TDI NEW ENGLAND (TDI-NE)
NEW ENGLAND CLEAN POWER LINK PROJECT (NECPL)

Grand Isle, Rutland, and
Windsor Counties, Vermont

Prepared for **Champlain VT, LLC d/b/a TDI New England**
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April 30, 2015

Project Number: 57666.00

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1.0 Introduction

On behalf of Champlain VT, LLC, d/b/a TDI New England ("TDI-NE" or "Applicant"), this Flood Hazard Area & River Corridor Permit ("Floodplain Permit") narrative and supporting application materials, prepared by VHB and TRC Environmental, Inc. ("TRC"), comprise an application to obtain an Individual Floodplain Permit from the Vermont Department of Environmental Conservation ("VT DEC") for the construction of the proposed New England Clean Power Link ("NECPL" or "Project"). The NECPL is a proposed high voltage direct current ("HVDC") electric transmission line that will provide electricity generated by renewable energy sources in Canada to the New England electric grid. The transmission line will consist of two parallel cables run from the Canadian border at Alburgh, Vermont to Ludlow, Vermont along underwater and terrestrial or overland routes. The overland portion of the route will traverse through portions of one town in Grand Isle County, Vermont and twelve towns in Rutland and Windsor Counties. Because of the breadth and complexity of the Project, it is assumed that the Secretary would require an individual permit rather than authorize coverage under the associated General Permit issued pursuant to the flood hazard area rules (10 V.S.A. § 754) for jurisdictional Project activities.

This narrative describes the locations and construction methods that would be used where the Project would cross perennial streams within the overland segment of the route within Rutland and Windsor Counties. There are no stream crossings proposed within the short overland segment of the route in Grand Isle County (Alburgh). Field delineation of streams crossed by the Project were completed by VHB/TRC or its sub-consultants. Additional field studies related to natural resources, including delineation of wetlands, were also conducted and were presented to the Vermont Public Service Board in the Natural Resources Report for the Project (VHB 2014). Although the map series included in Appendix 1 contains natural resources information (such as wetlands) that are not discussed in detail within this report, the information provided may be useful for the purpose of evaluating the site context at each crossing location. Much of this information has been previously provided in support of the Project's petition to the Vermont Public Service Board ("PSB") for a Certificate of Public Good ("CPG") under 30 V.S.A. § 248(b)(5) and the Stream Alteration Individual Permit application that was filed on March 6, 2015.

2.0 Project Description

From the US/Canadian border in Alburgh, Vermont, the high-voltage, direct current transmission line would be located underground for approximately 0.5 miles within public roadway right-of-way ("ROW") and then within a parcel owned by TDI-NE on the shore of Lake Champlain. The transmission line would then enter Lake Champlain via horizontal directional drill ("HDD") and would be constructed within the lake for approximately 97 miles. The HVDC transmission line would exit the lake in the town of Benson via HDD onto a parcel owned by TDI-NE. From there, the overland portion of the transmission line, approximately 57 miles in length, would traverse through twelve towns from Benson to Ludlow. The Perennial Stream Crossings Index Map included in Appendix 1 provides an overview of the overland portion of the proposed route.

The transmission line would be buried approximately four to six feet underground within existing public (state and town) road rights-of-way ("ROWs") for most of its length. In addition, a portion of the route follows the VTrans Railroad ROW for approximately 3.5 miles in the towns of Shrewsbury and Wallingford. The HVDC transmission line would terminate at a converter station that is proposed to be built on a parcel controlled by TDI-NE off Nelson Road in Ludlow, Vermont. A short segment of buried alternating current ("AC") cable would continue from the proposed convertor station to the nearby Vermont Electric Power Company ("VELCO") Coolidge substation in Cavendish, where power from the transmission line would be connected to the New England electric grid.

The HVDC transmission line will be comprised of two approximately 5-inch diameter cables – one positively charged and the other negatively charged – and will be solid-state dielectric and thus contain no fluids or gases. The nominal operating voltage of the line will be approximately 300 to 320 kilovolts ("kV"), and the system will be capable of delivering 1,000 megawatts ("MW") of electricity. A fiber optic cable will also be installed in the same trench with the HVDC cables along the overland segment of the route.

As proposed, the cables would be installed underground within the overland segment of the route as follows:

- Alburgh town road (0.3 miles)
- Benson town roads west of Vermont Route 22A (4.2 miles[1])
- Vermont Route 22A ROW south to U.S. Route 4 in Fair Haven (8.2 miles)
- U.S. Route 4 ROW east to U.S. Route 7 in Rutland (17.4 miles)
- U.S. Route 7 ROW south to Vermont Route 103 in North Clarendon (2.7 miles)
- Vermont Route 103 ROW south/southeast to the Railroad Route in Shrewsbury (3.9 miles)
- VTrans Railroad ROW in Shrewsbury to Vermont Route 103 in Shrewsbury (3.5 miles)
- Vermont Route 103 ROW to Vermont Route 100 in Ludlow (10.6 miles)
- Vermont Route 100 ROW north to Ludlow town roads (0.8 miles)
- Ludlow town roads to HVDC converter station (4.3 miles)
- AC cable from HVDC Converter Station in Ludlow to the existing VELCO Coolidge Substation in Cavendish along town roads (0.6 miles)

1. The route miles depicted herein may be slightly different compared to previous Project applications due to minor design changes.

Along the overland segment of the route, the transmission cables will be installed underground by utilizing a combination of open trench excavation, HDD, and jack-and-bore construction techniques. Along town roads (in Alburgh, Benson, and Ludlow), the cables are proposed to be installed in the existing roadways. Along state (VTrans) roads and railroads, the transmission line will primarily be installed along the edge of the existing ROWs, with some limited in-road installation proposed. Use of the previously disturbed roadway/railroad ROWs would allow the Project to avoid and minimize impacts to natural resource features and adjacent landowners. Furthermore, unavoidable impacts, when necessary, would occur primarily to natural resource features that have been previously impacted due to road/railroad construction and ongoing operational management activities. Several off-ROW laydown areas would also be required during the construction of the project. As proposed, these laydown areas avoid all flood hazard areas and river corridors.

As previously described in the Natural Resources Report, the lands along the proposed transmission line drain to five major Vermont watersheds, including the Lake Champlain Direct Main Lake, Lake Champlain Direct South End, Poultney River, Otter Creek, and the Black River. Eleven named streams were identified that would be crossed by the proposed project alignment, including the Hubbardton River, Mud Brook, North Brenton Brook, Castleton River, Clarendon River, Otter Creek, Cold River, Freeman Brook, Branch Brook (crossed twice), Coleman Brook, and Black River. The project would also cross 40 unnamed tributaries that were identified and delineated in the field as perennial streams. A summary of relevant information about each of the perennial stream crossings is included in Appendix 2.

3.0 Stream Crossing Analysis

Through a combination of field, database, and off-site resources review, VHB/TRC have assessed proposed stream crossings associated with the proposed project alignment. In addition, field and desktop studies included approximate mapping of an additional 50 feet on either side of the road or railroad right-of-way. This is to account for any resources that would not be captured by the detailed Study Area and which may retain buffers to be accounted for during Project planning and permitting, and/or to map approximate resources on private lands on which construction activity may be required. The following sections describe the field delineation and remote sensing methods that were used to identify streams that would be crossed by the Project.

3.1 Field Delineation

VHB and TRC environmental scientists conducted field delineation and assessment of stream features between May 2014 and October 2014. Streams were identified according to federal delineation procedures (USACE 2005) and were flagged with blue survey tape. Flagging was coded with the consultant identification (T or V), Town Name Abbreviation (West Rutland, WR) and stream number, along with the specific flag number (e.g., T-WR-S-1-1). Generally, perennial and intermittent streams (channels > 6 feet or wider) are flagged along the stream Top-of-Bank ("TB") or Top-of-Slope ("TOS"), according to guidelines published by the Agency of Natural Resources ("ANR") in *Guidance for Agency Act 250 and Section 248 Comments Regarding Riparian Buffers* (ANR 2005). Narrow features, including most ephemeral channels, are flagged along the center line. Ditches or constructed ponds are typically not included in the delineation if such features are due to excavation from upland. However, such features were included in the delineation if these features were determined to be modified, naturally occurring streams or wetlands that would meet state or federal criteria for jurisdiction. Stream flags were located in the field using a Trimble® GPS unit capable of sub-meter accuracy and post-processed using Trimble® Pathfinder software.

Stream identification and ordinary high water ("OHW") width was also assessed, according to methods detailed in the "Regulatory Guidance Letter: Subject – Ordinary High Water Identification" (USACE 2005). The OHW width for each channel segment is determined from an average of measurements of bank-to-bank OHW widths taken at regular intervals along the surveyed portion of the watercourse. During field work, flow regimes are preliminarily classified as perennial, intermittent, or ephemeral and are determined based on qualitative observations of in-stream hydrology indicators at the time of observation and existing geomorphic characteristics. The Summary of Proposed Perennial Stream Crossings table included in Appendix 2 provides information about each crossing, including:

- Mile Post
- Stream ID
- Stream Name (Geographic Names Information System ("GNIS"))
- Right of Way Name
- Town
- Proposed Crossing Method
- Average OHW Width (feet)
- Existing Structure Size (feet)
- Drainage Area (square miles)
- FEMA Floodplain / Floodway (Zone A, Zone AE and Floodway)
- Approximate Stream Elevation at Crossing (feet)
- Approximate Cable Elevation at Crossing (feet)
- Width of Refined River Corridor, Down Station of Crossing (feet)
- Width of Refined River Corridor, Up Station of Crossing (feet)

In response to the requirements of the Floodplain Permit, additional stream assessments and river corridor evaluations were conducted in March and April 2015. Observations of outlet scour depths, channel geometry, valley wall locations, and substrate conditions were made as part of this investigation. Results from this investigation were used to refine the elevation of the stream channel and the associated design depth for each crossing, which is presented in the Table of Proposed Stream Crossings included in Appendix 2. Photographs of each perennial stream that is proposed to be crossed by the Project, existing bridge or culvert structures that are in the vicinity of the crossing, and representative views the landscape setting of the crossing are presented in Appendix 3.

3.2 Approximate Delineations

In addition to the direct Study Area that VHB/TRC was able to access in order to conduct detailed field delineations, an area 50-feet wide adjacent to the direct Study Area in most locations (e.g., the linear components within road or railroad ROW) was added in order to approximate the boundaries of potential water resources. Such "Approximate Streams" are indicated on the Natural Resources Report Maps and can be identified by the "AS" designation in the feature name. Approximated resources are based on a combination of information gathering from public ROWs regarding off-site lands during field site visits, with reconnaissance-level verification and mapping from off-site resource review/interpretation. Five perennial streams that would be crossed by the project were mapped as approximate: an unnamed tributary to Lake Champlain (V-BE-AS-3), an unnamed tributary to Mill River (T-MH-AS-45), an unnamed tributary to Hubbardton River (V-BE-AS-10), and two unnamed tributaries to the Black River (T-MH-AS-20 and T-MH-AS-23). All streams that were mapped as approximate are small streams (OHW width less than five feet) and cross beneath the roadway in culverts that extend outside of the ROW.

Based on the field delineation and approximate resource mapping that has been performed, the proposed project alignment would cross perennial streams at 52 locations.

3.3 Drainage Areas

The contributing drainage area tributary to each proposed perennial stream crossing location was assessed using the Stream Watershed Size maps available from the VT DEC River Management Program (VT DEC 2011) and refined using the watershed delineation tool available on the U.S. Geological Survey StreamStats website (USGS 2014). The contributing drainage area for each crossing is provided in the Table of Proposed Stream Crossings included in Appendix 2. A summary of the proposed crossings is as follows:

- 10 of the stream crossings are located at sites with contributing drainage areas greater than 10 square miles.
- 6 of the stream crossings are located at sites with contributing drainage areas between 2 and 10 square miles.
- 36 of the stream crossings are located at sites with contributing drainage areas less than 2 square miles.

3.4 Fluvial Erosion Hazard Areas and River Corridors

As outlined in Vermont Environmental Protection Rules ("EPR"), Chapter 29 and the *Flood Hazard Area and River Corridor Protection Procedure* (VT DEC 2014), VT DEC has established guidelines for evaluating and avoiding risks associated with fluvial erosion and stream channel migration. To assist with the implementation of this Rule, meander belts or Fluvial Erosion Hazard areas ("FEH") have been mapped for most streams in Vermont with watershed areas greater than two square miles. The River Corridor concept enhances these delineated FEH areas by adding an additional 50 foot riparian buffer beginning at the edge of the meander belt. However, because the Project involves the installation of an underground utility along already-developed roadway and railroad corridors, the FEH boundary was considered to be sufficiently protective to avoid and minimize impacts to the project due to fluvial erosion or channel migration. For streams smaller than two square miles, the River Corridor is represented as a 50 foot buffer from the top of each bank that is assumed to provide both meander belt and riparian corridor functions.

GIS polygons for 12 streams with watershed areas larger than two square miles were obtained from VT DEC River Management Scientists. For the remaining streams, River Corridors were produced by VHB by buffering the field-delineated and approximate streams by 50 feet plus the width at OHW. The map series included in Appendix 1 displays the FEH and River Corridor polygons for the perennial streams that are proposed to be crossed by the Project, and are symbolized to indicate the source of the data (i.e., whether delineated by ANR or by VHB).

The *River Corridor Protection Guide* (ANR 2008) and *Flood Hazard Area and River Corridor Protection Procedure* (VT DEC 2014) detail the application of Flood Hazard Area and River Corridor principles. Throughout these documents, existing transportation corridors (roads and railways) as generally identified as constraining the ability of streams to fully express their plan form and to migrate laterally across the valley floor. However, the long-term constraints on stream geomorphology that may be imposed by public transportation infrastructure does not equate to such infrastructure being invulnerable to damage in the short-term, especially during extreme events that may result in sudden significant erosion or failure of stream crossing structures. As has been described previously, the proposed project alignment of the overland segment is located within roadway or railroad ROWs, and would therefore cross streams and rivers at or near the existing crossing structures. Although it is expected that such public infrastructure would be rebuilt in the event of a catastrophic failure along the route, it is preferable if the transmission cable were not exposed or damaged as the result of such a failure and if the public infrastructure could be repaired without impacting operations of the cable. For these reasons, the Project has been designed to maximize the resiliency of the cable by burying it deeply enough that it should be sufficiently protected from exposure. These burial details are described below.

For all crossings that involve burying the cable beneath a culvert or within a stream channel, the cable will be buried a minimum of five feet below the culvert invert or stream channel across the width of the stream OHW. This design depth takes into consideration the requirements of the Equilibrium and Connectivity Standards of the Vermont Stream Alteration Permit to the extent practicable and would be expected to allow for a replacement culvert to be properly sized and embedded with substrate in accordance with the requirements of the Stream Alteration Permit. In locations where the configuration of an existing structure has resulted in a severely perched outlet or otherwise significantly disrupts the longitudinal profile of the stream, extensive stream channel modifications outside of the existing ROW could be necessary to reconnect the upstream and downstream reaches. In the event that such a modification is required at a particular stream, TDI-NE may be responsible for adjusting the location of the cable.

For most of the stream crossings with watersheds less than two square miles, the cable will span the river corridor at a depth below the existing culvert invert or stream channel for a width equal to 20 feet on each side of the top of bank or four times the bankfull channel width, whichever is larger. At four locations where streams with watersheds smaller than two square miles are crossed, the stream channel is constrained by a natural feature such as bedrock or a valley wall and the width that the cable is proposed to be buried below the stream channel beyond the OHW is proposed to be reduced in accordance with guidance provided by Mike Kline, Manager of the VT DEC Rivers Program on April 10, 2015. Streams with burial depths that are proposed in accordance with this guidance are shown with a “Refined River Corridor” symbology on the cable alignment presented in Appendix 1.

For stream crossings with watersheds greater than two square miles that will be completed using direct burial or horizontal directional drilling methodologies, the cable will span the width of the OHW at a depth that is a minimum of five feet below the existing stream channel or culvert invert across and will span the remainder of the FEH corridor at a depth that is at least as deep as the existing channel or invert.

A total of six crossings are proposed to be constructed using methods that do not involve direct burial of the cable beneath the culvert or stream. These situations occur in response to specific site constraints, construction considerations, or requests from the ROW owner.

These locations are proposed to be constructed using the Aerial, Duct Bank, or Over Culvert crossing methods.

Additional information regarding the specific construction methods that will be used to construct the crossings is presented in Section 4. Specific information about the crossing burial depth and width for each stream is presented in Appendix 2 and on the typical construction detail provided on sheet TD-4 in Appendix 4.

3.5 Floodplains and Floodways

The Federal Emergency Management Agency ("FEMA") has mapped floodplains and/or floodways that are associated with streams and rivers that would be crossed by the Project. However, as proposed the Project would involve the installation of underground transmission cables and would therefore not result in the placement of fill within floodplains or impacts to floodways. A review of the FEMA mapping indicates that floodplains and/or floodways are associated with 22 of the streams that would be crossed by the Project. The FEMA floodplain and floodway polygons are shown on the map series included in Appendix 1.

The proposed HVDC converter station in Ludlow is the largest above-ground feature of the project and is located away from stream or wetland resources and is outside of any floodplain, floodway, FEH, or River Corridor. The proposed alignment also involves two locations where the cable would be above ground for short distances, both of which are associated with stream crossings, specifically crossings of T-LU-S1 (Black River) and T-LU-S20 (Unnamed Tributary to Black River). According to the effective FEMA floodplain map (Map Number 50027C0587E), there is a floodplain and floodway associated with the Black River at the proposed crossing location T-LU-S1 in Ludlow. This crossing is proposed to be completed by attaching the transmission cable to the downstream face of the East Lake Road Bridge, owned by the Town of Ludlow. By attaching the cable to the bridge, the Project will not have any impact on the floodplain or floodway associated with this crossing. According to the effective FEMA floodplain map (Map Number 50027C0580E), there is no mapped floodplain or floodway associated with T-LU-S20.

4.0 Proposed Crossing Methods

Six different construction methods are proposed to be used for crossing streams within the project area: Aerial, At Culvert, Over Culvert, Duct bank, HDD crossings, and open trench excavation ("OTE") crossings. Typical construction details for these crossing techniques have been excerpted from the Erosion Prevention and Sediment Control ("EPSC") plan set and are included in Appendix 4. Narrative descriptions of these methods and the locations that they will be used are described below.

4.1 Aerial Crossings

At aerial crossings, the transmission cable would be suspended above the stream being crossed in two locations where the fascia of an existing bridge or the headwall of an existing culvert provides a suitable face for attachment and the structure owner allows this configuration. With the current project alignment and layout, there are two locations where this type of stream crossing would be used, both located on East Lake Road in the Town of Ludlow. One is the bridge crossing of the Black River immediately downstream from the Lake Rescue Dam (T-LU-S1) and the other in a culvert headwall over an unnamed tributary to the Black River (T-LU-S21) that crosses beneath East Lake Road in a culvert. No in-stream work is proposed for these crossings. Both of these structures were replaced by the Town of Ludlow following Tropical Storm Irene and are not anticipated to require replacement in the foreseeable future. The narrow ROW and steep topography adjacent to Vermont Route 100 and East Lake Road also limit the types of construction that would be feasible at these locations and led to the selection of the aerial crossing type. Construction details for these crossings are included on sheet TD-3 of Appendix 4.

4.2 At Culvert Crossings

As previously described, all of the streams that would be crossed by the Project are already conveyed beneath an existing public road or railroad within a culvert or under a bridge. The Project proposes to complete “At Culvert” crossings by excavating a trench within the roadway or within the embankment adjacent to the roadway and installing the transmission cable a minimum of five feet beneath the existing culvert. This burial depth would be maintained for the full width of the stream OHW. In accordance with the recommended guidance provided by the VT DEC Rivers Program for crossings with watershed areas less than two square miles, the cable would also be buried at least as deep as the culvert invert within a 20-foot wide transition zone on either side of the crossing before returning to the standard project burial depth for upland work areas. The additional burial depth and width has been incorporated into the project design in order to protect the cable against potential avulsion or embankment failure during severe storm events and to provide sufficient separation between the transmission cable and culvert for future culvert maintenance activities to be conducted without impacting the cable, including the replacement of the culvert with a structure that fully complies with the Floodplain Permit criteria. At one location in Benson, (V-BE-S-8), the existing culvert is located entirely within the ROW and is proposed to be replaced as part of the Project with a structure that fully meets the Floodplain Permit criteria.

To complete this type of installation, the existing culvert would either be supported in place and a trench excavated beneath it to the required depth, or a segment of the culvert would be removed and replaced following installation of the transmission cable. Pipe bands or other appropriate construction techniques would be used to secure the segment of culvert that was being replaced to the remaining undisturbed segments of the culvert. This approach would avoid direct disturbance of the natural channel.

Eighteen of the proposed perennial stream crossings would be constructed using this method. The largest culvert that is proposed for an “at culvert” crossing is six feet in diameter and the largest stream OHW that is proposed for this type of crossing is seven feet wide. The majority of streams proposed for this type of crossing have OHWs of two to five feet and are currently carried in culverts that are between two and four feet in diameter. Typical construction details for these crossings are included on sheet TD-4 of Appendix 4.

4.3 Over Culvert Crossings

At over culvert crossings, the proposed cable would be installed in the roadway embankment above an existing culvert. This is proposed to occur at three locations where site constraints restrict the ability of the cable to be installed beneath the culvert. These locations are described below.

In Benson, an unnamed tributary to the Hubbardton River (V-BE-S-102) crosses through the Vermont Route 22A embankment in a six-foot wide concrete box culvert. Rolling topography and a narrow ROW limit the ability of the project to construct the crossing outside of the embankment and it is not practicable to excavate beneath a structure of this size. In Shrewsbury, an unnamed tributary to the Mill River (V-SH-S-14) crosses through the Vermont Route 103 embankment in a concrete box culvert located near the toe of the embankment with approximately 20 feet of fill over the top of the culvert. Applying the typical trench construction approach at this location would result in a prohibitively deep excavation.

In Mount Holly, an unnamed tributary to Branch Brook (T-MH-S14) crosses beneath Vermont Route 103 in a concrete box culvert. The stream channel at this location is deeply incised, private residential structures and road crossings are in close proximity to the culvert, and there is insufficient room in the ROW to construct an alternative crossing type.

Typical construction details for these crossings are included on sheet TD-2 of Appendix 4.

4.4 Duct Bank Crossings

In Ludlow, an unnamed tributary to Black River (T-LU-S5) crosses beneath Vermont Route 100 in an existing 42-inch corrugated metal pipe ("CMP") culvert. A duct bank is proposed to be installed beneath the road surface in conjunction with a VTrans roadway improvement project along this portion of Vermont Route 100. The existing culvert may be replaced as part of the roadway improvement project, however, the cable would be installed inside the duct bank, thereby avoiding any additional disturbance to the stream.

A construction detail for this crossing is included on sheet TD-2 of Appendix 4.

4.5 Horizontal Directional Drilling

The use of HDD techniques for stream crossings generally allows in-stream impacts to be completely avoided. HDD typically requires that two boreholes (a drill pit and a receiving pit) be excavated on either side of the drilled segment, and cleared areas at each end of the drill to provide sufficient distance for the drill string and cable to be handled and fed through the drill borehole. The specific requirements for the entry and exit angle of the cables, the channel width, and the required depth below the stream channel will be evaluated at each site during final design. HDD crossings will be a minimum of 20 feet below the stream channel in order to provide sufficient depth to allow dynamic stream processes to continue and to allow future bridge or culvert construction projects to be completed without disturbing the cable. This method is proposed for use at 18 crossings where suitable soils, topography, and alignment permit it to be used. With the exception of the Black River crossing (T-LU-S1), described above as an Aerial crossing, all 10 stream crossings with watersheds greater than 10 square miles would be crossed using HDD construction methods.

For the majority of these large stream crossings, the HDD would fully span the FEH identified by the VT DEC Rivers Program. Following consultation with the Rivers Program, the HDD crossing of Otter Creek (T-RU-S2) has been lengthened since the Stream Alteration Permit application materials were submitted, and this crossing will now fully span the FEH where the Otter Creek flows parallel to the roadway east of the bridge crossing. Two exceptions where the Project will not be able to fully span the FEH are the crossings of Hubbardton River (V-BE-S-106) and Clarendon River (T-WR-S36). At the Hubbardton River crossing, the available topography shows that the ground surface is approximately 10 feet higher on one side of the mapped FEH than on the other, in an area that is otherwise dominated by low gradient wetland features. The proposed HDD at this location stops short of fully spanning the FEH on the higher, southern side of the Vermont Route 22A culvert crossing. The project engineer evaluated the possibility of extending this HDD farther to meet this criteria but determined that it would involve potential impacts to wetlands and a bat roosting tree. These impacts did not appear warranted given the overall topography at the crossing and the potential threat to the cable. At the Clarendon River crossing, the available topography shows that the ground surface is approximately eight feet higher on one side of the mapped FEH than on the other. The proposed HDD at this location stops approximately five feet short of fully spanning the FEH on the higher, eastern side of the U.S. Route 4 culvert crossing. The project engineer evaluated the possibility of extending this HDD farther to meet this criteria but determined that it would involve significant cut and fill work along a steep embankment east of the crossing, in an area that has exposed bedrock near the crossing site. The presence of bedrock limits the erosion hazard at this location

Typical construction details for these crossings are included on sheet TD-5 of Appendix 4.

4.6 Open Trench Excavation

The alternative method for stream crossings involves deploying temporary in-stream flow diversion structures, digging an OTE across the stream channel, installing the transmission cable, backfilling with suitable materials, and restoring the stream bank and channel geometry. This construction method resembles the method used to construct the remainder of the transmission cable through upland areas, but involves added EPSC measures and increased burial depth to avoid and minimize impacts to the waterway. Timber matting will be used to protect bordering wetlands and smaller stream channels from impacts by mechanized equipment. Typical details for dewatering, such as using diversion flumes or coffer dam and pump-around systems, are included in Appendix 4 to illustrate the proposed management of flow associated with the OTE crossings.

This method is proposed for use at nine stream crossings and is generally limited to sites with smaller channels (OHW width less than 10 feet). Three crossings larger than 10 feet are proposed to be completed with OTE construction methods and would occur at locations where substrate and channel geometry would allow the cable to be installed with minimal stream impacts: unnamed tributary to Otter Creek T-CL-S4, unnamed tributary to Mill River T-SH-S3, and unnamed tributary to Mill River T-MH-S28.

As described above, the cable would be buried a minimum of five feet below the stream channel where OTE construction methods are proposed. This burial depth would be maintained for the full width of the stream OHW. In accordance with the recommended guidance provided by the VT DEC Rivers Program for crossings with watershed areas less than two square miles, the cable would also be buried at least as deep as the stream channel within a 20-foot wide transition zone on either side of the crossing before returning to the standard project burial depth for upland work areas. At locations where the contributing watershed area was greater than two square miles, the cable would be buried at least as deep as the stream channel within a 50-foot wide transition zone on either side of the crossing, thereby spanning the full River Corridor

This burial depth would allow for some natural channel migration to occur and to protect the cable against potential avulsion or embankment failure during severe storm events.

Burying the cable for a greater depth or greater width is not practicable due to the topography adjacent to these crossings, operational constraints associated with the cable, and the fact that the crossings are located adjacent to an existing roadway crossing structure (bridge or culvert) that will continue to direct the stream through the project area.

During the construction of the OTE crossings, stream bed and bank materials would be segregated from sub-surface mineral soils and the sediment profile would be recreated to the extent practicable following installation of the cable. Disturbed stream banks would be restored using stockpiled materials, seeded with a riparian and wetland seed mix, and protected with a rolled erosion control product ("RECP") for a distance of 25 feet beyond each top of bank. Additional measures, such as staked coir logs, may be used where necessary to restore preconstruction bank contours. Dewatering of the stream would be accomplished by means of a diversion flume or a bypass dam and pumps. Additional EPSC measures would be deployed in the vicinity of these crossings to avoid and minimize the release of sediment associated with this work.

Typical construction details for these crossings are included on Sheets TD-4 through TD-8 of Appendix 4. Plan and profile views of the HDD crossings are included in Appendix 5.

5.0 Intermittent Stream and Ephemeral Channel Crossings

Although intermittent stream and ephemeral channel crossings are not regulated under the Stream Alteration Permit or Floodplain Permit, TDI-NE recognizes that the failure of a culvert associated with one of these stream types could also impact the transmission cable. Because the project alignment follows existing transportation infrastructure (roads and railroad ROWs), the assessment of these crossings has focused on the protection of the proposed infrastructure as opposed to the enhancement or restoration of stream geomorphic equilibrium which is constricted by that existing infrastructure. In order to protect the cable against impacts resulting from a culvert failure, a typical crossing detail has been developed that provides the same five-foot depth of burial beneath the culvert invert or stream channel and incorporates a minimum 15-foot wide transition zone on either side of the stream OHW before returning to the standard burial depth for upland areas. Details for these crossings are shown on Sheet TD-5 of Appendix 4. The design standards described above at intermittent streams and ephemeral channels may be modified based on consultation with VTrans during final design. The additional depth and width of burial proposed for these culvert crossings would also provide a degree of flexibility to minimize potential conflicts associated with the restoration of habitat connectivity and geomorphic equilibrium when culvert replacements are considered in the future.

6.0 Summary

The project alignment for the NECPL was evaluated for locations where crossings of perennial streams would occur and suitable construction methods were identified for each site. The project team is aware that many of the existing bridges and culverts that carry perennial streams beneath town and state roadways may be undersized with respect to River Management criteria and that future upgrades by the agencies responsible for these structures may result in their replacement with wider and potentially deeper structures. Furthermore, existing structures that interrupt the stream profile (i.e. an upstream sediment wedge and/or a perched outlet) have also been taken into consideration and the proposed design accommodates these concerns and would allow future construction to restore the natural stream profile through the reach to the degree feasible.

The Project alignment was designed to minimize impacts to streams and rivers by proposing to construct the transmission cable within existing road and railroad ROWs. This approach avoids placing new infrastructure within otherwise unconstrained River Corridors and minimizes the amount of in-stream work by installing crossings at the locations of existing culverts and bridges. Additionally, the proposed burial depth of the cable has been increased through the width of the FEH (most of the larger streams) or within a refined river corridor (most of the smaller streams), thereby meeting the objectives of the Flood Hazard and River Corridor Protection Procedure.

7.0 References

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