERVED AND LOCATED APPROXIMATELY, NOT ALL BLAZE LINES THAT EXIST ARE SHOWN.
10. FOUNDATIONS SHOWN WERE OBSERVED AT THE TIME OF THIS SURVEY. ALL FOUNDATIONS MAY NOT BE SHOWN ON THIS PLAN.
11. EVIDENCE OF SEVERAL ROAD LAYOUTS AND DISCONTINUANCES WITHIN THE PREMISES AS SHOWN ON THIS PLAN WERE OBSERVED AT THE N.H. ARCHIVES OFFICE. DUE TO VAGUE DESCRIPTIONS, THE EXACT LOCATION AND LIMITS OF BOTH THE LAYOUT AND DISCONTINUANCE WERE NOT DETERMINED.
12. MAP 9 LOTS 2, 8, & 10 ARE SUBJECT TO A LEASE RECORDED IN BOOK 3747, PAGE 677 AS AMENDED IN BOOK 3843, PAGE 931 AND AS AMENDED BY A SECOND AMENDMENT TO LEASE DATED: MARCH 26, 2014 TO BE RECORDED HEREWITH.

LOCUS MAP
(Not to Scale)

14627
03/27/2014 11:00 AM Page: 1
REGISTER OF DEEDS, GRAFTON COUNTY
C/11
L-CHIP
GRANTEE(S)

No.	Revision	Date	Appvd.

Certification

I CERTIFY THAT THIS SURVEY PLAT IS NOT A SUBDIVISION PURSUANT TO THIS TITLE AND THAT THE LINES OF STREETS AND WAYS SHOWN ARE THOSE OF PUBLIC OR PRIVATE STREETS OR WAYS ALREADY ESTABLISHED AND THAT NO NEW WAYS ARE SHOWN. PURSUANT TO RSA 676:18 (IV), A COPY OF THIS PLAN HAS BEEN FILED WITH THE TOWN OF GROTON.

3/26/2014
DATE

LICENSED LAND SURVEYOR

STATE OF NEW HAMPSHIRE — No. 808 — GLEN E. JOHNSON — LICENSED LAND SURVEYOR

FINAL PLAN OF LEASED PREMISES
Groton Wind, LLC
MAP 9, LOTS 2, 8 & 10
IN
Groton
NEW HAMPSHIRE

RECORD OWNER: GREEN ACRE WOODLANDS, INC.

PREPARED FOR: IBERDROLA RENEWABLES
201 KING OF PRUSSIA ROAD, SUITE 500
RADNOR, PA 19087

PREPARED BY: ***Vanasse Hangen Brustlin, Inc.***
Six Bedford Farms Drive, Suite 607
Bedford, New Hampshire 03110-6532
603 644 0888 • FAX 603 644 2385

SCALE: 1 inch = 1000 feet
Sheet 1 of 8

DATE: DECEMBER 6, 2012
REV: MARCH 25, 2014

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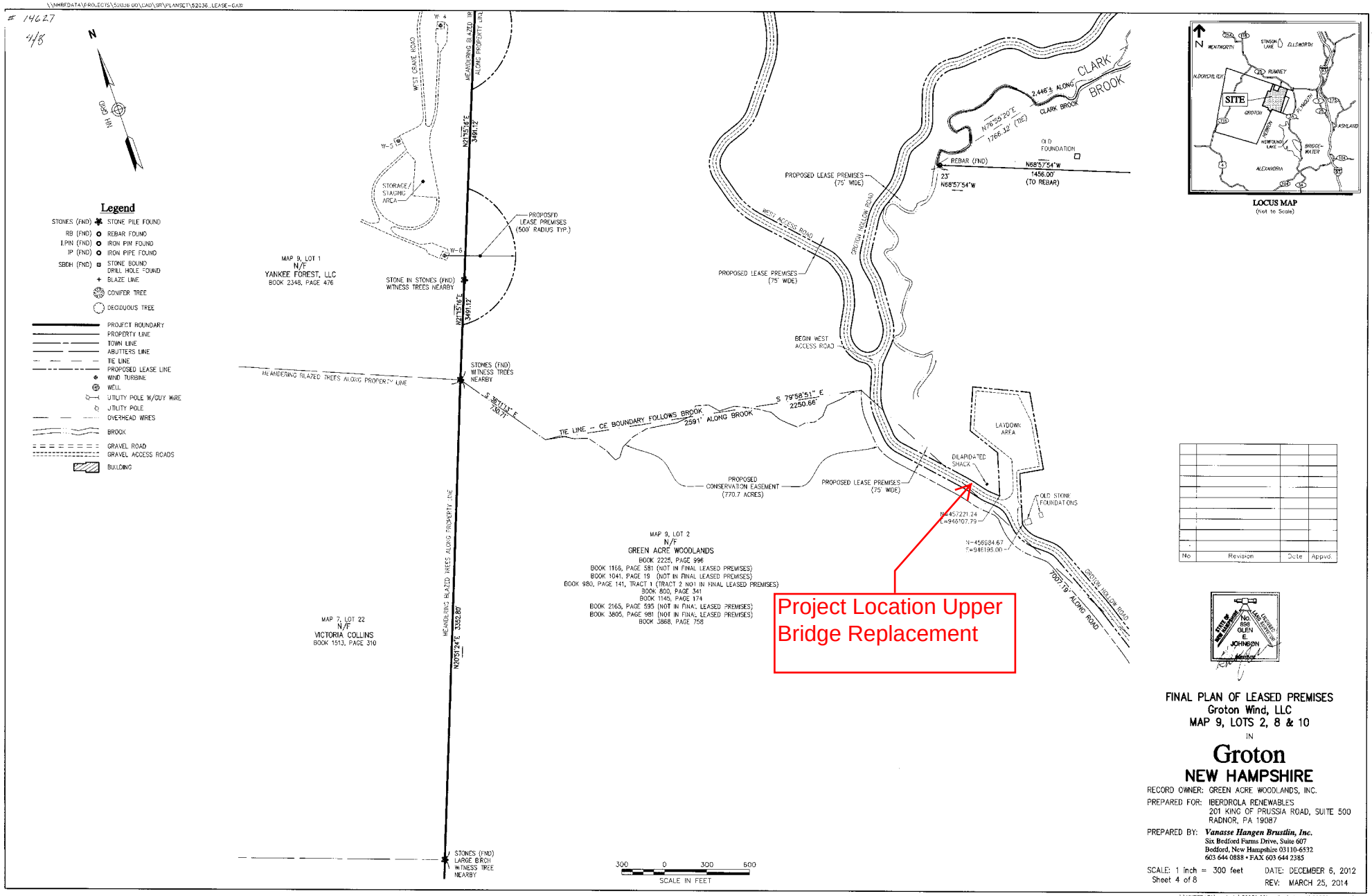
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14627
4/8
N
GRID N
Legend
STONES (FND) STONE PILE FOUND
RB (FND) REBAR FOUND
I.PIN (FND) IRON PIN FOUND
IP (FND) IRON PIPE FOUND
SBDH (FND) STONE BOUND DRILL HOLE FOUND
BLAZE LINE
CONIFER TREE
DECIDUOUS TREE
PROJECT BOUNDARY
PROPERTY LINE
TOWN LINE
ABUTTERS LINE
TIE LINE
PROPOSED LEASE LINE
WIND TURBINE
WELL
UTILITY POLE W/GUY WIRE
UTILITY POLE
OVERHEAD WIRES
BROOK
GRAVEL ROAD
GRAVEL ACCESS ROADS
BUILDING
MAP 8, LOT 1
N/F
YANKEE FOREST, LLC
BOOK 2348, PAGE 476
MAP 7, LOT 22
N/F
VICTORIA COLLINS
BOOK 1513, PAGE 310
MAP 9, LOT 2
N/F
GREEN ACRE WOODLANDS
BOOK 2225, PAGE 996
BOOK 1168, PAGE 581 (NOT IN FINAL LEASED PREMISES)
BOOK 1041, PAGE 19 (NOT IN FINAL LEASED PREMISES)
BOOK 980, PAGE 141, TRACT 1 (TRACT 2 NOT IN FINAL LEASED PREMISES)
BOOK 800, PAGE 341
BOOK 1145, PAGE 174
BOOK 2165, PAGE 595 (NOT IN FINAL LEASED PREMISES)
BOOK 3805, PAGE 981 (NOT IN FINAL LEASED PREMISES)
BOOK 3868, PAGE 758
WEST GRAVE ROAD
MEANDERING BLAZED TREES ALONG PROPERTY LINE
W-4
W-5
W-6
STORAGE / STAGING AREA
PROPOSED LEASE PREMISES (500' RADIUS TYP.)
STONE IN STONES (FND) WITNESS TREES NEARBY
N21°15'16"E 3491.12'
STONES (FND) WITNESS TREES NEARBY
S 38°11'13" E 730.71'
TIE LINE -- CE BOUNDARY FOLLOWS BROOK 2591' ALONG BROOK
S 79°58'51" E 2250.66'
N20°05'24"E 3452.80'
STONES (FND) LARGE BIRCH WITNESS TREE NEARBY
PROPOSED LEASE PREMISES (75' WIDE)
WEST ACCESS ROAD
BEGIN WEST ACCESS ROAD
PROPOSED CONSERVATION EASEMENT (770.7 ACRES)
CLARK BROOK
2,446'± ALONG CLARK BROOK
N78°59'20"E 1766.32' (TIE)
REBAR (FND)
23' N68°57'54"W
OLD FOUNDATION
N68°57'54"W 1456.00' (TO REBAR)
LAYDOWN AREA
DILAPIDATED SHACK
OLD STONE FOUNDATIONS
N=457221.24 E=946107.79
N=456884.67 E=946195.00
7007.79' ALONG ROAD
GROTON HOLLOW ROAD
Project Location Upper Bridge Replacement
300 0 300 600
SCALE IN FEET
LOCUS MAP
(not to Scale)
SITE
No. Revision Date Appvd.
FINAL PLAN OF LEASED PREMISES
Groton Wind, LLC
MAP 9, LOTS 2, 8 & 10
IN
Groton
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603 644 0888 • FAX 603 644 2385
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REV: MARCH 25, 2014
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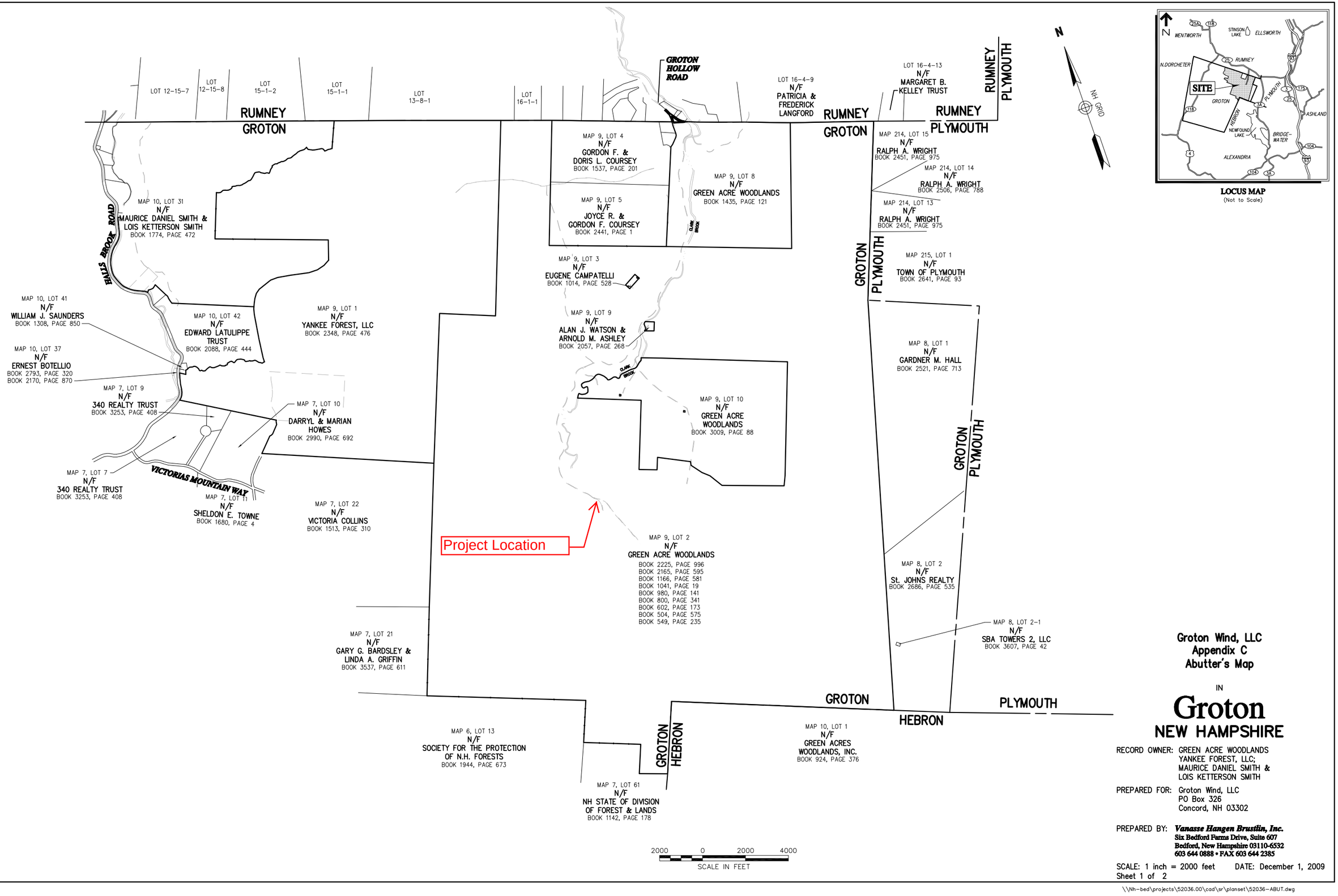

LOCUS MAP
(Not to Scale)

Groton Wind, LLC
Appendix C
Abutter's Map

IN

Groton
NEW HAMPSHIRE

RECORD OWNER: GREEN ACRE WOODLANDS
YANKEE FOREST, LLC;
MAURICE DANIEL SMITH &
LOIS KETTERSON SMITH

PREPARED FOR: Groton Wind, LLC
PO Box 326
Concord, NH 03302

PREPARED BY: ***Vanasse Hangen Brustlin, Inc.***
Six Bedford Farms Drive, Suite 607
Bedford, New Hampshire 03110-6532
603 644 0888 • FAX 603 644 2385

SCALE: 1 inch = 2000 feet DATE: December 1, 2009
Sheet 1 of 2

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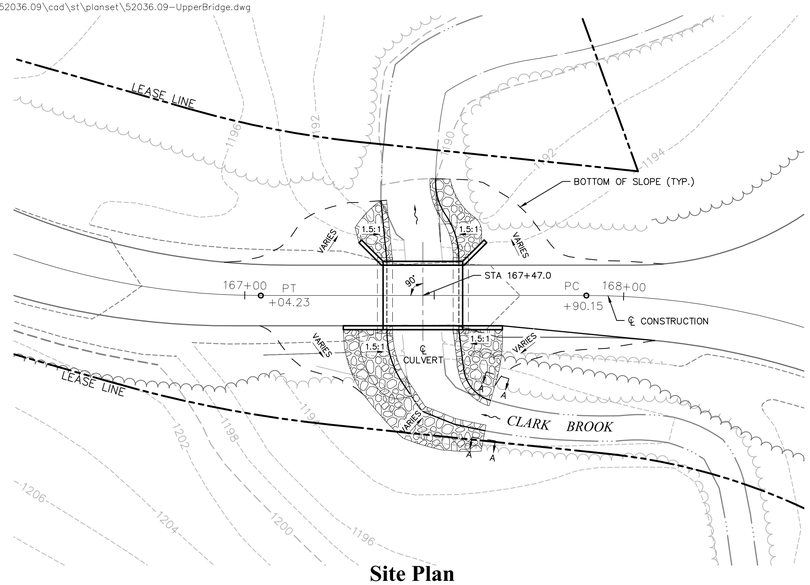
ABUTTERS TO THE UPPER BRIDGE AT GROTON WIND FARM

Owner/Abutter	Tax Map Number (map-lot)	Mailing Address
Green Acre Woodlands, Inc. c/o Foreco, LLC	9-2	PO Box 597 Rumney, NH 03266

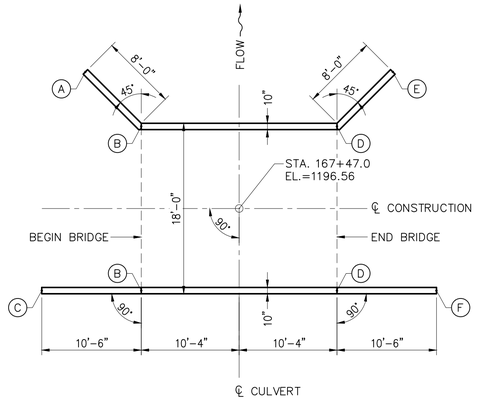
Appendix B

Project Plans



Site Plan

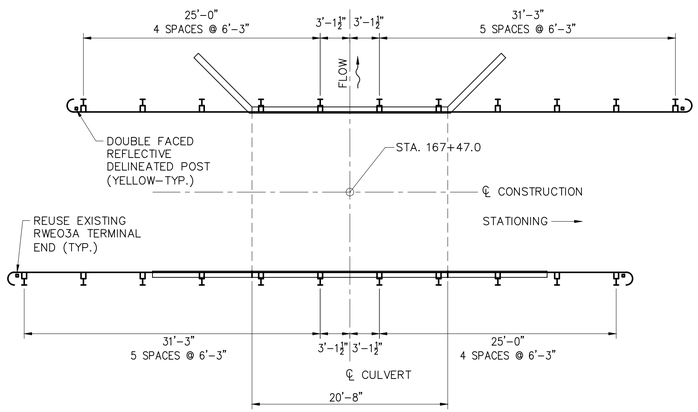
0 10 20 40 Feet



Masonry Elevation Table	
Location	**Elevation**
A	1194.57
B	1197.26
C	1197.47
D	1196.85
E	1193.94
F	1196.64

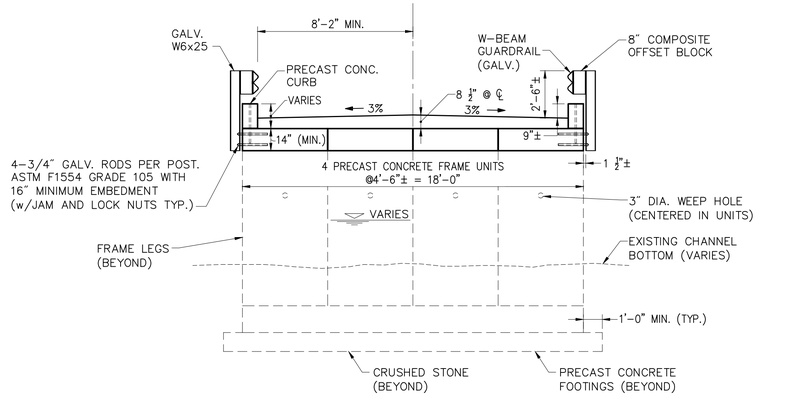
Bridge Layout & Elevations

N.T.S.



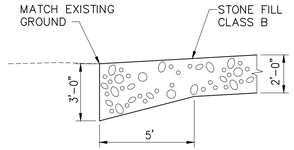
Guardrail Layout

N.T.S.



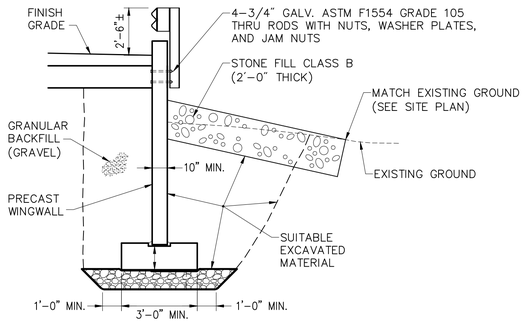
Transverse Bridge Section

N.T.S.



Section A-A
Riprap Terminus @ Upstream Slopes

N.T.S.



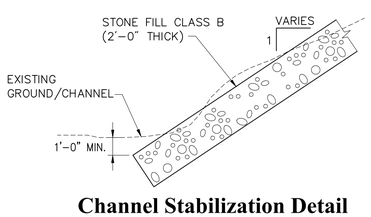
U-Back Wingwall

(OTHER WINGWALLS SIMILAR, NO RAIL ATTACHMENT)

N.T.S.

Longitudinal Bridge Section

N.T.S.



Channel Stabilization Detail

N.T.S.

Notes:

Construction Specification

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION (NHDOT) STANDARD SPECIFICATIONS FOR ROAD & BRIDGE CONSTRUCTION, 2010, WITH LATEST SUPPLEMENTS.

Design Specifications

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO) LRFD BRIDGE DESIGN SPECIFICATIONS, SEVENTH EDITION, 2014, WITH 2015 INTERIM REVISIONS.

Design and Material Notes

1. FUNCTIONAL CLASSIFICATION: VERY LOW VOLUME, LIMITED ACCESS ROAD, PRIVATE.
2. LIVE LOAD = HL-93, MODIFIED WITH 25% INCREASE IN TRUCK OR TANDEM PORTION OF LOADING.
3. BACKFILL UNIT WEIGHT = 125 PCF (COMPACTED NHDOT 209.2.1.2 GRAVEL BACKFILL)
4. SERVICE LIMIT STATE BEARING PRESSURE = 4.0 KSF MAXIMUM
5. AT-REST LATERAL EARTH PRESSURE COEFFICIENT = 0.5
6. INTERNAL FRICTION ANGLE OF BACKFILL = 30 DEGREES
7. MINIMUM CONCRETE 28-DAY CONCRETE STRENGTHS:
   A. PRECAST ELEMENTS = 5 KSI
   B. CAST-IN-PLACE ELEMENTS = 3 KSI
8. REINFORCING STEEL SHALL CONFORM TO AASHTO M 31 (ASTM A615) GRADE 60. PRECAST CULVERT REINFORCING STEEL SHALL BE EPOXY COATED (ASTM A775).
9. CONCRETE COVER FOR REINFORCING STEEL: 1.5"MINIMUM EXCEPT 3"MINIMUM FOR FOOTINGS AND 2"MINIMUM FOR TOP MAT REINFORCEMENT IN THE TOP SLAB OF THE CULVERT.
10. HYDRAULIC DATA:
    A. DRAINAGE AREA = 0.83 SQUARE MILES
    B. Q2 = 69 CFS; Q10 = 172 CFS; Q25 = 239 CFS; Q100 = 362 CFS
    C. MINIMUM CLEAR SPAN = 19 FEET (BANKFULL WIDTH X 1.2 PLUS 2 FEET)
    D. DESIGN VELOCITY = 6 FPS
    E. DESIGN FLOOD = 25 YEAR; CHECK FLOOD (SCOUR) = 100 YEAR
    F. DESIGN SCOUR = 2 FEET
    G. DESIGN FREEBOARD (Q25) = 2 FEET MINIMUM
    H. Q25 ELEVATION = 1192.2; Q100 ELEVATION = 1193.1
11. FROST DEPTH = 5.5 FEET
12. A GEOTECHNICAL REPORT WAS PREPARED FOR THIS PROJECT BY S.W.COLE ENGINEERING, INC. DATED MARCH 6, 2015.

Construction Notes

1. THE EXISTING BRIDGE SHALL BE CAREFULLY REMOVED IN ITS ENTIRETY INCLUDING CONCRETE BLOCKS, FOOTINGS, SUPERSTRUCTURE SLABS AND RAILINGS. COMPONENTS SHALL BE TRANSPORTED AND NEATLY STOCKPILED AT A SUITABLE LOCATION ON THE PROPERTY APPROVED BY IBERDROLA RENEWABLES. GUARDRAIL END UNITS AND GUARDRAIL BEAM SHALL BE SALVAGED AND INCORPORATED INTO THE REPLACEMENT BRIDGE.
2. WATER DIVERSION AND FOUNDATION DEWATERING IS ANTICIPATED FOR THIS PROJECT. THE WORK SHALL BE PERFORMED DURING LOW-FLOW PERIODS. THE WATERWAY OF THE BROOK SHALL BE MAINTAINED AT ALL TIMES WITH A MINIMUM CROSS-SECTIONAL AREA OF 9 SF AND A SPILL-WAY OR FLOOD ELEVATION OF 1192.
3. DEBRIS CONTAINMENT, SEDIMENT AND TURBIDITY CONTROL MEASURES SHALL BE EMPLOYED AT ALL TIMES TO ENSURE WATER QUALITY OF CLARK BROOK.
4. CULVERT AND WINGWALL FOOTINGS SHALL BE PLACED ON AT LEAST 12 INCHES OF COMPACTED CLEAN, CRUSHED STONE (ASTM #57) WRAPPED IN MIRAFI 180N NON-WOVEN GEOTEXTILE.
5. ALL UNCONTROLLED FILLS, RELIC STRUCTURES, ORGANICS, AND WOOD DEBRIS SHALL BE COMPLETELY REMOVED BENEATH PROPOSED FOUNDATIONS. THE EXTENT OF REMOVAL SHALL BE 1-FOOT LATERALLY FOR EVERY 1-FOOT OF EXCAVATION OUTSIDE THE PERIMETER OF ALL FOOTINGS.
6. EXCAVATION TO BEARING SURFACES SHALL BE COMPLETED WITH A SMOOTH-EDGED BUCKET TO MINIMIZE DISTURBANCE OF SENSITIVE GLACIAL TILL. DISTURBED AREAS THAT BECOME YIELDING SHALL BE FURTHER DEWATERED, EXCAVATED, AND BACKFILLED WITH CONTROLLED LIFTS OF COMPACTED GRAVEL BACKFILL.
7. CONTROL OF WATER WITHIN THE EXCAVATION SHALL BE CONDUCTED IN SUCH A MANNER AS TO PREVENT DISTURBANCE OF THE BEARING SOIL. WELL POINTS, SUMPS OR OTHER PUMPING AREAS SHALL BE LOCATED OUTSIDE THE FOOTING LIMITS AND PROPERLY FILTERED TO PREVENT PUMPING OF THE SOIL MATERIALS BELOW THE EXCAVATION SUBGRADE.
8. THE CONTRACTOR SHALL RESTORE DISTURBED AREAS TO THEIR ORIGINAL CONDITION, UNLESS OTHERWISE SHOWN ON THE PLANS. THE CONTRACTOR SHALL USE 2 FEET OF CLASS B STONE FILL WITH AN UNDERLYING GEOTEXTILE TO RESTORE DISTURBED STREAM EMBANKMENTS.

Concrete Culvert Notes

1. THE PRECAST CULVERT, WINGWALLS, AND FOOTINGS SHALL MEET THE DESIGN AND MANUFACTURING REQUIREMENTS OF THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS EXCEPT AS OTHERWISE SPECIFIED ON THE PLANS.
2. ALL CONCRETE MIX DESIGNS SHALL BE SIMILAR TO THAT PROVIDED AND APPROVED BY NHDOT WITHIN THE LAST 5 YEARS. VARIATIONS IN THE MIX DESIGN SHALL BE SUBJECT TO THE APPROVAL OF THE ENGINEER. CONCRETE USED IN PRE-CAST MEMBERS SHALL BE CLASS AAA WITH THE FOLLWING:
   A. 28-DAY STRENGTH = 5 KSI
   B. MINIMUM CEMENT PER CY OF CONCRETE = 8 BAGS
   C. MAXIMUM WATER/CEMENT RATIO = 0.38
   D. SLUMP = 5 TO 7 INCHES WITH HIGH RANGE WATER REDUCING ADMIXTURE
   E. AIR ENTRAINMENT = 5 TO 7 PERCENT
   F. MAXIMUM SIZE COARSE AGGREGATE = ¾"
3. CALCULATIONS FOR THE DESIGN OF THE CULVERT SECTIONS, FOOTINGS, CONNECTIONS, AND WINGWALLS SHALL BE PREPARED AND STAMPED BY A LICENSED PROFESSIONAL ENGINEER IN THE STATE OF NEW HAMPSHIRE. CALCULATIONS SHALL BE INCLUDED WITH THE DETAILED SHOP DRAWINGS THAT MUST BE SUBMITTED FOR APPROVAL. DRAWINGS SHALL BE APPROVED PRIOR TO FABRICATION.
4. DETAILS AND LOCATIONS OF ALL ITEMS TO BE EMBEDDED IN THE SECTIONS, METHOD OF CURING, HANDLING, STORING, TRANSPORTING, AND ERECTING SECTIONS SHALL BE INCLUDED IN THE SHOP DRAWINGS. THE CONTRACTOR IS RESPONSIBLE FOR THE PROPER CASTING, HANDLING, LIFTING, STORING, TRANSPORTING, AND ERECTION OF ALL COMPONENTS SO THAT THEY CAN BE PLACED IN THE COMPLETED STRUCTURE WITHOUT DAMAGE.
5. THE FOLLOWING ARE CONSIDERED DEFECTS WHICH MAY CONSTITUTE CAUSE FOR REJECTION: ANY CRACKS WHICH EXTEND TO THE REINFORCING STEEL; HONEYCOMBS OVER 6 SQUARE INCHES IN AREA AND OVER 1 INCH DEEP; ANY DISCONTINUITY OF THE CONCRETE WHICH MAY PERMIT MOISTURE TO REACH THE REINFORCING STEEL, EDGE OR CORNER BREAKS EXCEEDING 12 INCHES IN LENGTH OR OVER 1 INCH IN DEPTH, DAMAGED ENDS THAT PREVENT MAKING A SATISFACTORY JOINT, EXTENSIVE HAIRLINE CRACKS OR CHECKS, RACKED OR UN-SQUARE SECTIONS. THE ENGINEER MAY APPROVE REPAIRS TO OCCASIONAL, NON-RECURRING, AND ISOLATED DEFECTS.
6. ALL EXPOSED EDGES OF CONCRETE SHALL BE CHAMFERED ¾" UNLESS OTHERWISE NOTED.
7. ALL PRECAST JOINTS SHALL BE SEALED AND COVERED AS RECOMMENDED BY THE MANUFACTURER AND PRIOR TO BACKFILL PLACEMENT.
8. A SILANE SEALANT WATER REPELLENT SHALL BE APPLIED TO ALL EXPOSED SURFACES OF THE PRECAST CULVERT, HEADWALL, AND WINGWALL SURFACES TO 12 INCHES BELOW FINISHED GRADE. SEALANT SHALL BE APPLIED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS.

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Groton Wind Farm

Groton Hollow Road
Groton, New Hampshire

No.	Revision	Date	Appvd.

Designed by S. Hodgdon — Checked by J. Whitmore

Issued for — Date

April 24, 2015

Not For Construction

Drawing Title

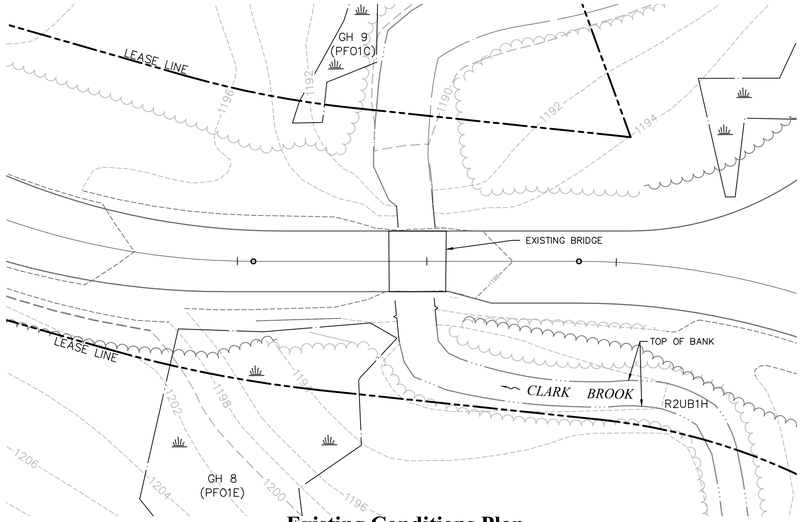
Upper Bridge Reconstruction

Drawing Number

Sheet 1 of 2

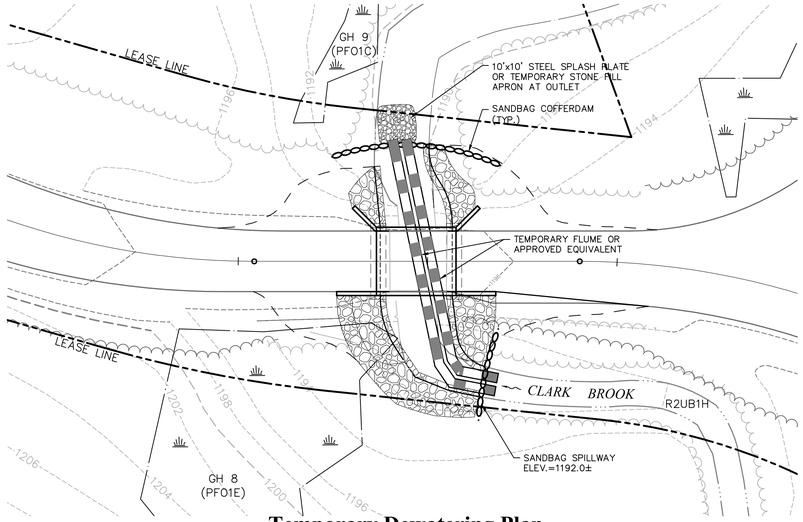
Project Number

52036.09



Existing Conditions Plan

0 10 20 40 Feet



Temporary Dewatering Plan

0 10 20 40 Feet

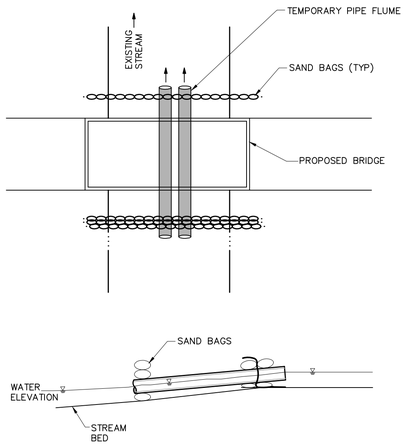
Wetland Classification Codes

PF01E	PALUSTRINE, FORESTED, BROAD-LEAVED DECIDUOUS, SEASONALLY FLOODED/SATURATED
R2UB1H	RIVERINE, LOWER PERENNIAL, UNCONSOLIDATED BOTTOM, COBBLE-GRAVEL, PERMANENTLY FLOODED

Wetland Impact Summary

Resource	USFWS Wetland Classification	Impact Location	Area (sf)			
			Permanent Impacts		Temporary Impacts	
			(sf)	(lf)	(sf)	(lf)
WETLAND	PF01E	A	140			
STREAMBED / BANK	R2UB1H	B			330	30
		C	290	30		
		D			270	30
TOTAL			430	30	600	60

PERMANENT IMPACTS:	430 SF
TEMPORARY IMPACTS:	600 SF
TOTAL IMPACTS =	1030 SF

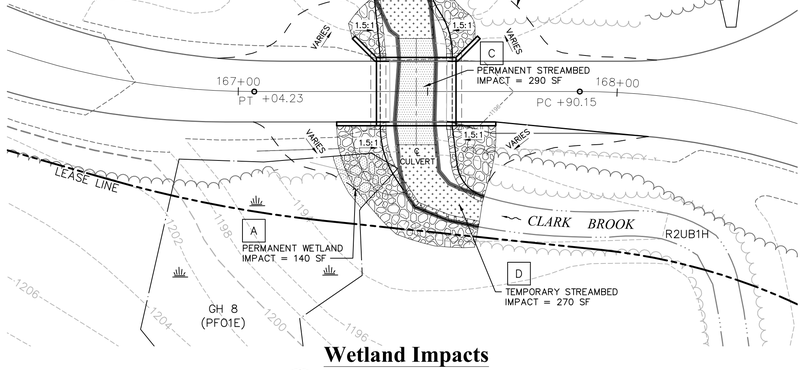


Dam and Flume For Bridge Construction

N.T.S.

Notes:

1. CONSTRUCTION ACTIVITIES IN STREAMS WILL BE SCHEDULED FOR PERIODS WHEN FLOWS ARE ANTICIPATED TO BE AT A MINIMUM. IF THERE IS FLOWING WATER DURING CONSTRUCTION THE FLOW SHALL BE DIVERTED AROUND THE WORK SITE IN A STABLE MANNER USING METHODS APPROVED BY THE ENGINEER.
2. ONCE SANDBAGS ARE IN PLACE, A TEMPORARY FLUME WILL BE PLACED TO CONVEY ANY FLOW AROUND THE WORK SITE, AS NEEDED.
3. COFFERDAMS AND FLUME WILL BE REMOVED AFTER BRIDGE IS INSTALLED. COMPLETE REMOVAL IMMEDIATELY AFTER BRIDGE INSTALLATION, WITHIN ONE DAY WHENEVER POSSIBLE.
4. TREES SHALL BE SELECTIVELY TRIMMED ALONG BANKS (IF APPLICABLE) OR CLEARED TO ALLOW EQUIPMENT TO OPERATE. GRUBBING OF ROOTS SHALL BE KEPT TO A MINIMUM.
5. DETAIL PROVIDED FOR GENERAL INFORMATION ONLY. THE CONTRACTOR SHALL MODIFY AS NECESSARY TO ACHIEVE REQUIRED DEWATERING OF WORK AREA.



Wetland Impacts

0 10 20 40 Feet

Streambed Restoration Notes

1. FOLLOWING INSTALLATION OF THE BRIDGE, THE CONTRACTOR SHALL RESTORE A NATURAL STREAMBED USING COBBLE-GRAVEL-SAND MIX PLACED APPROXIMATELY 1 FT THICK TO THE SATISFACTION OF THE ENGINEER. THE FINAL ELEVATIONS OF THE STREAMBED SHALL BLEND INTO UPSTREAM AND DOWNSTREAM ELEVATIONS.
2. COBBLE-GRAVEL-SAND MIX SHALL CONSIST OF NATURAL FIELD STONE, BANK RUN GRAVEL OR NATURAL RIVER ROCK. CRUSHED STONE FROM A QUARRY OR OTHER SOURCES WILL NOT BE PERMITTED. STONE GRADATION WILL APPROXIMATE THE FOLLOWING SIZE DISTRIBUTION; AMOUNTS FINER THAN EACH LABORATORY SIEVE (SQUARE OPENINGS) (PERCENT BY WEIGHT):

CUMULATIVE PERCENT FINER	PARTICLE SIZE (IN) MIN	MAX
D_{15}	0.5	1.5
D_{35}	2.0	3.0
D_{50}	5.0	7.0
D_{85}	10.0	12.0
D_{100}		14.0

3. COBBLE-GRAVEL-SAND FILL MAY CONTAIN SMALL AMOUNTS OF FINE AGGREGATE BUT SHALL CONTAIN NO AMOUNTS OF SOIL MATERIAL.
4. COBBLE-GRAVEL-SAND MIX WILL BE APPROVED BY THE ENGINEER PRIOR TO PLACEMENT.

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Notes:

1. ANY TURBID DEWATERING EFFLUENT SHALL BE PLACED IN AN UPLAND CATCHMENT / SETTLEMENT BASIN AS REQUIRED PRIOR TO DISCHARGING INTO BROOK.
2. CONSTRUCTION SHALL BE LIMITED TO LOW FLOW CONDITIONS.

Legend

- EDGE OF WATER (PHOTOGRAMETRY)
- LIMIT OF WETLAND (SURVEY)
- PF01E — WETLAND CLASSIFICATION
- A — WETLAND IMPACT LOCATION
- PERMANENT IMPACT
- TEMPORARY STREAMBED IMPACT

Groton Wind Farm
Upper Bridge Reconstruction

Groton Hollow Road
Groton, New Hampshire

No.	Revision	Date	Appvd.

Designed by: PGG / RRL
Checked by: PJW

Issued for
Date: April 24, 2015

Not For Construction

Drawing Title
Wetland Impact Plan

Drawing Number

Sheet 2 of 2

Project Number
52036.09

Appendix C

Representative Site Photographs

■

Appendix C
Representative Site Photographs
Upper Bridge Replacement, Groton, NH

Photo 1: Pre-Emergency Authorization- Looking southeast along Groton Hollow Road, Upper Bridge Crossing of Clark Brook.

Photo 2: Pre-Emergency Authorization - Looking west at Northwest corner of abutment #1 (downstream side)

Appendix C
Representative Site Photographs
Upper Bridge Replacement, Groton, NH

Photo 3. Pre- Emergency Authorization - Looking north at the southwest corner of abutment #1 (upstream side)

Photo 4. Pre- Emergency Authorization - Looking downstream along abutment #2

Appendix C
Representative Site Photographs
Upper Bridge Replacement, Groton, NH

Photo 5. Pre- Emergency Authorization - Looking downstream from bridge.

Photo 6. Pre- Emergency Authorization - Looking upstream from bridge.

Appendix C
Representative Site Photographs
Upper Bridge Replacement, Groton, NH

Photo 7. Pre- Emergency Authorization - Looking upstream toward bridge.

Photo 8. Post- Emergency Authorization - Looking southeast along Groton Hollow Road, Upper Bridge Crossing of Clark Brook

Appendix C
Representative Site Photographs
Upper Bridge Replacement, Groton, NH

Photo 9. Post- Emergency Authorization - Looking west at Northwest corner of abutment #1 (downstream side).

Photo 10. Post- Emergency Authorization - Looking north at the southwest corner of abutment #1 (upstream side)

Appendix C
Representative Site Photographs
Upper Bridge Replacement, Groton, NH

Photo 11. Post- Emergency Authorization - Looking downstream along abutment #2

Photo 12. Post- Emergency Authorization – Looking downstream along abutment #1

Appendix C
Representative Site Photographs
Upper Bridge Replacement, Groton, NH

Photo 13: Wetland GH-8 (PFO1E), located within the project area to the northwest of the existing bridge. 140 square feet of permanent impact is proposed in this area.

Appendix D

Clark Brook Technical Assessment

■

Memorandum

To: Jebby Varughese, Iberdrola Renewables
Doren Emmett, Iberdrola Renewables
Michael Clayton, Iberdrola Renewables

Date: December 19, 2014

Project #: 52036.06

From: Ryan Lizewski, VHB

Re: Upper Bridge Stream Crossing Evaluation
Clark Brook, Groton, NH

The following technical memorandum summaries VHB's hydrologic and hydraulic analysis for the "Upper Bridge" (Site) over Clark Brook at the Groton Wind Farm owned and operated by Iberdrola Renewables located in Groton, New Hampshire.

Existing Conditions

VHB conducted a field visit to the Site on November 24, 2014. Steady rain through the day increased flow in Clark Brook albeit not near bankfull stage. The National Weather Service station in Bridgewater, NH (KNHBRIDG3) recorded 0.81-inches of rain during the day of the site visit.

The existing crossing is visually undersized and constricting the natural bankfull channel and floodplain. VHB observed significant scour at the culvert inlet and along the outer northwestern footing. The constriction of stream flows has likely resulted in the observed scour that has moved and/or loosened several of the 3'x3'x3' abutment blocks. The crossing appears to have been temporarily improved with timber mats and soil over the existing structure. Other observations from the visit include:

- Existing stream crossing is located at a meander bend, which are naturally prone to scour along the outer bend of the channel.
- Existing bed material consist of cobbles and small boulders indicative of relatively high velocities and shear stressed during larger storm events.
- The upstream forested floodplain has significant evidence of debris loading. VHB observed trees, branches, and leaves trapped on the upstream side of standing trees.
- VHB measured the bankfull width (BFW) of Clark Brook at six locations near the crossing; three upstream and three downstream. The bankfull width measurements are provided in Table 1 below:

Table 1: Band Full Width Measurements (ft)

ID	Width	Description
US #3	14.9	Meander bend, approx. 150-feet upstream
US #2	12.5	Meander bend, approx. 90-feet upstream
US #1	14.2	Riffle section, approx. 50-feet upstream
DS #3	19.5	Riffle section approx. 35-ft downstream. Channel appears disturbed and not representative of natural BFW
DS #2	13.8	Riffle section, approx. 95-feet downstream
DS #1	13.5	Meander bend, approx. 130-feet downstream
Average	13.8	Measurement DS#3 not included

Memorandum

VHB recommends using a BFW of 14-feet for the stream crossing design.

Hydrology

VHB estimated peak flood flows to the Site from the contributing watershed using the United States Geological Service (USGS) Regional Regression Equations and the New England Transportation Consortium (NETC) Regression Equation for Streams in New England. VHB used the USGS StreamStats web application to calculate watershed parameters for calculating flood flow estimates. The calculated watershed stream slope of 673 ft/mile (using the 10 and 85 Method) is greater than the suggested maximum value of 543 ft/mile as recommended by USGS. The NETC regression equation are recommended for steep streams with a main channel slope that exceeds 50ft/mi with no maximum recommended value. The results are presented below in Table 2:

Table 2: Estimated Annual Return Period Flood Frequency Flows (cfs)

Storm	USGS	NETC
2-year	69	59
10-year	172	128
25-year	239	171
100-year	362	239

The USGS equations estimate higher flood flows for all storm events compared to the NETC estimates. The USGS and NETC calculations are included with the memorandum as Attachment A. While the watershed slope is just beyond the recommended maximum value, we feel the USGS equations still provide acceptable flow estimates. VHB recommends using the higher USGS flows for the crossing design.

Hydraulics

VHB evaluated culvert capacity and predicted peak water surface elevations using HY-8 Culvert Hydraulic Analysis Program (HY-8 7.3), which is a Federal Emergency Management Agency (FEMA) approved model. The model inputs and results are included with this memorandum as Attachment B. VHB used existing condition surveys and measurements taken during the site visit to generate the culvert inputs, overtopping sections, and tail water conditions. VHB analyzed the crossing with the USGS flows for all recurrence intervals listed above.

VHB evaluated the existing crossing as well as two proposed alternatives. The existing crossing is a single span structure with vertical abutments. For the two alternatives, VHB assumed a single span with a natural channel geometry and substrate as well as an embedded arch culvert. The New Hampshire Stream Crossing Guidelines from University of New Hampshire (UNH Guidelines) recommend a crossing span of BFW x 1.2 plus 2-feet. Based on the UNH guidelines, the measured 14-foot Clark Brook BFW results in a recommended span of 18.8-feet. VHB assumed a crossing span of 19-feet for both alternatives. The crossing structure geometries are summarized below in Table 3:

Memorandum

Table 3: Crossing Structure Geometries

Type	Span[1] (ft)	Rise[1] (ft)	Open Area (sf)	Openness Ratio[2]
Existing	9.5	5.8	55.1	3.4
Arch	19	4.7	61.5	3.8
Span	19	4.5	76.5	4.8

1: Crossing dimensions are the open area dimension and do not include embedment
2: Culvert length of 16-feet assumed for all crossing

VHB sized the culverts to pass the 25-year storm with at least 1-foot of freeboard to the low chord of the bridge and accommodate the 100-year storm without submerging the inlet. Results from VHBs analysis are summarized in Table 4 and Table 5 below.

Table 4: Water Surface Elevation (WSE) Summary Table

	Crossing		25-Year Flow		100-Year Flow	
Type	Invert[3]	Low Chord[3]	WSE[3]	Freeboard (ft)	WSE[3]	Freeboard (ft)
Existing	1188.7	1194.5	1193.10	1.40	1194.52	-0.02
Arch	1188.7	1193.4	1192.23	1.17	1193.36	0.04
Span	1188.7	1193.2	1192.18	1.02	1193.08	0.12

3: Elevations presented in feet NAVD88

Table 5: Crossing Outlet Velocity Summary Table (fps)

Storm	Existing	Arch	Span
2-year	5.0	2.6	3.2
10-year	7.9	4.3	4.6
25-year	9.3	5.3	5.2
100-year	10.7	6.9	6.3

Regulatory Compliance - Stream Crossing Standards

The proposed Upper Bridge replacement over Clark Brook must address the stream crossing standards outlined in the New Hampshire Administrative Rule Env-Wt 900 (the Regulations). Under this rule, stream crossings are classified as Tier 1, Tier 2, or Tier 3 based on the location of the project. This Site meets the requirements for a Tier 2 classification as defined by Env-Wt 904.03(a). A Tier 2 stream crossing must have a watershed area greater than 200 acres and less than 640 acres. The drainage area to the Site is 531 acres (0.83 mi2). The Site does not satisfy any of the other Tier 3 requirements as defined in Env-Wt 904.04.

The required Tier 2 stream crossing design criteria as defined in the Regulations are provided below in italics. Responses on how the proposed crossing meets each requirement are provided below the pertinent regulations. As of today, the proposed crossing design has not been finalized so recommendations have been provided for a few of responses.

Memorandum

Env-Wt 904.05 Design Criteria for Tier 2 and Tier 3 Stream Crossings. New tier 2 stream crossings, replacement Tier *2 stream crossings that do not meet the requirements of Env-Wt 904.07, and new and replacement* Tier *3 stream crossings shall be designed and constructed:*

(a) In accordance with the NH Stream Crossing Guidelines, University of New Hampshire, May 2009, which can be downloaded for free at http://www.streamcontinuity.org/pdf_files/nh_stream_crossing_guidelines_unh_web_rev_2.pdf/;

The proposed crossing will meet the requirements outlined in the NH Stream Crossing Guidelines issues from UNH. The proposed design components for a crossing structure which satisfy the UNH guidelines include:

- Maintaining a similar crossing slope to the natural channel
- Installing an open bottomed structure or embedded culvert with natural stream bed substrate
- Creating natural channel geometry with banks to accommodate low flows
- Spanning at least BFW (14-ft) x 1.2 + 2-ft = 18.8-ft
- Maintain an openness ratio of 0.25

(b) With the bed forms and streambed characteristics necessary to cause water depths and velocities within the crossing structure at a variety of flows to be comparable to those found in the natural channel

The proposed structure will be open-bottom or embedded which allow for natural streambed characteristics to be simulated. The crossing will have a natural channel geometry which will maintain comparable water depths and velocities to the natural channel.

(c) To provide a vegetated bank on both sides of the watercourse to allow for wildlife passage;

The recommended crossing span of 19-feet is 5 feet beyond the measured BFW to allow for creation of natural banks through the crossing.

(d) To preserve the natural alignment and gradient of the stream channel, so as to accommodate natural flow regimes and the functioning of the natural floodplain;

The proposed crossing will maintain a channel slope similar to the natural stream slope at the Site. The larger 19-foot span will mitigate impacts to stream flow regimes and floodplain functions compared to existing conditions.

(e) To accommodate the 100-year frequency flood, to ensure that:

(1) There is no increase in flood stages on abutting properties; and

(2) Flow and sediment transport characteristics will not be affected in a manner which could adversely affect channel stability;

Memorandum

The proposed crossing will simulate, to the extent practicable, the natural stream channel and stream processes including flow and sediment transport characteristics. Iberdrola Renewables owns and manages the surrounding land and there are no abutters in proximity to this crossing. Increases to abutting properties are not predicted.

(f) To simulate a natural stream channel; and

(g) So as not to alter sediment transport competence.

The proposed crossing will simulate, to the extent practicable, the natural stream channel and stream processes.

Conclusions

The existing Upper Bridge stream crossing over Clark Brook significantly impacts channel stability, stream flow regimes, floodplain function; creates scour/erosion; and impedes aquatic organism passage. VHB determined multiple design options and outlined specific design criteria that should be considered for the proposed replacement structure so that the crossing will simulate, to the extent practicable, the natural stream channel, stream processes, and satisfy the stream crossing regulations.

VHB recommends either of the crossing structures evaluated in this analysis. Other alternative bridge types including multi-plate steel crossings are acceptable as long as they meet the minimum recommended spans, heights, and open areas evaluated in this memorandum. VHB would be glad to work with Iberdrola to evaluate specific crossing designs from a bridge designer or manufacturer.

Memorandum

Attachment A

Hydrology Calculations

USGS
New Hampshire StreamStats

Streamstats Ungaged Site Report

Date: Fri Nov 7 2014 09:18:48 Mountain Standard Time
Site Location: New_Hampshire
NAD27 Latitude: 43.7544 (43 45 16)
NAD27 Longitude: -71.8117 (-71 48 42)
NAD83 Latitude: 43.7544 (43 45 16)
NAD83 Longitude: -71.8112 (-71 48 40)
Drainage Area: 0.83 mi2

Peak Flows Region Grid Basin Characteristics

100% Peak Flow Statewide SIR2008 5206 (0.83 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	0.83	0.7	1290
Mean April Precipitation (inches)	4.110	2.79	6.23
Percent Wetlands (dimensionless)	0.0000	0	21.8
Stream Slope 10 and 85 Method (feet per mi)	673 (above max value 543)	5.43	543

Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.

LowFlows Region Grid Basin Characteristics

100% Low Flow Statewide (0.83 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	0.83 (below min value 3.26)	3.26	689
Mean Basin Slope from 30m DEM (percent)	22.060	3.19	38.1
Maximum Basin Elevation (feet)	2128.521	260	6290
Percent Coniferous Forest (percent)	3.9763	3.07	56.2
Jan to Mar Basin Centroid Precip (inches)	8.7	5.79	15.1
Mean Annual Temperature (degrees F)	42.802	36	48.7
Jun to Oct Mean Basinwide Temp (degrees F)	59.212	52.9	64.4
Jun to Oct Gage Precipitation (inches)	21.2	16.5	23.1
Percent Mixed Forest (percent)	13.7775	6.21	46.1
Mar to May Gage Precipitation (inches)	10.5	6.83	11.5

Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.

Peak Flows Region Grid Streamflow Statistics

Statistic	Flow (ft^3/s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	68.9		3.2		
PK5	124		4.7		
PK10	172		6.2		
PK25	239		8		
PK50	294		9		
PK100	362		9.8		
PK500	526		11		

LowFlows Region Grid Streamflow Statistics

Statistic	Flow (ft^3/s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
D60	0.58				
D70	0.39				
D80	0.23				
D90	0.11				

D95	0.066				
D98	0.0403				
M7D2Y	0.0656				
D60SPR	2.19				
D60SUM	0.24				
D60WIN	0.93				
D70SPR	1.68				
D70SUM	0.18				
D70WIN	0.78				
D80SPR	1.31				
D80SUM	0.0931				
D80WIN	0.64				
D90SPR	0.9				
D90SUM	0.0561				
D90WIN	0.44				
D95SPR	0.65				
D95SUM	0.0376				
D95WIN	0.33				
D98SPR	0.5				
D98SUM	0.0288				
D98WIN	0.25				
M7D10Y	0.0217				
D60FALL	1.03				
D70FALL	0.86				
D80FALL	0.73				
D90FALL	0.53				
D95FALL	0.37				
D98FALL	0.24				
M7D2Y_FAL	0.64				
M7D2Y_SPR	0.73				
M7D2Y_SUM	0.0656				
M7D2Y_WIN	0.57				
M7D10Y_FAL	0.33				
M7D10Y_SPR	0.39				
M7D10Y_SUM	0.022				
M7D10Y_WIN	0.29				

Hydrology Calculations
New England Transportation Consortium (NETC)
Regression Equations

Project: Upper Bridge Stream Crossing Evaluation - Iberdrola Renewables
Location: Groton, NH
Notes: Calculations based on methodology outlined in the NETC publication (NETCR81, 2010): *Estimating the Magnitude of Peak Flows for Steep Gradient Streams in New England*

Peak-flow regression equation by recurrence interval	Standard Error of the Estimate (percent)		$(PRESS/n)^{1/2}$ (percent)		Average Prediction Error (percent)		Average Equivalent Yrs of Record
$Q_2=0.01601A^{0.889}P^{2.12}$	47.1%	-32.0%	46.9%	-31.9%	48.1%	-32.5%	2.09
$Q_5=0.01965A^{0.889}P^{2.19}$	45.1%	-31.1%	44.8%	-30.9%	46.1%	-31.6%	3.03
$Q_{10}=0.02430A^{0.891}P^{2.21}$	46.5%	-31.7%	46.4%	-31.7%	47.5%	-32.2%	3.89
$Q_{25}=0.03387A^{0.893}P^{2.20}$	50.4%	-33.5%	50.7%	-33.7%	51.5%	-34.0%	4.73
$Q_{50}=0.04372A^{0.895}P^{2.18}$	54.5%	-35.3%	55.2%	-30.9%	55.8%	-35.8%	5.10
$Q_{100}=0.05765A^{0.897}P^{2.15}$	59.4%	-37.3%	60.5%	-37.7%	60.8%	-37.8%	5.29
$Q_{500}=0.111A^{0.903}P^{2.08}$	73.4%	-42.3%	75.3%	-43.0%	75.1%	-42.9%	

Q = Peak flow (cfs)

A = Drainage Area (mi2)

P = Mean annual precipitation (in)

Calculations

A 0.83 mi2

P 52 in *Obtained from the PRISM climate Group at Oregon State University*

Storm	**Q**	
Q2	59	cfs
Q10	128	cfs
Q25	171	cfs
Q100	239	cfs

Memorandum

Attachment B

HY-8 Inputs and Results

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Recurrence

Table 1 - Summary of Culvert Flows at Crossing: Clark Brook Existing

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Existing Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1190.75	2 year	69.00	69.00	0.00	1
1192.42	10 year	172.00	172.00	0.00	1
1193.34	25 year	239.00	239.00	0.00	1
1194.82	100 year	362.00	362.00	0.00	1
1196.00	Overtopping	470.48	470.48	0.00	Overtopping

Rating Curve Plot for Crossing: Clark Brook Existing

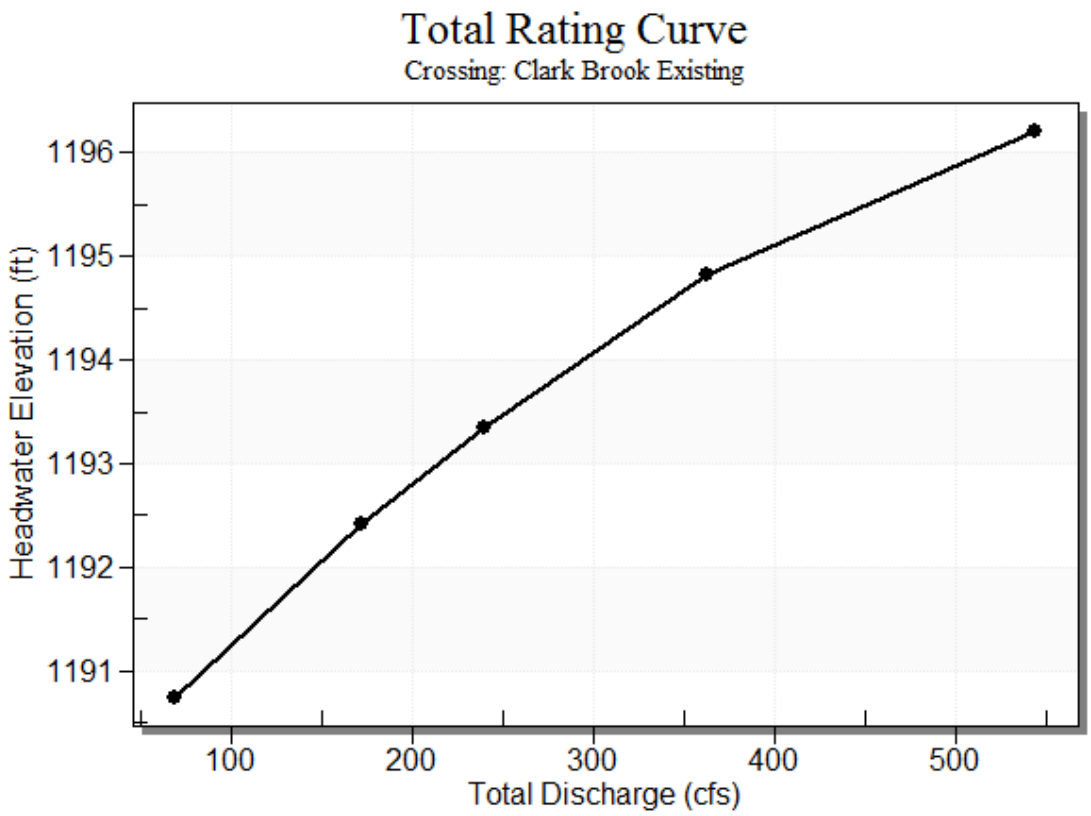
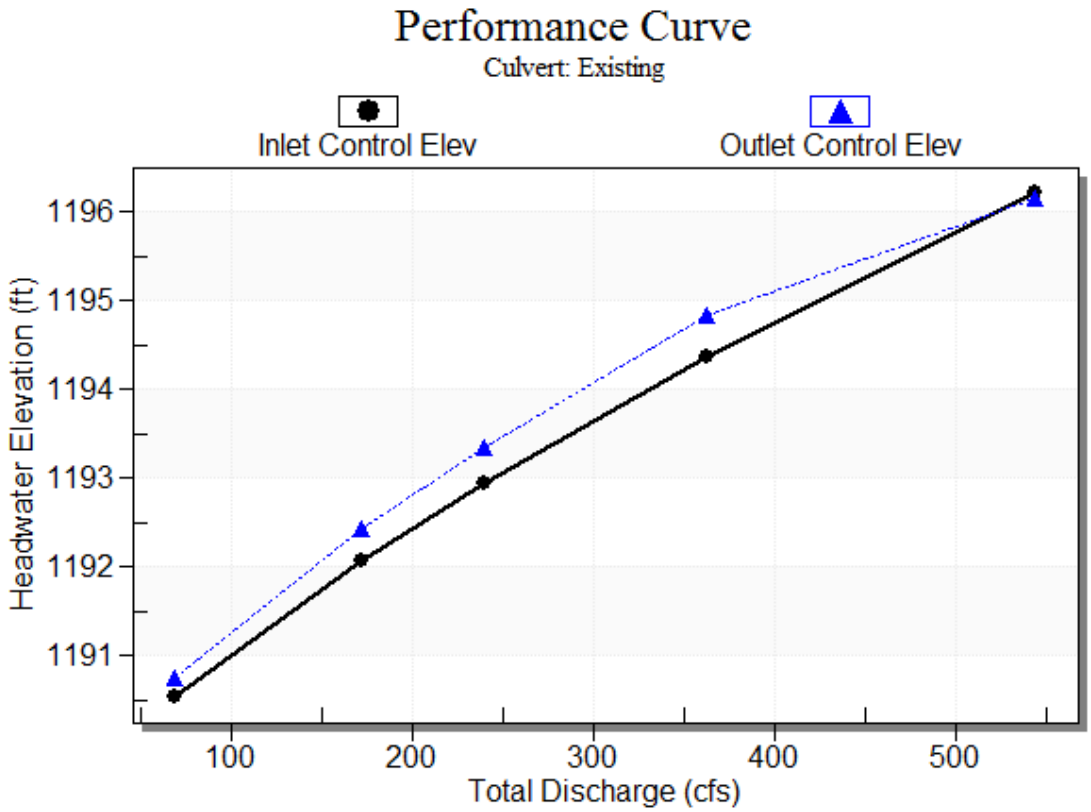


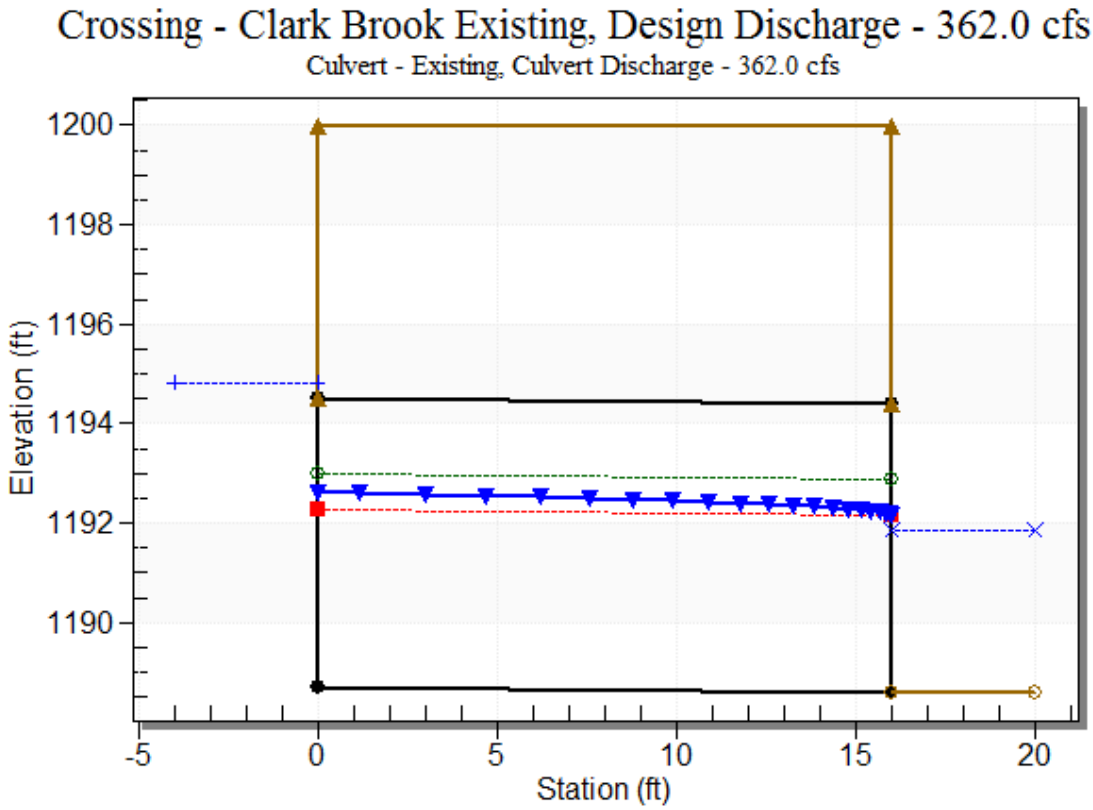
Table 2 - Culvert Summary Table: Existing

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
2 year	69.00	69.00	1190.75	1.837	2.049	3-M2t	1.566	1.186	1.458	1.458	4.982
10 year	172.00	172.00	1192.42	3.367	3.723	3-M2t	2.736	2.174	2.287	2.287	7.917
25 year	239.00	239.00	1193.34	4.251	4.636	2-M2c	3.339	2.704	2.704	2.672	9.303
100 year	362.00	362.00	1194.82	5.670	6.122	7-M2c	4.283	3.552	3.552	3.239	10.728

Culvert Performance Curve Plot: Existing



Water Surface Profile Plot for Culvert: Existing



Site Data - Existing

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1188.70 ft

Outlet Station: 16.00 ft

Outlet Elevation: 1188.60 ft

Number of Barrels: 1

Culvert Data Summary - Existing

Barrel Shape: User Defined

Barrel Span: 9.50 ft

Barrel Rise: 5.80 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Crossing Front View (Roadway Profile): Clark Brook Existing

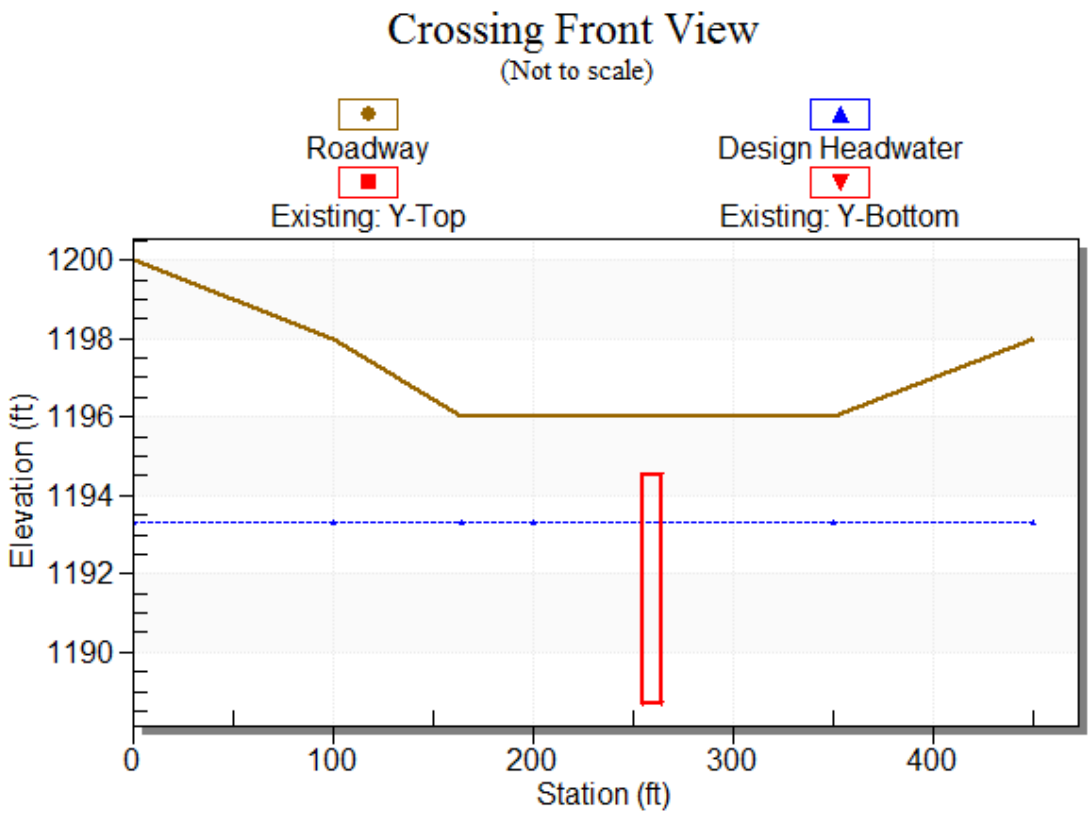


Table 3 - Downstream Channel Rating Curve (Crossing: Clark Brook Existing)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
69.00	1190.06	1.46	2.74	0.27	0.48
172.00	1190.89	2.29	3.51	0.43	0.51
239.00	1191.27	2.67	3.83	0.50	0.52
362.00	1191.84	3.24	4.27	0.61	0.53

Tailwater Channel Data - Clark Brook Existing

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 5.00 (_:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0300

Channel Invert Elevation: 1188.60 ft

Roadway Data for Crossing: Clark Brook Existing

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 16.00 ft

Table 4 - Summary of Culvert Flows at Crossing: Clark Brook Arch

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Prop Arch Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1190.38	2 year	69.00	69.00	0.00	1
1191.58	10 year	172.00	172.00	0.00	1
1192.23	25 year	239.00	239.00	0.00	1
1193.36	100 year	362.00	362.00	0.00	1
1196.00	Overtopping	593.38	593.38	0.00	Overtopping

Rating Curve Plot for Crossing: Clark Brook Arch

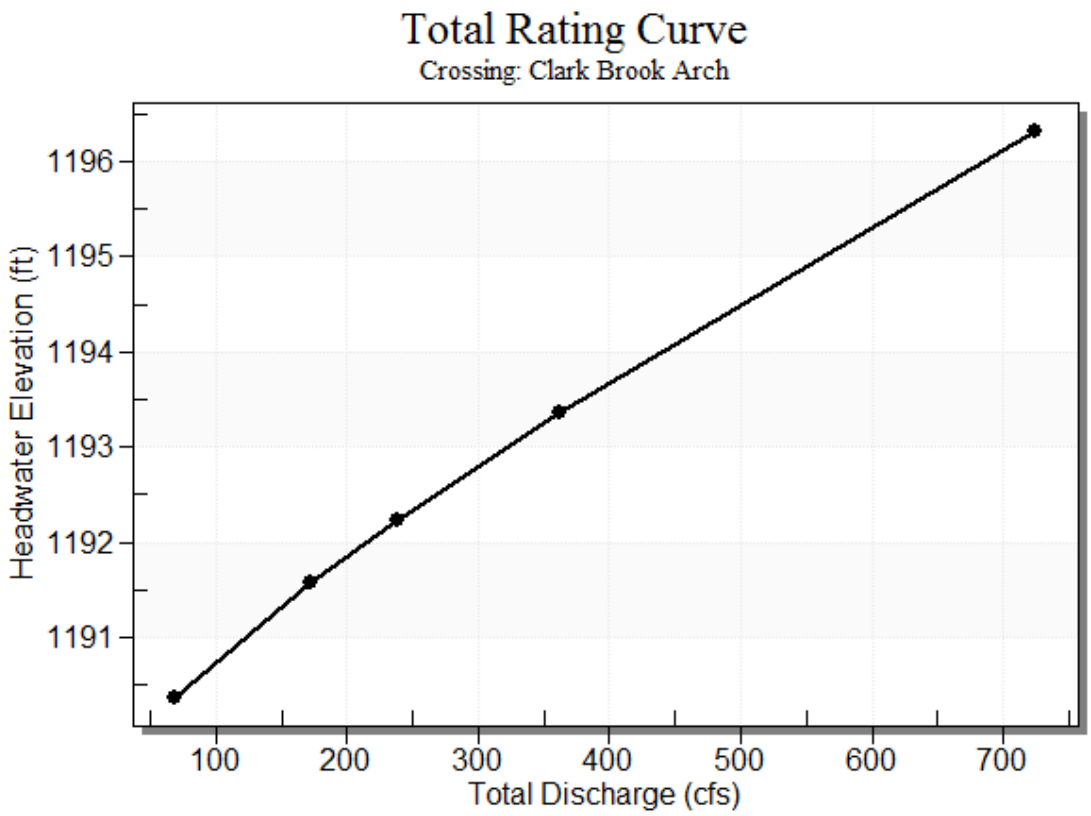
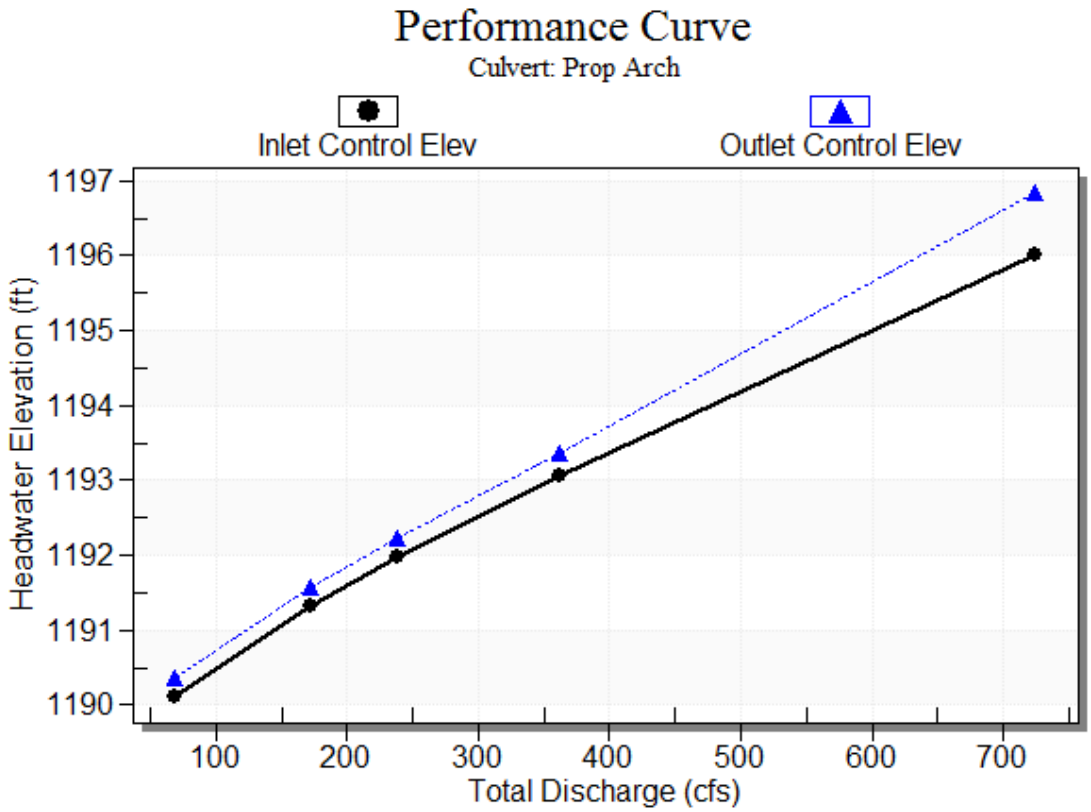


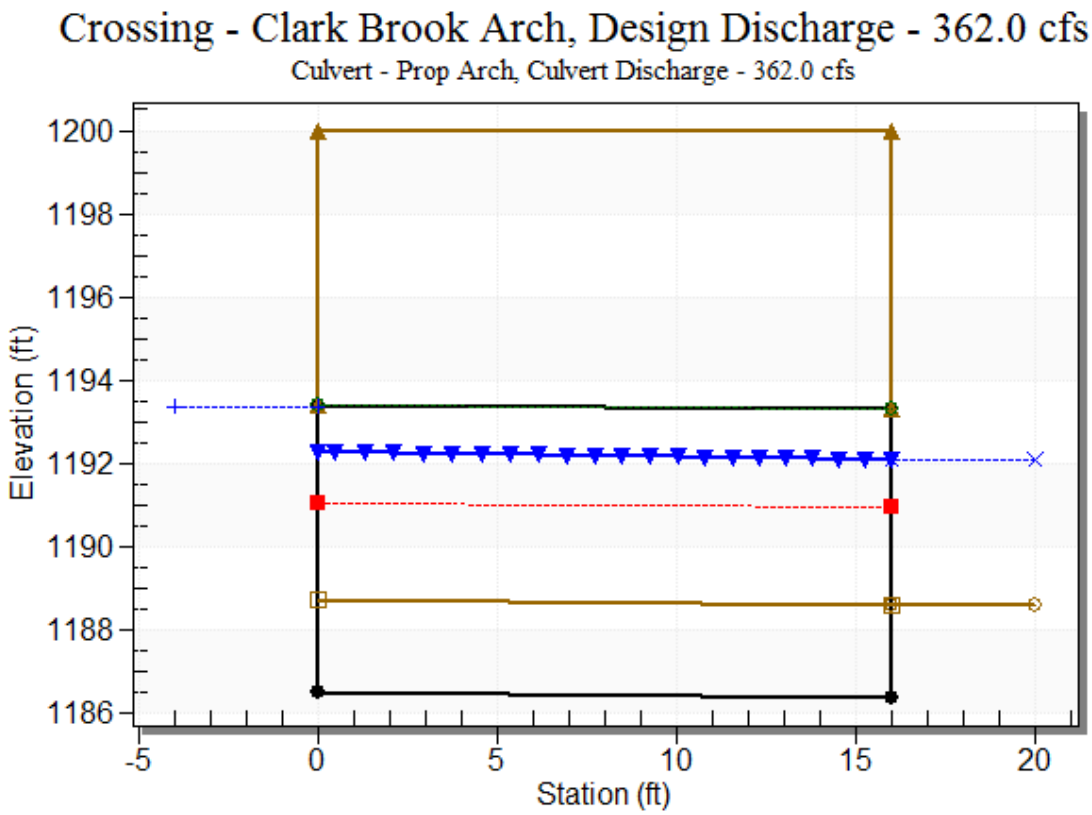
Table 5 - Culvert Summary Table: Prop Arch

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
2 year	69.00	69.00	1190.38	1.410	1.677	3-M1t	1.161	0.761	1.576	1.576	2.563
10 year	172.00	172.00	1191.58	2.613	2.877	3-M1t	2.238	1.428	2.461	2.461	4.315
25 year	239.00	239.00	1192.23	3.289	3.530	3-M2t	2.960	1.780	2.872	2.872	5.291
100 year	362.00	362.00	1193.36	4.365	4.657	3-M2t	4.697	2.350	3.475	3.475	6.963

Culvert Performance Curve Plot: Prop Arch



Water Surface Profile Plot for Culvert: Prop Arch



Site Data - Prop Arch

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1186.48 ft

Outlet Station: 16.00 ft

Outlet Elevation: 1186.38 ft

Number of Barrels: 1

Culvert Data Summary - Prop Arch

Barrel Shape: Arch, Open Bottom

Barrel Span: 21.00 ft

Barrel Rise: 6.92 ft

Barrel Material: Corrugated Steel

Embedment: 26.64 in

Barrel Manning's n: 0.0280 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Crossing Front View (Roadway Profile): Clark Brook Arch

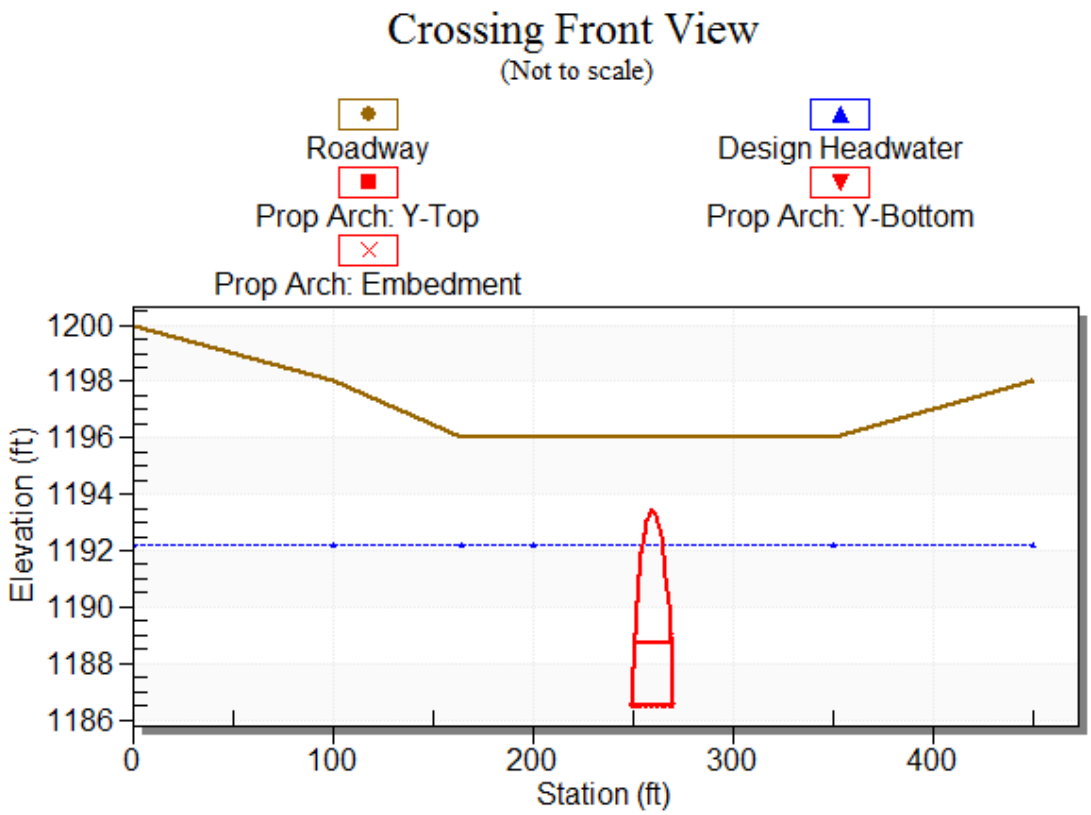


Table 6 - Downstream Channel Rating Curve (Crossing: Clark Brook Arch)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
69.00	1190.18	1.58	2.45	0.30	0.41
172.00	1191.06	2.46	3.13	0.46	0.44
239.00	1191.47	2.87	3.42	0.54	0.45
362.00	1192.07	3.47	3.81	0.65	0.46

Tailwater Channel Data - Clark Brook Arch

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 5.00 (_:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0350

Channel Invert Elevation: 1188.60 ft

Roadway Data for Crossing: Clark Brook Arch

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 16.00 ft

Table 7 - Summary of Culvert Flows at Crossing: Clark Brook Span

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Prop Span Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1190.48	2 year	69.00	69.00	0.00	1
1191.60	10 year	172.00	172.00	0.00	1
1192.18	25 year	239.00	239.00	0.00	1
1193.08	100 year	362.00	362.00	0.00	1
1196.00	Overtopping	662.89	662.89	0.00	Overtopping

Rating Curve Plot for Crossing: Clark Brook Span

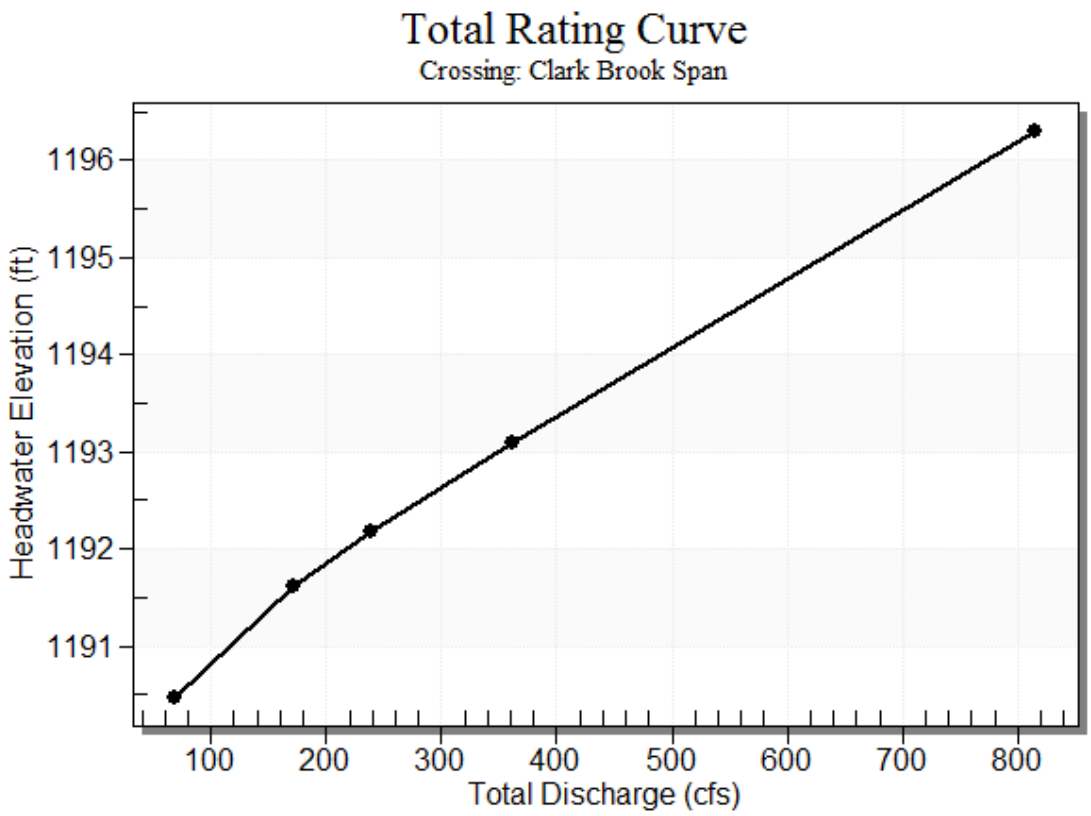
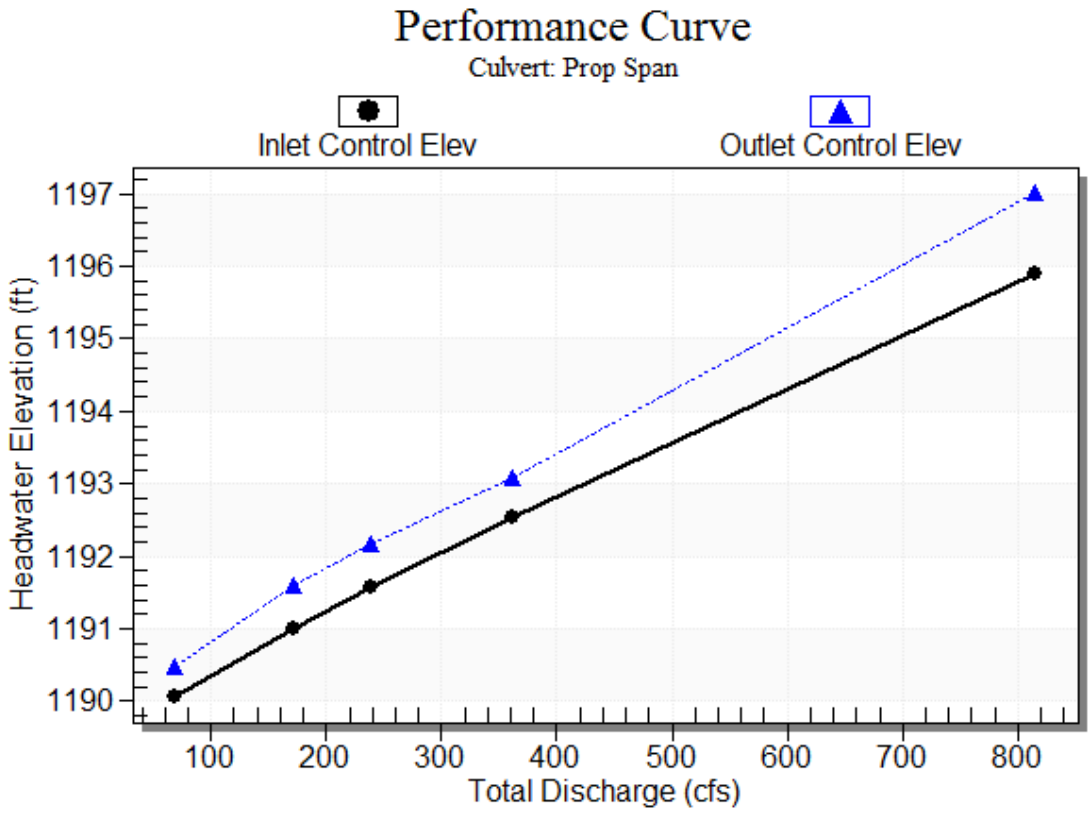


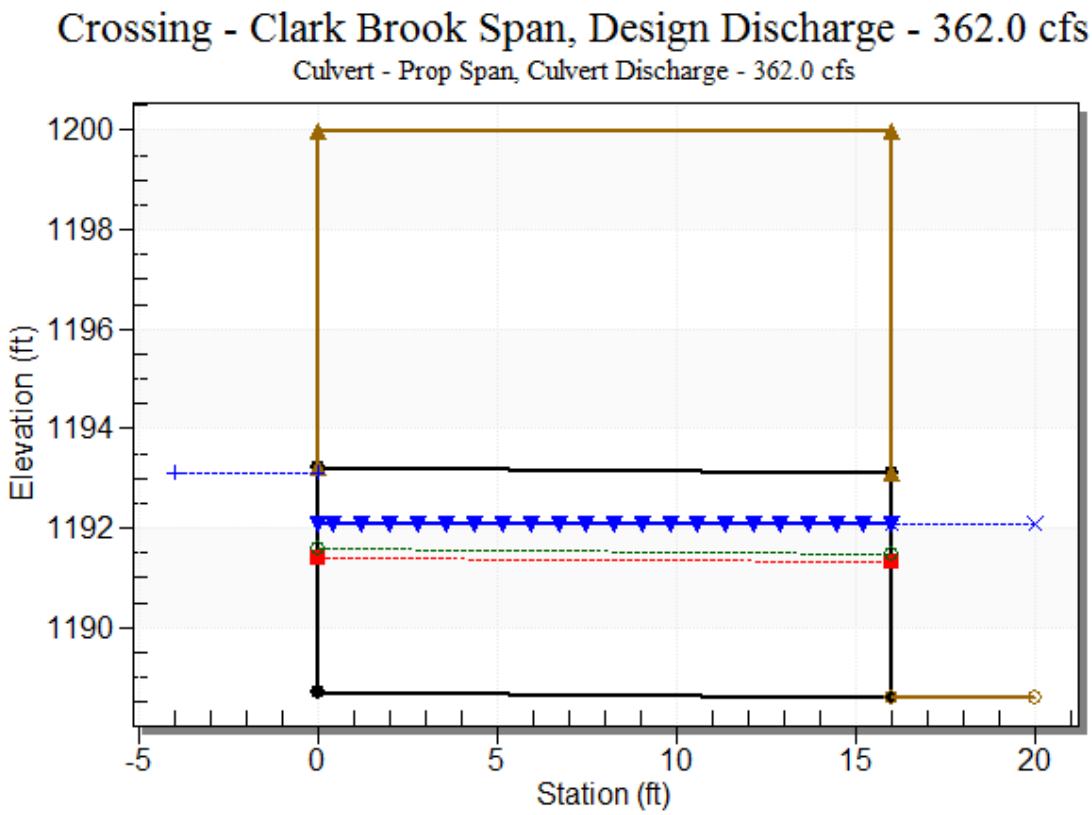
Table 8 - Culvert Summary Table: Prop Span

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
2 year	69.00	69.00	1190.48	1.360	1.776	3-M1t	1.237	1.044	1.576	1.576	3.232
10 year	172.00	172.00	1191.60	2.311	2.904	3-M1t	1.991	1.813	2.461	2.461	4.555
25 year	239.00	239.00	1192.18	2.884	3.476	3-M1t	2.324	2.175	2.872	2.872	5.245
100 year	362.00	362.00	1193.08	3.837	4.385	3-M1t	2.872	2.711	3.475	3.475	6.348

Culvert Performance Curve Plot: Prop Span



Water Surface Profile Plot for Culvert: Prop Span



Site Data - Prop Span

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1188.70 ft

Outlet Station: 16.00 ft

Outlet Elevation: 1188.60 ft

Number of Barrels: 1

Culvert Data Summary - Prop Span

Barrel Shape: User Defined

Barrel Span: 19.00 ft

Barrel Rise: 4.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Crossing Front View (Roadway Profile): Clark Brook Span

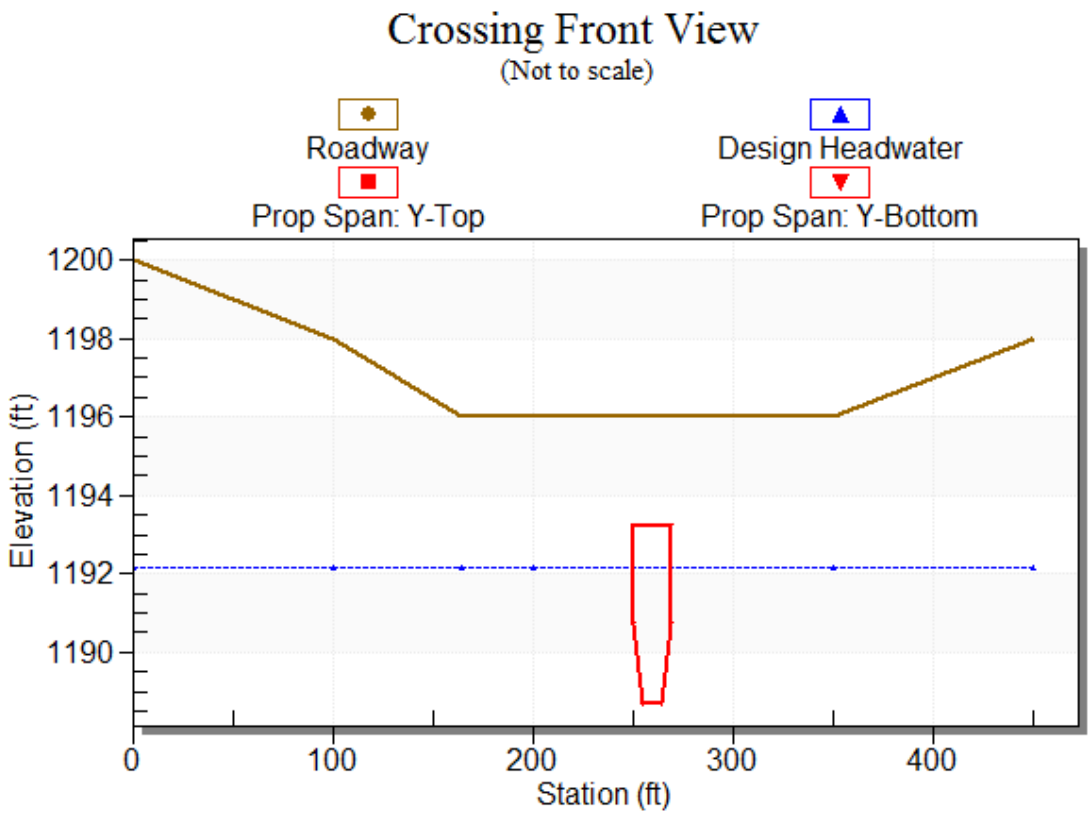


Table 9 - Downstream Channel Rating Curve (Crossing: Clark Brook Span)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
69.00	1190.18	1.58	2.45	0.30	0.41
172.00	1191.06	2.46	3.13	0.46	0.44
239.00	1191.47	2.87	3.42	0.54	0.45
362.00	1192.07	3.47	3.81	0.65	0.46

Tailwater Channel Data - Clark Brook Span

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 5.00 (_:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0350

Channel Invert Elevation: 1188.60 ft

Roadway Data for Crossing: Clark Brook Span

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 16.00 ft

Bridge and Arch Assessment Field Form – Geomorphic & Habitat Parameters

Structure type: **bridge** / **arch**

Structure ID		Unknown ☑		Structure Number	
Observer(s)/ Organization(s)	Ryan Lizewski, UNB Kris Wilkes, UNB	Tidal ☐		Date & Time	11/24/14 10:30 AM
Town	Groton, NH	Datum		Latitude (N/S)	
Location	Groton Wind Farm			Longitude (E/W)	
SGA Reach ID				Stream Name	
Road Name				Road Type	paved **gravel** trail railroad
# of shoulder lanes	0			Crossing Condition	new old eroding collapsing rusted
# of travel lanes	1/2	Structure Materials	Aluminum Concrete Masonry (arches) & Slabs Prestressed Concrete/ Post-tensioned Steel Timber Other: _____	Structure skewed to roadway	yes **no**
# of bridge cells or arches at crossing	1			Flow Conditions	unusually low typical low higher than average flood conditions
Overflow pipe(s)	yes **no**				

Geomorphic and Fish Passage Data

General

Floodplain filled by roadway approaches: **entirely** (> ¾ of floodplain) **partially** (¼ – ¾ of floodplain) **not significant** → where present
Structure within ⅓ mile downstream of a significantly steeper segment of stream: yes **no** unsure
Water depth in the crossing matches that of stream: yes **no (significantly deeper)** no (significantly shallower)
Water velocity in the crossing matches that of stream: yes **no (significantly faster)** no (significantly slower)

Upstream

Structure opening partially obstructed by (circle all that apply): wood sediment wood & sediment
failure of bridge none other: _____

Steep riffle present immediately upstream of structure: **yes** no w/in 20-ft
If channel avulses, stream will: cross road **follow road** cross and follow road **unsure**
Estimated distance avulsion would follow road: unsure (ft.)
Angle of stream flow approaching structure: **sharp bend (45° - 90°)** mild bend (5° - 45°)
naturally straight channelized straight
Evidence of streambed erosion or aggradation immediately upstream of bridge: **erosion** **aggradation** none — some point bar deposition
Upstream bankfull widths: 1.) 14.2 2.) 12.5 3.) 14.9 4.)_____ 5.)_____ (ft.)

Reference bankfull widths: 1.) 14.2 2.) 12.5 3.) 14.9 4.)_____ 5.)_____ (ft.)

Downstream

Pool present immediately downstream of structure: yes (no)
Pool depth at point of streamflow entry: NA (0.0 feet)
Maximum pool depth: NA (0.0 feet)
Downstream bank heights are substantially higher than upstream bank heights: yes (no)
Stepped footers: yes (no)
Hydraulic control type: bedrock (boulders) (cobble) gravel sand wood other:_____
Distance from downstream end of bridge/arch to hydraulic control: ≈ 30 (ft.)
Evidence of streambed erosion or aggradation immediately downstream of bridge: erosion (aggradation) none
Downstream bankfull widths: 1.) 19.5 2.) 13.8 3.) 13.5 4.)_____ 5.)_____ (ft.)

	Upstream	Downstream	In Structure
Dominant bed material at structure (use codes below)	1 (2) (3) (4) 5 6 UNK	1 2 (3) (4) (5) 6 UNK	1 2 3 (4) (5) 6 UNK
Bedrock present	yes (no)	yes (no)	yes (no)
Sediment deposit types (circle all that apply)	none delta side (point) mid-channel (some)	none delta (side) (point) (mid-channel)	(none) delta side point mid-channel
Elevation of sediment deposits is greater than or equal to ½ bankfull elevation	yes (no)	(yes) no	yes (no)
Beaver dam near structure Distance from structure to dam	yes (no) distance: _____ (ft.)	yes (no) distance: _____ (ft.)	**Bed Material Codes** **1** – bedrock **2** – boulder **3** – cobble **4** – gravel **5** – sand **6** – silt/clay **UNK** - unknown
Hard bank armoring	(intact) failing none UNK (boulder shows signs of erosion)	intact failing (none) UNK	
Bank erosion	(high) low none	high (low) none	
Stream bank scour causing undermining around/under structure (circle all that apply)	none (abutments) (footers) (wing walls) (upstream boulders)	none (abutments) (footers) wing walls	

Wildlife Data (left/right bank determined facing downstream)	Upstream		Downstream		
	LEFT	**RIGHT**	**LEFT**	**RIGHT**	
Dominant vegetation type (use codes to the right)	M	R	M	M	**Vegetation Type Codes** **C** – coniferous forest **D** – deciduous forest **M** – mixed forest **S** – shrub/sapling **H** – herbaceous/grass **B** – bare **R** – road embankment
Does a band of shrub/forest vegetation that is at least 50' wide start within 25' of structure and extend 500' or more up/downstream?	(yes) no	yes (no)	(yes) no	(yes) no	
Road-killed wildlife within ¼ mile of structure (circle none or list species)	species:			(none)	

Wildlife sign and species observed near (up/downstream) and inside structure (circle none or list species and sign types)	Outside Structure		Inside Structure	
	species (none)	sign	species (none)	sign

Spatial data collected with GPS: yes (no) **Comments/Drawings:**

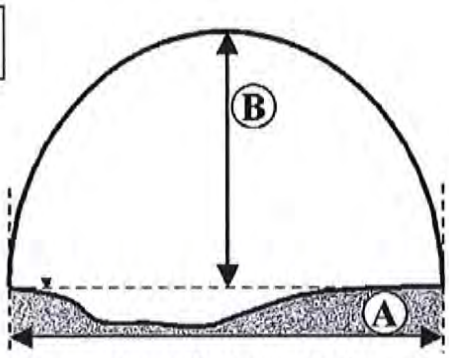
Photos taken: (yes) no
Please fill out photo log below

Folder Name:	Structure Inlet	Structure Outlet	Above Structure
Photo View - Upstream	☐	☐	☐
Photo View - Downstream	☐	☐	☐

Record the file name for each photo taken in the appropriate box

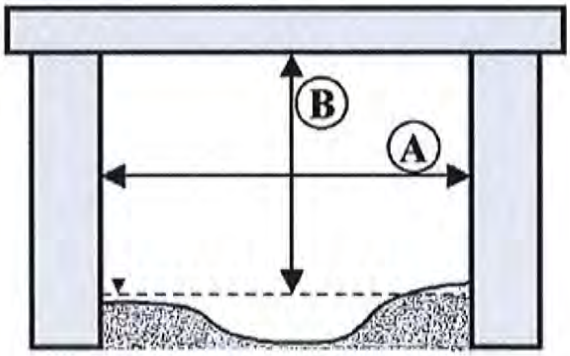
Crossing Dimensions

1.

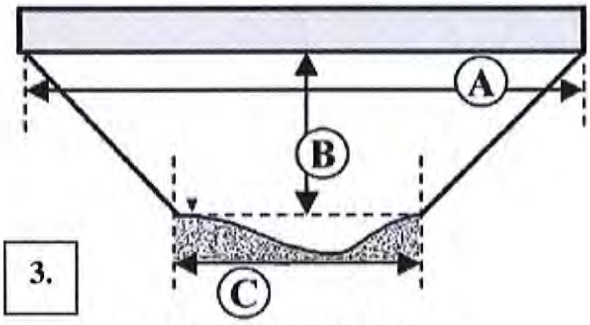


Open Bottom Arch

2.

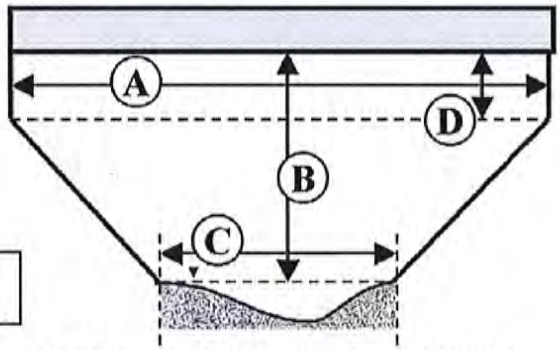


Bridge with Abutments



3.

Bridge with Side Slopes



4.

Bridge w/ Side Slopes & Abutments

Crossing Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4. ☐ **Ford**

	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Upstream Dimensions (ft.)	≈ 9' 6"			
Downstream Dimensions (ft.)	≈ 5' to 6'			

Length of stream through crossing (ft.): ≈ 16'
Crossing Slope (%): ≈ 0.3%

Note: When inventorying multiple culverts, label left culvert 1 and go in increasing order from left to right from downstream end (outlet) to looking upstream.

Bridge/Arch Cell 2 of _____

Crossing Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4.

	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Upstream Dimensions (ft.)				
Downstream Dimensions (ft.)				

Length of stream through crossing (ft.): _____
Crossing Slope (%): _____

Bridge/Arch Cell 3 of _____

Crossing Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4.

	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Upstream Dimensions (ft.)				
Downstream Dimensions (ft.)				

Length of stream through crossing (ft.): _____
Crossing Slope (%): _____

Bridge/Arch Cell 4 of _____

Crossing Type (from above): ☐ 1. ☐ 2. ☐ 3. ☐ 4.

	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Upstream Dimensions (ft.)				
Downstream Dimensions (ft.)				

Length of stream through crossing (ft.): _____
Crossing Slope (%): _____

Appendix E

Natural Resource Agency Correspondence

New Hampshire Natural Heritage Bureau

To: Stephanie Pelletier
2 Bedford Farms Drive
Suite 200
Bedford, NH 03110

Date: 4/27/2015

From: NH Natural Heritage Bureau

Re: Review by NH Natural Heritage Bureau of request dated 4/27/2015

NHB File ID: NHB15-1470

Applicant: Groton Wind, LLC

Location: Tax Map(s)/Lot(s): 9-2
Groton

Project Description: The proposed project will consist of removing, rebuilding and expanding an existing bridge that crosses over Clark Brook, known as "Upper Bridge". The existing bridge has been temporarily improved in the past, but the proposed project plans to remove all aspects of the current bridge and replace it with new precast concrete frame and decking.

The NH Natural Heritage database has been checked for records of rare species and exemplary natural communities near the area mapped below. The species considered include those listed as Threatened or Endangered by either the state of New Hampshire or the federal government. We currently have no recorded occurrences for sensitive species near this project area.

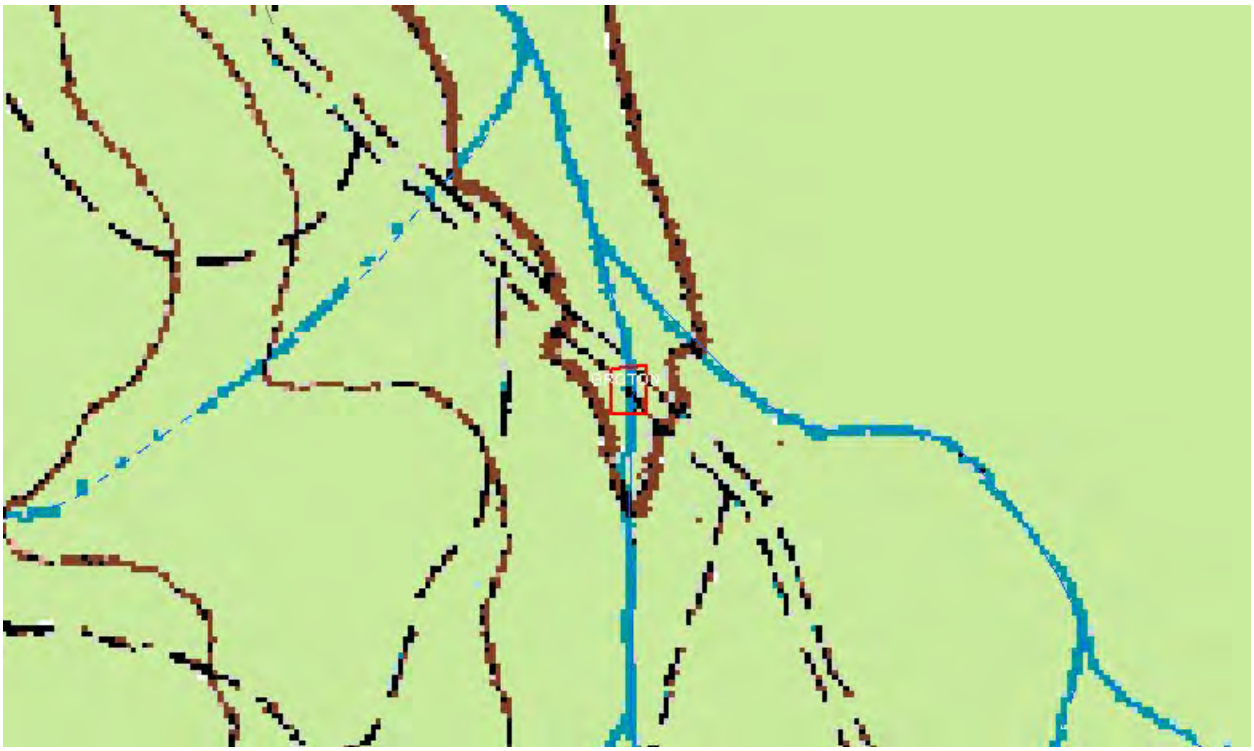
A negative result (no record in our database) does not mean that a sensitive species is not present. Our data can only tell you of known occurrences, based on information gathered by qualified biologists and reported to our office. However, many areas have never been surveyed, or have only been surveyed for certain species. An on-site survey would provide better information on what species and communities are indeed present.

This report is valid through 4/26/2016.

Department of Resources and Economic Development
Division of Forests and Lands
(603) 271-2214 fax: 271-6488

DRED/NHB
PO Box 1856
Concord NH 03302-1856

MAP OF PROJECT BOUNDARIES FOR NHB FILE ID: NHB15-1470



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