nationalgrid

Spier Falls -Rotterdam New 115 kV Transmission Project

Exhibit E-1

Description of Proposed Transmission Line

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EXHIBIT E-1: DESCRIPTION OF PROPOSED TRANSMISSION LINE

E-1.1 Introduction

The Project is comprised of the construction of new single 115 kV transmission line circuits called New Line 1 and New Line 302. These will be located primarily in the existing right-of-way ("ROW") for the Spier Falls-Rotterdam 115 kV Line 1 and Line 2 between the Spier Falls Substation and the Rotterdam Substation (a total of 32.5 circuit miles). The Project also will include busing together the Applicant's existing Line 1 and Line 2 into a single circuit (which Applicant refers to as Bused Line 2), and rebuilding and reconductoring the existing 115 kV Ballston Tap Line 2 (which Applicant refers to, after this work is completed, as Rebuilt Line 302) from the Ballston Tap east to the Ballston Substation (4.2 circuit miles, all in Ballston).

In order to co-locate New Line 1 and New Line 302 in the same ROW as existing Line 1 and Line 2, certain line modifications are required in the vicinity of three sub-transmission lines that cross that ROW. A 1.2-mile segment of each of existing Line 1 and Line 2 between Sacanadaga and Snake Hill Roads in the Town of Glenville will be relocated 50 feet east of its current position; in this relocation, the structures and conductors for existing Line 1 and Line 2 will be replaced. Work also will be done to the existing sub-transmission Rotterdam - Scotia 32 34.5 kV line over a distance of 1.5 miles between the Rotterdam Substation and Vley Road in the towns of Rotterdam and Glenville, and to a 0.4-mile segment of each of two other existing 34.5 kV sub-transmission lines; the Spier Falls - Brook Road 3 34.5 kV line and the Spier Falls - Saratoga 12 34.5 kV line, within the Moreau Lake State Park.

To co-locate New Line 1 and New Line 302 within the existing Line 1 and Line 2 ROW, the Applicant proposes a compact structure design involving the use of single, direct buried steel poles with davit arms and restrained suspension insulator assemblies. Steel poles will be the direct embedded type, except where concrete foundations will be utilized for those structures supporting two circuits, structures at angles in the ROW, and dead-end-type structures. Direct buried poles will be utilized over the majority of the proposed new transmission lines.

The wood poles that will be installed for the rebuild of the existing 115 kV Ballston Tap Line 2 will be installed in a manner similar to the direct embedded steel poles (i.e., placed in a corrugated steel pipe with crushed stone backfill).

National Grid will use numerous types of structures for the proposed New Line and the rebuild of Ballston Tap Line 2 (see Figures 5-6a through 5-6c, Exhibit 5).

E-1.2 Transmission Line Design

The structure designs for the Project have been developed in accordance with the latest edition of the National Electric Safety Code ("NESC"), the National Grid Transmission Line Design and Structure Loading criteria, and ROW considerations such as ROW width, the location of existing facilities, and environmental conditions.

E-1.2.1 Design Voltage, Conductor, Grounding, and Insulators

The three new transmission line segments of the Project (New Line 302, New Line 1 and Rebuilt Line 302) are designed to operate at a nominal system voltage of 115 kV alternating current ("AC"). Their voltage of initial operation also will be 115 kV.

The proposed conductor type for New Line 302 and New Line 1 is 795 MCM 26/7 ACSR "Drake" conductor. New Line 1 is designed with twin bundled 795 ACSR "Drake" over its entire length of 10.8 miles from Ballston Tap to Rotterdam Substation, with a maximum winter STE rating of 3,258 amps. New Line 302 is designed with a single 795 ACSR "Drake" wire for 13.8 circuit miles from the Spier Falls Substation to the Brook Road Tap, and twin bundled 795 ACSR "Drake" for the remaining 7.9 circuit miles from the Brook Road Tap to the Ballston Tap. The winter STE rating of the bundled conductor portion of New Line 302 is 3,258 amps and the single conductor per phase portion is 1,629 amps. The proposed conductor type on the Rebuilt Line 302 is 1113 MCM 54/19 ACSR "Finch" (4.2 circuit miles). The maximum winter STE rating of this segment will be 2,030 amps. All conductors to be installed for the new and rebuilt lines will include a non-specular finish.

The proposed conductor type on the 1.5 mile segment of the Rotterdam - Scotia 32 34.5 kV line to be rebuilt is to be 795 ACSR "Drake". The maximum winter STE rating of this portion of Line 32 will be 1629 amps. The 1.2-mile rebuilt portion of Line 1 and Line 2 also will be reconductored when it is relocated and the conductor type proposed is also 795 ACSR "Drake". Where the Spier Falls – Brook Road 3 34.5 kV line and the Spier Falls - Saratoga 12 34.5 kV line are to be relocated, it is proposed that they also be reconductored. This would be a distance of 0.4 miles for each line, and the potential conductor types would be either 336.4 ACSR

"Merlin" or 336.4 ACSR "Linnet," which have maximum winter STE ratings of 883 amps and 910 amps respectively.

For Bused Line 2, for a distance of 13.8 miles between the Spier Falls Substation and the Brook Road Tap, the winter STE rating will be 1660 amps which is the combined rating of two 4/0 copper conductors. For Bused Line 2, for a distance of 7.9 miles between Brook Road Tap and Ballston Tap, the winter STE rating will be 3258 amps the combined rating of two 795 ACSR "Drake" conductors. For Bused Line 2, a distance of 10.8 miles between Ballston Tap and the Rotterdam Substation, the winter STE rating will be 2392 amps, which is the combined rating of two ACSS 397.5 kcmil 24/7 conductors.

The type of aerial ground wire utilized on all new and rebuilt lines will be 3/8-inch extra high strength ("EHS") 7 strand steel cable. On New Line 1 and New Line 302, where there are single circuit steel mono-pole structures, there will be one aerial ground wire. Where New Line 1 is co-located on double circuit steel mono-pole structures with the segment of the Rotterdam - Scotia 32 34.5 kV line to be rebuilt (approximately 1.5 circuit miles between the Rotterdam Substation and Vley Road in the towns of Rotterdam and Glenville), there will be two aerial ground wires strung over each side of the structure. The new Rebuilt Line 302 will also have two aerial ground wires carried above the single circuit "H-frame" structures.

Grounding on the new and rebuilt lines will be provided in one of two ways. In locations where structures are to be direct embedded, a corrugated metal pipe serving as the foundation will be utilized as the grounding system. This method would be used on the proposed Rebuilt Line 302 wood pole structures, as well as on the direct embedded steel delta davit arm structures. In instances where the structures are set on reinforced concrete foundations, the grounding of the structure will be accomplished using the structure anchor bolts within the corrugated metal pipe used as part of the foundation construction, and bonded to the corrugated pipe with 3/8-inch common grade steel wire. If slip forms are used in lieu of corrugated metal pipe due to soil conditions, ground rods driven adjacent to the foundation shall be the sole means of structure grounding. In instances where the aerial ground wire cannot be continuous (primarily where the line is in an under-built situation), the use of buried wire grounding systems (counterpoise) will be considered.

Insulator design for all the proposed transmission lines will be suspension-type ball-and-socket insulators. In all suspension applications, regardless of structure type, insulator strings will

consist of ten (10) porcelain ball-and-socket insulators. Dead-end and angle structures will utilize thirteen (13) porcelain ball-and-socket insulators. Where required, restrained porcelain insulator assemblies will be utilized to mitigate the effects of conductor blow-out and to facilitate appropriate clearance between the conductor and the grounded surfaces of the structures.

E-1.2.2 Structure Type, Size, and Material

Several different structures and structure materials will be used for this Project. Structures for New Line 1 and New Line 302 will be galvanized tubular steel pole structures. The Rebuilt Line 302 will be a combination of wood pole structures and weathering tubular steel structures. The lattice tower structures currently supporting the existing Rotterdam - Scotia 32 34.5 kV line are to be replaced with tubular steel structures for the segment to be rebuilt. The 1.2 mile section of Bused Line 2 that will be rebuilt and relocated will be supported by a combination of double circuit wood pole structures with weathering steel davit arms and weathering tubular steel structures. The segments of the existing Spier Falls - Brook Road 3 34.5 kV line, the existing Spier Falls - Saratoga 12 34.5 kV line, and relocated distribution lines will be supported by wood pole structures. Structure types for each line are described as follows (figures accompanying Exhibit 5 provide cross-sections of these proposed structures within the Project ROW segments as well as figures representing each structure type proposed to be installed):

New Line 302

The predominant structure for New Line 302 is delta type configured on mono-pole structure. This structure type will be used in suspension and dead-end applications alike. Where insulator swing angles and conductor blow out are a concern, restrained insulator assemblies will be utilized. In total, 179 structures will be constructed on New Line 302. Of these 179 structures, 153 are to be delta configured steel mono-pole davit arm suspension structures, with 99 supporting a single wire per phase, and 54 supporting a twin bundled conductor. There are four (4) proposed delta configured light angle steel mono-pole structures on this line segment, two (2) supporting a single wire per phase and two (2) supporting a twin bundled conductor. In all, there will be seventeen (17) delta configured steel mono-pole dead-end structures. The remaining structures include two (2) steel pole switch structures, one (1) vertical dead-end, and two (2) three-pole dead-end pull off structures. Average structure height on this line segment is approximately 77 feet, and the average span length is approximately 640 feet.

New Line 1

New Line 1 is very similar in structure type to New Line 302. All of the structures on this line are to support a twin bundled 795 ACSR "Drake" conductor. There are a total of eighty-nine (89) structures proposed for the construction of New Line 1. The predominant structure type is also a delta configured mono-pole structure. The exception is where New Line 1 is co-located on structures with the segment of the Rotterdam - Scotia 32 34.5 kV line to be rebuilt, as discussed in the following section. Where New Line 1 is the only line supported by the proposed structures, there will be a total of 62 delta configured steel mono-pole davit arm suspension structures, five (5) delta configured steel mono-pole dead-end structures, and five (5) light angle steel mono-pole structures on the line. New Line 1 also includes three (3) single circuit steel vertical dead-end structures, one (1) 3-way switch structure, and two (2) three pole dead-end pull off structures. The average structure height on the line will be approximately 77 feet and approximately 110 feet, respectively, for the single and double circuit structures. The average span will be approximately 670 feet.

Rotterdam - Scotia 32 34.5 kV Line

The existing Rotterdam - Scotia 32 34.5 kV line is currently located on double circuit lattice tower structures with the opposing side of the tower vacant. The structure locations of the first twelve structures of this line are positioned where New Line 1 is to be constructed. Eleven of these first twelve structures are to be rebuilt as double circuit davit arm steel mono-pole structures so that the rebuilt segment of this line and New Line 1 can be co-located. These eleven structures will consist of four (4) double circuit phase-over-phase configured dead-end mono-pole structures and seven (7) double circuit phase-over-phase configured suspension mono-pole structures. These rebuilt structures will be placed such that the ROW centerline of the existing Rotterdam - Scotia 32 34.5 kV line is maintained. The average height of these double circuits, as mentioned above, will be approximately 110 feet with an average span length of approximately 670 feet.

Rebuilt Line 302

The existing Ballston Tap Line 2 will be completely rebuilt to support reconductoring with 1113 ACSR "Finch" conductor (4.2 circuit miles). Applicant refers to this line, after this work is completed, as Rebuilt Line 302. The structure work associated with this rebuild includes replacing all the existing wood pole "H-frame" structures in accordance with current National Grid standards. The wood pole suspension structures will be replaced with new National Grid

standard wood pole "H-frame" structures, and the existing angle and dead-end wood pole structures will be replaced with steel structures supported on concrete foundations. Currently there are thirty-one (31) wood pole suspension structures, ten (10) wood pole "H-frame" dead-end structures, and four (4) three pole dead-end pull-off structures. The proposed structure types on the line following the refurbishment include thirty (30) wood pole "H-frame" structures, ten (10) steel pole "H-frame" dead-end structures, four (4) steel three pole dead end structures, and one (1) steel pole dead-end with a 115 kV tap. The location of the new structures on the line will be generally at the same location as the existing structures. Some structures will be relocated from their existing location to avoid wetlands or unsuitable soil conditions. These relocations will occur such that the centerline of the ROW of Ballston Tap Line 2 is maintained; thus structure movement will be forward or back along the existing ROW centerline. The average span length will remain approximately 500 feet, and the average replacement structure height will be approximately 66 feet.

Relocation and Rebuild of Bused Line 2

A 1.2 mile section of Bused Line 2 will need to be relocated and rebuilt over a distance of 1.2 miles between Sacandaga Road and Snake Hill Road in the Town of Glenville. The existing lattice tower structures supporting existing Line 1 and Line 2 are to be replaced with wood pole double circuit davit arm suspension structures, double circuit phase-over-phase davit arm two pole steel suspension structures, and double circuit phase-over-phase two pole steel dead-end structures located 50 feet to the east of the existing lattice tower line. New Line 1 will occupy the former centerline of the existing Line 1 and Line 2 ROW. There are a total of ten (10) existing lattice towers to be replaced in this section of Line 1 and Line 2. Six (6) wood pole double circuit davit arm suspension structures are to be installed along with three (3) double circuit phase-over-phase two pole steel dead-end structures and one (1) double circuit phase-over-phase davit arm two pole steel suspension structure. Average structure height of the relocated and rebuilt Bused Line 2 is proposed to be approximately eighty-eight (88) feet with average span length of approximately 675 feet.

To make room for New Line 1, two (2) of the existing lattice towers supporting Line 1 and Line 2 located within the fence of the Rotterdam Substation property are to be replaced with two (2) single circuit steel mono-pole vertical dead-end structures. These new structures, proposed to be ninety (90) feet in height, will support Bused Line 2 in this location.

Spier Falls - Brook Road 3 34.5 Line and Spier Falls - Saratoga 12 34.5 kV Line

The existing Spier Falls - Brook Road 3 34.5 kV line and Spier Falls - Saratoga 12 34.5 kV line within Moreau Lake State Park will need to be relocated approximately 25 feet to the east of their existing locations over a distance of 0.4 miles to accommodate New Line 302. A total of seven existing structures will require relocation. These structures will be replaced with wood pole double circuit structures approximately 55 feet in height with an average span length of approximately 240 feet.

E-1.2.3 Structural Loading and Foundations

The NESC, latest edition, as well as other, more stringent criteria imposed by National Grid will be used to determine specific structural loading design. The minimum loads will be as follows:

- NESC Heavy Loading: ½-inch radial ice at 0° F with a 40 mph wind
- NESC High Wind: 90 mph wind at 60° F
- National Grid Heavy Ice: 1 ½ inch radial ice at 30°F with a 28 mph wind

Structure design will be done in accordance with applicable national and state codes, including the NESC. The NESC specifies both the minimum structural load criteria to determine the required structural capacity and clearances for energized parts and wires. Typical requirements defined by the NESC include clearances to ground, adjacent transmission lines, railroads, buildings, and other facilities.

In addition to the NESC, there are several published standards, depending on the type of structure and material used. Some of the common standards include:

- Steel Lattice Structures – American Society of Civil Engineers Manual 10-97 “Design of Latticed Steel Transmission Structures”

- Tubular Steel Poles – American Society of Civil Engineers Manual 72 “Design of Steel Transmission Pole Structures”

- Rural Utilities Service Bulletin 1724E-200 “Design Manual for High Voltage Transmission Lines”

- American National Standard Institute ("ANSI") O5.1-2002 "American National Standard for Wood Products – Specifications and Dimensions"

Structure Foundation Design

The Project will employ two types of foundations for steel structures: direct embedded steel poles and reinforced concrete pier foundations. The direct embedded foundation involves setting the pole in a corrugated metal pipe (commonly referred to as culvert) set to a depth of 10% of the pole length plus four feet. Upon setting the pole within the metal pipe, crushed stone backfill will be placed in the space remaining between the pole and the inside surface of the pipe. The purposes of the corrugated metal pipe are to provide a grounding system for the structure and to provide a foundation of suitable strength to support the structure loadings. Diameters of these culverts will be approximately 4 to 6 feet. Dead-end type structures and structures supporting angles in the ROW will be supported by reinforced concrete caisson foundations. These foundations will range from about 6 to 10 feet in diameter and will be set to a depth of from 20 to 40 feet.

The wood pole structures utilized on Rebuilt Line 302 and the relocation of Line 1 and Line 2 between Sacandaga Road and Snake Hill Road will be direct buried in a manner similar to the one used with the steel poles, except that the burial depth will be 10% of the pole length plus two feet. Culverts used in conjunction with wood pole foundations will be 2.5 to 4 feet in diameter.