NDT CORPORATION
Concrete & Geophysical Testing

NDT CORPORATION
153 Clinton Road, Sterling, MA 01564
Main: 978-563-1327 | Fax: 978-563-1340
eMail: Info@NDTCorporation.com

GROUND PENETRATING RADAR SURVEY
SEWER AND ELECTRICAL DUCT LOCATION
25 MAVRICK STREET
MARBLEHEAD, MASSACHUSETTS

Prepared for:
Brian Boucher, PE
Senior Structural Engineer – Bayside Engineering

Prepared by:
Keith Holster
Operations Manager – NDT Corporation

Reviewed by:
William Horne
President– NDT Corporation

NDT Project Number – M23061MA
October 12, 2023

Table of Contents

Introduction

The Marblehead Municipal Electric Light Department (MHDLD) plans to install a new transformer unit at their substation located at 25 Maverick St. in Marblehead, Massachusetts. Access to the substation is via the Marblehead Rail Trail and requires large equipment and heavy loads. This proposed route is expected to travel over a 24 inch diameter asbestos cement sewer line and a concrete encased electrical duct. To assist Bayside Engineering and MHDLD design the required bridging structure, NDT Corporation (NDT Corp.) conducted a Ground Penetrating Radar survey at this site. Fieldwork was conducted on October 10th, 2023 with the objective to locate and mark the location of the 24 inch diameter asbestos cement sewer line and the location of the concrete encased electrical ducts at the crossing location.

Survey Control and Location:

The location of the MHLDL substation and Marblehead Rail Trail is shown in Figure 1.

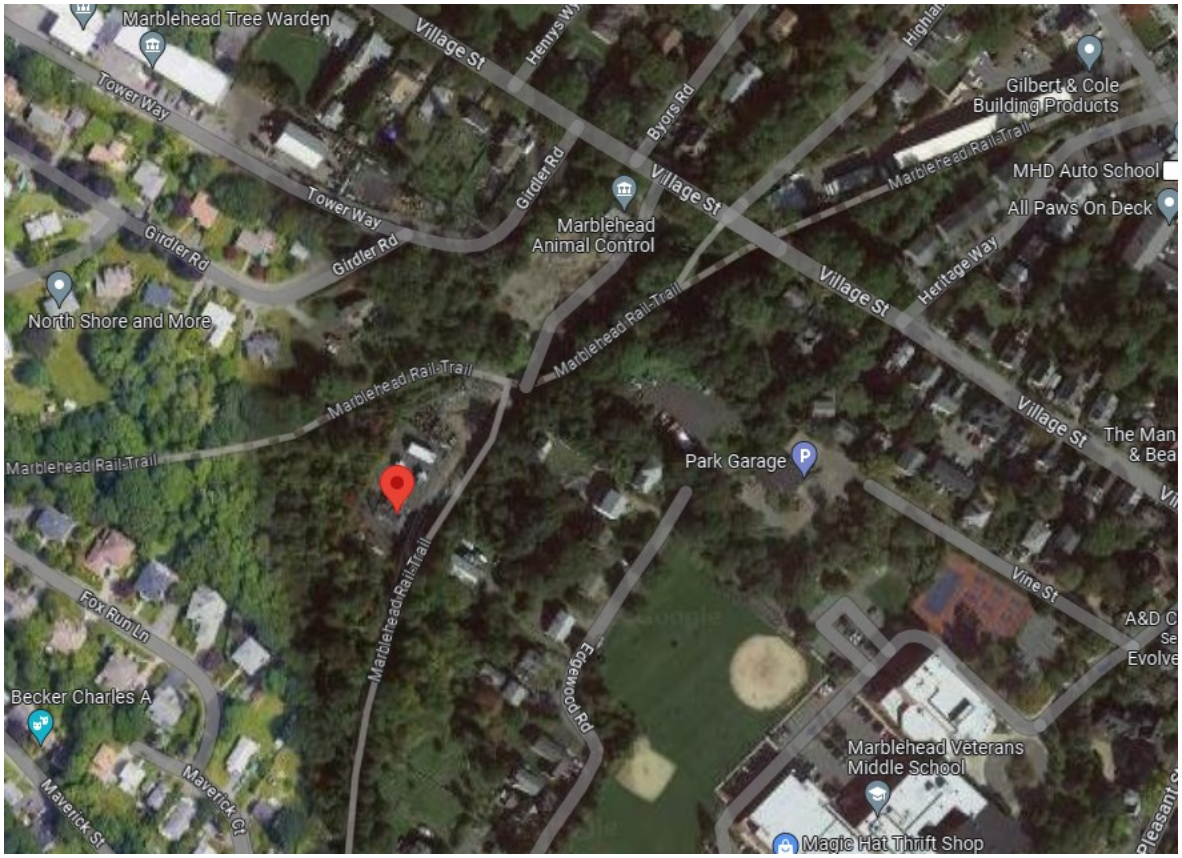

Figure 1: Site Location 25 Maverick St, Marblehead, Massachusetts

GPR data was collected along lines of data with an approximate spacing of 10 feet. Line location and NDT Corp. stationing was referenced to landmarks, and fence posts for future reference. Utility locations marked by NDT Corp. are scheduled to be surveyed and documented by North Shore Survey Corporation on October 11th, 2023.

The north-east corner chain link fence post Figure 2, of the substation was used as NDT station 0+00/0+00 lines south of this post were collected from the subsequent fence posts

east across/perpendicular to the rail trail. Lines north of the substation were located at 10 foot spacings along a 0 line Figure 3a - a tape measure which extended from the north east corner post to the “green” post Figure 3b on the west side of the access path.

Figure 2: Photograph of fence post used for station 0+00/0+00 (facing south)

a)

b)

Figure 3: a) Photograph of tape – 0 station line north of substation
b) photograph of “green” post at station 0+67 feet north of corner fence post.

Additional lines of coverage were collected across the eastern Rail Trail spur Figure 4 using a secondary chain link fence line as reverence to locate the electrical duct. Data lines were collected at the fence posts with Post A being the southernmost and Post D to the north.

Figure 4: Photograph showing fence posts along eastern spur of the Rail Trail

Test Methods & Results

Ground Penetrating Radar Survey

Ground Penetrating Radar (GPR) is an electrical geophysical method for evaluating subsurface conditions by transmitting high frequency electromagnetic waves into the ground and detecting the energy reflected to the surface. Electromagnetic signals are transmitted from the antenna (transmitter and receiver) at ground surface and reflected to the antenna from interfaces with differing electrical (dielectric constant and conductivity) properties. The greater the contrast in the electrical properties between two materials, the more energy that is reflected to the surface and the more defined results are. In dry soils, metal pipes and moisture are very conductive in comparison with the soils and have strong GPR reflections. PVC, asbestos-cement, concrete and clay pipes have similar conductivity/electrical properties as soils and consequently return weak GPR reflectors and can be problematic to detect. Changes in materials: asphalt pavement, concrete, cobblestone, brick, and naturally deposited soils or fill soils placed in lifts during construction retain moisture between material interfaces and typically have horizontal or near horizontal layering/bedding planes. These conditions cause a change in conductivity which shows as continuous reflective layers on GPR data. Filled utility trenches and old excavations may have similar characteristics, where the layering is often sloped or broken.

Signal penetration is dependent on moisture content of the soils and the frequency of the antenna. The 400 MHz antenna has an approximate depth of investigation from the surface to depths of 5 to 10 feet; the actual depth of investigation is dependent on the soil types and moisture conditions. Depths of investigation are usually deeper in dry sands and gravels than in moist silts and clays. Due to subsurface conditions, the GPR data for this site was

limited to approximately 60-72 inches (5.0- 6.0 feet). Typically, the depth to buried objects can be determined to within 6 +/- inches.

Figure 5 shows the GPR data collected along the line at NDT Corp. station +0+30 which shows the relationship between the 24 inch diameter sewer line (green) and the concrete encased electrical ducts (red) close to the crossing location.

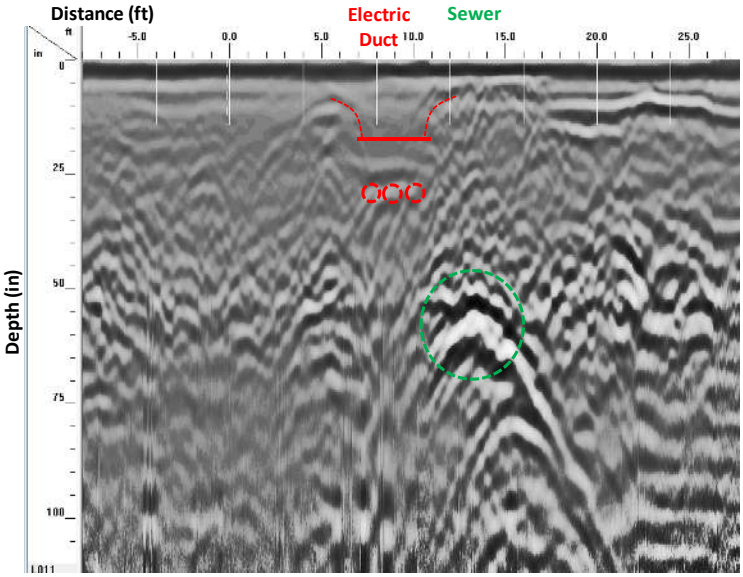

Figure 5: GPR data for GPR line at Station 0+30 show the sewer line (green) and electric duct (red)

The GPR survey located the 24 inch diameter sewer line in a south to north direction. The sewer line was marked in the field with green paint (Figure 6) and MHDLD employees drove drove several 10" bolts into the ground along the sewer line, down to grade level, to create a more permanent record of the sewer pipe location. These bolts were located at NDT Corp stations 0+15 and 0+50. The GPR survey located the concrete encased electric ducts in a northeast to southwest direction extending from the manhole cover up the eastern spur of the Rail Trail. The concrete encased electric duct was marked in the field with orange paint, Figure 7, and correlated with the previously marked locations by MHDLD. Figure 8 shows the results of the GPR survey and reference locations.

Figure 6: Photograph of Field markings- green sewer/orange electric duct (facing south)

Figure 7: Photograph of Field markings- orange electric duct (facing north up eastern spur)

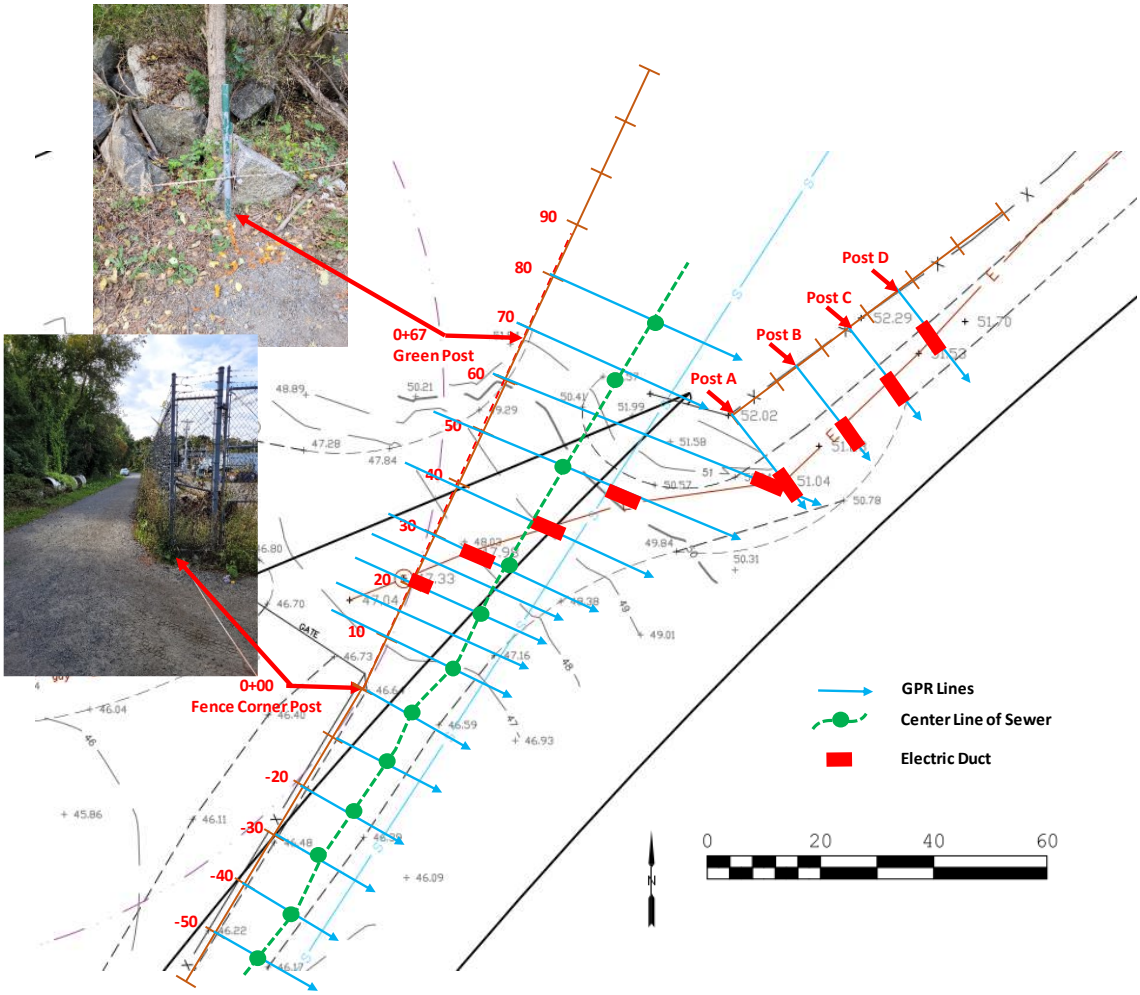

Figure 8: Sketch of GPR results overlying preliminary North Shore Survey Corporation plan map.

The results of the GPR survey are summarized in Table 1 for the 24 inch diameter sewer line and in Table 2 for the concrete electrical duct. In both tables the landmark is referenced to the NDT Corp. station and the offset locations are tape measurements from the NDT Corp. 0+00 line (Figure 3) with the estimated depth to the top of the utility.

Table 1: Summary of GPR results for 24 inch sewer line.

Landmark	NDT Station	GPR File	Sewer Location Offsets	Depth
	80	16	18'4"	66"
	70	15		59"
Green Post	67		16' 6"	
	60	14		54"
	50	13	15' 8"	50"
	40	12		49"
	30	11	13'7"	48"
	25	10		47"
Manhole	20	9	12'9"	42"
	15	8		42"
	10	7	12'1"	40"
Fence Post	0	6	10' 5"	38"
Fence Post	-10	5	10' 11"	38"
Fence Post	22	4	10' 4"	42"
Fence Post	-32	3	10' 2"	42"
Fence Post	-42	2	10' 4"	43"
Fence Post	-52	1	10'2"	41"

Table 2: Summary of GPR results for concrete electrical duct.

Landmark	NDT Station	GPR File	Electric Duct Location Offsets			Depth
Post D		20	8' 0"	-	12' 0"	11"
Post C		19	9' 8"	-	13' 7"	12"
Post B		18	11' 4"	-	15' 8"	13"
Post A		17	13'1"	-	18' 0"	16"
Green Post	67		47' 9"	-	53'1"	
	60	14		-		13"
	50	13	23' 4"	-	28' 4"	12"
	40	12	14' 3"	-	19' 0"	9"
	30	11	7' 9"	-	11' 6"	14"
	25	10		-		12"
Manhole	20	9	0' 0"	-	5'4"	9"

Thank you for the opportunity to work with you on this project and if you have any questions, please don't hesitate to contact me directly.

Sincerely,

Keith A. Holster

Keith Holster
Operations Manager
NDT Corporation
kholster@ndtcorporation.com
Office (978) 563-1327
Mobile (508)-314-3413