



Champlain Hudson Power Express Project

Exhibit 3

Alternatives Analysis

**EXHIBIT 3
ALTERNATIVES ANALYSIS**

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EXHIBIT 3: ALTERNATIVES ANALYSIS

This Exhibit describes alternatives considered by Champlain Hudson Power Express, Inc. (CHPEI) during the planning stages of the Champlain Hudson Power Express Project (the Project). In order for an alternative to be considered preferable to the Project, it had to meet the following criteria:

- Provide a significant environmental advantage over the Project;
- Meet Project objectives and schedule; and
- Be technically and economically feasible and practicable.

The types of alternatives discussed in this Exhibit are the no action alternative, demand-side management alternatives, alternative technologies, and alternative station sites and cable routes.

3.1 Project Purpose and Need

3.1.1 Project Purpose

CHPEI proposes to develop the Project to connect renewable sources of power generation in central and eastern Canada and upstate New York to load centers in and around the New York City and southwestern Connecticut regions. The Project will include underwater and underground, high-voltage direct current (HVDC) transmission cables connecting HVDC converter stations in Canada with HVDC converter stations in Yonkers, New York and Bridgeport, Connecticut. There will be no overhead transmission lines constructed as part of the Project. To the extent possible, CHPEI proposes to install the transmission cables along and within existing waterways to minimize land use and visual impacts typically associated with traditional overhead transmission lines, while simultaneously providing the additional capacity required to meet the increasing clean energy demands of the greater New York City metropolitan area and State of Connecticut.

The Project consists of a 2,000 megawatt (MW) HVDC underwater/underground HVDC transmission system that includes two 1,000 MW bipoles (each bipole includes two cables connected as a bipole pair), one extending between the Canadian border and New York City, New York and the other extending between the Canadian border and Bridgeport, Connecticut (Figure 3.1-1). CHPEI has designed the Project to meet the New York City area's need for additional sources of competitively priced electricity from safe and reliable renewable sources of energy. The stated purposes of the Project are to:

- Provide 1,000 MW of primarily carbon-neutral source electricity to New York City without contributing to additional congestion on the electric grid entering the City;
- Provide significant new transmission infrastructure into New York City without the aesthetic impacts from traditional overhead transmission using, HVDC cables that will be buried primarily within waterways or along relatively short underground routes;

- Place downward pressure on the price of electricity in the Location Marginal Price (LMP) spot markets operated by New York Independent System Operator (NYISO) in the New York City area;
- Reduce air pollution and greenhouse gas (GHG) emissions within the New York City area by alleviating the need to operate one or more existing fossil fueled power plants within the City during periods of congestion;
- Improve stability of the electric grid serving the New York City area due to the highly reliable and controllable nature of HVDC technology and its compatibility with Smart Grid initiatives; and
- Reduce the dependency of the New York City region on fossil fuels, such as imported oil thereby improving the security of the electric grid.

3.1.2 Project Need

New York's stated environmental goals regarding its electricity supply are: to increase the amount of electricity produced from renewable sources; to reduce GHG emissions and other air emissions associated with electric generation; and to decrease the amount of electricity used through energy efficiency (NYSEP 2009; Paterson 2008). The Project will promote these goals by supplying 1,000 MW of renewable energy from Canada and upstate New York to New York City and an additional 1,000 MW of renewable energy to neighboring areas in Connecticut.

Governor Paterson's "45 by 15" program, which he announced in his State of the State address on January 7, 2009, is one of the nation's most aggressive energy efficiency and renewable energy initiatives with a goal to meet 45 percent of its electricity needs through energy efficiency and clean renewable energy by 2015. In furtherance of this goal, the Renewable Portfolio Standard (RPS) goal was increased from 25 percent to 30 percent on January 8, 2010 (PSC 2010). Because the Project will bring clean renewable energy to New York City, it will assist New York in meeting its "45 by 15" goal to have 30 percent of its electricity needs met by renewable power.

Governor Paterson issued Executive Order 2 in 2008, which called for the drafting of a New York State Energy Plan, with one of the main goals being to reduce emissions of GHGs and the more traditional air pollutants (Paterson 2008). The resulting New York State Energy Plan calls for an increase in renewable energy because of the emissions of GHGs, nitrous oxides (NO_x), sulfur dioxide (SO₂), particulate matter (PM) and volatile organic compounds (VOC) associated with traditional fossil fueled power plants (NYSEP 2009). As noted by the New York State Energy Plan, an increase in renewable energy will require additional electric transmission capacity in New York.

The Clean Air Act (CAA) requires states, at a minimum, to meet national ambient air quality standards (NAAQS) (U.S.C. 2010). When a state is in nonattainment of the NAAQS, such as New York, it must have a plan to come into attainment. The New York City metropolitan area is currently considered to be in nonattainment of the ground level ozone NAAQS and in nonattainment of the PM₁₀ and PM_{2.5} NAAQS. Ground level ozone is created by emissions of

NO_x and VOCs, which are emitted by all fossil fuel-fired electric generating facilities. PM₁₀, PM_{2.5} and SO₂ are also emitted by fossil fuel-fired electric generating facilities.

In an effort to bring New York into attainment with the NAAQS, and sometimes to go beyond the federal standards, the New York State Department of Environmental Conservation (NYSDEC) has promulgated a number of air regulations aimed at reducing the air emissions, including GHGs, associated with the production of electricity (6 NYCRR Part 201). NYSDEC has also implemented policies that require new projects to account for, and potentially mitigate, GHG emissions (NYSDEC 2009). Producing electricity by hydropower and wind generation does not emit NO_x, SO₂, VOCs, or PM. Because other fossil fuel-generated electricity currently producing the electricity needed by New York City will be displaced by the Project's clean renewable generation sources, the Project can assist New York in coming into compliance with the NAAQS.

As New York Governor Paterson recognized in a press release dated January 21, 2010, the construction of the transmission facilities required to bring renewable resources to market is a key component of New York State's aggressive policy aimed at reducing GHG emissions by 80 percent, increasing New York's supply of renewable energy, and establishing a clean energy economy. To meet New York's established goals and regulatory requirements, any increase in transmission capabilities should take into account the source of the electricity that will be transmitted for use by New Yorkers. In order for New York to meet its goals of reducing air emissions associated with electricity generation, the source of the electricity that is being transmitted should emit less air pollutants than the current mixture of generation sources. As demonstrated by the study conducted by London Economics International (LEI) that is included in this Application as Appendix F, over the 10-year period from 2014 to 2024, the electricity that will be produced via hydropower in Canada and transmitted by the Project into New York and neighboring southwestern Connecticut will reduce emissions of carbon dioxide (CO₂) by 20,000,000 tons, SO₂ by 65,000 tons, and oxides of nitrogen by 50,000 tons, with no offsetting emissions at the point of generation (LEI 2010). The addition of this 1,000 MW of clean energy to energy markets in New York City is expected to save consumers in New York State \$930.9 million/year, while having no statistically significant impact on electricity prices in upstate New York (LEI 2010).¹

3.2 No Action Alternative

Under the No Action Alternative, the Project would not be constructed. Without construction of the Project, other sources of electrical generation, transmission or demand reduction would be required to meet the forecasted demand for electricity based on load projections in New York (New York State Energy Planning Board 2009). Additional generating facilities or new transmission options would be required to replace existing facilities that are scheduled or proposed for decommissioning. As a result, the reductions in emissions of GHG, CO₂, SO₂, and NO_x predicted by LEI would not occur, and consumers in New York City would pay an additional \$10.24 billion for electricity over the 10 year period from 2015 to 2024.

¹ The LEI study actually found that the Project would reduce prices for electricity in upstate New York by \$0.01 per MWH over the period from 2015 to 2024, a result which LEI dismissed as "statistically insignificant."

Additional generation and/or transmission infrastructure and/or demand reduction investment would also be required within the Eastern Interconnection Critical Congestion Area if the Project is not constructed. Development of electric infrastructure is capital-intensive and therefore expensive. If such investments must be made by New York's utilities or through the NYISO's Congestion Analysis and Resource Integration Studies process, captive utility customers will bear both the costs of the required investments and the associated operational risks.

CHPEI determined the No Action Alternative to be unacceptable because the existing transmission lines and in-area generating sources will not be sufficient to meet New York State's RPS goals and customer needs for competitively priced energy. The No Action Alternative would also mean an increased reliance on the construction of new generating facilities in the New York City area, where siting power plants is difficult and costly. As a result, CHPEI determined that the No Action Alternative is not in the best interest of the public and eliminated it from further consideration.

3.3 Demand-Side Management

Energy conservation measures will likely play an increasing role in reducing future energy demand in the United States. As energy prices have increased in recent years, energy conservation has received increased attention. For example, the Energy Policy Act of 2005 included mandatory energy conservation standards, and the new corporate average fuel economy standards, finalized in March 2006, established higher minimum fuel economy performance requirements for automobiles and light-duty trucks. Further energy conservation would require additional legislative or regulatory incentives or mandates. Predicting the additional measures that policymakers or end users might take in response to the No Action Alternative to the Project would be speculative and beyond the scope of this analysis. However, additional energy conservation would almost certainly be long-term and beyond the timeframe of the needs to be satisfied by the Project.

There are no easy solutions to the reliability concerns and congestion facing the electrical grid within the Eastern Interconnection Critical Congestion Area. It is likely that one solution alone will not sufficiently address the electrical needs in this area; rather, a combination of new transmission, generation, and demand-side resources are required over the next decade to protect grid reliability and ensure the area's economic viability.

The 2009 New York State Energy Plan sets forth a vision for a robust and innovative Clean Energy Economy that will stimulate investment, create jobs, and meet the energy needs of residents and businesses over its 10-year planning horizon. The Plan outlines five strategies required to work in combination to achieve New York's policy objectives, one of which is to produce, deliver, and use energy more efficiently.

New York's energy efficiency goal is to reduce electricity use by 15 percent by 2015 (a component of the "45 by 15" Plan). From 1997 to 2007, New York's electricity sales increased 1.2 percent annually. Results of the Starting Point case assumed reaching only 27 percent of the "45 by 15" goal and indicate that from 2009 to 2018, electricity demand would increase at an

average rate of 0.8 percent per year, or a total increase of 7.3 percent. The State Energy Plan notes that, even with the considerable achievements made to date in the State's end-user efficiency programs, achieving the "45 by 15" goal will require nearly a five-fold increase in annual energy savings by 2015 (State of New York Energy Planning Board 2009). Because energy conservation alone will not meet the State's goals to produce, deliver, and use energy more efficiently, or significantly reduce environmental impacts from air emissions, the demand-side management alternative should not be considered as a substitute for the Project.

3.4 Alternative Technologies

3.4.1 High-Voltage Alternating Current Transmission System

CHPEI considered the construction of a high-voltage alternating current (HVAC) underwater/underground transmission system to connect renewable sources of electrical generation with load centers in the New York City area and southwestern Connecticut. However, the technological limits of HVAC systems do not permit underwater/underground transmission over the significant distances required for this Project. Additionally, unlike HVDC technology, HVAC technology emits substantial electromagnetic fields, which have historically been met with strong opposition from citizens living in the vicinity of the Project. Furthermore, an HVAC transmission system would not provide system reliability, congestion management, and integration of renewable energy sources that an HVDC transmission system does provide.

3.4.2 Alternate High-Voltage Direct Current Transmission System Technology

Until the mid-1990s, HVDC systems primarily utilized paper-lapped, low-pressure fluid-filled (LPFF) or solid, mass-impregnated, non-draining (MIND) cables. CHPEI considered both of these options as alternatives to the cross-linked polyethylene (XLPE) cables currently selected for the Project. LPFF cables require auxiliary equipment to maintain pressure, and are not suitable for long-distance applications (DOE and the Bonneville Power Administration 2007). LPFF cables also present an oil spill risk, as they typically utilize low-viscosity oils to maintain pressure. While MIND cables are widely used in HVDC systems, they present greater installation and maintenance challenges for a transmission system of the Project's proposed dimensions. MIND cables also utilize oil in the cable insulation and have limitations in the operating conductor temperature. Therefore, CHPEI eliminated the LPFF and MIND technologies from further consideration and proceeded with the XLPE cables as the preferred technology for the Project.

3.4.3 Overhead Transmission

Overhead HVAC transmission is the traditional method of expanding transmission capacity within and between utility service territories. Overhead HVAC lines require significant land area for new utility corridors. In metropolitan areas, land costs are high, and public concern regarding aesthetics and potential environmental and health effects of HVAC transmission result in few such projects proceeding beyond the planning stage. Capacity at existing HVAC transmission corridors can be increased through upgrading and overbuilding; however, most of

the high-voltage corridors in the region are already at or near capacity because of both space constraints and contingency considerations over the loss of common towers.

CHPEI is not aware of any pending projects by Consolidated Edison Company of New York, Inc. (Con Edison), the New York Power Authority (NYPA), or the independent power producer sector for the construction of new or expanded, overhead, on-land HVAC transmission lines that would add to the transfer capacity of the region and decrease the need for increased generation or other capacity solutions.

CHPEI, as an HVDC system, provides a preferable alternative to new or expanded overhead HVAC transmission lines for the following reasons:

- **Fewer Environmental Effects:** The Project will consume considerably less space than comparably sized HVAC overhead systems. The proposed cables will be buried, and the total corridor requirements typically will be less than 42 feet in width. Overhead HVAC of similar capacity would require a right-of-way up to 200 feet wide. Overhead on-land HVAC rights-of-way require initial vegetative clearing and ongoing vegetative management (practices that create visual impacts) and can contribute to erosion/sedimentation when the rights-of-way are utilized for recreational purposes to biocide accumulation in the environment if managed with herbicides. HVDC underwater corridors do not require surficial maintenance or pose a threat to migrating birds. The cable technology selected by CHPEI contains no liquids and, therefore, no risk of contamination from the cables themselves.
- **Greater Reliability:** Underwater and underground armored cables have a higher reliability than overhead HVAC transmission lines, primarily because they are not subject to weather, collision, or vandalism damage. They also operate in a constant temperature regime; therefore, they are not as subject to thermal derating.
- **Enhanced Security:** Since September 11, 2001, energy infrastructure security has become a high national priority. The physical separation of transmission infrastructure in multiple corridors is one means of enhancing security, as is the installation of such facilities underwater and underground.
- **Greater Control to Improve System Stability:** HVDC interconnections to AC systems have the added advantage of being able to enhance the controllability and stability of the AC system. Similar benefits can be achieved through generator voltage control or transmission compensation devices, such as phase shifters, but such alternative measures serve to reduce the real power output of generators, reduce or limit transfer capability, and are generally not as time responsive as DC control.

For these reasons, CHPEI has determined that overhead HVAC transmission lines are not a feasible alternative to the Project and has eliminated them from further consideration.

3.5 Alternative Station Sites

3.5.1 *Alternative Substation and Converter Station Site Evaluation Process*

In evaluating the Project's potential substation and converter station sites, CHPEI used a multi-step process involving the review and evaluation of various opportunities and constraints including:

- The location of existing substations within the New York City metropolitan area;
 - Evaluation of existing substations as a viable point of interconnection for the Project and costs associated with the Project interconnection;
 - Evaluation of the potential converter station sites to ensure the property is of sufficient size to build a 1,000 MW converter station (~5 acre site), is located within proximity to a waterway, and has reasonable likelihood that site control can be achieved within the Project timeline;
- Potential HVAC cable routes between the converter station and substation sites;
- Environmental features and potential impacts associated with construction and operation; and
- Engineering opportunities and constraints associated with Project development.

3.5.2 *Identification of Potential Substation Interconnection Sites*

The Project has been designed to deliver renewable energy generated in central and eastern Canada and upstate New York to load centers in and around the New York City area and southwestern Connecticut in an effort to meet the future electricity needs of these areas while also resulting in an increase in grid reliability and a decline in ratepayer energy prices. CHPEI evaluated numerous existing substations located in the New York City area as potential points of interconnection (POIs) for the Project. The objective of this evaluation was to identify a POI that met the following criteria:

- Availability of interconnection points (breaker positions) at the POI or the capability to add additional interconnection positions;
- Capability of existing distribution circuits, connected to the POI, to evacuate the additional capacity of the Project, or the possibility of distribution system upgrades if necessary;
- Proximity of the POI to the converter station site;
- Accessibility to the POI property for the HVAC cables from the converter station; and
- Relative costs for each of the aforementioned criteria.

Siemens Energy, Inc./Siemens Power Technologies International (Siemens PTI) conducted a Feasibility Study of potential Project POIs relating to the reliability of the New York State transmission system. The Feasibility Study evaluated possible POIs of the 1,000 MW, +/- 320 kV HVDC transmission line at the following four substations, located in proximity to New York City (Figure 3.5-1):

- Gowanus 345 kV substation, located in New York County, New York;
- West 49th Street 345 kV substation, located in Kings County, New York;
- Astoria (Polletti) 345 kV substation, located in Queens County, New York; and
- Sherman Creek 138 kV substation, located in New York County, New York.

Siemens PTI's Interconnection Feasibility Study, in collaboration with Con Edison, indicated that the West 49th Street 345 kV substation was not a practical POI location for the Project due to insufficient space for Project interconnection equipment and excessive costs (>\$600 million) for required substation upgrades that would render the Project economically infeasible. Therefore, CHPEI determined that the West 49th Street 345 kV substation is not a viable POI for the Project and eliminated it from further consideration.

CHPEI determined that the Gowanus, Astoria, and Sherman Creek substations represent viable POIs for the Project that warrant additional evaluation.

3.5.3 Identification of Potential Converter Station Sites

Following the identification of viable POIs in the New York City area, CHPEI identified potential converter station sites in proximity to the POIs for evaluation. The evaluation criteria included the following:

- Proximity to preferred POIs (substations) in order to minimize overall cable length between the converter station and substation;
- Proximity to preferred HVDC cable route (waterway) in order to minimize environmental impacts, neighborhood disruption, and costs associated with the cable connections to the converter station;
- Surrounding zoning designation(s) and land use(s) in proximity to the converter station site in order to maintain compliance with local ordinances and land use expectations;
- Potential to minimize impacts to shipping traffic by utilizing the shortest viable route through a navigable water;
- Potential to minimize environmental impacts associated with the cable landfall approach as well as the construction of the converter station; and
- Sufficient land available for the converter station building.

3.5.3.1 Evaluation of Gowanus Points of Interconnection

The existing Gowanus 345 kV substation is located in a highly urban, industrialized area in Brooklyn, New York between the Gowanus Expressway and Gowanus Bay, near the confluence of the Gowanus Canal (Figure 3.5-1). CHPEI identified the following three potential converter station locations near the existing Gowanus 345 kV substation for evaluation:

- 611 Smith Street in Brooklyn, New York;
- 688 Court Street in Brooklyn, New York; and
- Property located within the Sunset Industrial Park in Brooklyn, New York.

Figure 3.5-1 shows the location of these potential converter station sites in relation to the Gowanus POI. In order to connect the HVDC cables to one of the aforementioned converter station sites, it is likely that the HVDC cable route would extend through either the Hudson River or the East River towards Gowanus Bay. Both the Hudson and East Rivers in the vicinity of New York City experience heavy vessel traffic, including transportation ferries and cargo ships. Additionally, the presence of existing infrastructure (e.g., existing cables and pipelines) and numerous underground roadway tunnels located throughout these regions of New York City could make installation of the HVDC cables extremely costly.

During the initial investigations conducted to evaluate the feasibility of siting the converter station near the existing Gowanus 345 kV substation, CHPEI determined that significant contamination exists within Gowanus Bay and the Gowanus Canal. Completed in 1869, the Gowanus Canal was once a major transportation route for the then-separate cities of Brooklyn and New York. Manufactured gas plants, mills, tanneries, and chemical plants were among the many facilities that operated along the Canal. As a result of the years of discharge, storm water runoff, sewer outfalls, and industrial pollutants, the Gowanus Canal has become one of the nation's most extensively contaminated water bodies (USEPA 2010). Contaminants in the canal include polychlorinated biphenyls (PCBs), coal tar, heavy metals, and volatile organics. Recently, the USEPA added the Gowanus Canal to the Superfund National Priorities List (NPL); As a result of this determination, the USEPA can be expected to expand its investigations to further define the nature and extent of the contamination and to develop an approach to address the contamination (USEPA 2010). These activities could impact the Project construction schedule and result in other cable installation constraints.

Based on the engineering and environmental constraints identified above, as well as the difficulties that would be associated with the recent designation of the area as a NPL site, CHPEI determined that the Gowanus 345 kV substation is not the preferred POI for the Project at this time.

3.5.3.2 Evaluation of Astoria Points of Interconnection

The existing Astoria 345 kV substation is located on the Con Edison power plant property in Long Island, New York along the southern shore of the East River (Figure 3.5-1). The area surrounding the Astoria substation and power plant consists of industrial/manufacturing uses. Historically, portions of the site were occupied by the Astoria Gas Works, a manufactured gas

plant that began operations in 1906. By 1912, the Astoria Gas Works had grown to be the largest manufactured gas plant in the world. Manufactured gas production ended in Astoria in the 1960s, and the site was later converted to a sintering plant used to process fly ash generated by coal-burning power plants that had replaced the site's manufactured gas facilities. Fly ash processing at the site continued until 1972, when the process was phased out due to environmental restrictions. Based on the historical use of the property, NYSDEC has required the site to be investigated because contaminated soils and/or groundwater are believed to exist at the site, creating both engineering and environmental constraints for Project construction.

The site has also been identified by the State Historic Preservation officer as an archaeologically sensitive area that may contain potentially significant cultural deposits associated with the historic operation of the Astoria Gas Works. Ground-disturbing activities at this location have the potential to adversely affect the integrity of archaeological resources at the site, should any exist. Conducting subsurface investigations to determine the location and extent of cultural deposits is complicated by the likely presence of contaminated soils and /or groundwater. The archaeological potential of the Astoria site poses constraints for both engineering and construction activities at this location.

Based on the engineering and environmental constraints identified above, CHPEI determined that the Astoria 345 kV substation is not the preferred POI for the Project at this time.

3.5.3.3 Evaluation of Sherman Creek Points of Interconnection

The Sherman Creek 138 kV substation is located on the western shoreline of the Harlem River in the vicinity of 9th Avenue and West 201nd Street in the Borough of Manhattan (Figure 3.5-1). There are two existing substations associated with the Sherman Creek 138 kV substation – Sherman Creek East and Sherman Creek West. Because Sherman Creek is a 138 kV substation and the Project would include a 345 kV transmission line from the converter station to the substation, a 345/138 kV AC transformer substation would be required to be constructed adjacent to the Sherman Creek substation for this option to be viable.

CHPEI identified and evaluated one potential location for the 1,000 MW converter station located near the existing Sherman Creek 138 kV substation. This property is located in Yonkers, New York and is situated between Alexander Street and Woodworth Avenue (Figure 3.5-1).

CHPEI identified the Wells Avenue property due to its close proximity to the Hudson River, where the HVDC cables have been sited. Utilization of a property with close proximity to a waterway along the HVDC cable route minimizes potential impacts to the environment and community. In addition, siting the converter station at the Wells Avenue property would minimize the overall length of the 1,000 MW HVDC bipole cables extending from the Canadian border (as compared to the Gowanus or Astoria POI), which would reduce the overall cost and environmental impact of the HVDC cable installation.

3.6 Alternative Cable Routes

3.6.1 Alternative High-Voltage Direct Current Cable Route Evaluation Process

The Project has been designed to primarily be an underwater HVDC transmission system utilizing existing waterways, to the greatest extent feasible, for the siting of the HVDC transmission cables between the Project's Canadian and United States POIs. As discussed in Exhibit 2, the Project will utilize the Lake Champlain, Champlain Canal, Hudson River, Harlem River, East River, and Long Island Sound for the HVDC cable route.

CHPEI evaluated the following criteria to identify alternative routes and ultimately select a preferred alignment for the underwater HVDC transmission cable:

1. bathymetry of waterways;
2. surficial geology and sediment characteristics;
3. sediment quality (contamination);
4. infrastructure crossings (bridges, cables, pipelines);
5. commercial and recreational fishing activities;
6. navigation channels;
7. anchorage areas;
8. shipping activities;
9. restricted areas;
10. environmentally sensitive areas; and
11. cultural and historical resources.

Based on these factors, CHPEI identified a preferred HVDC underwater transmission cable route which represents the most suitable alignment for the installation of the cables. CHPEI also identified alternative routes at various locations between the Canadian border and New York City to avoid, to the extent possible, potential physical, environmental, and cultural resources.

Alternative routes make use of other alignments to connect the proposed POIs, including the use of existing utility rights-of-way or other infrastructure. While the final alignment of the routes would differ, alternative routes were identified to satisfy the Project objectives and balance various environmental and socioeconomic impacts in an effort to select the best overall Project alignment. Any alternative route that would result in significantly less impact, while maintaining the committed schedule and economic parameters of the Project, would be preferable to the proposed Project. A discussion of the preferred route and site-specific alternative routes is presented below.

3.6.1.1 Preferred High-Voltage Direct Current Transmission Cable Route

As discussed in Exhibit 2, the preferred route for the portion of the Project within the United States begins at the Canadian border, and continues south through Lake Champlain to the northern entrance of the Champlain Canal, near Whitehall, New York. To the extent practicable, the submerged cables will continue south along the bed of the Champlain Canal to Fort Edward, where the canal joins the Hudson River. An underground route will be necessary to bypass Lock

C12 at Whitehall and Lock C11 Fort Ann. These bypass sections will have a combined length of approximately 2.1 miles along an existing railroad right-of-way. The cables will also use a 0.5-mile underground route within Canal Corp-owned land to bypass Lock C9. South of Lock C9, the HVDC cable route continues through the Champlain Canal towards Lock C8.

To avoid installing underwater HVDC cables within three contaminated sediment areas in the Upper Hudson River PCB Dredging Project, the preferred HVDC cable route will exit the Champlain Canal north of Lock C8 and follow a 69.9-mile long underground railroad bypass route. The cables will be buried for the full length of the railroad bypass route to avoid the visual impacts of overhead transmission lines. The HVDC cables will exit the railroad bypass route and enter the Hudson River south of Albany, in the Town of Coeymans, New York.

South of Coeymans, the Project route is sited within the Hudson River until it reaches the New York City metropolitan area. Two HVDC cables (one bipole) will terminate at Yonkers, New York at an HVDC converter station. From the Yonkers HVDC converter station, HVAC cables will re-enter the Hudson River and travel south through the Harlem River for a distance of approximately 6.6 miles. The HVAC cables will terminate at a new 345/138 kV AC transformer substation near to Con Edison's existing Sherman Creek substation located near the intersection of West 201st Street and 9th Avenue, in the Borough of Manhattan.

At the Yonkers converter station, the remaining two HVDC cables (the second bipole) will continue another 66 miles through the Hudson River, the Harlem River, the East River, and into Long Island Sound continuing to an HVDC converter station in Bridgeport, Connecticut.

3.6.1.2 Champlain Canal Alternative Routes

During initial design stages of the Project, CHPEI evaluated a potential cable route in the Champlain Canal for approximately 63 miles to the Federal Dam at Troy. However, during consultations with the New York State Canal Corporation (Canal Corp), staff indicated that the Canal Corp would not allow the HVDC cables to be installed through or under the locks and/or dams within the Champlain Canal.

In addition, USEPA staff indicated that the HVDC cables should not be installed within the upper Hudson River before completion of the dredging activities associated with the Upper Hudson River PCB Dredging Project, estimated to continue through 2016. The northern limit of the Upper Hudson River PCB Dredging Project is near the former Fort Edward Dam at Lock C7. In order to avoid the dredging activities and contaminated sediments associated with the Upper Hudson River PCB Dredging Project, CHPEI determined that the HVDC cables would not be sited within the Champlain Canal/upper Hudson River south of Lock C7.

CHPEI identified an existing railroad right-of-way owned/operated by Canadian Pacific (CP) located immediately west of the Champlain Canal (Figure 3.6-1). CHPEI conducted further investigations to evaluate the feasibility of locating the HVDC cables within the CP railroad right-of-way to completely bypass the Champlain Canal and associated lock systems. These investigations determined that utilizing the CP railroad right-of-way for approximately 17.9

miles to bypass the entire northern portion of the Champlain Canal (from Lock C12 to Lock C8) was not the preferred option because:

- Extensive tree clearing would be required along the narrow CP railroad right-of-way resulting in an increase in impacts to habitat and vegetation;
- Underground cable installation would require cable burial within conduits, resulting in a greater area of impact in comparison to underwater cable installation;
- Underground cable installation would often require the use of large, heavy machinery to excavate the trenches for cable burial, which would result in a greater area of impact to the land and a greater level of noise impacts to surrounding communities;
- Increased duration of cable installation activities would result in an increase in environmental and community impacts; and
- The costs per mile associated with underground cable installation would be significantly higher than underwater cable installation.

Based on the aforementioned environmental and engineering constraints, CHPEI eliminated the alternative route that utilized the CP railroad right-of-way to completely bypass the Champlain Canal from Lock C12 to Lock C8 from further consideration.

Subsequently, CHPEI conducted additional investigations to evaluate the feasibility of installing the HVDC cables along short on-land bypass routes to circumvent Locks C12, C11, C9, and C8 (there is no Lock C10) within the Champlain Canal (Figure 3.6-1). The lock bypass route evaluations considered the minimization of roadway crossings, minimization of sensitive environmental resource area crossings, and the ownership and current use of lands along the potential bypass routes.

CHPEI evaluated the feasibility of installing the HVDC cables immediately adjacent to the locks within Canal Corp-owned land to avoid impacts to adjacent private landowners. These investigations determined that it would be extremely difficult to install the HVDC cables within the Canal Corp-owned land immediately adjacent to Locks C12 and C11 due to the presence of bedrock and the retaining infrastructure associated with the lock system. Based on the engineering constraints associated with a bypass route through the Canal Corp-owned land around Locks C12 and C11, CHPEI determined that this route was not a viable alternative and eliminated it from further consideration.

CHPEI also evaluated potential underground bypass routes to circumvent Lock C9. These investigations evaluated the siting of the cable along the CP railroad right-of-way to bypass Lock C9. However, this alternate route was later rejected when it was determined that a shorter underground bypass route (0.5 mile) immediately adjacent to Lock C9 on the Canal Corp-owned land was feasible. Due to the shorter length (and associated minimization of impacts) of the underground bypass route along the Canal Corp-owned land, CHPEI eliminated the CP railroad right-of-way bypass route around Lock C9 from further consideration.

CHPEI identified a short underground bypass route around Lock C8, but this route was later abandoned because of the adoption of the railroad right-of-way bypass route around the Upper Hudson River PCB Dredging Project.

3.6.1.3 Upper Hudson River Polychlorinated Biphenyl Dredging Project Alternative Routes

As discussed in Section 3.5.4.2, CHPEI routed the HVDC cables to avoid the dredging activities and contaminated areas associated with the Upper Hudson River PCB Dredging Project. Therefore, an on-land route was needed to bypass approximately 40 miles of the upper Hudson River from Lock C7 to the Federal Dam at Troy, New York. CHPEI considered the use of existing roadway, railroad, and transmission line rights-of-way to avoid this section of the Hudson River. Figure 3.6-2 shows the location of the Upper Hudson River PCB Dredging Project, the preferred route, and the alternative routes considered by CHPEI.

Based on a review of the area, CHPEI evaluated the use of a roadway right-of-way (United States Route 320) located near the Champlain Canal and Hudson River that would afford an opportunity to utilize an existing corridor to bypass the Upper Hudson River PCB Dredging Project. However, based on CHPEI's initial review of this right-of-way, the following environmental and engineering constraints were identified:

- Safety of workers along the roadway right-of-way during cable installation activities; and
- Project-related impacts to traffic patterns and increased installation costs related to the greater number of roadway crossings encountered along the right-of-way.

An extensive railroad system exists in the Albany, New York area. CHPEI reviewed the existing railroads to develop a suitable on-land route alternative to bypass the Upper Hudson River PCB Dredging Project.

CHPEI identified numerous railroad rights-of-way west of the Champlain Canal as possible underground corridors to exit the Champlain Canal north of Lock C7 to bypass the upper Hudson River/Champlain Canal. The alternative routes evaluated by CHPEI that utilize railroad rights-of-way are shown on Figure 3.6-2.

Railroad Route Option 1

As the CP railroad right-of-way approaches Schenectady from the north, a CSX railroad right-of-way spurs eastward, extending through the northern portions of Albany before approaching the Hudson River. CHPEI determined that this railroad right-of-way was unsuitable for installation of the cables due to the engineering constraints and associated impacts of routing and installing the HVDC cables through a highly congested urban area in and immediately around the city of Albany. Therefore, CHPEI eliminated this route option from further consideration.

Railroad Route Option 2

As the CP railroad right-of-way extends southward through Schenectady, it continues west (away from the Hudson River) towards Delanson, New York where it intersects with another railroad right-of-way owned/operated by SMS Rail Lines of New York, LLC. The line extends southeast towards Albany before intersecting with another railroad right-of-way owned/operated by CSX. CHPEI evaluated this railroad right-of-way alternative as an option to avoid developed areas in the vicinity of Albany; however, CHPEI determined that this route was not preferred based on the additional route length and increased material and installation costs associated with this option as well as the additional coordination with a third railroad company for the use of their right-of-way. Therefore, CHPEI eliminated this route from further consideration.

Railroad Route Option 3

CHPEI identified an abandoned railroad right-of-way extending from Voorheesville to Albany. CHPEI considered the use of this abandoned right-of-way as an option for the HVDC cable route, but later rejected it due to the uncertainty regarding property ownership and the potential future development of this right-of-way as a recreational bike path. As a result, CHPEI did not consider this option to be a viable alternative route and eliminated it from further consideration.

3.6.1.4 Haverstraw Bay Alternative Routes

Approximately 35 miles north of New York City, the HVDC cable route enters the Haverstraw Bay area of the Hudson River. About 3.5 miles wide, Haverstraw Bay is the widest portion of the Hudson River estuary and is considered an environmentally sensitive resource area. CHPEI has identified the preferred route for the HVDC cables as located within in the federal navigation channel for the crossing of Haverstraw Bay to utilize a previously disturbed area within this sensitive environment. As discussed below, CHPEI evaluated several alternative routes within and around Haverstraw Bay (Figure 3.6-3).

Hudson River Alternative Route

CHPEI identified an alternate route within Haverstraw Bay, but outside of the federal navigation channel, to avoid potential impacts to shipping and the deep burial depths that will be required for installation of the cables within the navigation channel. During initial consultations with the New York Department of State (NYDOS), NYDOS staff indicated that the NYDOS would not allow the HVDC cables to be installed within undisturbed portions of Significant Coastal Habitat area located in Haverstraw Bay. Because the majority of Haverstraw Bay (Stony Point State Park to Tellers Point) is designated as Significant Coastal Habitat area, CHPEI determined that the route within Haverstraw Bay, outside of the navigation channel, was not viable and has, therefore, not been incorporated it into the preferred route.

Railroad Alternative Routes

CHPEI evaluated alternative underground routes around Haverstraw Bay to avoid installing the HVDC cables within the navigation channel or Significant Coastal Fish and Wildlife Habitat

areas. CHPEI identified railroad rights-of-way along the eastern and western shores of Haverstraw Bay, both of which are operated by CSX.

The Eastern Railroad Route (located along the eastern shoreline of Haverstraw Bay) is heavily travelled and portions of the right-of-way are constructed over the waters of Haverstraw Bay via bridges, both factors that make the use of this corridor unfavorable for cable installation activities. In addition, nearly the entire stretch of the CSX railroad right-of-way on the eastern shore of Haverstraw Bay is located within designated Critical Environmental Areas.

The Western Railroad Route (located along the western shore of Haverstraw Bay) does not cross Critical Environmental Areas; however, the western-shore route crosses (or passes nearby) several NYDEC-mapped wetland areas. Urban areas and a railroad tunnel are also located along the western railroad right-of-way, which are considered engineering constraints for HVDC cable installation. Additionally, as the western railroad right-of-way continues towards the southern end of Haverstraw Bay, the route begins to deviate away from the Hudson River, which would complicate re-entry into the river south of the bay.

Because of environmental and engineering constraints associated with the use of either of the Railroad Alternative Routes in the Haverstraw Bay area, CHPEI has not incorporated either of these routes into the preferred route.

3.6.1.5 New York City Alternative Routes

As the HVDC cable route continues south in the Hudson River, it approaches the New York City metropolitan area. The preferred HVDC cable route exits the Hudson River at Spuyten Duyvil Creek and continues within the waters of New York through the Harlem and East Rivers before entering the waters of Connecticut in Long Island Sound (Figure 3.6-4).

CHPEI evaluated an alternative route in the New York City area that would extend in the Hudson River into New York-New Jersey Harbor and then turn northeast into the East River towards Long Island Sound. CHPEI's evaluation of this alternative route indicated that numerous engineering constraints exist, including:

- Extensive marine traffic, including cargo ships entering the New York-New Jersey Harbor and ferries travelling between New York and New Jersey;
- Numerous anchorage areas;
- Numerous existing pipelines/cables crossing the Harbor; and
- Crossing of numerous underground roadway tunnels and numerous overhead bridges.

The aforementioned features present a very challenging condition for HVDC cable installation activities. It is anticipated that extensive coordination with the marine pilots would be required and would severely limit installation procedures. Based on historical submerged cable projects, it is anticipated that very deep burial depths would be required along this stretch of the Hudson/East Rivers to avoid potential interference with shipping traffic (anchorage) and

existing infrastructure. Compared to the preferred route that avoids this portion of the Hudson River (by travelling through the Harlem River), this route is 12.8 miles longer than the preferred route, resulting in a greater cumulative environmental impact and increased cost for the Project. Because of environmental and engineering constraints associated with the use of the New York City Alternative Route, CHPEI has not incorporated this alternative into the preferred route.

3.6.1.6 Underground Cable Alternative Route from Canada to New York City

The Project has been designed to deliver safe, dependable, and renewable sources of energy generated in eastern and central Canada and upstate New York to the New York City market area.

However, CHPEI evaluated an alternate underground route with a corridor suitable for burial of the HVDC cables extending between the Canadian border and Yonkers, New York. CHPEI focused its review on previously disturbed areas including existing roadway corridors, railroad rights-of-way, and transmission rights-of-way (Figure 3.6-5).

CHPEI identified continuous existing corridors of state and/or local highways and roadways as well as railroad rights-of-way between the international border and New York City. CHPEI conducted a further evaluation of these corridors for underground HVDC cable installation. The evaluation of existing transmission line corridors within eastern New York indicated that a continuous corridor does not exist. In comparison to the continuous roadway and railroad right-of-way corridors that were identified in New York, it was determined that use of existing transmission corridors is not considered the preferable route and no further evaluation was conducted.

CHPEI conducted an evaluation of these continuous roadway and railroad corridors for underground HVDC cable installation. These evaluations identified the following engineering constraints:

- The underground routes cross steep mountainous terrain along the northern portions of the corridor, creating difficult or infeasible conditions for cable burial;
- The underground routes cross urban areas, particularly along the southern portions of the corridor, creating difficult or infeasible conditions for cable burial and impacts to traffic patterns and property owners;
- The underground routes would cross numerous roadways resulting in impacts to traffic patterns and/or increase costs associated with horizontal direction drilling techniques utilized to cross these roadways;
- Potential for extensive tree clearing along narrow rights-of-way resulting in an increase in impacts to habitat and vegetation;
- Underground cable installation requires cable burial within conduits, resulting in a greater area of impact; and

- Underground cable installation would often require the use of large, heavy machinery to excavate the trenches for cable burial, which will result in a greater area of impact to the land and a greater level of noise impacts to surrounding communities.

The aforementioned criteria would all contribute heavily to the duration and costs of the cable installation activities in comparison to cable burial within waterways. In ideal conditions, HVDC cables can be buried within waterways at a rate of approximately 20 miles/day (assuming a 24-hour work day) with an average cost of \$370,000/mile². In comparison, HVDC cable burial along ideal overland portions consists of an installation rate of 0.5 to 1 mile/day (assuming a 24-hour work day) with an average cost of \$1.03 million/mile³. Additional items contributing to extensive cost increases associated with underground cable installation result from an increase in the required number of cable splices, an increase in the required number of horizontal direction drill locations, and an increase in overall route length. For these engineering, environmental, and cost reasons, CHPEI does not propose an underground route for the Project.

3.7 REFERENCES

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² Submarine cable installation costs were derived from a project-specific study which indicated that on average cable transport, lay, and installation (via water jetting) would cost approximately \$230/meter. This estimate does not include costs associated with existing infrastructure crossings or horizontal directional drills.

³ Underground cable installation costs were derived from a project-specific study performed, which indicated that on average cable transport, lay, and installation (via trenching) would cost approximately \$640/meter. This estimate does not include costs associated with existing infrastructure crossings or horizontal directional drills.

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