BAKER BOTTS L.L.P.

700 K STREET, N.W.
WASHINGTON, D.C.
20001

TEL +1 202.639.7700
FAX +1 202.639.7890
BakerBotts.com

AUSTIN
BEIJING
BRUSSELS
DALLAS
DUBAI
HONG KONG
HOUSTON
LONDON
MOSCOW
NEW YORK
PALO ALTO
RIYADH
SAN FRANCISCO
WASHINGTON

January 15, 2021

Jay T. Ryan
TEL: 2026397789
FAX: 2025851015
jay.ryan@bakerbotts.com

Christopher Lawrence
Office of Electricity
OE-20, Room 8E-0
United States Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

RE: CHPE LLC
OE Docket No. PP-481
Supplement to Pending Application of CHPE LLC
to Amend Presidential Permit No. 481

Dear Mr. Lawrence:

On September 25, 2020, CHPE LLC (CHPE) filed an application with the U.S. Department of Energy (DOE) to amend Presidential Permit No. PP-481 (Amendment Application) to incorporate proposed changes to the permitted route for the Champlain Hudson Power Express Project (Project). The Project, as currently permitted, is a 336-mile, 1000 megawatt (MW), high-voltage direct current underwater and underground merchant transmission line that will extend from the United States-Canada border south into New York City.

Notice of the Amendment Application appeared in the Federal Register on October 5, 2020 and the public comment period concluded November 4, 2020. DOE has not yet acted on the Amendment Application.

Since the filing of the Amendment Application last September, the New York Independent System Operator (NYISO) completed a System Reliability Impact Study (SRIS) that assessed the potential impact of increasing the Project's transmission capacity from 1,000 MW to 1,250 MW. The SRIS determined that the Project can interconnect and operate at 1,250 MW without adversely affecting the reliability of the interstate transmission grid. In addition to the completed SRIS, an expert retained by CHPE completed an analysis of the potential impacts of operating a 1,250 MW transmission line. This analysis, which addressed magnetic fields, compass deviations, and thermal cable losses, determined there would be no material change in impacts beyond those identified for the permitted 1,000 MW project.

Based on this new information, CHPE is supplementing the pending Amendment Application with an additional request that PP-481 be amended to allow CHPE to construct, operate, maintain, and connect a 1,250 MW transmission line (Supplement). As discussed in the Supplement, increasing the Project's transmission capacity will not require any material changes to the construction methods previously analyzed by DOE. Similarly, there will be no material changes to the operation and maintenance of the Project.

CHPE is enclosing an original and two (2) copies of the Supplement, and requests that it be incorporated into the Amendment Application which was filed in accordance with Executive Order 10485, as amended by Executive Order 12038, and DOE's implementing regulations, 10 C.F.R. § 205.320 *et seq.* As required by DOE's regulations, the Supplement includes technical information regarding the proposed upgrade to 1,250 MW and an analysis of the associated environmental impacts. The SRIS, which contains critical energy infrastructure information, will be transmitted directly to DOE by NYISO.

Please do not hesitate to contact me if you have any questions regarding this matter.

Sincerely,

/s/ Jay Ryan

Jay Ryan

cc: Melissa Pauley, DOE
Josh Bagnato, TDI
Bill Helmer, TDI
Sean Murphy, VHB
John Katz, FERC
Brian Ossias, New York Department of Public Service

UNITED STATES OF AMERICA

BEFORE THE DEPARTMENT OF ENERGY

OFFICE OF ELECTRICITY DELIVERY AND

ENERGY RELIABILITY

CHPE LLC

Docket No. PP-481

SUPPLEMENT TO PENDING APPLICATION OF CHPE LLC TO AMEND PRESIDENTIAL PERMIT NO. 481

January 15, 2021

UNITED STATES OF AMERICA

BEFORE THE DEPARTMENT OF ENERGY

OFFICE OF ELECTRICITY DELIVERY AND

ENERGY RELIABILITY

CHPE LLC	**)))**	**OE DOCKET NO. PP-481**

SUPPLEMENT TO PENDING APPLICATION OF CHPE, LLC
TO AMEND PRESIDENTIAL PERMIT NO. 481

On September 25, 2020, CHPE LLC (CHPE) filed an application with the U.S. Department of Energy (DOE) to amend Presidential Permit No. PP-481 (Amendment Application) to incorporate proposed changes to the permitted route for the Champlain Hudson Power Express Project (Project). The Project, as currently permitted, is a 336-mile, 1000 megawatt (MW), high-voltage direct current underwater and underground merchant transmission line that will extend from the United States-Canada border south into New York City. The Amendment Application was filed pursuant to Executive Order 10485, as amended by Executive Order 12038, and applicable regulations of the United States Department of Energy (DOE), 10 C.F.R. §§ 205.320 *et seq*. CHPE is filing this supplement to the pending Amendment Application to request that DOE also amend PP-481 to authorize CHPE to construct, operate, maintain, and connect the Project as a 1,250 MW transmission line (Supplement). As discussed herein, upgrading the Project's capacity will not adversely affect the reliability of the interstate transmission grid and there will be no material changes in the environmental impacts beyond those already identified and analyzed in DOE's *Final Environmental Impact Statement for the Champlain Hudson Power Express Transmission Line Project* (DOE/EIS-0447).

BACKGROUND

On October 6, 2014, DOE issued a Presidential Permit (PP-362) authorizing Champlain Hudson Power Express Inc. (CHPEI) to construct, operate, and maintain the Project. The aquatic segments of the transmission line will primarily be submerged in and/or under Lake Champlain and the Hudson, Harlem, and East Rivers. The terrestrial portions of the transmission line will primarily be buried in existing road and railroad rights-of-way (ROW).

On April 6, 2020, CHPEI and CHPE LLC jointly filed an application with DOE requesting that DOE amend or, in the alternative, rescind and reissue Presidential Permit No. PP-362 to enable the transfer of the permit from CHPEI to its affiliate CHPE LLC. In response to the joint application, DOE issued Presidential Permit No. 481 to CHPE LLC on July 21, 2020.

On September 25, 2020, the CHPE LLC filed the Amendment Application requesting that DOE amend Presidential Permit PP-481 to incorporate certain modifications to the permitted route and the location of the converter station. These modifications were developed in consultation with various stakeholders and are principally driven by environmental, landowner/stakeholder, and engineering considerations that have been identified as the Applicant has refined the design of the Project. The Applicant also proposed a new construction method that will reduce environmental impacts.

While working with HVDC equipment manufacturers to finalize the design of the Project, the Applicants were made aware of continuing advances in the design of HVDC cables that allow for increased transmission capacity with no significant change in cable size. Additionally, the

New York Independent System Operator (NYISO) recently completed a System Reliability Impact Study (SRIS) finding that the Project can interconnect at 1,250 MW without adversely affecting the reliability of the interstate transmission grid. Applicant also retained an expert to assess the potential environmental impacts of the 250 MW upgrade; the expert determined that operating a 1,250 MW transmission line would not have impacts materially different than those previously identified and assessed by DOE. The discussion below summarizes this new information and provides the basis upon which DOE can approve the requested 250 MW increase in the Project's capacity.

PROPOSED ADDITIONAL MODIFICATION

As currently permitted, CHPE LLC is authorized to construct, operate, and maintain a 1,000 MW transmission line. The Applicant seeks to amend PP-481 to authorize CHPE LLC to construct, operate and maintain a 1,250 MW transmission line (Proposed Modification).

To implement the Proposed Modification, no changes to the construction and operation activities as previously described in the administrative record in this proceeding (Project Documentation) are necessary. Additionally, the design of the upland and submarine cables for the Proposed Modification are consistent with those provided in the Project Documentation. The conductor design, which consists of copper wires surrounded by a conductor shield, insulation, metallic shield / sheath, moisture barrier, and jacket / outer sheath, is unchanged. The submarine cables will continue to have armoring for additional protection.

The mechanical properties of the proposed cables are also similar to the cables as permitted. As shown in the table below, the diameter of the proposed cables does not necessitate any modifications to the previously approved overland or in-water installation, including the width of trenches as described in the Project Documentation.

	Permitted Transmission System HVDC Cables	**Proposed Transmission System HVDC Cables**	**Delta**
Capacity (MW)	1,000	1,250	25%
Rated Continuous Voltage (kV)	320	400	25%
Rated Continuous Current Under Installation Conditions (Amps)	1638	1638	0
Overland Cables			
Diameter	4.72 in (119.96 mm)	4.86 in (123.53 mm)	3.0%
Weight in Air	20.7 lbs/ft (30.7 kg/m)	21.1 lbs/ft (31.4 kg/m)	2.1%
Submarine Cables			
Diameter	5.24 in (133 mm)	5.36 in (137.3 mm)	3.2%
Weight in Air	34.9 lbs/ft (51.9 kg/m)	35.9 lbs/ft (53.4 kg/m)	2.9%
Weight in Water	26.9 lbs/ft (40 kg/m)	26.4 lbs/ft (39.3 kg/m)	-1.8%

Due to the similarities of the proposed HVDC cables to those previously considered, there will be no changes in the construction and operation of the Project as described in the Project Documentation. For the terrestrial portions of the Project route, the underground HVDC cables will still be buried via excavated trenches or Horizontal Directional Drilling (HDD) methods. There also will be no changes to the initial clearing, trench excavation, backfilling, and restoration and revegetation activities as described in the Project Documentation. The proposed HVAC cables are also similar enough to those previously analyzed so there will be no changes in the construction and operation of the Project as described in the Project Documentation.

For underwater cable installation, the primary methods for installation will still be jet-plowing and shear plowing, with shoreline transitions completed by HDD. The HVDC submarine cables will continue to be bundled together when installed within the water bodies either by jet-plow or shear-plow techniques. The slight decrease of the in-water weight of the submarine cables is not expected to substantially impact the expected depth of self-burial of the cables in the deeper waters of Lake Champlain, where the cables will be placed on the lake bottom. The installation vessels used for in-water construction will remain the same as those described in Project Documentation.

HVAC cables extending from the Astoria East substation to the Rainey substation will be installed using techniques that remain unchanged from those described in the Project Documentation. To accommodate the additional 250 MW, the design of this HVAC system has been altered such that there are now two conductors per phase proposed instead of one conductor per phase. The outcome of this change is a different configuration of the AC system underground, but no changes above ground. A typical diagram showing the new HVAC configuration is included as Appendix A.

In the Project Documentation, the converter station is described as a "compact type" with a total footprint (*i.e.*, building and associated footprint) of approximately four-and-a-half (4.5) acres. The converter station to support the Proposed Modification would occupy a total footprint of approximately 5.5 acres, which represents a minor increase in the necessary area given the available land in the vicinity.

INFORMATION REGARDING THE APPLICANT[1]

No updates or changes to the information regarding the Applicant are necessitated by this Supplement to the Amendment Application. The information regarding the Applicant previously provided to DOE, as incorporated into the Amendment Application, remains current and correct.

BULK POWER SYSTEM INFORMATION[2]

In accordance with applicable NYISO tariff requirements, as approved by the Federal Energy Regulatory Commission, Applicant submitted an interconnection request (NYISO Queue Position #887) for an additional 250 MW injection at the Point of Interconnection at the New York Power Authority's Astoria Annex 345 kV substation. In response to the interconnection request, NYISO completed an "*Interconnection System Reliability Impact Study for the NYISO Q887: CH Uprate Project*." The SRIS, which will be forwarded directly to DOE by NYISO, concluded that:

- The Project will be operated in accordance with all NYISO requirements;
- The Project will be designed in accordance with all applicable reliability standards; and
- The Project will not adversely impact the reliability of the New York State Transmission System.

NYISO's conclusions were based on, among other things, steady state, short circuit, and stability analyses. On December 10, 2020, the NYISO Operating Committee approved the SRIS.[3]

[1] *See*10 C.F.R. § 205.322(a).
[2] *See*10 C.F.R. § 205.322(b).
[3] *See* Attachment C (copy of minutes from the December 10, 2020 NYISO Operating Committee meeting).

ENVIRONMENTAL ANALYSIS

A. Introduction

Set forth below is an analysis of potential environmental impacts associated with upgrading the Project's capacity from 1,000 MW to 1,250 MW. The analysis includes a comparison of the impacts to those previously analyzed by DOE in DOE/EIS-0447. DOE's approval of the modifications to the routing and the location of the converter station as requested in the Amendment Application will have no bearing on the environmental impacts associated with this Proposed Modification.

B. Resource Areas with No Change

The Applicant reviewed the environmental resource areas that were considered in the EIS. The Proposed Modification will not have any substantive effect on certain resources and there is no new information that would suggest there are impacts that were not considered in the EIS to these resources. These resources are discussed below, as well as the rationale for excluding them from a more detailed analysis.

Land Use

The EIS evaluated potential impacts to land use resources related to the construction and operation of the Project and concluded that during construction there would be temporary, non-significant disruption of normal routines due to access limitations from presence of construction activities. During operations, there would be a potential for restrictions to allow for operations and maintenance.

The Proposed Modification would not substantively change the affected environment for land use as described in Sections 3.1.1, 3.2.1, 3.3.1 and 3.4.1 of the EIS. The Proposed Modification would impact the same land uses as those considered in the EIS and there would be no change in the trench or, as proposed in the Amendment Application, conduit design. The converter station associated with the modification will occupy 1 acre of additional area than had been considered in the EIS but still be within the same industrialized location that was discussed in the EIS. The Applicant would employ the same impact avoidance and minimization measures, including BMPs, described in Section G.1 of Appendix G in the EIS, such as engaging a qualified Agricultural Inspector and proper site restoration. There would be no additional land use issues for the Proposed Modification over those considered in the EIS.

Transportation and Traffic

The EIS evaluated potential impacts to transportation and traffic related to the Project and concluded there would be non-significant disruptions to navigation, railroad operations, and traffic flow, as well as commercial and recreational transportation uses, during construction. The EIS also evaluated the impacts associated with anchor snag during operation of the Project.

The Proposed Modification would not substantively change the affected environment for transportation and traffic as described in Sections 3.1.2, 3.2.2, 3.3.2, and 3.4.2 of the EIS. The Proposed Modification would impact the same overland (*e.g.*, roadway, railroad) and maritime (*e.g.*, Lake Champlain, Hudson River, and Harlem River) transportation corridors as those described in the EIS. The Applicant would employ the same impact avoidance and minimization measures, including Best Management Practices (BMPs), described in Section G.2 of Appendix G in the EIS. There would be no additional transportation or traffic issues for the Proposed Modification over those considered in the EIS.

Water Resources and Quality

The EIS evaluated potential impacts to water resources and quality related to the construction and operation of the Project and concluded there would be localized and non-significant increases in turbidity, suspension of sediments in surface waters, nearby groundwater wells, and wetland areas during construction.

The Proposed Modification would not substantively change the affected environment for water resources and quality as described in Sections 3.1.3, 3.2.3, 3.3.3, and 3.4.3 of the EIS. The Proposed Modification would traverse the same types of waterbodies as described in the EIS, with similar impacts on aquatic habitat and species (see discussion of Aquatic Habitats and Species below). There would be no change in the previously considered trench dimensions. The Applicant would employ the same impact avoidance and minimization measures, including BMPs, described in Section G.3 of Appendix G in the EIS, such as the use of horizontal direction drill (HDD) technology for water to land transitions and installation under major waterways. There would be no additional water resources or quality issues for the Proposed Modification over those considered in the EIS.

Aquatic Habitats and Species

The EIS evaluated potential impacts to aquatic habitats and species related to the construction and operation of the Project and concluded that there would be localized non-significant disturbance of lake, stream and river bottoms, resulting in habitat degradation, avoidance, or loss; noise, and vibration; impacts on benthic communities; potential for accidental exposure to hazardous materials, as well as non-significant increases in turbidity, suspension of sediments in surface waters, nearby groundwater wells, and wetland areas during construction. During operation there would be non-significant generation of magnetic fields and induced electric fields, as well as potential sediment temperature increase around the cables.

The Proposed Modification would not substantively change the affected environment for aquatic habitat and species as described in Sections 3.1.4, 3.2.4, 3.3.4, and 3.4.4 of the EIS. The

Proposed Modification would traverse the same types of waterbodies as described in the EIS, with similar impacts on aquatic habitat and species. The Applicant would employ the same impact avoidance and minimization measures, including BMPs, described in Section G.4 of Appendix G in the EIS. These measures include, but are not limited to, utilizing HDD for the crossing of larger waterbodies, engaging an Environmental Inspector, maintaining vegetative buffers as practical, and employing pre-approved crossing methods. There would be no additional aquatic habitat and species issues for the Proposed Modification over those considered in the EIS.

Terrestrial Habitats and Species

The EIS evaluated potential impacts to terrestrial habitats and species related to the construction and operation of the Project and concluded that there would be impacts associated with the conversion of fringe-forest habitat to scrub-shrub habitat. Other impacts, such as noise, dust, soil compaction, and habitat fragmentation, were determined to be localized and non-significant. Operation impacts were limited to some species potentially detecting the transmission system's magnetic fields and heat generation, as well as those associated with periodic maintenance and infrequent emergency repair.

The Proposed Modification would not substantively change the affected environment for terrestrial habitats and species as described in Sections 3.1.6, 3.2.6, 3.3.6, and 3.4.6 of the EIS. The Proposed Modification would be located within and along previously disturbed and heavily used railroad and road ROWs previously approved. Temporary impacts to wildlife species, such as disturbance and displacement, are expected to be similar as those considered in the EIS. The Applicant would employ the same impact avoidance and minimization measures, including BMPs, described in Section G.6 of Appendix G in the EIS, such as invasive species control and targeted vegetative clearing. There would be no additional terrestrial habitat and species issues for the Proposed Modification over those considered in the EIS.

Terrestrial Protected and Sensitive Species

The EIS evaluated potential impacts to terrestrial protected and sensitive species related to the construction and operation of the Project and concluded that there would be localized non-significant effects on federally listed and state-listed species including the Indiana bat (*Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), the Karner blue butterfly (*Plebejus melissa samuelis*), and migratory birds potentially present during construction.

The Proposed Modification would not substantively change the affected environment for terrestrial protected and sensitive species as described in Sections 3.1.7, 3.2.7, 3.3.7, and 3.4.7 of the EIS. The Proposed Modification would be located in the same habitats as those considered in the EIS and there should be no significant difference in impacts. The Applicant would employ the same impact avoidance and minimization measures, including BMPs, described in Section G.7 of Appendix G in the EIS, which were developed in consultation with the U.S. Fish and Wildlife Service. These include, but are not limited to, conducting tree clearing during winter months to avoid Indiana bats and northern long-eared bats, employing HDD technology to install cables under sensitive Karner blue butterfly lupine habitat, and marking all known locations of protected and sensitive species on construction drawings and in the field. There would be no additional terrestrial protected and sensitive species for the Proposed Modification over those considered in the EIS.

Wetlands

The EIS evaluated potential impacts to wetland resources related to the construction and operation of the Project and concluded that there would be potential localized non-significant impacts on wetlands during construction. During operation there would be non-significant heat impacts associated with the heat of the cables due to subsurface dissipation, as well as temporary impacts associated with vegetative maintenance and emergency repairs.

The Proposed Modification would not substantively change the affected environment for wetlands as described in Sections 3.1.8, 3.2.8, 3.3.8, and 3.4.8 of the EIS. The Proposed Modification would be located in the same landscapes as that considered in the EIS and there would be no difference in impacts to wetlands. There would be no increase in the thermal impacts associated with subsurface dissipation (see Aquatic Protected and Sensitive Species below). The Applicant will provide compensatory mitigation for all permanent impacts. The Applicant would employ the same impact avoidance and minimization measures, including BMPs, described in Section G.8 of Appendix G in the EIS, such as the marking of wetlands during construction and installation of sediment- and erosion-control devices. There would be no additional wetland resource issues for the Proposed Modification over those considered in the EIS.

Geology and Soils

The EIS evaluated potential impacts to geology and soils resources related to the construction and operation of the Project and concluded that there would be temporary disturbance of soils as well as non-significant impacts from bedrock blasting and removal, increased erosion and sedimentation, and soil compaction on land and sediment disturbance in waterways and wetlands.

The Proposed Modification would not substantively change the affected environment for geology and soils as described in Sections 3.1.9, 3.2.9, 3.3.9, and 3.4.9 of the EIS. The Proposed Modification would be located in the same landscape as that considered in the EIS and there should be no significant difference in the impacts. The Applicant would employ the same impact avoidance and minimization measures, including BMPs, described in Section G.9 of Appendix G in the EIS, such as erosion and sediment control measures. There would be no additional geology and soils issues for the Proposed Modification over those considered in the EIS.

Cultural Resources

The EIS evaluated potential impacts to cultural resources related to the construction and operation of the Project and concluded that there would be potential adverse effects on terrestrial and aquatic sites. As noted in the EIS, ground-disturbing activities associated with construction could damage archaeological features and disturb the context of artifacts of terrestrial archaeological sites, underwater sites, and historic cemeteries. In the case of terrestrial and underwater archaeological sites that are listed or eligible for listing in the National Registrar of Historic Properties (NRHP), this could constitute an adverse effect under 36 C.F.R. § 800.5(a)(1).

The Proposed Modification would not substantively change the affected environment for geology and soils as described in Sections 3.1.10, 3.2.10, 3.3.10, and 3.4.10 of the EIS. The Proposed Modification would be located in the same cultural setting as that considered in the EIS and there should be no significant difference in the impacts. Consultation regarding potential adverse effects on historic properties is ongoing through the Section 106 process, and a CRMP will manage and resolve adverse effects through avoidance, minimization, or mitigation. There would be no additional cultural resource issues for the Proposed Modification over those considered in the EIS.

Visual Resources

The EIS evaluated potential impacts to visual resources related to the construction and operation of the Project and concluded that there would be non-significant impacts from the temporary presence of construction equipment and activities, as well as those related to the presence of cooling stations.

The Proposed Modification would not substantively change the affected environment for visual resources as described in Sections 3.1.11, 3.2.11, 3.3.11 and 3.4.11 of the EIS. The Proposed Modification would also bury cables primarily within existing ROWs and there would be no substantive increase in the impacts associated with the construction of the transmission system. There would also not be the need for the installation of any cooling stations which would have been above grade structures since they are no longer required. The proposed converter station site would be slightly larger but there will be no increase in visual impacts due to the separation of this facility from residential homes and roadways. The Applicant would employ the same impact avoidance and minimization measures, including BMPs, described in Section G.11 of Appendix G in the EIS, such as good housekeeping practices. There would be no additional visual resources issues for the Proposed Modification over those considered in the EIS.

Infrastructure

The EIS evaluated potential impacts to infrastructure related to the construction and operation of the Project and concluded there would be non-significant impacts associated with intersecting utility lines, potential temporary service disruption of public water supply, increased fuel use, storm water management, and solid waste management.

The Proposed Modification would not substantively change the affected environment for infrastructure resources as described in Sections 3.1.12, 3.2.12, 3.3.12 and 3.4.12 of the EIS. The Proposed Modification would employ the same protections for collocated infrastructure and public water supply as those set forth in the New York State Certificate of Environmental Compatibility and Public Need. The Applicant also would employ the same impact avoidance and minimization measures, including BMPs, described in Section G.12 of Appendix G in the EIS. There would be no additional infrastructure issues for the Proposed Modification over those considered in the EIS.

Recreation

The EIS evaluated potential impacts to recreational resources related to the construction and operation of the Project and concluded that there would be non-significant restrictions on recreational use during construction, maintenance, and repair activities from the temporary presence of construction equipment and activities.

The Proposed Modification would not substantively change the affected environment for recreational resources as described in Sections 3.1.13, 3.2.13, 3.3.13 and 3.4.13 of the EIS. The Proposed Modification would impact the same overland and aquatic recreational corridors as those described in the EIS (e.g. roadway, railroad). Recreationalists would continue to only experience temporary disturbances and traffic inconveniences associated with construction activities. These effects will be temporary and, in general, most disturbances will last only a brief period of a few days or a week at any particular location. The Applicant would employ the same impact avoidance and minimization measures, including BMPs, described in Section G.13 of Appendix G in the EIS, such as site restoration activities. There would be no additional recreation issues for the Proposed Modification over those considered in the EIS.

Hazardous Materials and Wastes

The EIS evaluated potential impacts to hazardous materials and waste related to the construction and operation of the Project and concluded that the storage of hazardous materials (e.g. oils, solvents, anti-freeze) presented a potential risk of land and water contamination should a spill occur.

The Proposed Modification would not substantively change the affected environment for hazardous materials and waste as described in Sections 3.1.15, 3.2.15, 3.3.15 and 3.4.15 of the EIS. The Proposed Modification would store and use the same materials as those considered in the EIS. The proposed converter station would occupy a marginally larger site than was considered in the EIS but, due to historic uses in the larger industrial complex, the potential issues associated with the discovery and handling of contaminated soils would essentially be the same. The Applicant would employ the same impact avoidance and minimization measures, including BMPs, described in Section G.15 of Appendix G in the EIS, such as appropriate transport and storage measures. There would be no additional hazards materials and waste issues for the Proposed Modification over those considered in the EIS.

Air Quality

The EIS evaluated potential impacts to air resources related to the construction and operation of the Project and concluded that there would be localized, intermittent impacts from use of construction equipment, including greenhouse gas emissions.

The Proposed Modification would not substantively change the affected environment for air quality as described in Sections 3.1.16, 3.2.16, 3.3.16 and 3.4.16 of the EIS. The Proposed Modification would employ the same equipment, with the same associated impacts as those considered in the EIS. The Applicant would employ the same impact avoidance and minimization measures, including BMPs, described in Section G.16 of Appendix G in the EIS, such as proper operation and maintenance of construction equipment and vehicles. There would be no additional air quality issues for the Proposed Modification over those considered in the EIS.

Noise

The EIS evaluated potential noise impacts related to the construction and operation of the Project and concluded that there would be temporary, localized construction noise impacts indicated for terrestrial and aquatic habitats and species during construction, maintenance, and repairs. Noise from equipment during operation would be within state standards and insignificant.

The Proposed Modification would not substantively change the affected environment for noise as described in Sections 3.1.17, 3.2.17, 3.3.17 and 3.4.17 of the EIS. The Proposed Modification would employ the same equipment, with the same associated noise impacts as those considered in the EIS. The Applicant would employ the same impact avoidance and minimization measures, including BMPs, described in Section G.17 of Appendix G in the EIS, such as appropriate steps to take in the vicinity of residential areas and other noise-sensitive locations. There would be no additional noise issues for the Proposed Modification over those considered in the EIS.

Socioeconomics

The EIS evaluated potential socioeconomic impacts related to the construction and operation of the Project and concluded that there would be localized benefits during construction and real property tax revenue and potential savings on energy costs during operations.

The Proposed Modification would not substantively change the affected environment for socioeconomic resources as described in Sections 3.1.18, 3.2.18, 3.3.18 and 3.4.18 of the EIS. The Proposed Modification would provide the same socioeconomic benefits as those considered in the EIS. There would be no additional socioeconomic issues for the Proposed Modification over those considered in the EIS.

Environmental Justice

The EIS evaluated potential environmental justice impacts related to the construction and operation of the Project and concluded that there would not be disproportionately high and adverse human health or environmental effects on minority or low-income populations.

The Proposed Modification would not substantively change the affected environment for environmental justice resources as described in Sections 3.1.19, 3.2.19, 3.3.19 and 3.4.19 of the EIS. As the Proposed Modification is in the same counties and/or metropolitan areas, it would not pose any different human health (see Public Health and Safety below) or environmental impacts than those considered in the EIS and therefore any human health or environmental effects related to minority or low-income populations would be negligible. There would be no additional environmental justice issues for the Proposed Modification over those considered in the EIS.

C. <u>Resource Areas Considered</u>

Based on a review of the environmental resource areas that were considered in the EIS, the Applicant believes the following two resource categories require supplemental discussion: Aquatic Protected and Sensitive Species and Public Health and Safety. These resource areas are presented below.

Aquatic Protected and Sensitive Species

The EIS evaluated potential impacts to aquatic protected and sensitive species related to the construction and operation of the Project and concluded there would be localized non-significant effects on two federally listed and state-listed sturgeon species in the Hudson River: shortnose sturgeon (*Acipenser brevirostrum*) and Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchu).*

The Proposed Modification would not substantively change the affected environment for aquatic protected and sensitive species as described in Sections 3.1.5, 3.2.5, 3.3.5, and 3.4.5 of the EIS. The HVDC cables will be installed in the same manner and depth as considered in the EIS. Exponent, Inc. (Exponent) developed a report assessing the expected magnetic fields and thermal loss associated with the modification in waterways (Appendix B). Exponent calculated direct current (DC) magnetic field values at the river and lake bottom for multiple configurations and distances. The results showed that the expected magnetic fields associated with the modification are similar to those values associated with the Project as permitted. For thermal impacts, Exponent concluded that the expected thermal losses from the modified HVDC cables as modeled are expected to be 7.6 watts per foot (W/ft) (24.9 watts per meter (W/m)), which is significantly less than the expected loss of 13.1 W/ft (43.1 W/m) associated with the Project as permitted. The Applicant would employ the same impact avoidance and minimization measures during construction and operation, including BMPs, described in Section G.5 of Appendix G in the EIS. There would be no aquatic protected and sensitive species issues for the Proposed Modification over those considered in the EIS.

Public Health and Safety

The EIS evaluated potential impacts to public health and safety related to the construction and operation of the Project and concluded that the only potential health and safety impacts would be for construction workers during construction, maintenance, and repair operations.

The Proposed Modification would not substantively change the affected environment for public health and safety resources as described in Sections 3.1.14, 3.2.14, 3.3.14 and 3.4.14 of the EIS. As discussed in the EIS, the burial of the transmission cables would effectively eliminate any above ground exposure to the electric field associated with the flow of energy through the cables.

Exponent developed a report on the potential change in thermal emissions associated with the modification and compared the anticipated change in the magnetic field generated by the overland HVDC cables (Appendix C). This report found that the new design specifications for cable operation will result in DC magnetic fields less than 200 milligauss (mG) within six feet of the centerline of the cables, which is consistent with the New York Public Service Commission's Interim Policy Statement on Magnetic Fields, issued September 11, 1990.[4] As previously discussed, Exponent's report on the potential change to the magnetic field associated with the modification of the submarine HVDC cables (Appendix B) states that the magnetic fields at the surface of water bodies will be far less than 200 mG. Exponent also calculated the expected magnetic fields associated with the HVAC cables on land based on the 2-conductors per phase design (see Exhibit D) and a rating capacity of 1,250 MW as is proposed by the modification. The modeling showed that the calculated magnetic field above the 2-conducter/phase design would be 61 milligauss (mG), compared to 182 mG above the 1-conductor/phase design that was previously approved. The Applicant would employ the same impact avoidance and minimization measures, including BMPs, described in Section G.14 of Appendix G in the EIS, such as proper planning related to safety concerns. There would be no additional health and safety issues for the Proposed Modification over those considered in the EIS.

[4] For additional context, the International Commission on Non-Ionizing Radiation Protection has established a DC magnetic field exposure limit of 4,000,000 mG as a general public health standard.

CONCLUSION

WHEREFORE, for the reasons stated herein, the Applicant respectfully requests that DOE amend PP-481 as requested in the Amendment Application and incorporate the proposed capacity modification, as well as the related modifications to the transmission system components, as set forth in this Supplement.

Respectfully submitted,

/s/ Jay Ryan

Jay Ryan
Baker Botts LLP
700 K Street, N.W.
Washington, D.C. 20001
(202) 256-9813
jay.ryan@bakerbotts.com

January 15, 2021

Verification Statement

The undersigned attests that he is an officer of CHPE LLC and that he has read and has knowledge of the matters set forth in this application, and that the facts and representations set forth in said application are true and correct to the best of his knowledge.

By: William S. Helmer

Date: January 15, 2021

Sworn to before me
this 15th day of January 2021
Tracie A. Chase

TRACIE A. CHASE
Notary Public, State of New York
Qualified in Albany Co. No. 01CH4989574
My Commission Expires 12/9/2021

OPINION OF COUNSEL

I, William S. Helmer, General Counsel and Corporate Secretary of CHPE LLC, do hereby state and give my opinion, pursuant to 10 C.F.R. § 205.322(a)(6) as follows:

1. I have examined and am familiar with the Articles of Organization and Operating Agreement of CHPE LLC;
2. I have examined and am familiar with the contents of CHPE LLC's Supplement to which this Opinion is attached; and
3. I am of the opinion that the construction, connection, operation and maintenance of the facilities, as described in Presidential Permit No. 481 and this Supplement to the Amendment Application pending before DOE, are within the corporate power of CHPE LLC as set out in CHPE LLC's Articles of Organization and Operating Agreement, and that CHPE LLC has complied with or will comply with all pertinent Federal and State laws.

William S. Helmer

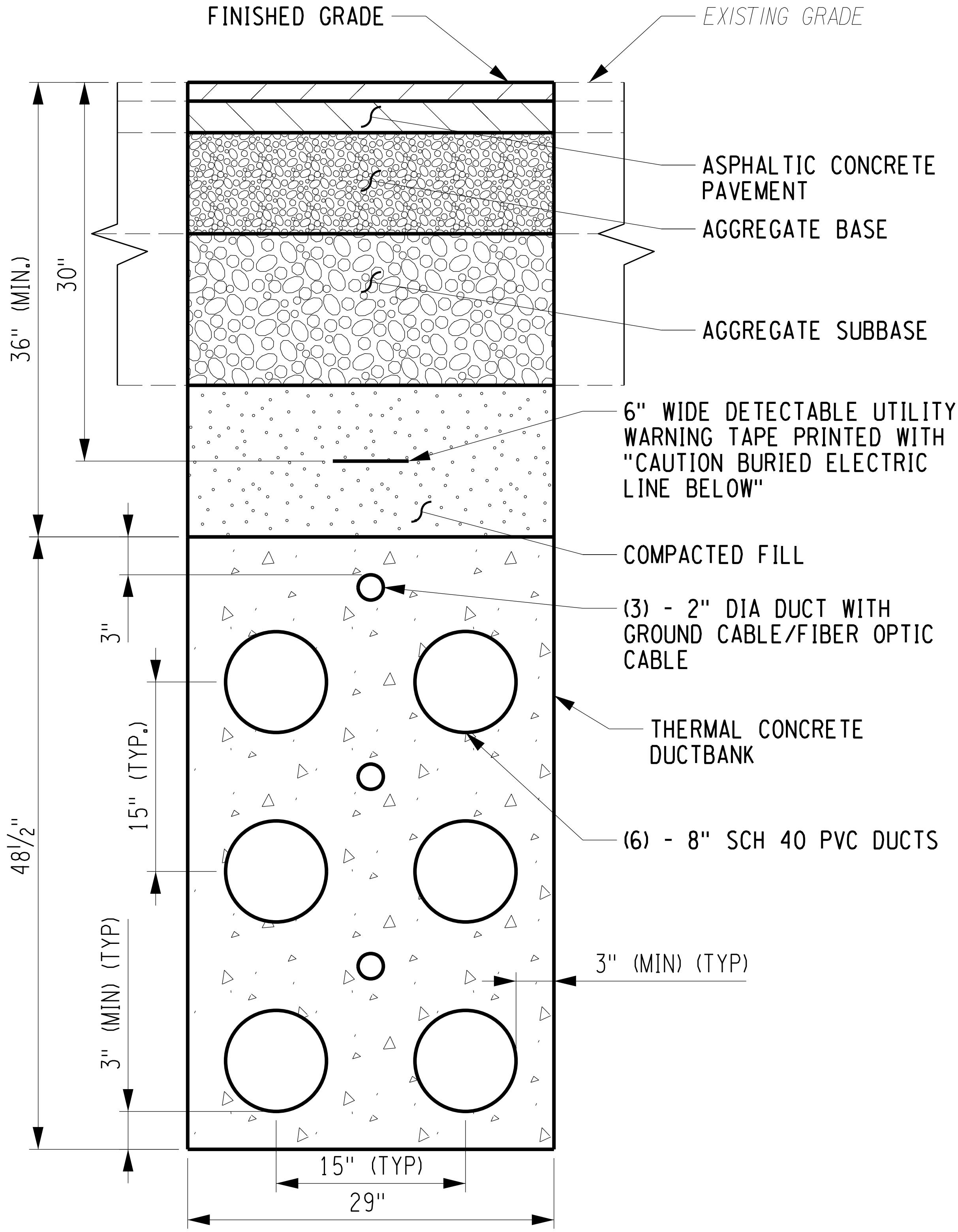
William S. Helmer, Esq.
General Counsel and Secretary
CHPE LLC

Dated January 15, 2021

APPENDIX A

REVISED TYPICAL TRENCH DETAIL

FOR HVAC CONFIGURATION



TYPICAL ELECTRIC DUCTBANK TRENCH CROSS SECTION

NOT TO SCALE

PROJECT TITLE CHAMPLAIN HUDSON POWER EXPRESS TRANSMISSION DEVELOPERS, INC.	LOCATIONS	
	DRAWING TITLE	DATE: 02/21/2020
AECOM	ASTORIA–RAINEY HVAC CABLE	DRAWING NUMBER: FIG 01

DESIGN SUPERVISOR:
DESIGNED BY:
CHECKED BY:
DRAFTED BY:
CHECKED BY:

APPENDIX B

MAGNETIC FIELD CALCULATIONS FOR CHAMPLAIN HUDSON POWER EXPRESS TRANSMISSION PROJECT: COMPARISONS OF 1,000 MW AND 1,250 MW DC CABLE CONFIGURATIONS IN WATER BODIES

Exponent®

MEMORANDUM

TO:	Josh Bagnato Transmission Developers, Inc.
FROM:	Benjamin Cotts, Ph.D., P.E. William H. Bailey, Ph.D.
DATE:	January 14, 2021
PROJECT:	1709319.EX0
SUBJECT:	Magnetic Field Calculations for Champlain Hudson Power Express Transmission Project: 1,000 MW and 1,250 MW DC Cable Configurations in Water Bodies

Executive Summary

Transmission Developers, Inc. (TDI) is proposing to operate the direct current (DC) cables to be installed under Lake Champlain and New York rivers as part of the Champlain Hudson Power Express (CHPE) Transmission Project at 400 kilovolts (kV), which will raise the maximum power capacity of the cables to 1,250 megawatts (MW). Exponent calculated the DC magnetic fields during operation at 1,250 MW for comparison to the DC magnetic fields previously calculated for operation at 1,000 MW, the power transfer capacity permitted for this project by the New York Public Service Commission (NYPSC). The current plan to install the DC transmission cables strapped together in all water bodies will result in very low magnetic-field levels at the surface of water bodies, which will be far less than 200 mG.[1]

Consistent with the permitted analysis at 1,000 MW the magnetic-field levels were calculated for heights of 1 and 10 feet above the lake or river bottom, the calculated magnetic-field values are slightly higher for operation at 1,250 MW than at 1,000 MW. At distances of 10 ft to either side of the cable centerline the differences in magnetic-field levels are just a few mG or less.

The calculated compass deviations at 1 and 10 feet above the bottom are very similar for operation at 1,000 and 1,250 MW. The differences in compass deviations between these power transfer levels at these depths is less than2.5 degrees. At the surface of water bodies, the greater distances from the cables means that compass deviations will be even less.

[1] New York Public Service Commission (NYPSC). Opinion No. 78-13. Cases 26529 and 26559, Issued June 19, 1978 and New York Public Service Commission (NYPSC). Statement of Interim Policy on Magnetic Fields of Major Electric Transmission Facilities. Cases 26529 and 26559 Proceeding on Motion of the Commission. Issued and Effective: September 11, 1990.

As for heat losses, the cables now proposed to accommodate the 1,250 MW load are specified to have a heat loss of 25 Watts per meter (W/m), which is significantly less than the previously assumed 43.1 W/m for the operation of previous cables at 1,000 MW. Thus, the heat loss at the higher power transfer now proposed will be less than was evaluated in previous state and federal reviews of the Project.

In summary, power transfers at 1,250 MW will not cause DC magnetic field levels, compass deviations, or power losses due to heating to change because of current flow on the cables. The small differences between prior calculations and those for proposed operation at 1,250 MW are due to small changes in cable diameter and burial depth.

Introduction

The purpose of this memorandum is to provide calculations of DC magnetic fields, compass deviations, and thermal cable losses from DC submarine cable configurations in lakes and rivers at 1,250 MW in anticipation of the TDI proposal to operate these permitted transmission facilities at 400 kV and increase the total power from 1,000 MW to 1,250 MW. The 1,000 MW cable loading was approved by the NYPSC Certificate of Environmental Compatibility and Public Need in case 10-T-0139 on April 18, 2013.

The configurations that Champlain Hudson Power Express (CHPE) proposed to be installed in water bodies remain relatively unchanged between the permitted 1,000 MW cables and the proposed 1,250 MW cables, (with the primary differences being slightly larger cables and somewhat different burial depths) and are summarized below:

Proposed Cable Configurations in Water Bodies

Three cable configurations to be installed in water bodies were evaluated:

1. In ***Lake Champlain***, cables are strapped together and buried 4 feet (ft) below the lake bottom;

2. In the ***Hudson River***, cables are strapped together and buried a minimum of 7 ft below the river bottom in areas outside the Federal navigation channel;[2]

3. In the ***Harlem River***, cables are strapped together and buried a minimum of 6 ft below the river bottom except in areas with rock, where the burial depth is 15 ft; [3]

The proposed cables are slightly larger in diameter compared to the previously-modeled cables which increases the separation by .05 feet. As with the permitted cables, the proposed

[2] For areas within the Federal navigation channel, the design burial depth is 9 ft below the riverbed. The calculated deviations to the geomagnetic field at these locations are less than for a 7-ft burial depth case and are not included in figures and tables below.

[3] For other areas in the Harlem River, the design burial depth is 8 ft below the riverbed. The calculated deviations to the geomagnetic field at these locations are less than the 6-ft burial depth case and are not included in figures and tables below.

will be strapped together in all configurations. Calculations of magnetic field levels and compass deviations were performed for each of the three above configurations with the cables modeled side-by-side (the horizontal arrangement) and with one cable on top of the other (the vertical arrangement), consistent with the permitting record.

Previous Cable Configurations in Water Bodies

Previous assessments submitted by TDI to the NYPSC included DC magnetic-field calculations at the surface of water bodies from underwater cables. In addition, Exponent had provided calculations of DC magnetic fields and compass deviations at 1 ft, 10 ft, and 19 ft above the lakebed or riverbed for various burial depths requested by the NYPSC. These previous calculations performed for a 1,000 MW operating condition are compared in this report to the proposed operation at 1,250 MW.

A. DC Magnetic Fields

Input Data for Magnetic Field Calculations

The input data used for the calculations of the DC magnetic fields, compass deviations, and thermal losses for the three configurations in water bodies are provided in Table 1.

Table 1. Summary of inputs to DC magnetic field and heat loss calculations for permitted and proposed designs for cable installations in water bodies

Location	Input Parameter	Prior Modeling Design[†,‡,§]	Proposed Modeling Design
	Nominal Line Voltage (kV)	±300	±400
	Nominal Power Transfer (MW)	1,000	1,250
	Current Flow (Amperes) at Winter Conductor Rating	1,670	1,638
	Heat Loss (W/m per cable)	43.1	25
Lake Champlain	Horizontal Cable Separation center to center (ft)	0.40	0.45
	Burial Depth, to cable center (ft)	4, 6	4
	Water Depth (ft)	400	400
Harlem River	Horizontal Cable Separation, center to center (ft)	0.40	0.45
	Burial Depth, to cable center (ft)	6	6
	Water Depth (ft)	15	15
Hudson River, Outside Channel	Horizontal Cable Separation, center to center (ft)	0.40	0.45
	Burial Depth, to cable center (ft)	3	7*
	Water Depth (ft)	32	32

† Attachment M, Revised Electric and Magnetic Fields Report, 7/13/2010. Also cited in Case Record as Exhibit 39 to Joint Proposal, filed 2/24/12.

‡ Exhibit 92, 02-18-11 HDR response letter to DOS. Attachment A. Exponent Inc Report on Heat and EMF, 2-8-2011.

§ Exhibit 100, 03-18-11- HDR Letter to DOS. Attachment A. Exponent Inc Report on Heat and EMF, 3-11-2011

* Depth in Hudson River outside the Maintained Federal Navigation Channel was increased from six feet to seven feet in the permit issued by the U.S. Army Corps of Engineers. This burial depth was approved in the Commission's amendment order issued on March 19,2020.

Calculated Magnetic Field Levels at 1,000 and 1,250 MW

Table 2 to Table 4 summarize the DC magnetic-field levels from the cables reported for the permitted configurations of DC cables evaluated at a height of 3.3 ft above the surface of the water bodies traversed by the Project's DC cables. These calculations were previously reported without incorporation of earth's geomagnetic field and so results here are also presented only in terms of the magnetic field from the cable (consistent with cited comparisons in the record). Calculated values for other cases and a 19-ft distance above the cables are contained in Appendix A.

Additional calculations of DC magnetic field values for below the water surface, close to the lake or river bottom, are summarized in Table 5 and Table 6. These calculations include the additive effect of earth's geomagnetic field (consistent with cited comparisons in the record).

Water Surface

The calculated values at the water surface were previously submitted into the record with a spacing between cables of 6 to more than 11 feet.[4] These installation configurations result in higher magnetic field levels at the surface of the water than a configuration where the two cables are strapped together. Comparisons of DC magnetic fields for the prior configurations and power transfer of 1,000 MW in the record and the new proposed configuration with closer cable spacing and 1,250 MW are shown below in Table 2 to Table 4. DC magnetic fields calculated at the surface of water bodies during operation at 1,250 MW are far lower than the prior values calculated at 1,000 MW.

Table 2. Calculated magnetic-field levels (mG) at 3.3 ft above water surface in Lake Champlain for buried cables in water depth of 400 ft

	Calculated Magnetic-Field Levels (mG) at Horizontal Distances from the Center of the Cables				
Cable Configuration	**−50 ft**	**-25 ft**	**Max**	**+25 ft**	**+50 ft**
Prior 6-ft separation (3-ft burial depth; 1,000 MW)*	0.4	0.4	0.4	0.4	0.4
Proposed 0.45-ft separation (4-ft burial depth; 1,250 MW)	<0.1	<0.1	<0.1	<0.1	<0.1

[4] Article VII Petition, Volume 3 – Appendix H: - EMF report. Electric and Magnetic Fields Report. TRC, March 2010. Also cited in Case Record as Exhibit 22 to Joint Proposal, filed 2/24/12.

Attachment M, Revised Electric and Magnetic Fields Report, 7/13/2010. Also cited in Case Record as Exhibit 39 to Joint Proposal, filed 2/24/12.

* Attachment M, Revised Electric and Magnetic Fields Report, 7/13/2010. Also cited in Case Record as Exhibit 39 to Joint Proposal, filed 2/24/12.. Note: the values of 0.4 mG in the table were calculated for a cable separation of 6 feet. At a later date the horizontal separation between the cables was reduced to 0.4 feet and so for that separation, the computed magnetic field values would be even lower, < 0.1 mG, at all distances from the centerline.

Table 3. Calculated magnetic-field levels (mG) at 3.3 ft above water surface in the Harlem River for buried cables in water depth of 18 ft

Cable Configuration	Calculated Magnetic-Field Levels (mG) at Distances from the Center of the Cables				
	−50 ft	-25 ft	Max	+25 ft	+50 ft
Prior (1,000 MW)*	-	-	-	-	-
Proposed 0.45-ft separation (6-ft burial; 1,250 MW)	1.5	3.5	6.5	3.5	1.5

* No previous calculations of DC magnetic-fields at the surface of the water in the Harlem River.

Table 4. Calculated magnetic-field levels (mG) at 3.3 ft above water surface in the Hudson River for buried cables in water depth of 32 ft

Cable Configuration	Calculated Magnetic-Field Levels (mG) at Distances from the Center of the Cables				
	−50 ft	-25 ft	Max	+25 ft	+50 ft
Prior 11.6-ft separation (3-ft burial 1,000 MW)*	16.6	31.4	44.6	31.4	16.6
Proposed 0.45-ft separation (7-ft burial; 1,250 MW)	1.1	2.0	2.7	2.0	1.1

* Article VII Petition, Volume 3 – Appendix H: - EMF report. Electric and Magnetic Fields Report. TRC, March 2010. Also cited in Case Record as Exhibit 22 to Joint Proposal, filed 2/24/12. Note: the values in the table had previously been calculated for a cable separation of 11.6 feet. At a later date the horizontal separation between the cables was reduced to 0.4 feet and so for that separation, the computed magnetic field values would be lower, and more similar to that calculated for the 1,250 MW case with 0.45-ft separation, presented above.

Subsurface

Exponent calculated DC magnetic field values below the water surface close to the lake or river bottom for multiple configurations and distances. The direction of current flow on the cables, geographic alignment of the cables, and cable arrangement were assessed including the effect of earth's geomagnetic field and so are presented as deviations from earth's geomagnetic field (consistent with cited comparisons in the record). In Table 5 and Table 6 below only the cases with the largest absolute maximum value above the cables are shown. These values would apply to installations of the cables in any water body.

Table 5. Calculated magnetic-field deviation (mG) at 1 ft above the bottom for the north-south alignment of touching cables and southward current in the easternmost cable (H) or southward current top (V)

Location/ Burial Depth	Configuration	Magnetic-field Deviation (mG) at Distances from Center of Cables		
		-10 ft	0 ft or max	+10 ft
Lake Champlain 4 ft	Prior (1,000 MW) – H‡	-21.1	164.8	-16.0
	Proposed (1,250 MW) – H	-23.1	181.8	-17.4
	Prior (1,000 MW) – V	-	-	-
	Proposed (1,250 MW) – V	27.1	129.4	-29.9
Hudson / Harlem River 6 ft	Prior (1,000 MW) – H§	-11.0	83.5	-6.1
	Proposed (1,250 MW) – H	-12.0	92.0	-6.5
	Prior (1,000 MW) – V§	24.8	15.3	-26.2
	Proposed (1,250 MW) – V	27.3	64.3	-28.7
Hudson River 7 ft	Prior (1,000 MW) – H	-	-	-
	Proposed (1, 250 MW) – H	-7.7	70.2	-2.5
	Prior (1,000 MW) – V	-	-	-
	Proposed (1,250 MW) – V	26.0	48.9	-26.8
Hudson River 8 ft	Prior (1,000 MW) – H‡	-3.9	50.3	0.3
	Proposed (1,250 MW) – H	-	-	-

H = horizontal arrangement; V = vertical arrangement.

‡ Exhibit 92, 02-18-11 HDR response letter to DOS. Attachment A. Exponent Inc Report on Heat and EMF, 2-8-2011.

§ Exhibit 100, 03-18-11- HDR Letter to DOS. Attachment A. Exponent Inc Report on Heat and EMF, 3-11-2011.

Table 6. Calculated magnetic-field levels (mG) at 10-ft above the bottom for the north-south alignment of touching cables and southward current in the easternmost cable (H) or southward current top (V)

Location/ Burial Depth	Configuration	Magnetic-field Deviation (mG) at Distances from Center of Cables		
		-10 ft	0 ft or max	+10 ft
Lake Champlain 4 ft	Prior (1,000 MW) – H‡	3.4	20.7	5.8
	Proposed (1,250 MW) – H	3.7	22.8	6.5
	Prior (1,000 MW) – V	-	-	-
	Proposed (1,250 MW) – V	14.7	15.7	-13.6
Hudson / Harlem River 6 ft	Prior (1,000 MW) – H§	4.1	15.8	6.1
	Proposed (1,250 MW) – H	4.5	17.4	6.7
	Prior (1,000 MW) – V§	10.7	1.8*	-9.7
	Proposed (1,250 MW) – V	11.8	12.0	-10.6
Hudson River 7 ft	Prior (1,000 MW) – H	-	-	-
	Proposed (1, 250 MW) – H	4.7	15.4	6.6
	Prior (1,000 MW) – V	-	-	-
	Proposed (1,250 MW) – V	10.6	10.6	-9.4
Hudson River 8 ft	Prior (1,000 MW) - H‡	4.3	12.5	5.9
	Proposed (1,250 MW) – H	-	-	-

H = horizontal arrangement; V = vertical arrangement.

‡ Exhibit 92, 02-18-11 HDR response letter to DOS. Attachment A. Exponent Inc Report on Heat and EMF, 2-8-2011.

§ Exhibit 100, 03-18-11- HDR Letter to DOS. Attachment A. Exponent Inc Report on Heat and EMF, 3-11-2011.

* In the vertical configuration the maximum value is offset from the center of the cables. The results presented in Exhibit 100 reported values at 0 feet horizontally from the cable (see Exhibit 100, Table 1 while the maximum deviation occurs at a few feet from the centerline (see Exhibit 100, Figure 2).

The calculated subsurface magnetic fields in these tables at 1 and 10 feet above the bottom for cables buried to varying depths are very similar for operation at 1,000 and 1,250 MW. Compared at the same burial depths, the largest difference between the DC magnetic fields calculated at these two power transfer levels in Table 5 at 1 foot above bottom is 17 mG, just 3.3% of the background geomagnetic field (515.6 mG). At 10 feet to either side of the cables the maximum difference is even less, 2.5 mG or 0.48%. Small differences of similar magnitudes also are evident at a distance of 10 feet above bottom in Table 5.

B. Compass Deflections

Comparisons of compass deflections produced by changes to the magnetic field calculated for operation at 1,000 MW and 1,250 MW are summarized in Table 7 at 1 foot and 10 feet above the bottom for cables in a side-by side horizontal arrangement and in Table 8 in a vertical arrangement.

Table 7. Calculated deflection (degrees) from magnetic north declination at 1 ft and 10 ft above the bottom for cables, in a north-south orientation, buried 4 ft below bottom (in a side-by side horizontal arrangement, southward current in the easternmost cable)

Cable Configuration	Evaluation Height Above Bottom	Deflection from Magnetic North (degrees) at Distances from Center of Cables				
		−25 ft	-10 ft	max	+10 ft	+25 ft
Prior (1,000 MW) ‡	1 ft	-0.7	-7.9	-32.1	7.4	0.7
	10 ft	-1.3	-3.9	-4.1	3.8	1.2
Proposed (1,250 MW)	1 ft	-0.8	-8.6	-34.4	8.1	0.8
	10 ft	-1.4	-4.2	-4.4	4.1	1.4

‡ Exhibit 92, 02-18-11 HDR response letter to DOS. Attachment A. Exponent Inc Report on Heat and EMF, 2-8-2011, Table 8

Table 8. Calculated deflection (degrees) from magnetic north declination at 1 ft and 10 ft above the bottom for cables in a north-south orientation buried 6 ft below bottom (in a vertical arrangement, southward current top).

Cable Configuration	Evaluation Height Above Bottom	Deflection from Magnetic North (degrees) at Distances from Center of Cables				
		−25 ft	-10 ft	max	+10 ft	+25 ft
Prior (1,000 MW)§	1 ft	-1.5	-2.8	21.3	-2.8	-1.5
	10 ft	-0.6	1.5	4.6	1.5	-0.6
Proposed (1,250 MW)	1 ft	-1.7	-3.0	22.9	-3.0	-1.7
	10 ft	-0.6	1.6	5.0	1.6	-0.6

§ Exhibit 100, 03-18-11- HDR Letter to DOS. Attachment A. Exponent Inc Report on Heat and EMF, 3-11-2011. Table 3

The calculated compass deviations in these tables at 1 and 10 feet above the bottom for cables in a horizontal arrangement and buried 4 feet or in a vertical arrangement and buried 6 feet are very similar for operation at 1,000 and 1,250 MW. The differences in compass deviations between these power transfer levels are all less than 2.5 degrees. In addition, the expected maximum deflection at 19 feet above the bottom for the 1,000 MW project was 1.9 degrees, very similar to the maximum compass deviation of 2.1 degrees calculated at the same 19-ft height above the Hudson and Harlem riverbeds.

Calculation Methods

Exponent calculated the DC magnetic fields for the 1,250 MW cable configurations of the CHPE DC transmission line of the CHPE DC transmission line and loading provided by TDI by the application of the Biot-Savart law which is derived from fundamental laws of physics. Application of the Biot-Savart Law is particularly appropriate for long straight conductors such as those in the present case. Modeling was performed for the submarine cable system installed in Lake Champlain, the Hudson River, and the Harlem River. For comparisons to calculated values reported by TRC in reports filed by TDI with the NYPSC and summarized above in Table 2 to Table 4, Exponent calculated the magnetic field produced by the just the DC cables as did TRC in previous filings.

For other calculations of the magnetic field and compass deviations by Exponent that were submitted by TDI to the NYPSC and summarized above in Table 5 to Table 8, both the contribution of the DC cables and the geomagnetic field of the earth were considered, and the results expressed as the magnetic field deviation or compass deflection. In this report, the figures prepared by Exponent in the Appendix present the deviation from ambient magnetic field along transects perpendicular to the cables and compass deviations calculated from these results.

The magnetic field vectors from the cables along north, east, and vertical axes were combined with the parallel vectors of the earth's geomagnetic field as determined by the latest International Geomagnetic Reference Field Model (IGRF13) for specified latitude and longitude coordinates (NGDC, 2019) to obtain the total resultant magnetic field. The geomagnetic field at 40.932272 N latitude and 73.914373 W latitude was used in all calculations, corresponding to the geomagnetic components:

Northern component	201.54 mG
Eastern component	-45.96 mG
Downward component	472.40 mG
Total Magnetic Field	**515.6 mG**

Along the project route, the geomagnetic field does not vary sufficiently to affect the reported magnetic-field values and compass deflections by more than 0.5%.

Appendix A

Supplementary Calculations for Proposed Operation at 1,250 MW

In addition to Exponent's calculations for proposed operation of the CHPE DC submarine cables at 1,250 MW summarized in the body of this memorandum, Exponent prepared graphical profiles of calculated magnetic fields and compass deviations and tabulated values for selected aquatic route segments as in Table A-1. These calculations reflect variations in burial depth, horizontal and vertical distances from the cables, and orientation of the cables in north-south and east-west directions.

Table A-1. Tables and Figures in Appendix A

	DC Magnetic Field		Compass Deviation	
Water Body	**Figures**	**Tables**	**Figures**	**Tables**
Lake Champlain	A-1	A-2, A-4, A-6, A-8	A-4	A-10, A-12, A-14, A-16
Hudson River	A-2	A-2, A-4, A-6, A-8	A-5	A-10, A-12, A-14, A-16
Harlem River	A-3	A-3, A-5, A-7, A-9	A-6	A-11, A-13, A-15, A-17

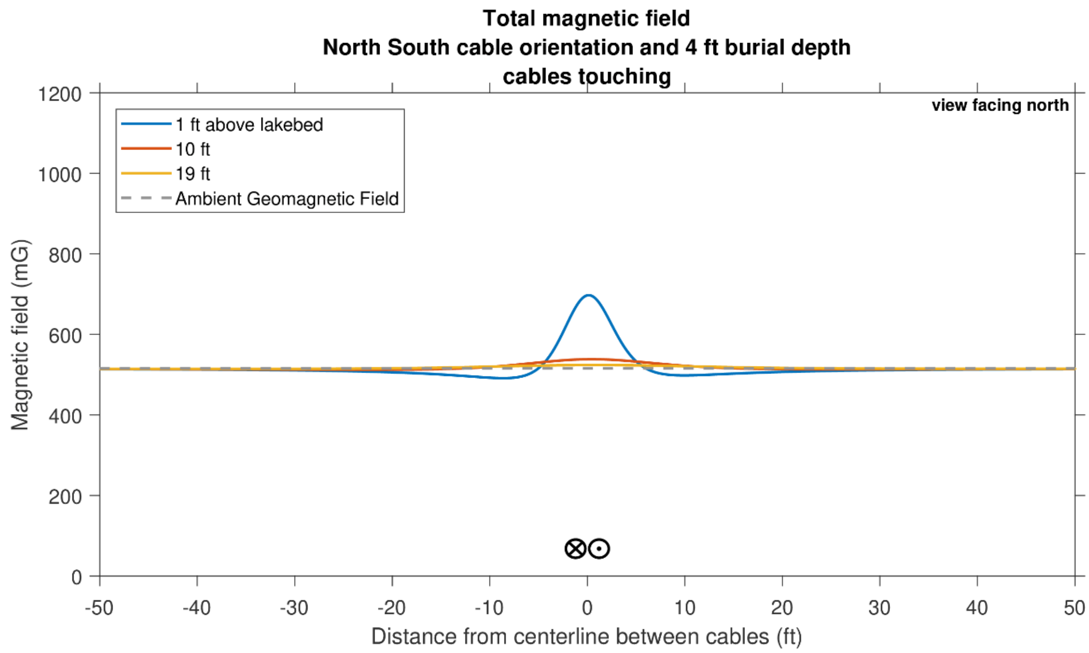


Figure A-1. Magnetic field profile (mG) above north-south-oriented cables buried 4 ft below the bottom of Lake Champlain, with cables touching and a southward current in the eastern cable.

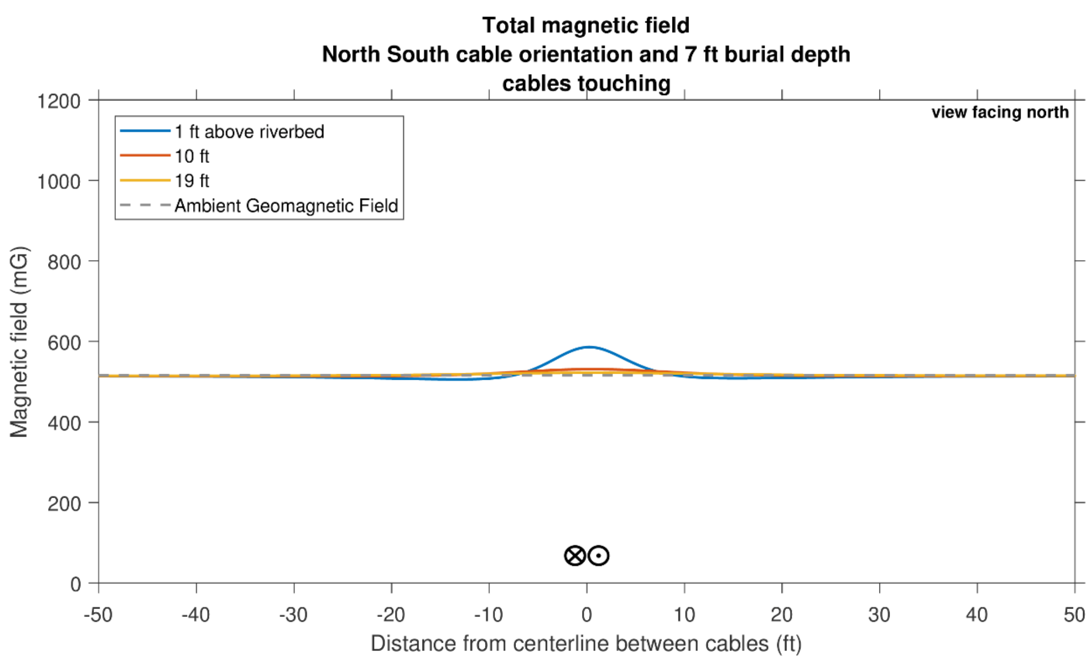


Figure A-2. Magnetic field profile (mG) above north-south-oriented cables buried 7 ft below the bottom of the Hudson River, with the cables touching and a southward current in the eastern cable.

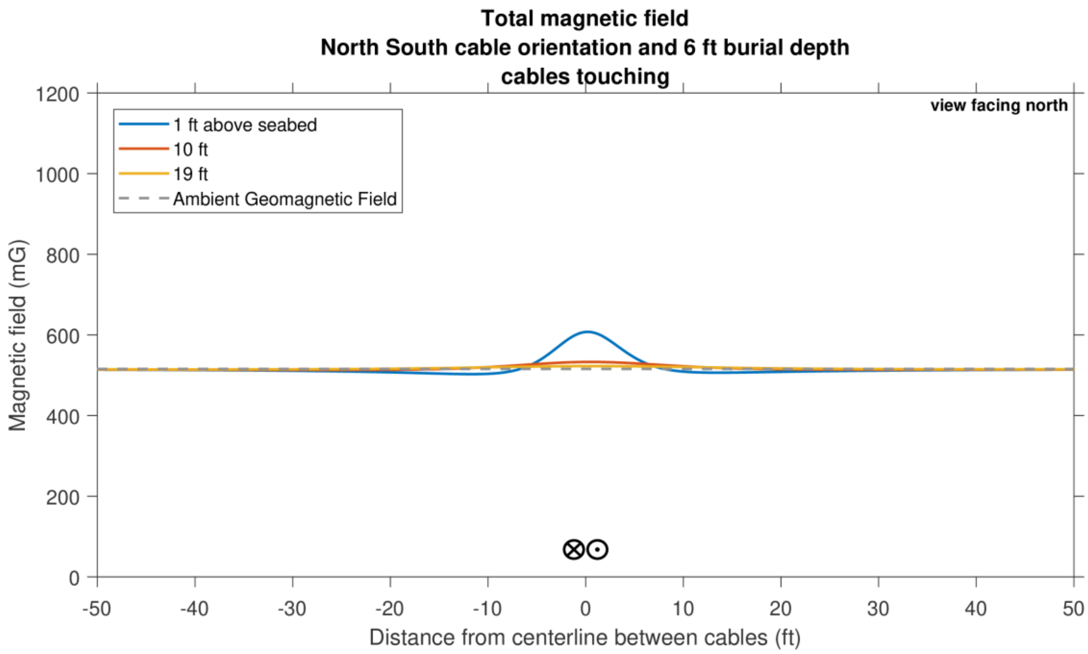


Figure A-3. Magnetic field profile (mG) above north-south-oriented cables buried 6 ft below the bottom of the Harlem River, with cables touching and a southward current in the eastern cable.

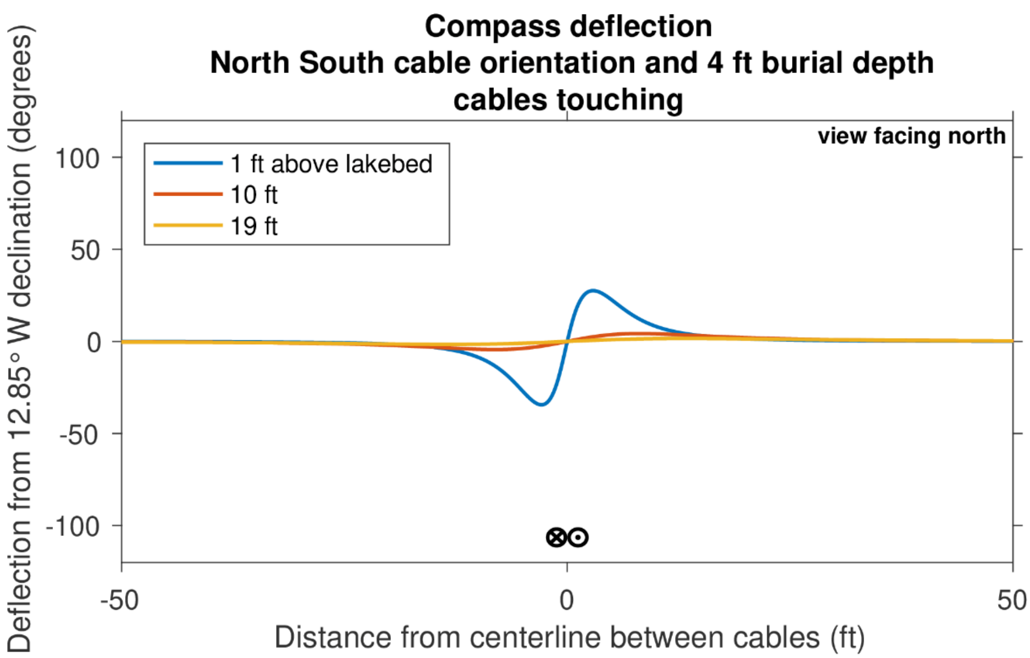


Figure A-4. Compass deflection (degrees) from 12.85° W declination above the north-south-oriented cables buried 4 ft below the bottom of Lake Champlain, with cables touching and a southward current in the eastern cable.

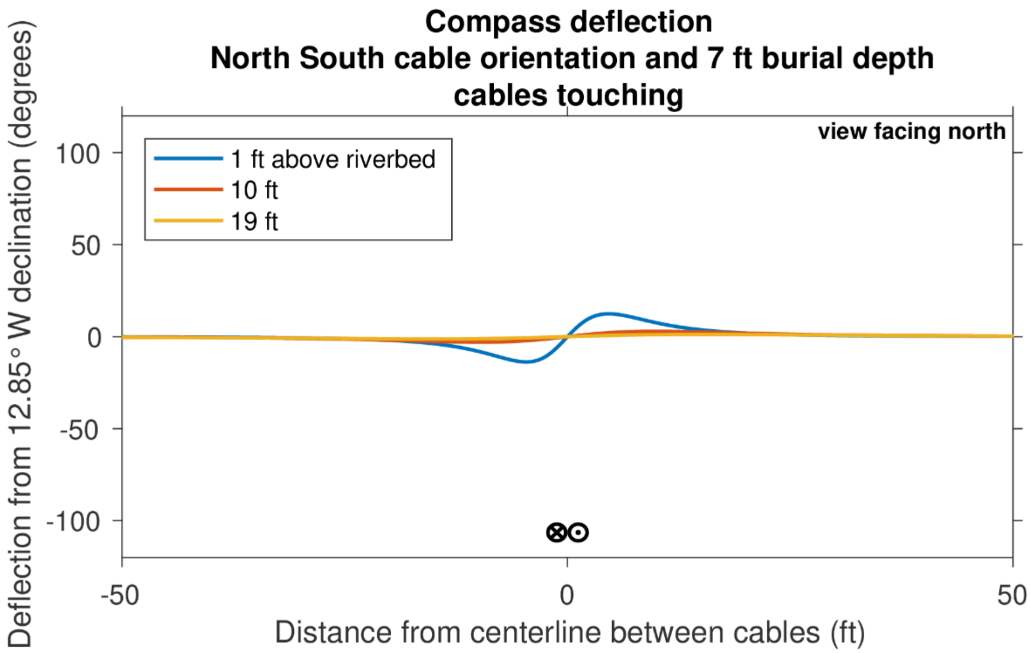


Figure A-5. Compass deflection (degrees) from 12.85° W declination above the north-south-oriented cables buried 7 ft below the bottom of the Hudson River, with cables touching and a southward current in the eastern cable.

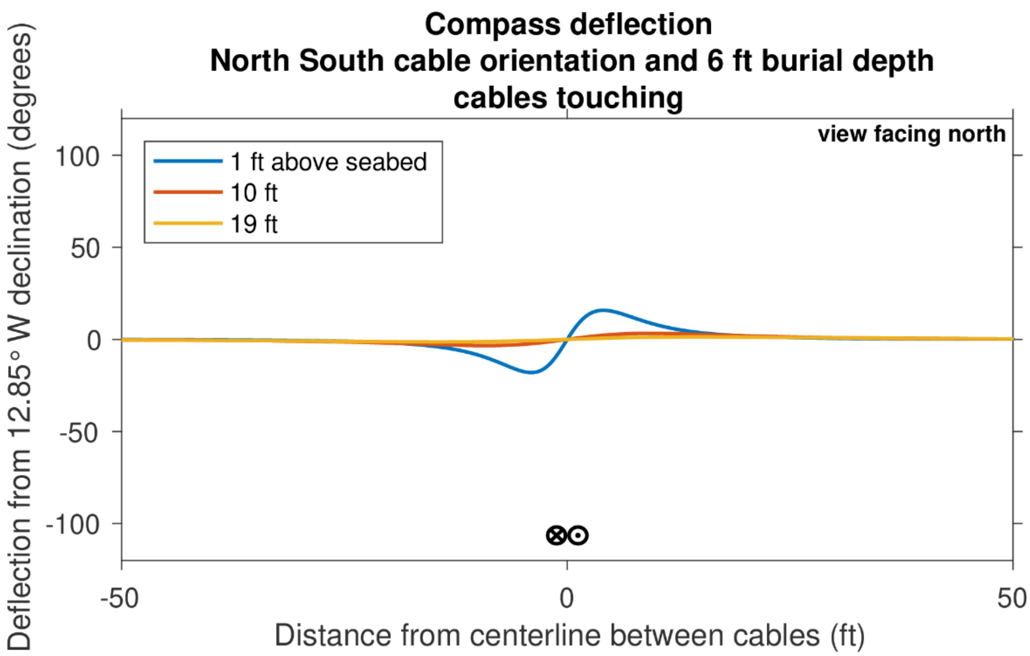


Figure A-6. Compass deflection (degrees) from 12.85° W declination above the north-south-oriented cables buried 6 ft below the bottom of the Harlem River, with cables touching and a southward current in the eastern cable

Table A-2. Magnetic-field deviation (mG) from the 515.6 mG geomagnetic field, above the lakebed or riverbed and offset from the centerline of the bipolar DC circuit (horizontal arrangement) with north-south orientation of cables in Lake Champlain and the Hudson River

Location	Cable burial depth (phasing)	Height above the lakebed or riverbed (ft)	Magnetic-field deviation at distances from the circuit centerline -50 ft	-25 ft	-10 ft	max + deviation	max - deviation	+10 ft	+25 ft	+50 ft
Lake Champlain	4 ft (southward current west)	1	1.8	6.6	24.9	28.6	-169.3	19.6	6.1	1.7
		10	1.5	3.3	-3.2	3.4	-22.6	-6.0	2.4	1.3
		19	1.1	0.7	-4.3	1.2	-8.4	-5.3	<0.1	0.8
	4 ft (southward current east)	1	-1.8	-6.5	-23.1	181.8	-24.2	-17.4	-6.0	-1.7
		10	-1.5	-3.2	3.7	22.8	-3.3	6.5	-2.3	-1.3
		19	-1.1	-0.7	4.4	8.4	-1.2	5.3	0.1	-0.8
Hudson River	7 ft (southward current west)	1	1.7	5.6	9.3	10.6	-68.5	4.2	4.9	1.6
		10	1.4	2.2	-4.4	2.3	-15.4	-6.4	1.4	1.2
		19	0.9	0.2	-3.8	1.0	-6.6	-4.6	-0.4	0.7
	7 ft (southward current east)	1	-1.7	-5.6	-7.7	70.2	-9.9	-2.5	-4.9	-1.6
		10	-1.4	-2.2	4.7	15.4	-2.2	6.6	-1.3	-1.2
		19	-0.9	-0.2	3.9	6.6	-1.0	4.6	0.5	-0.7

Table A-3. Magnetic-field deviation (mG) from the 515.6 mG geomagnetic field, above the riverbed and offset from the centerline of the bipolar DC circuit (horizontal arrangement) with a north-south orientation of cables in the Harlem River and at the Crossing Location

Location	Cable burial depth (phasing)	Height above the riverbed	Magnetic-field deviation at distances from the circuit centerline							
			-50 ft	-25 ft	-10 ft	max + deviation	max - deviation	+10 ft	+25 ft	+50 ft
Harlem River	6 ft (southward current west)	1	1.7	6.0	13.8	14.0	-89.0	8.4	5.3	1.6
		10	1.4	2.6	-4.2	2.6	-17.3	-6.4	1.7	1.2
		19	1.0	0.4	-4.0	1.1	-7.1	-4.8	-0.3	0.7
	6 ft (southward current east)	1	-1.7	-5.9	-12.0	92.0	-12.8	-6.5	-5.3	-1.6
		10	-1.4	-2.5	4.5	17.4	-2.5	6.7	-1.6	-1.2
		19	-1.0	-0.3	4.1	7.1	-1.0	4.9	0.4	-0.7

Table A-4. Magnetic-field deviation (mG) from the 515.6 mG geomagnetic field, above the lakebed or riverbed and offset from the centerline of the bipolar DC circuit (horizontal arrangement) with an east-west orientation of cables in Lake Champlain and the Hudson River

Location	Cable burial depth (phasing)	Height above the lakebed or riverbed (ft)	Magnetic-field deviation at distances from the circuit centerline							
			-50 ft	-25 ft	-10 ft	max + deviation	max - deviation	+10 ft	+25 ft	+50 ft
Lake Champlain	4 ft (westward current north)	1	1.9	7.4	33.8	47.5	-186.3	10.5	5.2	1.6
		10	1.8	4.8	1.4	5.7	-23.9	-10.8	0.9	1
		19	1.4	2	-2.6	2.1	-8.9	-7	-1.3	0.5
	4 ft (westward current south)	1	-1.9	-7.4	-33	188.2	-41.1	-7.8	-5.2	-1.6
		10	-1.8	-4.8	-0.9	24	-5.6	11.1	-0.8	-1
		19	-1.4	-1.9	2.7	8.9	-2.1	7	1.3	-0.5
Hudson River	7 ft (westward current north)	1	1.9	6.8	17.7	17.7	-73.1	-4.5	3.7	1.4
		10	1.7	3.7	-1.1	3.8	-16.2	-9.7	-0.1	0.9
		19	1.3	1.3	-2.6	1.6	-6.9	-5.9	-1.6	0.3
	7 ft (westward current south)	1	-1.9	-6.8	-16.6	73.4	-16.8	6.1	-3.6	-1.4
		10	-1.7	-3.7	1.4	16.3	-3.8	9.9	0.2	-0.8
		19	-1.3	-1.3	2.6	6.9	-1.6	5.9	1.6	-0.3

Table A-5. Magnetic-field magnitude (mG) from the 515.6 mG geomagnetic field, above the riverbed and offset from the centerline of the bipolar DC circuit (horizontal arrangement) with an east-west orientation of cables in the Harlem River and at the Crossing location

Location	Cable burial depth (phasing)	Height above riverbed	Magnetic-field deviation at distances from the circuit centerline							
			-50 ft	-25 ft	-10 ft	max + deviation	max - deviation	+10 ft	+25 ft	+50 ft
Harlem River	6 ft (westward current north)	1	1.9	7.1	22.7	23.4	-95.5	-0.7	4.2	1.5
		10	1.7	4.1	-0.5	4.3	-18.3	-10.2	0.2	0.9
		19	1.3	1.5	-2.6	1.8	-7.5	-6.2	-1.5	0.4
	6 ft (westward current south)	1	-1.9	-7.1	-21.6	95.9	-21.7	2.8	-4.1	-1.5
		10	-1.7	-4	0.9	18.3	-4.3	10.3	-0.1	-0.9
		19	-1.3	-1.5	2.7	7.5	-1.8	6.2	1.5	-0.4

Table A-6. Magnetic-field deviation (mG) from the 515.6 mG geomagnetic field, above the lakebed or riverbed and offset from the centerline of the bipolar DC circuit (vertical arrangement) with a north-south orientation of cables in Lake Champlain and the Hudson River

Location	Cable burial depth (phasing)	Height above the lakebed or riverbed (ft)	Magnetic-field deviation at distances from the circuit centerline							
			-50 ft	-25 ft	-10 ft	max + deviation	max - deviation	+10 ft	+25 ft	+50 ft
Lake Champlain	4 ft (southward current top)	1	0.2	2.1	27.1	129.4	-101.7	-29.9	-3.2	-0.5
		10	0.7	4.4	14.7	15.7	-13.8	-13.6	-4.9	-1.0
		19	1.0	3.8	5.7	5.8	-5.1	-4.7	-3.9	-1.2
	4 ft (southward current bottom)	1	-0.2	-2.0	-25.5	116.5	-114.2	31	3.3	0.5
		10	-0.7	-4.3	-14.6	14.1	-15.5	13.8	4.9	1
		19	-1.0	-3.8	-5.6	5.2	-5.8	4.7	3.9	1.2
Hudson River	7 ft (southward current top)	1	0.4	3.3	26.0	48.9	-41.6	-26.8	-4.2	-0.7
		10	0.9	4.4	10.6	10.6	-9.4	-9.4	-4.7	-1.1
		19	1.1	3.4	4.3	4.5	-4.0	-3.4	-3.4	-1.2
	7 ft (southward current bottom)	1	-0.4	-3.2	-25.6	43.8	-46.6	27.1	4.3	0.7
		10	-0.8	-4.3	-10.5	9.5	-10.5	9.5	4.7	1.1
		19	-1.1	-3.4	-4.2	4.1	-4.5	3.4	3.4	1.2

Table A-7. Magnetic-field deviation (mG) from the 515.6 mG geomagnetic field, above the riverbed and offset from the centerline of the bipolar DC circuit (vertical arrangement) with a north-south orientation of cables in the Harlem River

		Magnetic-field deviation at distances from the circuit centerline							
Cable burial depth (phasing)	**Height above the riverbed (ft)**	**-50 ft**	**-25 ft**	**-10 ft**	**max + deviation**	**max - deviation**	**+10 ft**	**+25 ft**	**+50 ft**
6 ft (southward current top)	1	0.3	2.9	27.3	64.3	-53.8	-28.7	-3.9	-0.6
	10	0.8	4.4	11.8	12.0	-10.6	-10.6	-4.8	-1.1
	19	1.1	3.6	4.7	4.9	-4.4	-3.8	-3.5	-1.2
6 ft (southward current bottom)	1	-0.3	-2.8	-26.6	57.7	-60.4	29.2	4.0	0.6
	10	-0.8	-4.4	-11.7	10.7	-11.9	10.7	4.8	1.1
	19	-1.0	-3.5	-4.6	4.4	-4.9	3.8	3.6	1.2

Table A-8. Magnetic-field deviation (mG) from the 515.6 mG geomagnetic field, above the lakebed or riverbed and offset from the centerline of the bipolar DC circuit (vertical arrangement) with an east-west orientation of cables in Lake Champlain and the Hudson River

Location	Cable burial depth (phasing)	Height above the lakebed or riverbed (ft)	Magnetic-field deviation at distances from the circuit centerline: -50 ft	-25 ft	-10 ft	max + deviation	max - deviation	+10 ft	+25 ft	+50 ft
Lake Champlain	4 ft (westward current top)	1	-0.4	<0.1	20.4	156.9	-90.3	-37.4	-5.3	-1.1
		10	0.3	3.4	16.3	19.6	-12.1	-12.0	-5.8	-1.5
		19	0.7	3.7	7.2	7.2	-4.5	-3.1	-4.0	-1.5
	4 ft (westward current bottom)	1	0.4	0.1	-18.2	101.2	-148.7	37.6	5.3	1.1
		10	-0.2	-3.4	-16.3	12.3	-19.4	12.2	5.8	1.5
		19	-0.7	-3.7	-7.2	4.5	-7.2	3.2	4.0	1.5
Hudson River	7 ft (westward current top)	1	-0.2	1.5	24.1	60.3	-36.5	-28.9	-6.0	-1.2
		10	0.4	3.8	12.3	13.3	-8.2	-7.5	-5.3	-1.5
		19	0.8	3.5	5.7	5.7	-3.5	-2.0	-3.3	-1.5
	7 ft (westward current bottom)	1	0.2	-1.5	-23.5	38.2	-59.1	29	6.0	1.2
		10	-0.4	-3.7	-12.3	8.3	-13.2	7.7	5.3	1.5
		19	-0.8	-3.5	-5.6	3.5	-5.6	2.1	3.4	1.5

Table A-9. Magnetic-field deviation (mG) from the 515.6 mG geomagnetic field, above the riverbed and offset from the centerline of the bipolar DC circuit (vertical arrangement) with an east-west orientation of cables in the Harlem River

Cable burial depth (phasing)	Height above riverbed (ft)	Magnetic-field deviation at distances from the circuit centerline							
		-50 ft	-25 ft	-10 ft	max + deviation	max - deviation	+10 ft	+25 ft	+50 ft
6 ft (westward current top)	1	-0.2	1.1	24.1	79.1	-47.4	-32.3	-5.8	-1.2
	10	0.4	3.7	13.5	15.0	-9.3	-8.8	-5.5	-1.5
	19	0.8	3.6	6.1	6.1	-3.8	-2.3	-3.5	-1.5
6 ft (westward current bottom)	1	0.2	-1.0	-23.1	50.2	-77.0	32.3	5.8	1.2
	10	-0.4	-3.7	-13.5	9.4	-14.9	9.0	5.5	1.5
	19	-0.8	-3.5	-6.1	3.8	-6.1	2.4	3.6	1.5

Table A-10. Compass deflection (degrees) from 12.85° W declination, above the lakebed or riverbed and offset from the centerline of the bipolar DC circuit (horizontal arrangement) with a north-south orientation of cables in Lake Champlain and the Hudson River

Location	Cable burial depth and phasing	Height above lakebed or riverbed (ft)	Compass deflection at distances from the circuit centerline							
			-50 ft	-25 ft	-10 ft	max + deflection	max - deflection	+10 ft	+25 ft	+50 ft
Lake Champlain	4 ft (southward current west)	1	0.1	0.8	8.1	27.6	-34.4	-8.6	-0.8	-0.1
		10	0.3	1.4	4.1	4.3	-4.4	-4.2	-1.4	-0.3
		19	0.3	1.1	1.5	1.6	-1.6	-1.5	-1.1	-0.3
	4 ft (southward current east)	1	-0.1	-0.8	-8.6	27.6	-34.4	8.1	0.8	0.1
		10	-0.3	-1.4	-4.2	4.3	-4.4	4.1	1.4	0.3
		19	-0.3	-1.1	-1.5	1.6	-1.6	1.5	1.1	0.3
Hudson River	7 ft (southward current west)	1	0.2	1.1	7.5	12.4	-13.7	-8.0	-1.1	-0.2
		10	0.3	1.3	2.9	2.9	-3.0	-3.0	-1.3	-0.3
		19	0.3	1.0	1.1	1.3	-1.3	-1.1	-1.0	-0.3
	7 ft (southward current east)	1	-0.2	-1.1	-8.0	12.4	-13.7	7.5	1.1	0.2
		10	-0.3	-1.3	-3.0	2.9	-3.0	2.9	1.3	0.3
		19	-0.3	-1.0	-1.1	1.3	-1.3	1.1	1.0	0.3

Table A-11. Compass deflection (degrees) from 12.85° W declination, above the riverbed or concrete blanket and offset from the centerline of the bipolar DC circuit (horizontal arrangement) with a north-south orientation of cables for the Harlem River and Crossing locations

Location	Cable burial depth (phasing)	Height above riverbed	Compass deflection at distances from the circuit centerline							
			-50 ft	-25 ft	-10 ft	max + deflection	max - deflection	+10 ft	+25 ft	+50 ft
Harlem River	6 ft (southward current west)	1	0.1	1.0	7.9	15.8	-18.0	-8.5	-1.0	-0.1
		10	0.3	1.3	3.3	3.3	-3.4	-3.3	-1.4	-0.3
		19	0.3	1.0	1.2	1.4	-1.4	-1.3	-1.1	-0.3
	6 ft (southward current east)	1	-0.1	-1.0	-8.5	15.8	-18.0	7.9	1.0	0.1
		10	-0.3	-1.4	-3.3	3.3	-3.4	3.3	1.3	0.3
		19	-0.3	-1.1	-1.3	1.4	-1.4	1.2	1.0	0.3

Table A-12. Compass deflection (degrees) from 12.85° W declination, above the lakebed or riverbed and offset from the centerline of the bipolar DC circuit (horizontal arrangement) with an east-west orientation of cables for Lake Champlain and the Hudson River

Location	Cable burial depth (phasing)	Height above lake/riverbed (ft)	Compass deflection at distances from the circuit centerline							
			-50 ft	-25 ft	-10 ft	max + deflection	max - deflection	+10 ft	+25 ft	+50 ft
Lake Champlain	4 ft (westward current north)	1	<0.1	-0.2	-1.7	18.4	-4.9	2.2	0.2	<0.1
		10	-0.1	-0.3	-0.9	1.1	-0.9	1.0	0.3	0.1
		19	-0.1	-0.3	-0.3	0.4	-0.4	0.4	0.3	0.1
	4 ft (westward current south)	1	<0.1	0.2	2.2	18.4	-4.9	-1.7	-0.2	<0.1
		10	0.1	0.3	1.0	1.1	-0.9	-0.9	-0.3	-0.1
		19	0.1	0.3	0.4	0.4	-0.4	-0.3	-0.3	-0.1
Hudson River	7 ft (westward current north)	1	<0.1	-0.2	-1.6	3.9	-2.5	2.1	0.3	<0.1
		10	-0.1	-0.3	-0.6	0.7	-0.6	0.7	0.3	0.1
		19	-0.1	-0.2	-0.3	0.3	-0.3	0.3	0.2	0.1
	7 ft (westward current south)	1	<0.1	0.3	2.1	3.9	-2.5	-1.6	-0.2	<0.1
		10	0.1	0.3	0.7	0.7	-0.6	-0.6	-0.3	-0.1
		19	0.1	0.2	0.3	0.3	-0.3	-0.3	-0.2	-0.1

Table A-13. Compass deflection (degrees) from 12.85° W declination, above the riverbed or the concrete blanket and offset from the centerline of the bipolar DC circuit (horizontal arrangement) with an east-west orientation of cables

Location	Cable burial depth (phasing)	Height above riverbed	Compass deflection at distances from the circuit centerline							
			-50 ft	-25 ft	-10 ft	max + deflection	max - deflection	+10 ft	+25 ft	+50 ft
Harlem River	6 ft (westward current north)	1	<0.1	-0.2	-1.6	5.7	-3.0	2.2	0.2	<0.1
		10	-0.1	-0.3	-0.7	0.8	-0.7	0.8	0.3	0.1
		19	-0.1	-0.2	-0.3	0.3	-0.3	0.3	0.2	0.1
	6 ft (westward current south)	1	<0.1	0.2	2.2	5.7	-3.0	-1.6	-0.2	<0.1
		10	0.1	0.3	0.8	0.8	-0.7	-0.7	-0.3	-0.1
		19	0.1	0.2	0.3	0.3	-0.3	-0.3	-0.2	-0.1

Table A-14. Compass deflection (degrees) from 12.85° W declination, above the lakebed or riverbed and offset from the centerline of the bipolar DC circuit (vertical arrangement) with a north-south orientation of cables

Location	Cable burial depth and phasing	Height above lakebed or riverbed (ft)	Compass deflection at distances from the circuit centerline							
			-50 ft	-25 ft	-10 ft	max + deflection	max - deflection	+10 ft	+25 ft	+50 ft
Lake Champlain	4 ft (southward current top)	1	-0.5	-1.9	-6.4	37.1	-6.7	-6.4	-1.9	-0.5
		10	-0.4	-0.8	1.4	6.5	-0.8	1.4	-0.8	-0.4
		19	-0.3	-0.1	1.4	2.4	-0.3	1.4	-0.1	-0.3
	4 ft (southward current bottom)	1	0.5	1.8	6.1	6.4	-49.2	6.1	1.8	0.5
		10	0.4	0.8	-1.4	0.8	-6.8	-1.4	0.8	0.4
		19	0.3	0.1	-1.4	0.3	-2.5	-1.4	0.1	0.3
Hudson River	7 ft (southward current top)	1	-0.5	-1.6	-1.8	18.3	-2.6	-1.8	-1.6	-0.5
		10	-0.4	-0.5	1.6	4.4	-0.6	1.6	-0.5	-0.4
		19	-0.2	<0.1	1.2	1.9	-0.2	1.2	<0.1	-0.2
	7 ft (southward current bottom)	1	0.5	1.5	1.7	2.5	-21.3	1.7	1.5	0.5
		10	0.4	0.5	-1.6	0.6	-4.6	-1.6	0.5	0.4
		19	0.2	<0.1	-1.3	0.2	-2.0	-1.3	<0.1	0.2

Table A-15. Compass deflection (degrees) from 12.85° W declination, above the riverbed and offset from the centerline of the bipolar DC circuit (vertical arrangement) with a north-south orientation of cables in the Harlem River

		Compass deflection at distances from the circuit centerline							
Cable burial depth (phasing)	**Height above lake/riverbed (ft)**	**-50 ft**	**-25 ft**	**-10 ft**	**-50 ft**	**max - deflection**	**+10 ft**	**-50 ft**	**+50 ft**
6 ft (southward current top)	1	-0.5	-1.7	-3.0	22.9	-3.4	-3.0	-1.7	-0.5
	10	-0.4	-0.6	1.6	5.0	-0.6	1.6	-0.6	-0.4
	19	-0.3	<0.1	1.3	2.1	-0.3	1.3	<0.1	-0.3
6 ft (southward current bottom)	1	0.5	1.6	3.0	3.3	-27.6	3.0	1.6	0.5
	10	0.4	0.6	-1.6	0.6	-5.2	-1.6	0.6	0.4
	19	0.3	<0.1	-1.3	0.3	-2.1	-1.3	<0.1	0.3

Table A-16. Compass deflection (degrees) from 12.85° W declination, above the lakebed or riverbed and offset from the centerline of the bipolar DC circuit (vertical arrangement) with an east-west orientation of cables for Lake Champlain and the Hudson River

Location	Cable burial depth (phasing)	Height above lake/riverbed (ft)	Compass deflection at distances from the circuit centerline							
			-50 ft	-25 ft	-10 ft	max + deflection	max - deflection	+10 ft	+25 ft	+50 ft
Lake Champlain	4 ft (westward current top)	1	0.1	0.4	1.6	1.7	-6.2	1.6	0.4	0.1
		10	0.1	0.2	-0.3	0.2	-1.4	-0.3	0.2	0.1
		19	0.1	<0.1	-0.3	0.1	-0.5	-0.3	<0.1	0.1
	4 ft (westward current bottom)	1	-0.1	-0.4	-1.3	68.0	-1.3	-1.3	-0.4	-0.1
		10	-0.1	-0.2	0.3	1.7	-0.2	0.3	-0.2	-0.1
		19	-0.1	0	0.3	0.6	-0.1	0.3	<0.1	-0.1
Hudson River	7 ft (westward current top)	1	0.1	0.4	0.4	0.6	-3.4	0.4	0.4	0.1
		10	0.1	0.1	-0.4	0.1	-1	-0.4	0.1	0.1
		19	0.1	<0.1	-0.3	0.1	-0.4	-0.3	<0.1	0.1
	7 ft (westward current bottom)	1	-0.1	-0.3	-0.4	7.2	-0.6	-0.4	-0.3	-0.1
		10	-0.1	-0.1	0.4	1.1	-0.1	0.4	-0.1	-0.1
		19	-0.1	<0.1	0.3	0.5	-0.1	0.3	<0.1	-0.1

Table A-17. Compass deflection (degrees) from 12.85° W declination, above the riverbed and offset from the centerline of the bipolar DC circuit (vertical arrangement) with an east-west orientation of cables for the Harlem River

Cable burial depth (phasing)	Height above riverbed (ft)	Compass deflection at distances from the circuit centerline: -50 ft	-25 ft	-10 ft	max + deflection	max - deflection	+10 ft	+25 ft	+50 ft
6 ft (westward current top)	1	0.1	0.4	0.7	0.8	-4.2	0.7	0.4	0.1
	10	0.1	0.1	-0.4	0.1	-1.1	-0.4	0.1	0.1
	19	0.1	<0.1	-0.3	0.1	-0.5	-0.3	<0.1	0.1
6 ft (westward current bottom)	1	-0.1	-0.4	-0.7	11.3	-0.7	-0.7	-0.4	-0.1
	10	-0.1	-0.1	0.4	1.3	-0.1	0.4	-0.1	-0.1
	19	-0.1	<0.1	0.3	0.5	-0.1	0.3	<0.1	-0.1

APPENDIX C

MAGNETIC FIELD CALCULATIONS FOR CHAMPLAIN HUDSON POWER EXPRESS TRANSMISSION PROJECT: COMPARISONS OF 1,000 MW AND 1,250 MW DC CABLE CONFIGURATIONS ON LAND

Exponent®

M E M O R A N D U M

TO:	Josh Bagnato Transmission Developers, Inc.
FROM:	Benjamin Cotts, Ph.D., P.E.
DATE:	January 14, 2021
PROJECT:	1709319.EX0
SUBJECT:	Magnetic Field Calculations for Champlain Hudson Power Express Transmission Project: 1,000 MW and 1,250 MW DC Cable Configurations on Land

Executive Summary

Transmission Developers, Inc. is proposing to operate the direct current (DC) cables to be installed on land as part of the Champlain Hudson Power Express (CHPE) Transmission Project at 400 kilovolts(kV), which will raise the maximum power capacity of the cables to 1,250 megawatts (MW). Exponent compared the calculated DC magnetic fields at 1,000 MW for the design permitted in the New York Public Service Commission (NYPSC) Certificate of Environmental Compatibility and Public Need in case 10-T-0139 on April 18, 2013 to the DC magnetic fields calculated at 1,250 MW for the newly proposed project capacity. This comparison shows that the new design specifications for cable operation will result in DC magnetic fields less than 200 milligauss (mG) within six feet of the centerline of the cables. Differences between previous and proposed magnetic field values result from small differences in the separation and burial depth of the cables, not current flow which is the source of the magnetic field.

Introduction

The purpose of this memorandum is to compare the calculated DC magnetic fields from the DC cable configurations on land for the Champlain Hudson Power Express Transmission project at the 1,000 MW cable loadings previously submitted by TDI to the NYPSC in case 10-T-0139, and permitted by the NYPSC, to new values in anticipation of the TDI proposal to operate these permitted transmission facilities at 400 kV and 1,250 MW. These comparisons are provided for two burial depths of the DC transmission line. With the exception of a one-mile segment proposed on Randall's Island, which involves a six-foot burial depth (or greater), the on-land portion of the project has assumed an approximately three-foot burial depth.[1] Although the new

[1] The assumed 3.2-ft burial depth used for modeling is the minimum depth of the cable burial on land. The cables could be buried deeper in certain segments of the route.

proposed operating conditions for permitted DC transmission facilities on land would increase the line voltage, they would not increase the maximum current carried by the cables so the magnetic fields will not be changed based solely on line currents or the increase in capacity from 1,000 MW to 1,250 MW;[2] any changes in magnetic field levels will be small and result from differences between the previous and proposed configurations and burial depths of the DC cables.

Input Data for Magnetic Field Calculations

The input data used for the calculations of the DC magnetic fields and related parameters for the new design proposed, are compared in Table 1 below to those used for the prior calculations that were used to describe the permitted design.

Table 1. Summary of Inputs to DC Magnetic Field Calculations for Previous and Proposed Designs for Underground Cable Installations on Land

Input Parameter	Previous Modeling Design*	Proposed Modeling Design
Nominal Line Voltage (kilovolts)	±300	±400
Nominal Power (MW)	1,000	1,250
Current Flow (amperes) at Winter Conductor Rating	1670	1638
On Land Configuration		
Horizontal Cable Separation (feet)†	1.00	1.33
Burial Depth, to cable center (feet)	3.25	3.2
Randall's Island Configuration		
Horizontal Cable Separation, center to center (feet)	Not Evaluated	1.33
Burial Depth to center of cable (feet)	Not Evaluated	6.2

* Exhibit 116 to Joint Proposal, filed 2/24/12.

† Representative results for prior design configurations included other separation distances including 0.34 feet (cables touching). It is Exponent's understanding that this cable separation and a cable separation of 3-ft were not carried forward in the design.

[2] Magnetic-field levels depend on the current flowing on the cables of the transmission line. Current is proportional to the power and inversely proportional to the voltage so at a higher voltage (±400 kV) more power can be transferred with the same current. The original calculations assumed a voltage of ±300 kV and 1670 Amperes. The prior modeled load current is slightly higher than the more recent load current for the 1,000 MW cable which is 1643 A. The maximum current on the ±400-kV, 1,250-MW cables will be the same 1643 A.

Summary of Magnetic Field Calculations

Table 2 summarizes the DC magnetic-field levels reported for the permitted design of the DC cables on land for the previous 1,000 MW cable design operating at ±300/±320 kV and the new proposed 1,250 MW cables designed to operate at ±400 kV.

Table 2. Calculated magnetic-field levels (mG) at 1 m above ground for On Land Cables

Cable Configuration	Burial depth (ft)	Cable Spacing (ft)	Horizontal Distance from Center of Cables						
			−20 ft	−10 ft	−6 ft	0 ft	+6 ft	+10 ft	+20 ft
Prior on Land* (1,000 MW)	3.25	1.00	24.8	76.9	<161.8[†]	255.5	<161.8[†]	76.9	24.8
Proposed on Land (1,250 MW)	3.2	1.33	32.4	101	183.6	337.5	183.6	101	32.4
Proposed Randall Island (1,250 MW)[§]	6.2	1.33	29.3	75.5	113.6	158.6	113.6	75.5	29.3

[*] Results presented along a transect perpendicular to the transmission centerline. The calculations do not reflect any contribution from the static magnetic field of the earth.

[†] Exhibit 116 from which prior calculations were extracted reported values in 5-foot increments and thus did not present calculations at ± 6 feet (the minimum ROW width).

[§] The calculated DC magnetic field values listed in the table above in the column for 6 feet distance from the center of cables was calculated by Exponent in a previous analysis for TDI.

The DC magnetic field for proposed operation at 400 kV at a distance of six feet from the centerline of the cables and one meter above the ground is 183.6 mG. This distance is within the right-of-way allowed adjacent to lands owned or controlled by a railroad company or a public highway (six feet from outer edge of cables) and all other areas (eight feet from outer edge of cables) as specified in modified Certificate Condition 140.[3]

The NYPSC's Interim Policy on magnetic fields states that magnetic fields from new Article VII transmission lines cannot exceed 200 mG at the edge of the right of way (ROW).[4] As shown in Table 2, above, the calculated DC magnetic-field levels at six feet to either side of the cables at a height of one meter above ground is below 200 mG for both the previous 1,000 MW and Proposed 1,250 MW underground DC configurations are below 200 mG at specified boundaries. For additional context, the International Commission on Non-Ionizing Radiation

---

3 Order Granting, In Part, Amendment of Certificate of Environmental Compatibility and Public Need Subject To Conditions (Issued and Effective March 20, 2020).

Note: distances in Order refer to distances from the outer surface of the cable. Distances in Tables are referenced to the centerline of the circuit so equivalent distances to the effective edge of the specified right-of-way in the Order from the centerline are 6.9 feet and 8.9 feet.

4 New York Public Service Commission (NYPSC). Opinion No. 78-13. Cases 26529 and 26559, Issued June 19, 1978 and New York Public Service Commission (NYPSC). Statement of Interim Policy on Magnetic Fields of Major Electric Transmission Facilities. Cases 26529 and 26559 Proceeding on Motion of the Commission. Issued and Effective: September 11, 1990.

Protection (ICNIRP) has established a DC magnetic field exposure limit of 4,000,000 mG as a general public health standard.[5]

Calculation Methods

For comparisons to DC magnetic field values calculated in previous submissions, Exponent calculated DC magnetic fields by the application of the Biot-Savart Law, which is derived from fundamental laws of physics. Application of the Biot-Savart Law is particularly appropriate for long straight conductors such as those in the present case. The calculations assumed that all conductors are parallel to one another, infinite in length, and that there is no attenuation of magnetic-field levels by any surrounding medium. Magnetic fields were calculated along a transect perpendicular to the transmission line centerlines and reported at a height of one meter above ground, as recommended by Institute of Electrical and Electronics Engineers (IEEE) Standards—C95.3.1-2010 and 0644-2019.[6]

For the proposed configuration of the cables on Randall's Island, Exponent calculated magnetic fields from the DC cables by Finite Element Analysis (FEA) using COMSOL Multiphysics software.

---

5 International Commission on Non-Ionizing Radiation Protection (ICNIRP). Guidelines on limits of exposure to static magnetic fields. Health Phys. 96:504-14, 2009.

6 Institute of Electrical and Electronics Engineers (IEEE). IEEE Recommended Practice for Measurements and Computations of Electric, Magnetic, and Electromagnetic fields with respect to Human Exposure to Such Fields, 0 Hz to 100 kHz. New York: IEEE. IEEE Std. C95.3.1-2010 and Institute of Electrical and Electronics Engineers (IEEE). Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines (ANSI/IEEE Std. 644-2019). New York: IEEE, 2019.

APPENDIX D

MAGNETIC FIELD CALCULATIONS FOR CHAMPLAIN HUDSON POWER EXPRESS TRANSMISSION PROJECT: COMPARISONS OF 1,000 MVA AND 1,250 MVA AC DUCT BANK CONFIGURATIONS

MEMORANDUM

TO:	Josh Bagnato Transmission Developers, Inc.
FROM:	Benjamin Cotts, Ph.D., P.E.
DATE:	December 16, 2020
PROJECT:	1709319.EX0
SUBJECT:	Magnetic Field Calculations for Champlain Hudson Power Express Transmission Project: Comparisons of 1,000 MVA and 1,250 MVA AC Duct Bank Configurations

Introduction

The purpose of this memorandum is to compare the calculated alternating current (AC) magnetic fields submitted by Transmission Developers, Inc. (TDI) to the New York Public Service Commission (NYPSC) in case 10-T-0139 for a single-circuit, 345-kV XLPE underground line with 1 conductor per phase[1] to a new configuration of the single-circuit, 345-kV XLPE underground line with 2 conductors per phase now proposed by TDI to support operation at 1250 mega-volt amperes (MVA).

Input Data for Magnetic Field Calculations

The input data used for the calculations of the magnetic fields for the two configurations of the single-circuit duct banks are summarized in Table 1 below. Additional detail is provided in Appendix A.

1 Exhibit 119 Revised EMF Report for HVAC Cable. Thomas J. F. Ordon. Electric and Magnetic Fields Report. Project # 169201. Report Supplement. The Champlain Hudson Power Express Project. TRC, December 28, 2011.

Table 1. Summary of Inputs to AC Magnetic Field Calculations for Permitted and Proposed XLPE Cable Designs on Land

Input Parameter	Permitted Design* § (1 conductor per phase)	Proposed Design (2 conductors per phase)
Nominal Line Voltage (kilovolts)	345	345
Nominal Power (mega-volt-amperes)	1,000	1,250
Current Flow (amperes) at Winter Conductor Rating	1673	1,049
NYPA GIS Substation to Con Edison Rainey Substation		
Horizontal Cable Separation (feet)	0.75	1.25
Burial Depth, Conductor Centers (feet)	4.23, 4.98, 4.98	4.05, 5.30, 6.55

* Sources: Exhibit 39: Attachment M, 7/13/2010.
§ Exhibit 119 Revised EMF Report for HVAC Cable Dec 28, 2011.

Summary of Magnetic Field Calculations

Table 2 summarizes the magnetic-field levels reported for the previous 1-conductor per phase configuration and the magnetic field levels calculated by Exponent for the new proposed configuration of the duct bank with 2-conductors per phase.

Table 2. Calculated magnetic-field levels (mG) at 1 m above ground

Duct Bank Configuration	Distance from Center of Duct Bank				
	−50 feet	-20 feet	0 feet	+20 feet	+50 feet
Previous (1-conductor/phase)	4.6	25	182	25	4.6
Proposed (2-conductor/phase)*	0.3	3.6	61	3.6	0.3

* At each location along a transect perpendicular to the transmission centerline, magnetic-field levels are presented as the rms flux density of the maximum field ellipse as specified by NYPSC EMF policy (NYPSC, 1990).

The magnetic field of the previous duct bank configuration was calculated to be 182 mG directly above the duct bank, measured at 1 m above ground. At ± 20 feet and ± 50 feet from the centerline the magnetic field level diminished to 25 mG and 4.6 mG, respectively. At these same locations, the magnetic fields from the proposed 2-conductors per phase duct bank configuration were calculated to be about 3 to 15-fold lower than the previously permitted 1-conductor per phase design. The lower magnetic fields of the 2-conductors per phase design above ground result from the lower currents on each conductor, optimal phasing of the split-phases, and the placement of two phase conductor at a deeper burial depth of 6.55 feet (Table 1).

The NYPSC's Interim Policy on magnetic fields states that magnetic fields created by new Article VII transmission lines cannot exceed 200 mG at the edge of the right of way (ROW).[2] Thus, both the previous design of the 345-kV duct bank and the proposed design of the 345-kV duct bank comply with the NPSPSC standard both above the duct bank and for distances away from the centerline of the duct bank.

Calculation Methods

Exponent calculated the AC magnetic fields as the rms flux density of the maximum field ellipse as specified by NYPSC Interim Policy using algorithms developed by the Bonneville Power Administration (BPA), an agency of the U.S. Department of Energy, for modeling AC transmission lines.[3] BPA's algorithms apply simplifying assumptions about the conductors that have shown to yield accurate magnetic-field levels from AC transmission lines. The calculations assumed that all conductors are parallel to one another and infinite in length, there is no attenuation of magnetic-field levels by any surrounding medium, the load on phase conductors is balanced and there are no unbalanced currents flowing on the outer sheaths of

[2] New York Public Service Commission (NYPSC). Opinion No. 78-13. Cases 26529 and 26559, Issued June 19, 1978 and New York Public Service Commission (NYPSC). Statement of Interim Policy on Magnetic Fields of Major Electric Transmission Facilities. Cases 26529 and 26559 Proceeding on Motion of the Commission. Issued and Effective: September 11, 1990

[3] Bonneville Power Administration (BPA). Corona and Field Effects Computer Program. Bonneville Power Administration, 1991.

XLPE cables. The proposed cables were modeled at an assumed winter normal conductor (WNC) rating of 1,049 amperes (A) at 60 Hertz. The proposed duct bank was designed with an optimal phase configuration for the two sets of conductors in the duct bank. This means that the conductors on the left and right sides of the duct bank are designed with phases of ABC and CBA, top-to-bottom, respectively (Figure 1) which reduces magnetic-field levels substantially compared to other phasing alternatives.

Magnetic fields were calculated along a transect perpendicular to the transmission line centerlines and reported at a height of 1 m above ground, as recommended by Institute of Electrical and Electronics Engineers (IEEE) Standards—C95.3.1-2010 and 0644-2019.[4]

[4] Institute of Electrical and Electronics Engineers (IEEE). IEEE Recommended Practice for Measurements and Computations of Electric, Magnetic, and Electromagnetic fields with respect to Human Exposure to Such Fields, 0 Hz to 100 kHz. New York: IEEE. IEEE Std. C95.3.1-2010 and Institute of Electrical and Electronics Engineers (IEEE). Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines (ANSI/IEEE Std. 644-2019). New York: IEEE, 2019.

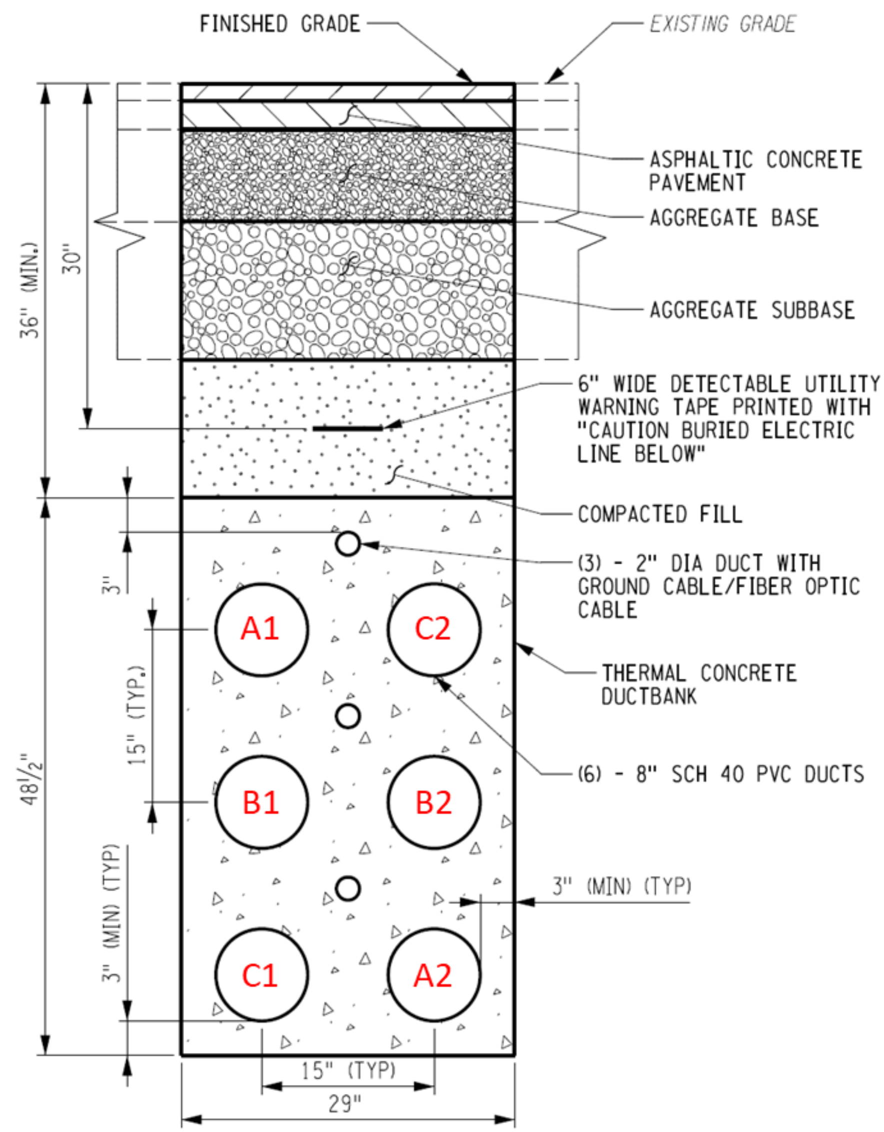


Figure 1. Representative cross-section of the proposed duct bank configuration with 2-conductors per phase.

Calculated Magnetic Field Profile

Figure 2 illustrates the graphic profile of the calculated magnetic-field levels for the proposed 2-conductors per phase duct bank over a wider range of distances than presented in Table 2. A table of the calculated magnetic-field levels for the 2-conductors per phase configuration of the duct bank at 1-ft increments to ±150 ft from the duct-bank centerline is provided in Appendix B.

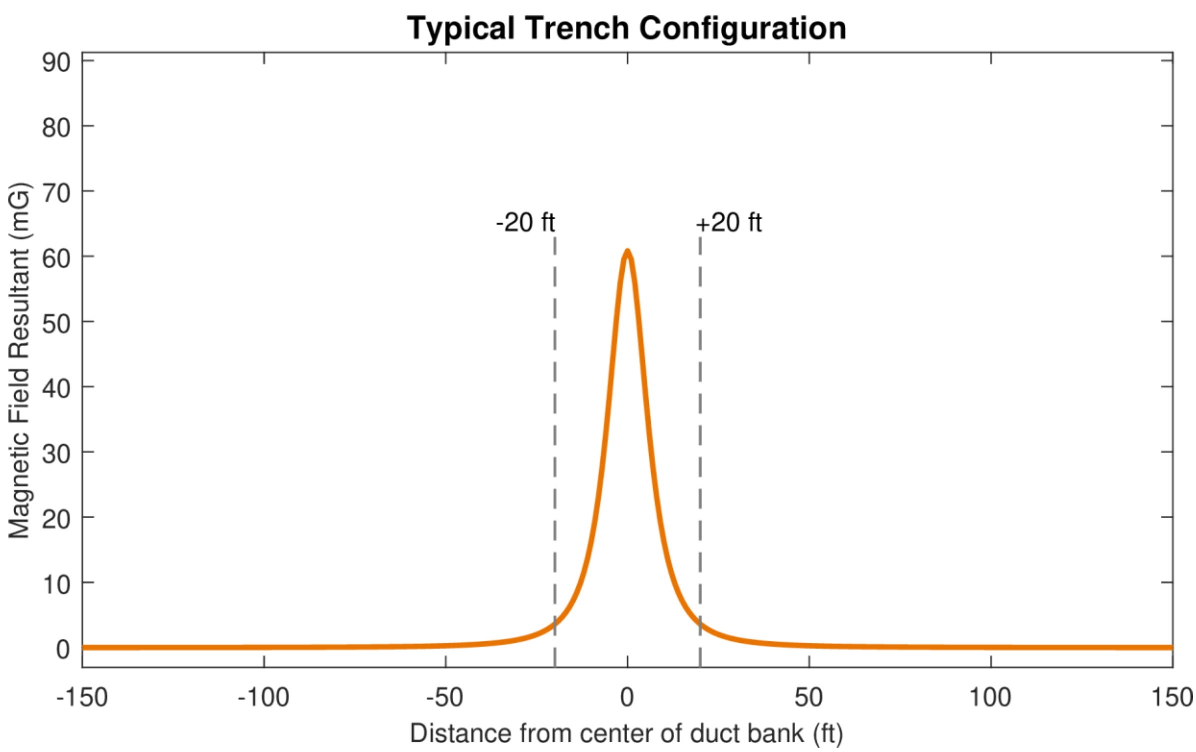


Figure 2. Magnetic-field levels at 3.3 ft (1.0 m) above ground from the proposed 2-conductors per phase at WNC conductor rating.

Appendix A

The Champlain Hudson Power Express

Input Data for Transmission Line AC Magnetic Field Calculations

Table A-1. Input data for AC magnetic field calculations (2 conductors/phase)

Bundle	x-feet	y-feet	n cond	cond dia (inches)	Spacing (inches)	l-n voltage (kV)	V Phasing	Current (A)	Ph-Ph Voltage	I Phasing
1	-0.63	-4.05	1	5.760	0	199.186	0	1049	345	0
2	-0.63	-5.30	1	5.760	0	199.186	240	1049	345	240
3	-0.63	-6.55	1	5.760	0	199.186	120	1049	345	120
4	0.63	-6.55	1	5.760	0	199.186	0	1049	345	0
5	0.63	-5.30	1	5.760	0	199.186	240	1049	345	240
6	0.63	-4.05	1	5.760	0	199.186	120	1049	345	120

Appendix B

The Champlain Hudson Power Express

Calculated AC Magnetic Field Levels

Table B-1. Calculated AC magnetic fields (2 conductors/phase)

Dist (feet)	Magnetic Field Maximum (mG)
-150	<0.1
-149	<0.1
-148	<0.1
-147	<0.1
-146	<0.1
-145	<0.1
-144	<0.1
-143	<0.1
-142	<0.1
-141	<0.1
-140	<0.1
-139	<0.1
-138	<0.1
-137	<0.1
-136	<0.1
-135	<0.1
-134	<0.1
-133	<0.1
-132	<0.1
-131	<0.1
-130	<0.1
-129	<0.1
-128	<0.1
-127	<0.1
-126	<0.1
-125	<0.1
-124	<0.1
-123	<0.1
-122	<0.1
-121	<0.1
-120	<0.1
-119	<0.1
-118	<0.1
-117	<0.1
-116	<0.1
-115	<0.1
-114	<0.1
-113	<0.1
-112	<0.1
-111	<0.1
-110	<0.1
-109	<0.1
-108	<0.1
-107	<0.1

Continued on next page

Table B-1 – Continued from previous page

Dist (feet)	Magnetic Field Maximum (mG)
-106	<0.1
-105	<0.1
-104	<0.1
-103	<0.1
-102	<0.1
-101	<0.1
-100	<0.1
-99	<0.1
-98	<0.1
-97	<0.1
-96	<0.1
-95	<0.1
-94	<0.1
-93	<0.1
-92	<0.1
-91	<0.1
-90	<0.1
-89	<0.1
-88	<0.1
-87	<0.1
-86	<0.1
-85	<0.1
-84	<0.1
-83	<0.1
-82	<0.1
-81	<0.1
-80	<0.1
-79	<0.1
-78	<0.1
-77	<0.1
-76	<0.1
-75	<0.1
-74	<0.1
-73	<0.1
-72	<0.1
-71	0.1
-70	0.1
-69	0.1
-68	0.1
-67	0.1
-66	0.1
-65	0.1
-64	0.1
-63	0.1

Continued on next page

Table B-1 – Continued from previous page

Dist (feet)	Magnetic Field Maximum (mG)
-62	0.2
-61	0.2
-60	0.2
-59	0.2
-58	0.2
-57	0.2
-56	0.2
-55	0.2
-54	0.2
-53	0.2
-52	0.3
-51	0.3
-50	0.3
-49	0.3
-48	0.3
-47	0.3
-46	0.4
-45	0.4
-44	0.4
-43	0.4
-42	0.5
-41	0.5
-40	0.5
-39	0.6
-38	0.6
-37	0.7
-36	0.7
-35	0.8
-34	0.9
-33	0.9
-32	1.0
-31	1.1
-30	1.2
-29	1.3
-28	1.5
-27	1.6
-26	1.8
-25	2.0
-24	2.2
-23	2.5
-22	2.8
-21	3.2
-20	3.6
-19	4.1

Continued on next page

Table B-1 – Continued from previous page

Dist (feet)	Magnetic Field Maximum (mG)
-18	4.7
-17	5.4
-16	6.2
-15	7.2
-14	8.4
-13	9.8
-12	11.6
-11	13.7
-10	16.2
-9	19.4
-8	23.1
-7	27.5
-6	32.7
-5	38.5
-4	44.6
-3	50.7
-2	55.9
-1	59.5
0	60.8
1	59.5
2	55.9
3	50.7
4	44.6
5	38.5
6	32.7
7	27.5
8	23.1
9	19.4
10	16.2
11	13.7
12	11.6
13	9.8
14	8.4
15	7.2
16	6.2
17	5.4
18	4.7
19	4.1
20	3.6
21	3.2
22	2.8
23	2.5
24	2.2
25	2.0

Continued on next page

Table B-1 – Continued from previous page

Dist (feet)	Magnetic Field Maximum (mG)
26	1.8
27	1.6
28	1.5
29	1.3
30	1.2
31	1.1
32	1.0
33	0.9
34	0.9
35	0.8
36	0.7
37	0.7
38	0.6
39	0.6
40	0.5
41	0.5
42	0.5
43	0.4
44	0.4
45	0.4
46	0.4
47	0.3
48	0.3
49	0.3
50	0.3
51	0.3
52	0.3
53	0.2
54	0.2
55	0.2
56	0.2
57	0.2
58	0.2
59	0.2
60	0.2
61	0.2
62	0.2
63	0.1
64	0.1
65	0.1
66	0.1
67	0.1
68	0.1
69	0.1

Continued on next page

Table B-1 – Continued from previous page

Dist (feet)	Magnetic Field Maximum (mG)
70	0.1
71	0.1
72	<0.1
73	<0.1
74	<0.1
75	<0.1
76	<0.1
77	<0.1
78	<0.1
79	<0.1
80	<0.1
81	<0.1
82	<0.1
83	<0.1
84	<0.1
85	<0.1
86	<0.1
87	<0.1
88	<0.1
89	<0.1
90	<0.1
91	<0.1
92	<0.1
93	<0.1
94	<0.1
95	<0.1
96	<0.1
97	<0.1
98	<0.1
99	<0.1
100	<0.1
101	<0.1
102	<0.1
103	<0.1
104	<0.1
105	<0.1
106	<0.1
107	<0.1
108	<0.1
109	<0.1
110	<0.1
111	<0.1
112	<0.1
113	<0.1

Continued on next page

Table B-1 – Continued from previous page

Dist (feet)	Magnetic Field Maximum (mG)
114	<0.1
115	<0.1
116	<0.1
117	<0.1
118	<0.1
119	<0.1
120	<0.1
121	<0.1
122	<0.1
123	<0.1
124	<0.1
125	<0.1
126	<0.1
127	<0.1
128	<0.1
129	<0.1
130	<0.1
131	<0.1
132	<0.1
133	<0.1
134	<0.1
135	<0.1
136	<0.1
137	<0.1
138	<0.1
139	<0.1
140	<0.1
141	<0.1
142	<0.1
143	<0.1
144	<0.1
145	<0.1
146	<0.1
147	<0.1
148	<0.1
149	<0.1
150	<0.1