Robinson+Cole

PETER V. LACOUTURE

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***Via Hand Delivery***

October 21, 2014

Todd Bianco
Siting Board Coordinator
Energy Facility Siting Board
89 Jefferson Boulevard
Warwick, RI 02888

Re: **Docket No. SB-2003-1**
**In re: The Narragansett Electric Company d/b/a National Grid**
**(E-183 115kV Transmission Line Relocation)**

Dear Todd:

I am enclosing an original and five (5) copies of National Grid's Project Cost Estimate for the E-183 underground project, and the following supporting materials:

- Report Accompanying Project Cost Estimate of The Narragansett Electric Company d/b/a National Grid
- Underground Project Investigation & Estimate Assumptions
- Design Information Package
- Proposed route site plans.

Please acknowledge receipt of this filing on the enclosed copy of this letter and the report and return them to me. Thank you.

Sincerely,

Peter V. Lacouture

PVL/blv

Enclosure

13195015-v1

Copy to: Chairperson Margaret E. Curran, Esq. *(via hand delivery)*
Janet Coit *(via hand delivery)*
Kevin Flynn *(via hand delivery)*
Patricia S. Lucarelli, Esq. *(via hand delivery)*
Service List *(via electronic mail)*

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
ENERGY FACILITY SITING BOARD

| | | |
|---|---|---|
| In re: The Narragansett Electric Company | : | |
| (E-183 115 kV Transmission Line | : | Docket No. SB-2003-01 |
| Relocation Project – A/C I-195 Relocation) | : | |

# PROJECT COST ESTIMATE
# OF NATIONAL GRID FOR E-183 UNDERGROUND PROJECT

1. Project Cost Estimate

2. Report Accompanying Project Cost Estimate of The Narragansett Electric Company d/b/a National Grid

3. Underground Project Investigation & Estimate Assumptions

4. Design Information Package

5. Proposed Route Site Plans

October 21, 2014

C014262 E-183W 115KV UG Transmission Line Project Combined Summary 10/21/2014

| | Underground | Overhead | Transition Stations | | Totals |
|---|---|---|---|---|---|
| | | | Franklin | Mauran | |
| | | | | | |
| Material, Labor & Equipment | 17,308,877 | 2,829,759 | 882,565 | 1,298,821 | 22,320,023 |
| ROW / Land & Land Rights | 1,900,000 | | | | 1,900,000 |
| Engineering/Indirects | 2,714,483 | 367,294 | 203,477 | 201,588 | 3,486,841 |
| Escalation | | | | | - |
| AFUDC | 630,047 | - | 28,625 | 39,569 | 698,240 |
| Contingency | 4,328,574 | 950,562 | 107,330 | 148,279 | 5,534,745 |
| | | | | | |
| | 26,881,981 | 4,147,615 | 1,221,997 | 1,688,256 | 33,939,850 |
| | | | | | |

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
ENERGY FACILITY SITING BOARD

| | | |
|---|---|---|
| In re: The Narragansett Electric Company (E-183 115 kV Transmission Line Relocation Project – A/C I-195 Relocation) | : : : | Docket No. SB-2003-01 |

REPORT ACCOMPANYING PROJECT COST ESTIMATE
OF THE NARRAGANSETT ELECTRIC COMPANY d/b/a NATIONAL GRID

The Narragansett Electric Company d/b/a National Grid ("National Grid" or the "Company") is filing herewith its cost estimate for the construction of the E-183 115 kV underground transmission line project (the "Project") indicating an estimated cost of $33,939,850 (+/- 25%).[1] The purpose of this report is to provide context for the Project estimate, address the Project schedule, address the use of funds for ongoing Project costs and, finally, request a modification of the Company's ongoing reporting requirements.

I. Project Estimate

A. Components of Estimate

The Project cost estimate which is filed herewith includes typical project costs such as the cost of materials, labor, and financing costs associated with completing engineering and construction of the 115 kV underground cables between the Franklin Square Substation in Providence and a new transition station on Mauran Avenue in East Providence, the cost of transition stations at each end of the underground cables, overhead 115 kV transmission line work to relocate the Phillipsdale Tap Line and convert it to main line, the cost of removal of the existing overhead line, and permitting costs for the Project.

B. Property Rights

The estimate include funds for acquisition of the Singh lot on the east side of the Providence River, and expenses related to acquisition of the Singh lot, the Tockwotton property, and easements from Providence, East Providence and RIDOT, including the costs of survey, Phase I environmental investigations, and legal fees. No funds are included for purchase of Tockwotton property and rights (the property for the Mauran Avenue Transition Station and an easement for the relocated line between the Transition Station and the old Phillipsdale Tap Point) as National Grid assumes that this will be negotiated by East Providence as a swap of land and easements among National Grid, Tockwotton, and East Providence.

[1] As Mr. Campilli testified, "a 'Construction Grade Estimate' as that term is now used by National Grid, is prepared only after the final construction bids have been received for a project." TR, 12/17/13, pp. 26-27.

C. Tolerances vs. Contingencies

The Project cost estimate has a range (tolerances) and includes contingencies. Tolerances are expressed as percentages by which the cost might be expected to increase or decrease based on the magnitude of the unknown risk for a project at the time the estimate is prepared. The level of tolerance depends on the amount of investigation and engineering design that has been completed for a project and also depends on the complexity and/or unique features of a project (e.g., a project requiring significant horizontal directional drilling versus a project involving the construction of an overhead transmission line). The tolerance of the E-183 underground project cost estimate is currently at a planning grade level of plus or minus twenty-five percent (± 25%).

In contrast to tolerances which are based on unknown risks, contingencies refer to known costs that will probably occur based on past experience, but with some uncertainty regarding the magnitude. Each component of the estimate includes contingencies in anticipation of project cost increases in that component. The estimate is based on substantial engineering and field investigations, including geotechnical borings, receipt of estimating bids, and review of the project cost of other similar projects.

D. Review of Estimate

The detailed work papers for the components of the estimate will be made available upon request to the parties and their engineering consultant subject to a confidentiality agreement or a protective order.

## II. Project Schedule

The parties have submitted to the EFSB various project schedules and milestones for the construction of the Project. National Grid has recently determined that certain portions of the proposed South Street Substation and Transmission Project will be constructed in some of the same areas adjacent to the Franklin Square Substation as the E-183 Underground Project. As a result, it will be necessary to coordinate the timing of the construction of the projects. A better determination as to any potential conflict between the projects will be made and presented to the EFSB after the parties (Providence, East Providence and the Attorney General) have made a decision to proceed with the E-183 Underground Project.

## III. Future/Ongoing Project Costs

As the Board knows, there are a number of sources of funding for the Project and the order in which the funds are to be used for the Project has been the subject of considerable debate among the parties. By Order dated December 17, 2013, the EFSB authorized National Grid "to use $1,000,000 of interest accrued on the retained refund amounts from Providence and East Providence ratepayers for the purpose of conducting the engineering and design of the underground relocation of the E-183 line." Assuming that the parties decide that the Project should proceed, National Grid requests approval from the Board to apply the following funds to ongoing Project costs in the order specified:

- Balance of interest on refunds and refunds from National Grid rate settlement in PUC Docket Nos. 2930/3617.
- Storm Fund Grant (§42-98-1.1(b)) - $2,000,000.

- RIDOT - Contribution from State matching funds - $2,100,000.
- RIDOT - Contribution from Federal transportation enhancement funds - $600,000.
- RIDOT - "Safe, Accountable, Flexible and Efficient Transportation Equity Act of 2005" ("SAFETEA") grant - $2,500,000.
- Contribution from regional customers as provided in Feb. 6, 2006 letter from ISO - $1,500,000.
- Surcharge on bills of electric customers in Providence and East Providence (§42-98-1.1(d)).

National Grid assumes that the $375,000 Greenway Grant to Providence from the Rhode Island Department of Environmental Management is no longer available. National Grid will advise the EFSB in the event that it is necessary to use funds in any order other than as proposed above.

IV. Ongoing Reporting

In EFSB Order No. 70 dated December 17, 2013, the EFSB required that National Grid provide written status reports every forty-five (45) days. National Grid has followed this direction with reports on the following dates:

- January 30, 2014
- March 7, 2014
- May 1, 2014
- June 13, 2014
- July 28, 2014 (Revised July 31, 2014)
- September 11, 2014

Having submitted its Project cost estimate for review and consideration by the parties in determining whether or not to proceed with the Project, National Grid respectfully requests that the Board terminate this requirement and suggests that the other parties (Providence, East Providence and the Attorney General) be directed to report (i) the identity and qualifications of any engineering consultant who is to review National Grid's Project cost estimate, before the consultant is hired, and (ii) on or before November 30, 2014 and every forty-five (45) days thereafter as to the status of their review of National Grid's Project cost estimate and their progress on deciding whether to proceed with the Project.[2]

[2] As the parties weigh the cost and benefits of proceeding with the Project, it is important to remember that placing a short piece of a longer transmission line underground does not protect the line from storm damage but increases the complexity of operating the line. In addition, burying a transmission line does not reduce the magnitude of the magnetic fields that are encountered in the vicinity of the line.

Respectfully Submitted,

THE NARRAGANSETT ELECTRIC COMPANY
d/b/a NATIONAL GRID

By its Attorneys,

Peter V. Lacouture
Robinson & Cole LLP
One Financial Plaza, Suite 1430
Providence, RI 02903
401-709-3314
401-709-3377 (facsimile)
placouture@rc.com

CERTIFICATE OF SERVICE

I hereby certify that a true copy of the within was sent by e-mail to the following this the 21st day of October, 2014.

| | |
|---|---|
| Department of Attorney General<br>150 South Main Street<br>Providence, RI 02903 | LWold@riag.ri.gov<br><br>klyons@riag.ri.gov<br>Jmunoz@riag.ri.gov<br>dmacrae@riag.ri.gov |
| Division of Public Utilities & Carriers | Thomas.kogut@ripuc.state.ri.us<br>JHagopian@dpuc.ri.gov<br>Steve.scialabba@ripuc.state.ri.us |
| Janet Coit, Director<br>Dept. of Environmental Management<br>235 Promenade Street<br>Providence, RI 02908 | janet.coit@dem.ri.gov<br><br>Rayna.maguire@dem.ri.gov |
| Kevin Flynn, Associate Director for<br>Division of Planning<br>Department of Administration<br>One Capitol Hill, 3rd Floor<br>Providence, RI 02903 | kevin.flynn@doa.ri.gov |

| | |
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| Adrienne G. Southgate, City Solicitor<br>City of Providence<br>Department of Law<br>275 Westminster Street<br>Providence, RI 02903 | asouthgate@providenceri.com |
| RI Public Utilities Commission<br>89 Jefferson Boulevard<br>Warwick, RI 02888 | Cynthia.WilsonFrias@puc.ri.gov<br><br>alan.nault@puc.ri.gov<br><br>Paul.roberti@puc.ri.gov |
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| National Grid | jennifer.hutchinson@nationalgrid.com |
| National Grid | celia.obrien@nationalgrid.com |

**File an original and 5 copies w/:**

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Brenda L. Vucci

October 21, 2014

NATIONAL GRID

# The Narragansett Electric Company
# E183W

*Underground Project Investigation*
*& Estimate Assumptions*


*PROJECT NUMBER:*
*134776*

*PROJECT CONTACT:*
*Todd S Goyette*
*EMAIL:*
*todd.goyette@powereng.com*
*PHONE:*
*(774) 643-1833*


POWER ENGINEERS

# The Narragansett Electric Company
# E183W
*Underground Project Investigation*
*& Estimate Assumptions*

PREPARED FOR: NATIONAL GRID
PREPARED BY: TODD GOYETTE
TODD.GOYETTE@POWERENG.COM

| REVISION HISTORY | | |
|---|---|---|
| DATE | REVISED BY | REVISION |
| 10.13.2014 | T. Goyette | Original |
| 10.21.2014 | T. Goyette | Minor edits |
| | | |

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# 1 PROJECT DESCRIPTION

The Narragansett Electric Company d/b/a National Grid (National Grid) retained POWER Engineers, Inc. (POWER) for engineering and design services to support the route verification, cost estimating, permitting, licensing and installation of a proposed underground 115 kV electric transmission line in Providence and East Providence, RI. The proposed line will be installed between National Grid's existing Franklin Square Substation and a proposed overhead to underground transition substation on Mauran Avenue in East Providence, RI. The new underground line will replace an existing overhead transmission line installed in the same vicinity.

The proposed transmission line will be approximately 1.2 miles in length and will be rated for 398 MVA (2000 Amps). The cable system will require multiple construction methods including open cut trenching, jack & bores, and horizontal directional drilling (HDD). Approximately 2,300 of the 6,330 foot route will be installed in trenchless installations including two (2) HDDs and one (1) jack & bore.

This report outlines the tasks performed as part of the design and engineering efforts undertaken to develop construction grade estimates for the project.

## 1.1 Route

The route for the proposed transmission line begins at the Franklin Square Substation in Providence, Rhode Island. The existing E183W line will transition from overhead to underground in the parking lot outside of the guard house of the Franklin Square Substation. The installation would be performed by open cut trench excavation for an approximate 200 feet in a northeast direction in the parking lot of the Franklin Square Substation. From this point a horizontal directional drill will be utilized to cross the Providence River. This HDD would span for approximately 1,200 feet in an easterly direction under the Providence River and South Water Street. It would then exit into a parking lot at the corner of Tockwotten Street and South Water Street. At this point the underground system will transition back to an open cut trench excavation.

The underground line will proceed through the parking lot for a brief distance before turning north east up Tockwotton Street for 600 feet. At this point the alignment will parallel I-195 and will be going through the strip of grass in between I-195 and the off ramp for exit 2. The approximate distance for this is 200 feet, afterwards the line crosses under I-195. An extension of the Fox Point Hurricane barrier is built into the relocated I-195 highway. This prevents an open cut trenching method from being utilized in the underpasses of the bridge. For this reason a trenchless technology of either jack & bore or pipe jacking will be utilized to cross underneath I-195 from the grass strip and exit around India Street (approximately 275 feet).

After the I-195 crossing the underground line will head east down India Street and into India Point Park for approximately 2,400 feet. The open cut trench will terminate to the south of the Brown University Boathouse where it will transition into the routes last HDD to cross the Seekonk River. This is the shorter of the two HDDs at an approximate length of 950 feet. The HDD will exit next to the transition station on Mauran Avenue where it will be terminated at the new substation.

## 1.2 Survey & Mapping

POWER subcontracted the survey and mapping efforts to generate the base mapping for the project. The base maps were used to develop the plan and profile drawings required for construction. In developing the base mapping the following tasks were completed:

- Coordinated and performed an aerial flight over the project area;
  - Aerial photography used to set project controls and establish visual points of reference for the mapping
- Collected and reviewed available mapping and data from the following utilities to identify existing infrastructure (type, number and location)
  - National Grid – Electric & Gas
  - Verizon – Communication
  - Cox Communications – Communication
  - Narragansett Bay Commission
  - Municipal Water
- Field surveys conducted to verify location of utility and other surficial detail not gathered as part of the aerial data acquisition efforts.
- Coordination of collected data into a consolidated base map of the project area

## 1.3 Marine Survey & Investigation

To support the investigation and design of the two river crossings, POWER subcontracted with a marine surveying company to perform a multi-sensor geophysical survey of the Providence and Seekonk Rivers.

The survey program consisted of the acquisition of multi-sensor geophysical data (hydrographic, sub-bottom profiling, magnetometer and side scan sonar imagery) along the proposed transmission line alignment. Survey investigations were performed within an approximate 100-foot wide corridor centered on the proposed HDD alignment across each river. Track-line spacing within the survey corridors was established at 50-foot intervals. Along all survey tracks, the surveyor acquired hydrographic, sub-bottom profiling and magnetometer data. Side scan sonar imagery was acquired along specific tracks with the intent of providing close to 100 percent overlapping coverage of the bottom within the entire survey corridor. Sonar imagery data will be used for precisely locating specific objects and features exposed on the bottom (including abandon piles, debris, pipes, cables, rock outcrops) and mapping varying sediment types.

## 1.4 Geotechnical & Geothermal Investigation

In addition to the surveying and mapping efforts along the proposed transmission line corridor, POWER subcontracted with a geotechnical investigation contractor to obtain subsurface information along the land and marine route.

A total of twelve (12) drilled soil borings were taken in the project area to identify and classify underlying soil conditions along the proposed transmission line. The soil borings were advanced to a depth of approximately fifteen (15) feet at each location, except for the borings located at the landfall of each proposed horizontal directional drill. These borings (4 total) were advanced to a depth of sixty (60) feet to support the design of the directional drill alignments.

In addition to the twelve land based borings, two (2) borings were performed in the Providence River and two (2) borings were performed in the Seekonk River. These borings were advanced to a depth of eighty (80) feet beneath the mudline.

Soil samples from each boring location were collected and sent to a third party laboratory for thermal property analysis. Laboratory tests on selected samples were performed to cover the range of soils encountered. A thermal evaluation report was prepared including soil descriptions, measurements of moisture content, density, organic content and thermal dry-out tests (thermal resistivity vs. moisture content).

## 1.5 Transmission Line Design & Identification

POWER reviewed the information obtained through the field investigation efforts outlined in the previous tasks to select a preferred centerline for the proposed transmission line facilities. Manhole locations and configurations were identified and added to the base maps. In addition, the centerline of the proposed ductbank was selected and shown on the base map. In siting the manhole and centerline locations, POWER considered the routing, raceway elevations, burial depths, clearances to obstructions, crossings, horizontal and vertical curves, cable lengths, cable pulling tensions, site constraints, crossings, burial depths, construction access, grounding, installation and maintenance of the facilities.

Ampacity calculations were performed to determine the appropriate conductor size for the cable considering at a minimum: burial depth, cable spacing, transmission voltage mutual heating, distribution cable mutual heating, soil thermal conductivity, insulation wall thickness, earth ambient temperature, air ambient temperature, load factor, dielectric losses, conductor material and anticipated load requirements.

## 1.6 Cable System Description

POWER performed cable ampacity calculations for the proposed underground transmission line alignment. Ampacity calculations were performed using CYME International's Cable Ampacity Program (CAP) to model the cable system based on the agreed upon design criteria and the measurements obtained during the field investigation (thermal resistivities, ambient soil temperatures, etc.)

Based on these calculations, POWER has confirmed that National Grid's proposed cable system design consisting of two sets of 3000kcmil copper solid dielectric insulated cables will achieve the desired capacity of 2000 amperes.

## 1.7 Cost Estimate Assumptions

To support National Grid's permitting and licensing efforts, POWER developed project cost estimates. The cost estimates are based on pricing obtained from the following sources:

- Budgetary estimates for cable and accessories from several cable manufacturers

- Construction rates obtained from area contractors and recent projects in the New England area with similar scopes of work (voltage, length, pipe-jackings, etc.)
- Consultation with a contractor specializing in horizontal directional drill construction methodology

The following assumptions were used in the development of the cost estimate.

1. Materials used in the cost estimates meet all applicable industry standards.
2. Construction would be performed by qualified craftsmen experienced in installing high voltage XLPE underground and submarine transmission systems.
3. Due to the volatility of material costs, these estimates are subject to market fluctuations.
4. Costs to obtain all environmental, local, state, and federal permits and mitigation as required are not included.
5. Costs to obtain all necessary right-of-way, easement, and property as required are not included.
6. One spare cable reel, one spare termination and two spare splices have been included in the estimates.
7. Costs to install a fiber optic cable for communication are included.
8. Costs to include the installation of temperature monitoring equipment for the cable system are included.
9. Costs for reactive compensation are not included. A system study would need to be conducted to determine the detailed engineering and construction requirements for reactive compensation, if required.
10. Cost estimates assumed 10% open cut trench installation would be through rock (based on a combination of historical construction efforts in this area and the geotechnical investigation)
11. Cost estimates assumed dewatering of the trench would be required along 75% of the cable route due to the proximity of the tidal rivers.
12. Civil contingency of 15%
13. Electrical contingency of 25%
14. No sales tax included
15. No internal National Grid overheads included.

## 1.8 Summary

To assist National Grid's engineering department with permitting & licensing of the proposed 115kV underground transmission line, E183W, POWER performed a series of field investigations to develop plan & profile drawings and construction grade estimates.

October 21, 2014

NATIONAL GRID

# E183W UNDERGROUND RELOCATION PROVIDENCE, RI

*Design Information Package*

*ISSUED FOR REVIEW*

*PROJECT NUMBER:*
134776
*PROJECT CONTACT:*
*TODD GOYETTE*
*EMAIL:*
*TODD.GOYETTE@POWERENG.COM*
*PHONE:*
*(774) 643-1833*

POWER ENGINEERS

# *Design Information Package*

*PREPARED BY:* _____

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*REVIEWED BY:* _____

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*APPROVED BY:* _____

*DAVID CAMPILII*
*(781) 907-3062*
*DAVID.CAMPILII@NATIONALGRID.COM*

| DOCUMENT HISTORY | | |
|---|---|---|
| DATE | BY | REVISION |
| 06.20.2014 | Sean Gamache | Original |
| 10.13.2014 | Todd S. Goyette | 1 – Updated Info |
| 10.21.2014 | Todd S. Goyette | 2 – Minor Edits |
| | | |

# TABLE OF CONTENTS

# 1.0 GENERAL

## 1.1 Project Information

| | |
|---|---|
| Owner's Name: | National Grid |
| Project Name: | 115 kV E183W Underground Relocation |
| Project Location: | East Providence & Providence, Rhode Island |
| Length: | Approximately 1.2 miles |
| Voltage: | 115 kV |
| Planned Energization Date: | TBD |

## 1.2 Correspondence/Project Personnel

### 1.2.1 POWER Engineers, Inc.


Project Manager — Jerry Johnson
Email: jjohnson@powereng.com
Phone: (208)788-0364

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Hailey, ID 83333

Project Engineer — Todd Goyette, PE
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Address: 100 John L. Dietsch Square
North Attleboro, MA 02763


### 1.2.2 National Grid


Project Manager — David Beron
Email: David.beron@nationalgrid.com
Phone: (774) 643-1803

Address: 100 John L. Dietsch Square
North Attleboro, MA 02763

Project Engineer — Dave Campilii
Email: David.Campilii@nationalgrid.com
Phone: (781) 907-3062

Address: 40 Sylvan Road
Waltham, MA 02451

## 1.3 Project Description

National Grid (NGRID) is proposing to design, engineer and construct a new underground transmission line in Providence, Rhode Island. The new 115kV circuit will be replacing an existing overhead 115kV circuit (E183W). The new circuit will closely follow the existing E183W overhead line on a corridor that would connect the Franklin Square Power Station with Mauran Avenue Transition Station (to be built). National Grid has requested that POWER Engineers, Inc. (POWER) perform the underground design and engineering for the new transmission line.

The 1.2 mile underground transmission line will be rated for 398 MVA (2000 Amps) and will operate on new extruded dielectric cables (XLPE). The cable system will require multiple construction methods including open cut trenching, jack & bores, and horizontal directional drilling (HDD). Approximately 2,300 of the 6,330 foot route will be installed in trenchless installations including two (2) HDDs and one (1) jack & bore. The following design criteria will be used by POWER to provide National Grid with detailed design and engineering of the relocated E183W underground transmission line.

# 2.0 ROUTE DESCRIPTION

## 2.1 Route

The route begins at the Franklin Square Substation in Providence, Rhode Island. The existing E183W line will transition from overhead to underground in the parking lot outside of the guard house of the Franklin Square Substation. The installation would be performed by open cut trench excavation for an approximate 200 feet in a northeast direction in the parking lot of the Franklin Square Substation. From this point a horizontal directional drill will be utilized to cross the Providence River. This HDD would span for approximately 1,200 feet in an easterly direction under the Providence River and South Water Street. It would then exit into a parking lot at the corner of Tockwotten Street and South Water Street. At this point the underground system will transition back to an open cut trench excavation.

The underground line will proceed through the parking lot for a brief distance before turning north east up Tockwotton Street for 600 feet. At this point the alignment will parallel I-195 and will be going through the strip of grass in between I-195 and the off ramp for exit 2. The approximate distance for this is 200 feet, afterwards the line crosses under I-195. An extension of the Fox Point Hurricane barrier is built into the relocated I-195 highway. This prevents an open cut trenching method from being utilized in the underpasses of the bridge.. For this reason a trenchless technology of either jack & bore or pipe jacking will be utilized to cross underneath I-195 from the grass strip and exit around India Street (approximately 275 feet).

After the I-195 crossing the underground line will head east down India Street and into India Point Park for approximately 2,400 feet. The open cut trench will terminate to the south of the Brown University Boathouse where it will transition into the routes last HDD to cross the Seekonk River. This is the shorter of the two HDDs at an approximate length of 950 feet. The HDD will exit next to the transition station on Mauran Avenue where it will be terminated at the new substation.

## 2.2 Right of Way

| | |
|---|---|
| Location of Line in ROW: | Varies |
| ROW Width: | Varies |
| Comments: | National Grid still needs to acquire the ROW needed for this project. |

# 3.0 UNDERGROUND SYSTEM PARAMETERS

## 3.1 Cable System Operating Parameters

The underground cable system will be operated under the following requirements:

| | | |
|---|---|---|
| Nominal Voltage | 115 | kV |
| Nominal Frequency | 60 | Hertz |
| Maximum Steady State Ampacity | | |
| (summer) | 2000 | Amps (398 MVA) |
| (winter) | 2400 | Amps (477 MVA) |
| Emergency Load Rating (12 hour) | TBD | Amps (MVA) |
| Steady State Conductor Temperature | 90 | ˚C |
| Emergency Conductor Temperature | 105 | ˚C |
| Load Factor | 80 | % |
| BIL Rating | 550 | kV |
| Ultimate Short Circuit Load | 39,814 | Amps |
| Ultimate Short Circuit Duration | 30 | Cycles |
| Ultimate Short Circuit Conductor Temperature | 250 | ˚C |
| Shield/Sheath Operation (SPB,MPB, Cross) | SPB | |
| Shield/Sheath Open Circuit Voltage Limit | TBD | V |

## 3.2 Underground Cable Installation Parameters

The following describes the installation methods and environments for which the underground cables will be operated.

### 3.2.1 Duct Bank

The majority of the overall route will be installed within a concrete encased ductbank. The ductbank will be designed based on the following criteria.

| | | |
|---|---|---|
| Minimum Burial Depth to Top of Duct Bank | 30 | inches |
| Minimum Conduit Sweep Radii | 50 | feet |
| @terminations | 10 | feet |
| Foreign Utility Vertical Clearance | 12 | inches |
| Foreign Utility Horizontal Clearance | 12 | inches |
| Obstruction Clearance (Foundations, Anchors) | 10 | Feet |
| Ambient Soil Temperature | | |
| Summer | 25 | ºC |
| Winter | 15 | ºC |

| | |
|---|---|
| Native Soil Thermal Resistivity | 90 Cº-cm/W |
| Encasement Thermal Resisitivity | 60 Cº-cm/W |
| Backfill Thermal Resisitivity | 90 Cº-cm/W |
| Conduit Material | PVC |
| Cable Conduit Size | 6″ Schedule 40 |
| Ground Continuity Conductor Duct Size | 2″ Schedule 40 |
| Communication Duct Size | 4″ Schedule 40 |
| Innerduct Material and Size | TBD |
| Installation Conditions (Rural, Roadway, etc) | Roadway |
| | Private Property |
| | Public Park (India Point Park) |

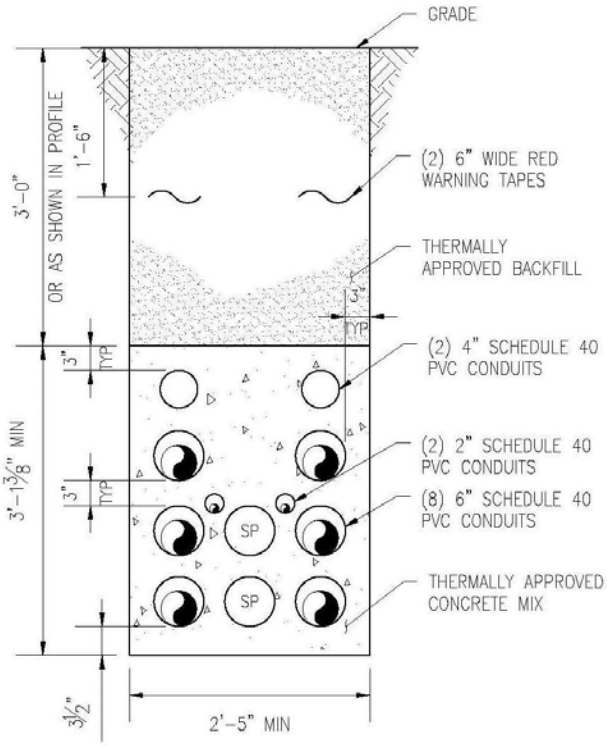



Figure 1 – Typical Open Trench Configuration

### 3.2.2 Horizontal Directional Drill

Part of the overall route will be installed via horizontal directional drilling. Two separate HDD crossings will be required to cross the Providence & Seekonk Rivers. Each HDD crossing will consist of two borings separated both vertically and horizontally. The conduits will be bundled together and directly pulled back into the bore hole.

The HDD crossing will be designed based on the following criteria:

| | | |
|---|---|---|
| Minimum Drill Depth (to top of bore hole) | 35 | feet |
| Maximum Drill Depth (to top of bore hole) | 60 | feet |
| Obstruction Clearance (Foundations, Anchors) | 25 | Feet |
| Ambient Soil Temperature | | |
| Summer | 15 | ºC |
| Winter | 15 | ºC |
| Native Soil Thermal Resistivity | 90 | Cº-cm/W |
| Grout / Bentonite Thermal Resisitivity | 120 | Cº-cm/W |
| Casing Material | | No Casing |
| Casing Size | | No Casing |
| Conduit Material | | High Density Polyethylene (HDPE) PE3608 IPS |
| Cable Conduit Size | | 10″ SDR 9 |
| Ground Continuity Conductor Duct Size | | 2″ SDR 9 |
| Communication Duct Size | | 4″ SDR 9 |
| Innerduct Material and Size | | TBD |
| Installation Conditions (Rural, Roadway, etc) | | River |

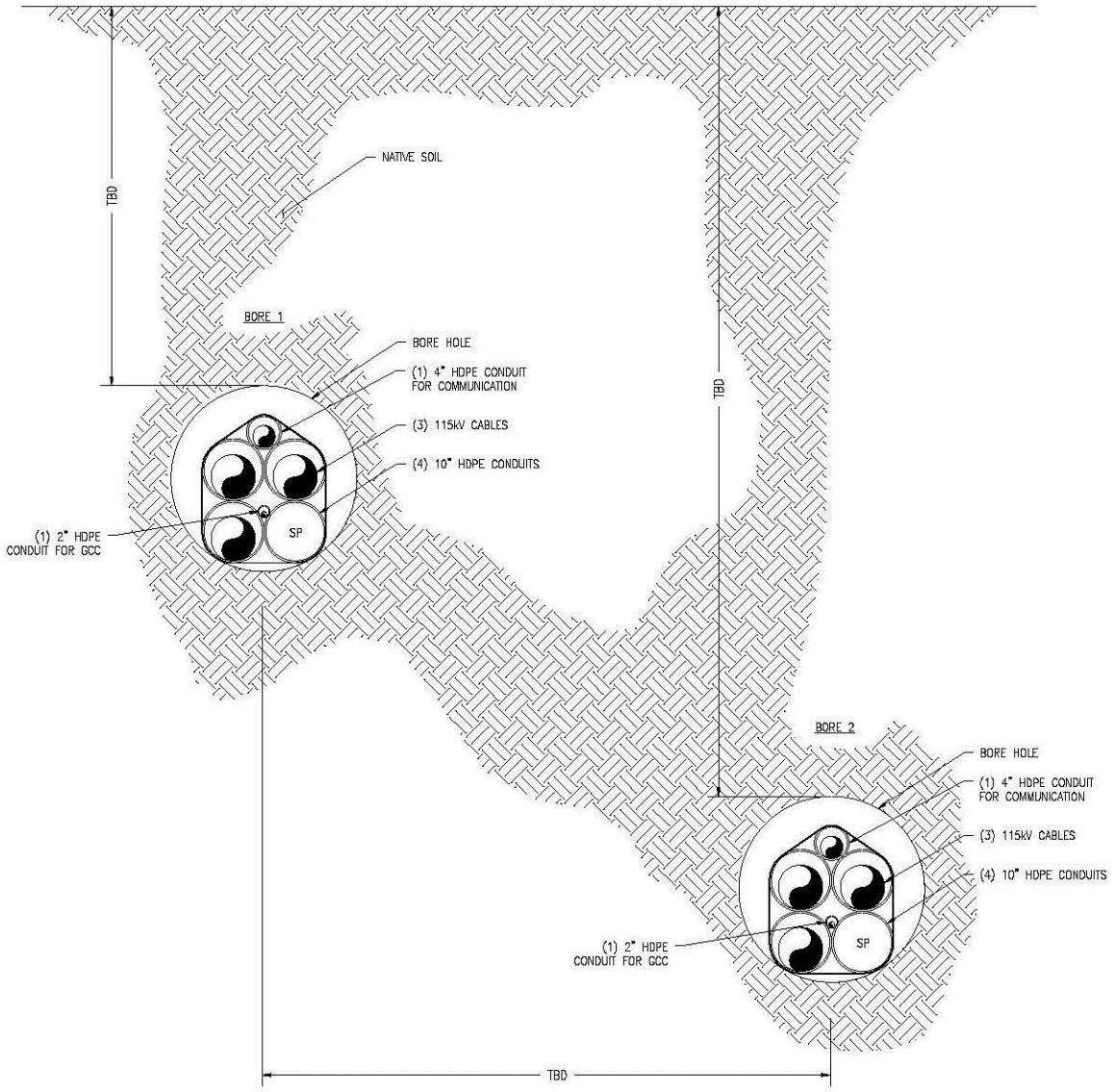



Figure 2 – Typical HDD Cross Section

### 3.2.3 Other Installation Methods

A portion of the overall route will be installed via jack and bore (J&B) or pipe jacking to cross interstate highway, I-195.

The installation of the cable will be designed based on the following criteria:

| | | |
|---|---|---|
| Minimum Installation Depth (to top of bore hole) | 15 | feet |
| Maximum Drill Depth (to top of bore hole) | 30 | feet |
| Obstruction Clearance (Foundations, Anchors) | 15 | Feet |
| Ambient Soil Temperature | | |
| Summer | 15 | ºC |

| | | |
|---|---|---|
| Winter | 15 | ºC |
| Native Soil Thermal Resistivity | 90 | Cº-cm/W |
| Grout / Bentonite Thermal Resisitivity | 120 | Cº-cm/W |
| Casing Material | Steel or HOBAS | |
| Casing Size | 42″ | |
| Conduit Material | Fiberglass Reinforced Epoxy (FRE) Heavy Wall | |
| Cable Conduit Size | 6″ | |
| Ground Continuity Conductor Duct Size | 2″ | |
| Communication Duct Size | 4″ | |
| Innerduct Material and Size | TBD | |

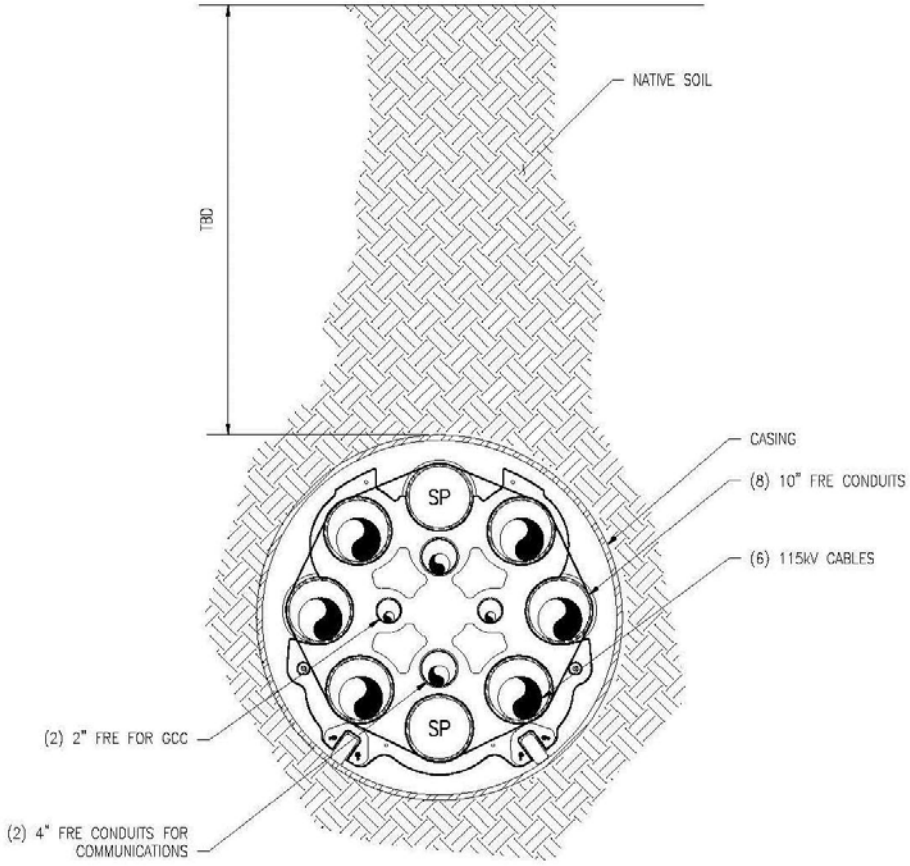



Figure 3 – Typical Pipe-Jacking Cross Section

# 4.0 ELECTRICAL SYSTEM DESIGN CRITERIA

## 4.1 Codes and Standards

The system electrical design for the underground lines shall be in accordance with the latest revision of all applicable industry codes and standards as well as applicable regulations of the Federal, State, and Local authorities.

The following codes that will be used are as follows:

- American National Standards Institute (ANSI):
  - Standard C2-2002, National Electric Safety Code (NESC)
- Association of Edison Illuminating Companies (AEIC):
  - CS9-06, Specification for Extruded Insulation Power Cables and Their Accessories Rated above 46kV Through 345kV.
- Institute of Electrical and Electronics Engineers (IEEE):
  - Std 48-2009, IEEE Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5kV Through 765kV.
  - Std 404-2006, IEEE Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500V to 500000V.
  - Std 575, IEEE Guide for the Application of Sheath-Bonding Methods for Single-Conductor Cables and the Calculation of Induced Voltages and Currents in Cable Sheaths.
- Insulated Cable Engineers Association (ICEA):
  - P-45-482, Short Circuit Performance of Metallic Shields and Sheaths on Insulated Cables.
  - S-108-720, Standard for Extruded Insulation Power Cables Rated Above 46kV Through 345kV.
- International Electrotechnical Commission (IEC):
  - 62067, Power Cables with Extruded Insulation and their Accessories for Rated Voltages Above 150kV ($U_m$ = 170kV) up to 500kV ($U_m$ = 550kV)
  - 60840, Power Cables with Extruded Insulation and their Accessories for Voltages Above 30kV ($U_m$ = 36kV) up to 150kV ($U_m$ = 170kV)

## 4.2 Underground Cable and Accessories Design Criteria

This section describes the cable and accessories that will be used for the underground electrical system. All accessories will be designed and verified to accommodate the cable construction described below via a qualified type test in accordance with IEC 62067.

### 4.2.1 Cable

| | |
|---|---|
| Cable Type (Solid Dielectric, HPFF, etc) | Solid Dielectric |
| Voltage Class | 115 kV |
| Conductor Size | 3000 kcmil |
| Conductor Type and Construction | Segmented Copper |
| Insulation Material | Cross-linked Polyethylene (XLPE) |
| Insulation Thickness | 800 mils |
| Shield Type | Concentric Neutral with foil laminate |
| Jacket Type | Polyethylene |
| Fiber Optic Strand(s) Type (DTS) | N/A |
| Skid Wire/Armoring Type and Size | N/A |
| Minimum Bend Radius | 10 feet |

| | |
|---|---|
| Supplied by | CableManufacturer |

Comments: Final design will incorporate an ultimate cable build out using a lead sheath to model the heaviest cable that National Grid could potentially install in the future.

### 4.2.2 Terminations

| | |
|---|---|
| Termination Type & Style (Fluid, Gas, etc) | Fluid Filled, Outdoor, ANSI 70 gray, polymer |
| Voltage Class | 115 kV |
| Quantity | Twelve (12) total terminations |
| BIL | 550 kV |
| Supplied by | Cable Manufacturer |

Comments:

### 4.2.3 Splices

| | |
|---|---|
| Splice Style | Pre Molded |
| Voltage Class | 115 kV |
| Quantity | 30 $\leq$ total splices $\geq$ 36 |
| BIL | 550 kV |
| Supplied by | Cable Manufacturer |

Comments: Cable Splices shall be suitable for long term underwater operation. Total number of splices will be determined once more data becomes available for design.

### 4.2.4 Splice Vaults/Manholes

| | |
|---|---|
| Splice Vault Type (Precast or Cast in Place) | Precast |
| Splice Vault Size (L' x W' x H' inside) | 22′ x 7′ x 7′ (TYP) |
| Number of Circuits per Vault | One |
| Number of Pull-Through Vaults | N/A |
| Minimum Cover | 18″ in Overhead Corridor |
| Number of Access Lids | (2) 26″ covers with a 36″ ring (TYP) |
| Vault Spacing | 2000 - 2500′ |
| Vault Loading Requirements (H-20, etc) | H-20 Loading |
| Supplied by | Contractor |

Comments

### 4.2.5 Sheath Bonding

| | |
|---|---|
| Bonding Configuration | Single-Point Bonding |
| Type of Link Box (Single or Three Phase) | Three Phase Link Boxes |
| Allowable Standing Sheath Voltage | 200 V (Max) |
| Sheath Voltage Limiter Type (MOV, ZnO) | Non Fragmenting MOV |
| Supplied by | Cable Manufacturer |

Comments: Link boxes will be able to withstand overvoltages from single-phase or three phase system faults. The link boxes will be waterproof.

### 4.2.6 Arresters

| | |
|---|---|
| Maximum Continuous Over Voltage (MCOV) | 96kV |
| Leakage Distance | TBD |
| Duty Cycle Rating | TBD |
| Number of Arresters | Twelve (12) total – one per termination |
| Supplied by | National Grid |

Comments:

### 4.2.7 Communications

| | |
|---|---|
| Number of Communication Circuits | (2) –one per set of cables |
| Fiber Type | TBD |
| Number of Fibers | TBD |
| Supplied by | Contractor |

Comments

# 5.0 SUBSTATION/RISER TERMINATION STRUCTURE(S)

## 5.1 Codes and Standards

The system electrical design for the underground lines shall be in accordance with the latest revision of all applicable industry codes and standards as well as applicable regulations of the Federal, State, and Local authorities. The following controlling codes are as follows:

| | |
|---|---|
| NESC District: | Heavy Loading zone |
| Location or State Specific: | Providence, Rhode Island |
| Client Specific: | National Grid |

## 5.2 Loading Conditions

| Case | Description | Weather Case | NESC Table | Cable Condition | Vert. Load Factor | Wind Load Factor | Tension Load Factor | Strength Reduction Factor |
|---|---|---|---|---|---|---|---|---|
| 1 | NESC HEAVY STEEL | 30°F, 0" ICE, 9 PSF | 253-1 / 261-1A | Initial | 1.5 | 2.5 | 1.10 | 1 |
| 2 | EXTREME WIND STEEL | 60°F, 90 PSF | 253-1 / 261-1A | Initial | 1.0 | 1.0 | 1.0 | 1 |
| 3 | NESC UNIFORM ICE WITH CONCURRENT WIND | 15°F, 0" ICE, 2.3 PSF | 253-1 / 261-1A | Initial | 1.0 | 1.0 | 1.0 | 1 |
| 4 | EVERYDAY LOADS | 60°F | | Initial | 1.0 | 1.0 | 1.0 | 1 |

Notes:

1. Load cases 1 through 4 shall be analyzed assuming a foundation rotation of 2 degrees.
2. Deflection of structure shall be in accordance with NEMA SG6 for Class A structures.
3. Load Case 2 shall also be analyzed with the wind at a 45° yawed angle and with a longitudinal wind.
4. All load cases shall include the weight of the terminations with oil and hardware plus 500 lb. additional vertical load at each cable clamp location.

## 5.3 Substation Structure Information

| | |
|---|---|
| Number of Circuits (single, double, etc) | Single |
| Number of Cables per Phase (One,Two,etc) | Two – one set per structure |
| Configuration/Layout | Three-phase structure per National Grid standards |
| Material Type (Tubular, Wide Flange, etc) | Steel |
| Structure Coating (Galvanized, Paint, etc) | Galvanized |
| Responsible for Design | NGRID |

Comments:

## 5.4 Substation Structure Foundation

| | |
|---|---|
| Type | Pier style |
| Concrete Compressive Strength @ 28 days | TBD |
| Anchor Bolts (Cast, Drilled, Epoxy) | Cast |
| Geotechnical Data Available (Yes, No) | No |

| | |
|---|---|
| Geotechnical Study Required (Yes, No) | Yes |
| Responsible for Design | NGRID |

Comments

## 5.5 Substation/Switchyard Interface

| | |
|---|---|
| Terminate at Existing Substation Structure? | No |
| Cable Attachment Height Above Grade: | NGRID Standards |
| Horizontal and Vertical Clearances | NGRID Standards |

Comments:

# 6.0 MISCELLANEOUS

## 6.1 Permits

Describe any permitting requirements:

All local, federal, and state permits will be required.

## 6.2 Special Equipment

Describe any special equipment requirements (switches, distribution underbuild, reclosers, etc.):

Each set of cable will have isolation / disconnect switches at each transition station end.

## 6.3 Material

Describe Owner supplied material (attach additional sheets if necessary):

National Grid to provide termination foundations and all substation equipment.

Does the utility have a standard material list it uses: YES ☐ NO ✓

Describe Contractor supplied material (attach additional sheets if necessary):

All material will be supplied by contractor unless otherwise specified within this document.

## 6.4 Environmental Protection

State any measures required or agencies to be contacted for wildlife protection requirements:

Permitting/Easement sketches are required for Submerged Lands and Environmental Resources Program.

Describe any known industrial, salt-water contamination or other environment that may impact or has been known to impact electrical insulation:

Located directly adjacent to tidal rivers, additional leakage distance on terminations may be required and will be evaluated.

State any measures required for airborne contamination protection (dust control):

Describe any known caustic or corrosive soil conditions:

None anticipated

## 6.5 Other Criteria

State any economic, reliability, public impact, etc information that is required for a successful design, but is not adequately addressed in this document.

Project need is regulatory driven and third party funded. Project schedule will need to be monitored closely.

# 7.0 DRAWINGS AND MAPS

## 7.1 Maps

Existing facility maps, P&P's available: YES ☐ NO ✓

List foreign utilities to be considered for project, if maps are available:

| | | | |
|---|---|---|---|
| Power: | National Grid | Gas: | National Grid |
| Phone: | Verizon | TV: | Cox Communications |
| Sewer: | Municipal | Water: | Municipal |
| Highways: | Local and State (RIDOT) | Railroad: | n/a |
| Other: | Algonquin Gas – crossing of Providence River | | |

Separate access road maps required: YES ☐ NO ✓

Describe ROW/Environmental or Easement Maps required, if any:

See section 6.4 Environmental Protection

## 7.2 Drawing Requirements

Map and Plan and Profile Scales:

Key Map Scale:

Plan Scale: 1" = 40'

Profile Scale: 1" = 8' Vertical (HDD)

1" = 4' Vertical (Trench/J&B)

Plan Type:

Planimetric:

Topographic: YES

Title Block:

POWER Standard:

Other: National Grid standard title blocks

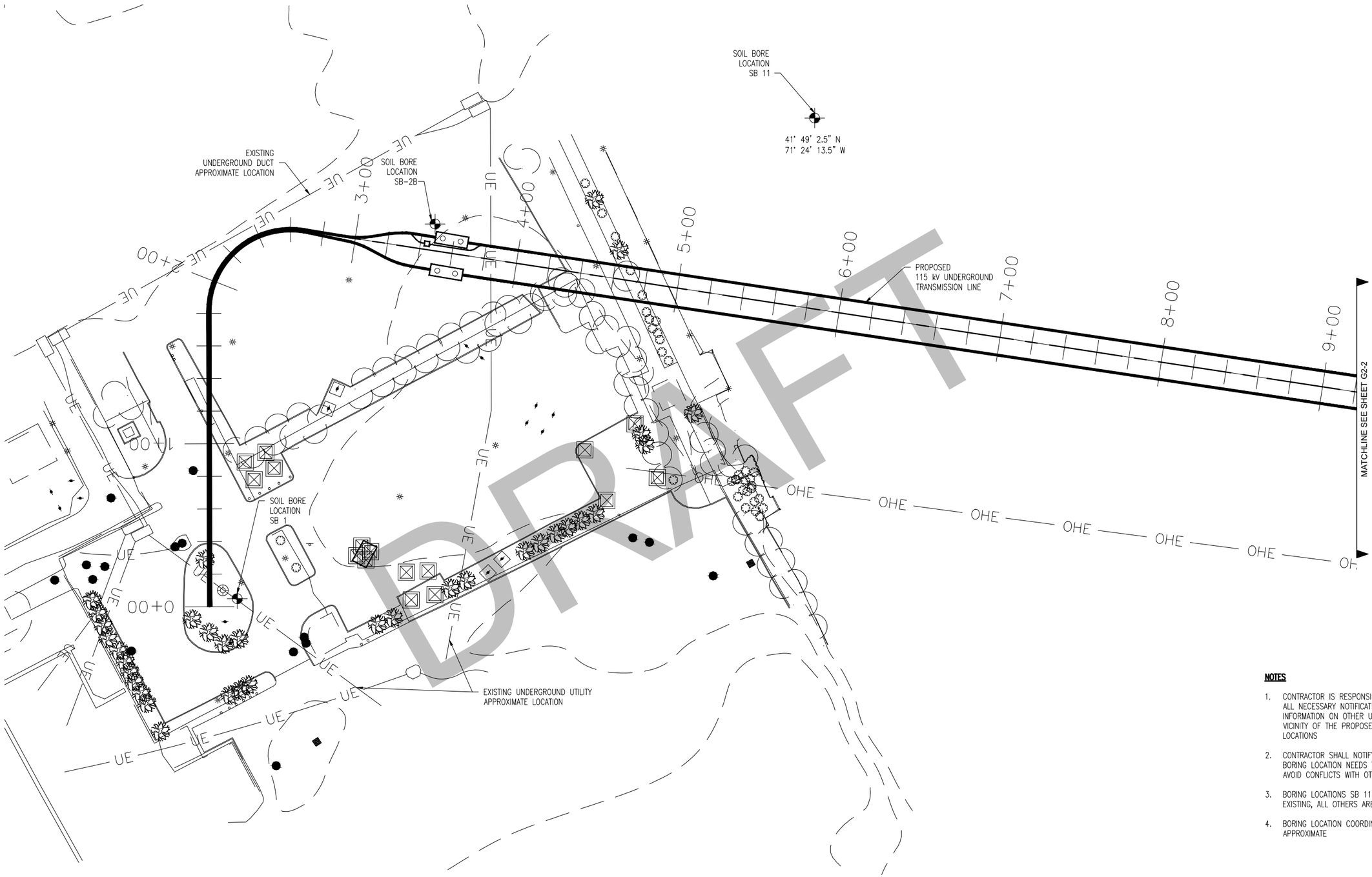
Drawing Numbers:

POWER Generated: No

Owner Generated Yes

Final Drawings:

Describe any controlling mapping specifications:






**NOTES**

1. CONTRACTOR IS RESPONSIBLE TO PERFORM ALL NECESSARY NOTIFICATIONS AND OBTAIN INFORMATION ON OTHER UTILITIES IN THE VICINITY OF THE PROPOSED BORING LOCATIONS
2. CONTRACTOR SHALL NOTIFY ENGINEER IF ANY BORING LOCATION NEEDS TO BE SHIFTED TO AVOID CONFLICTS WITH OTHER FACILITIES
3. BORING LOCATIONS SB 11–SB 14 ARE EXISTING, ALL OTHERS ARE PROPOSED
4. BORING LOCATION COORDINATES ARE APPROXIMATE



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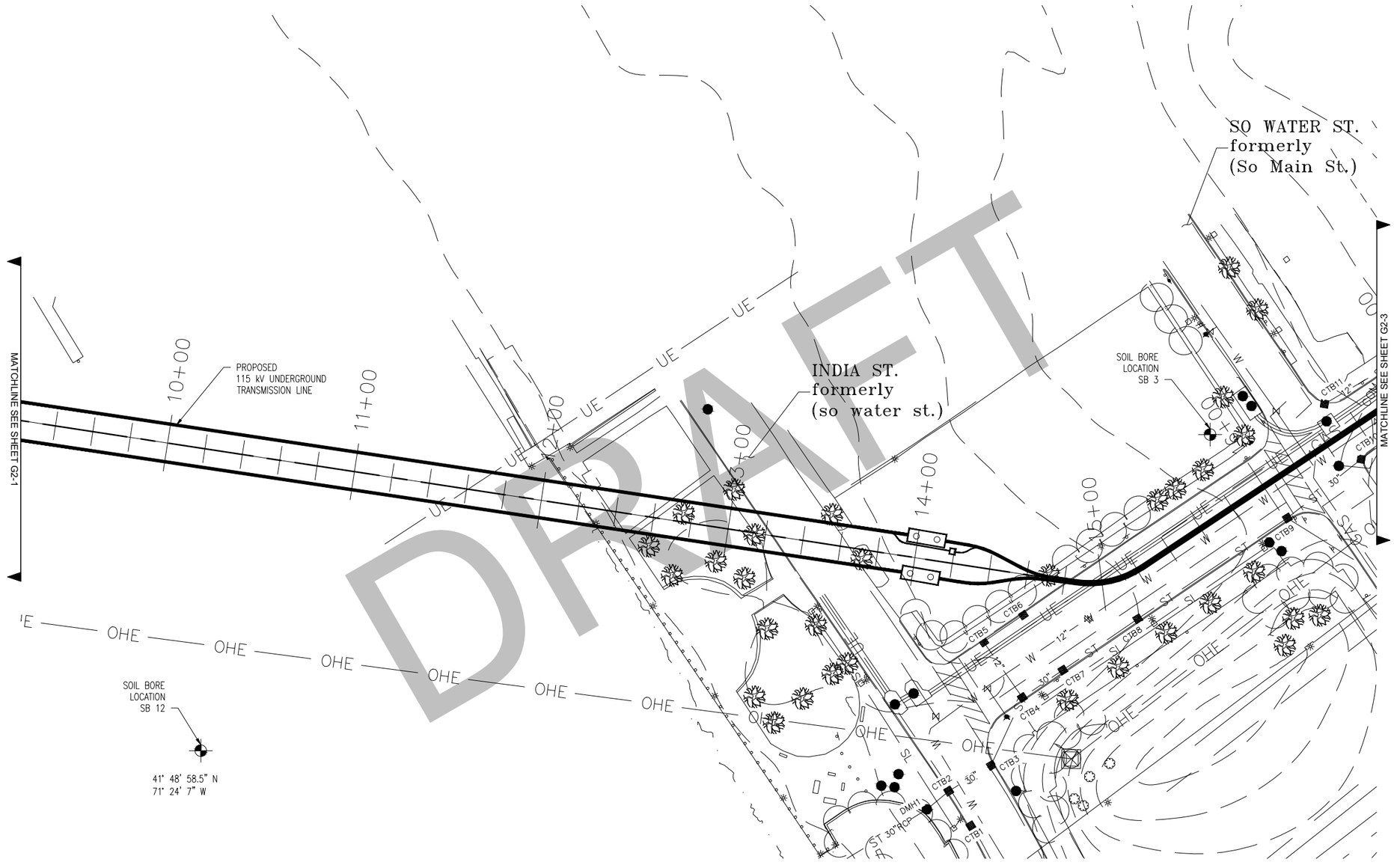


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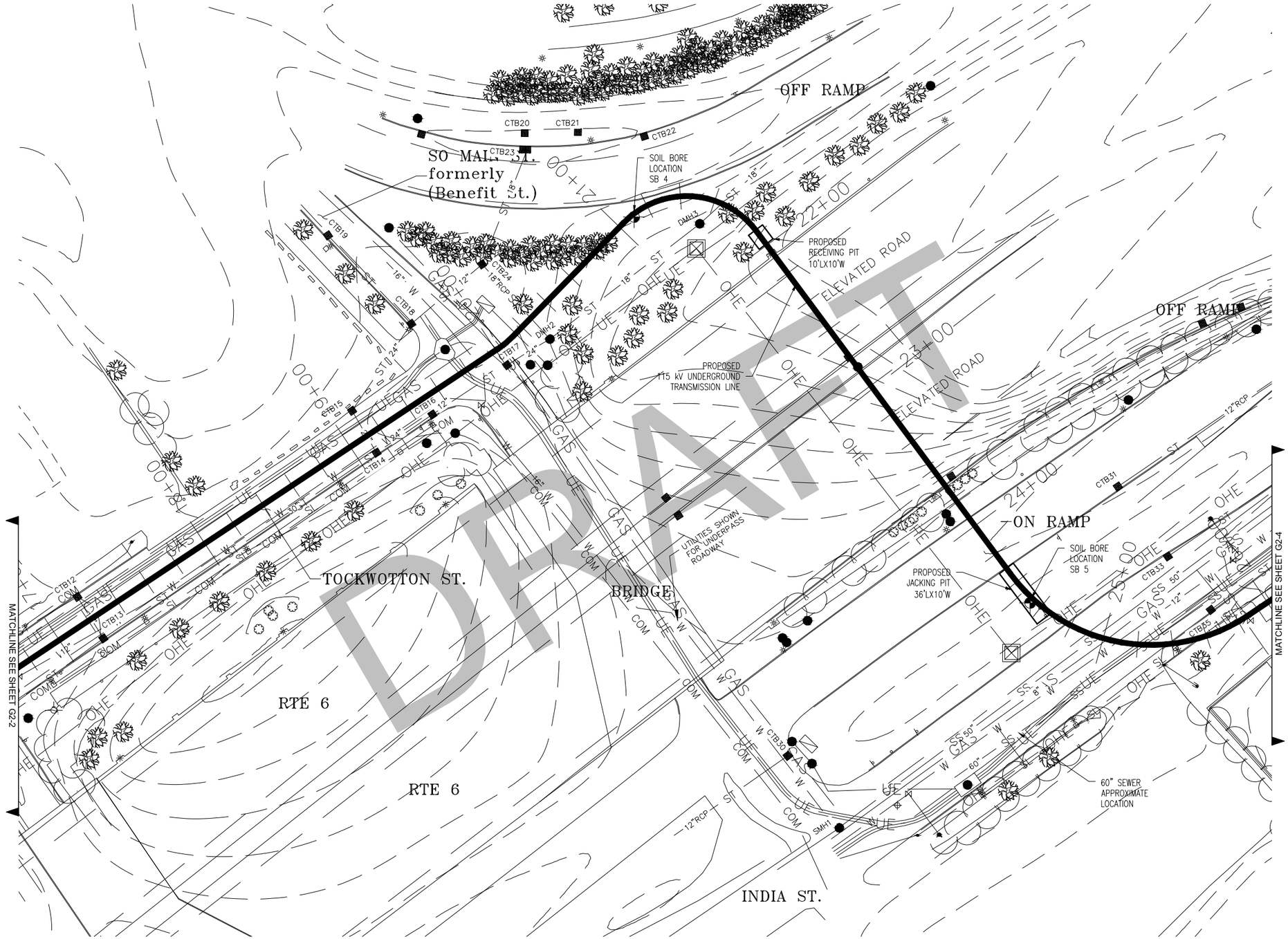


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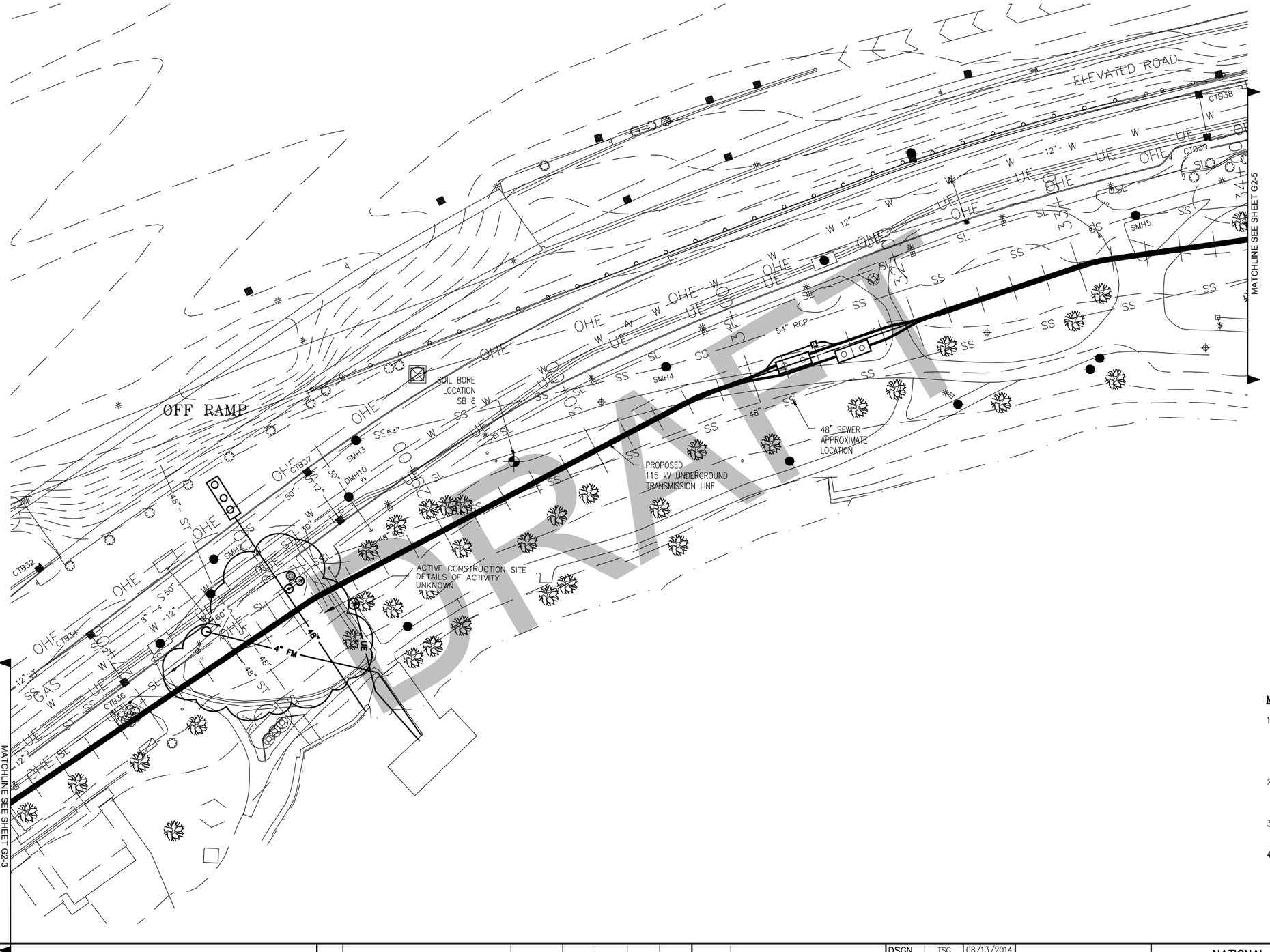




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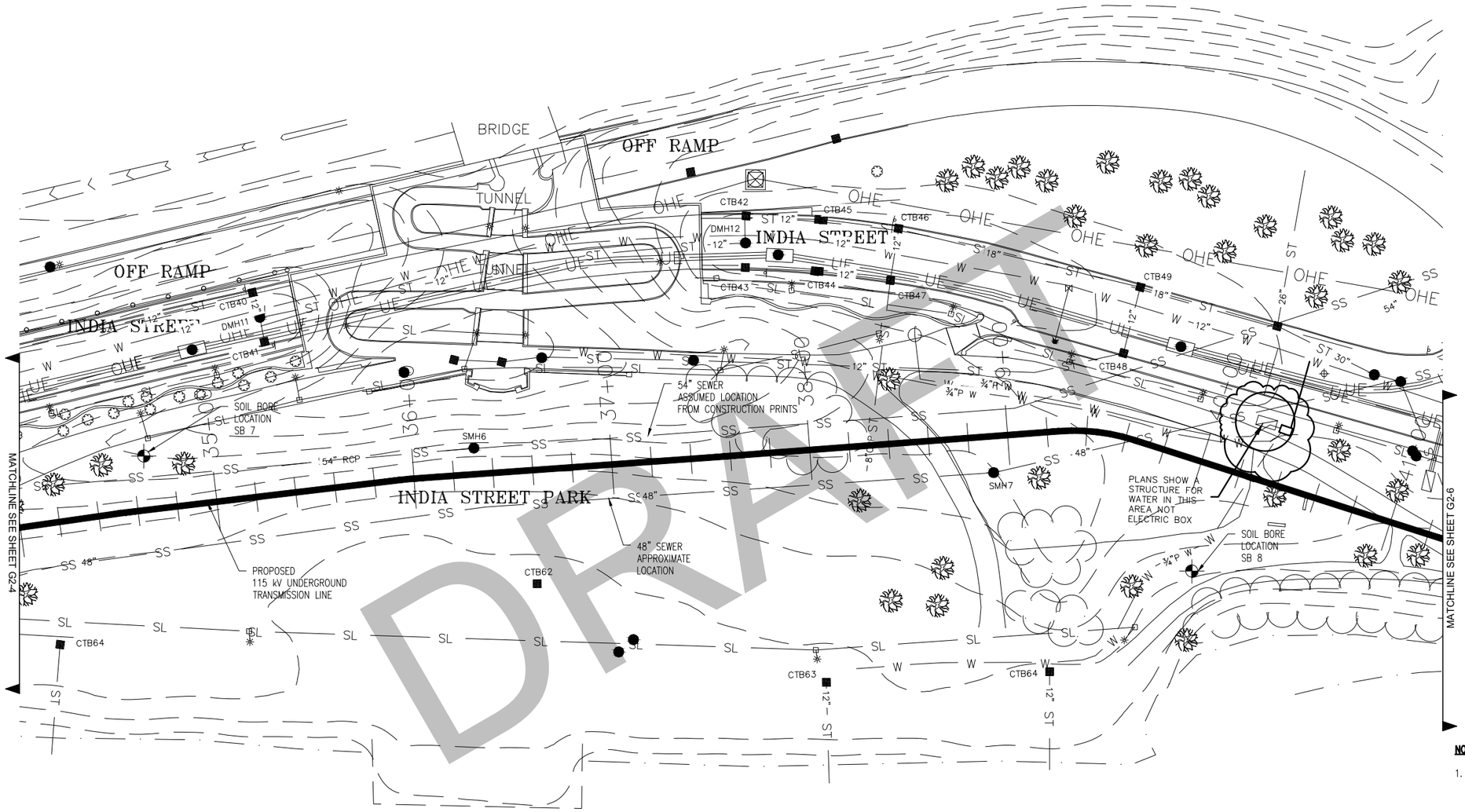




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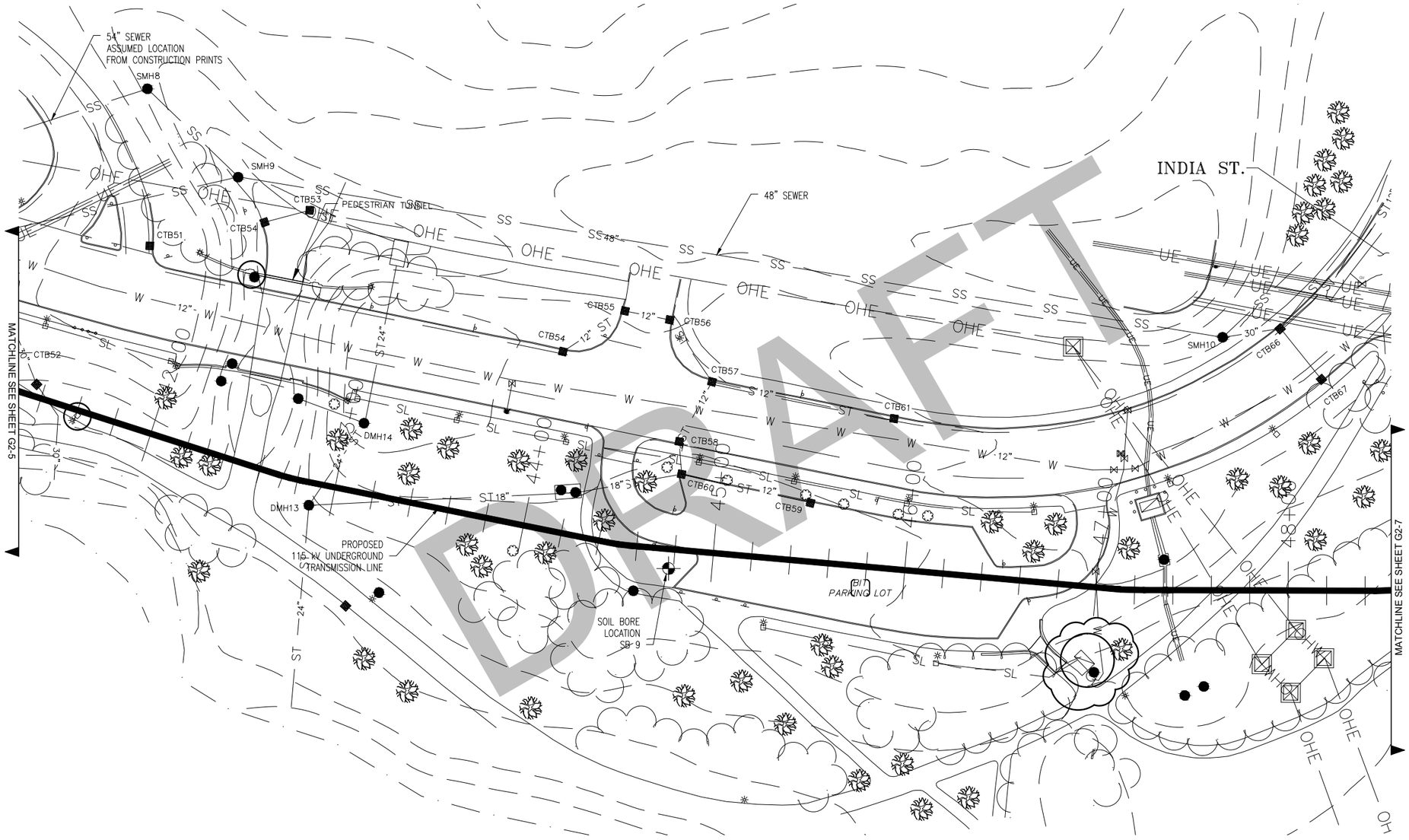


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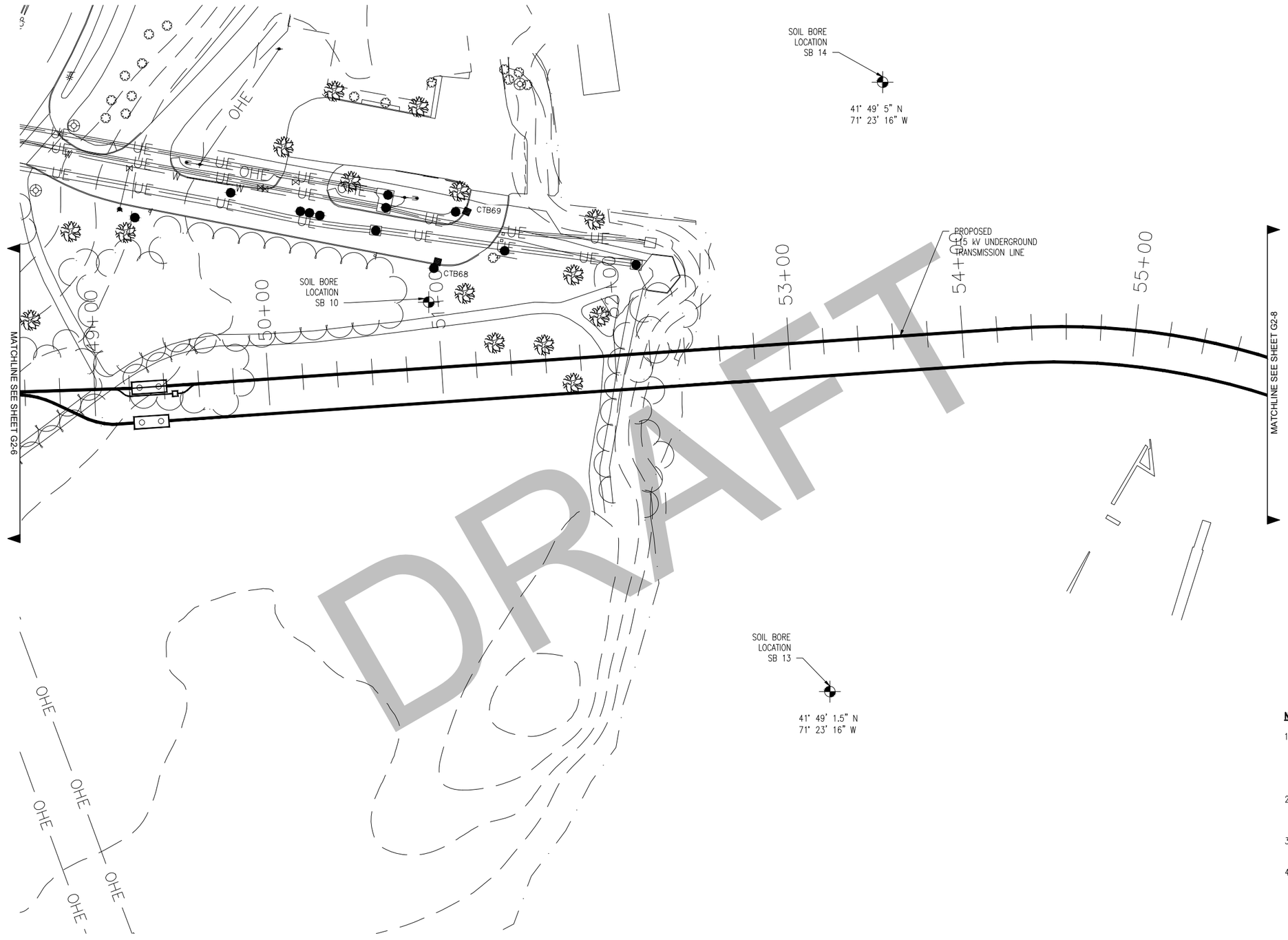




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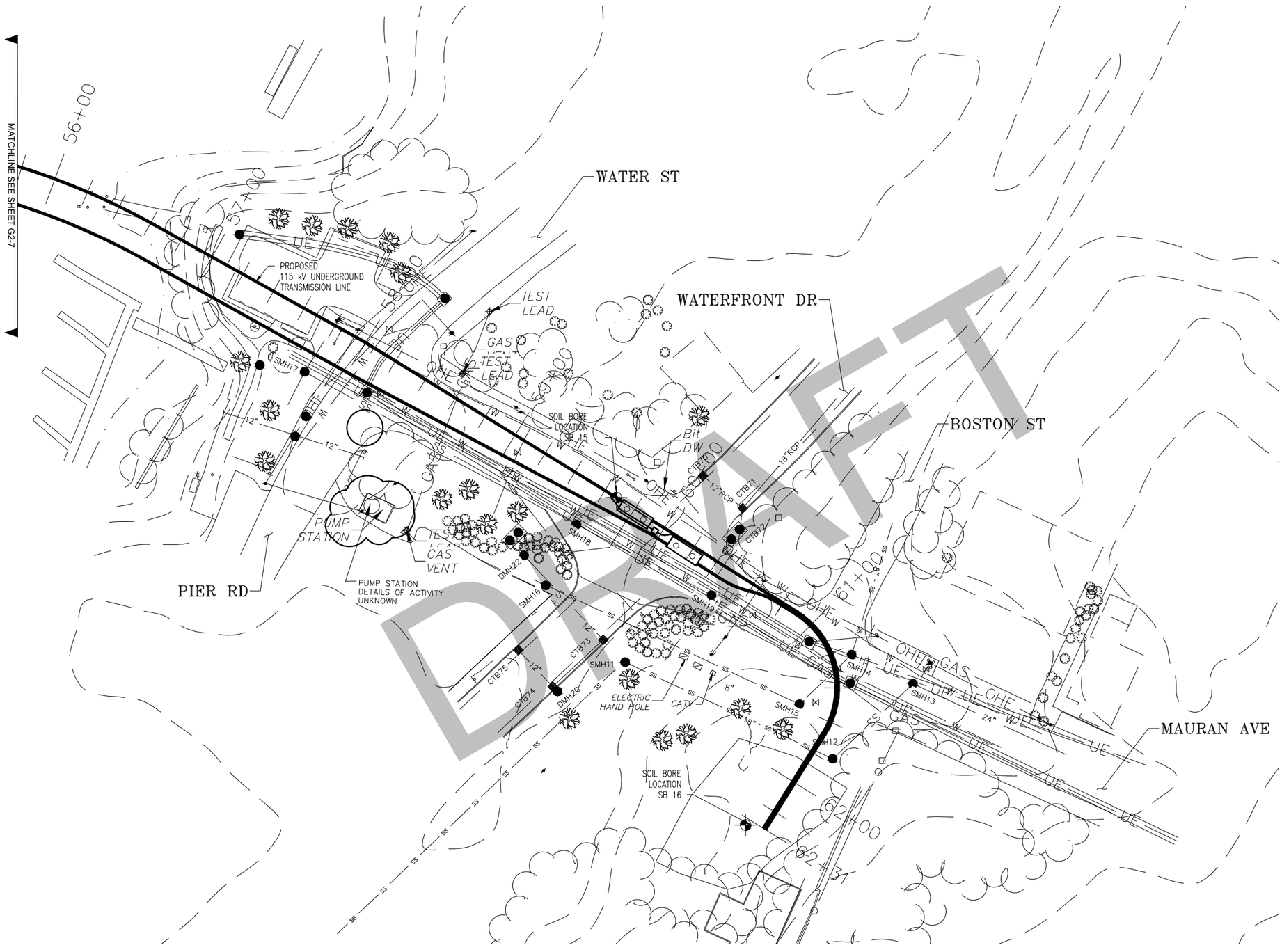




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