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Lyndon – IM091-3(53) Geotechnical Baseline Report

June 2023

Contents

1 Introduction 1
1.1 Purpose of Geotechnical Baselines 1
1.2 Geotechnical Baseline Applicability 1
1.2.1 Plan Area 1
1.3 Sources of Geotechnical and Geologic Information 1
1.4 Design-Builders Means and Methods 2

2 Project Description 3
2.1 Previous Construction Information 3
2.2 Ground Characterization 3
2.2.1 Granular Fill 3
2.2.2 Embankment Fill 5
2.2.3 Glacial Till 7
2.2.4 Bedrock 9
2.3 Boulders / Obstructions 9
2.4 Groundwater 10

3 Sequential Excavation Method Design and Construction Considerations 11
3.1 Anticipated Ground Behavior for SEM 11
3.1.1 Granular Fill 11
3.1.2 Embankment Fill 11
3.1.3 Glacial Till 11

Figures

Figure 1 Maximum, Minimum and Average Grain Size Distribution for Granular Fill 4
Figure 2 SPT N-Value Distribution for Granular Fill 5
Figure 3 Maximum, Minimum and Average Grain Size Distribution for Embankment Fill 6
Figure 4 SPT N-Value Distribution for Embankment Fill 7
Figure 5 Maximum and Minimum Grain Size Distribution for Glacial Till 8
Figure 6 SPT N-Value Distribution for Glacial Till 9

Appendices

Appendix A: Geologic Cross Sections

1 Introduction

The Vermont Agency of Transportation is procuring Design Build Services for Lyndon – IM091-3(53). The project is located in Lyndon, Vermont and includes the replacement of the existing corrugated galvanized metal plate pipes with reinforced concrete buried structures.

The base technical concept (BTC) included within the request for proposals (RFP) is defined as an open cut construction method to install replacement culverts and abandon the existing culverts.

The Vermont Agency of Transportation (VTrans) is allowing bidders to propose alternative technical concepts (ATC) for the proposed construction.

1.1 Purpose of Geotechnical Baselines

The purpose of the baselines is to:

- Establish contractual limits for anticipated subsurface conditions to be encountered during construction of the culvert.
- Summarize the geotechnical basis for the design of the replacement culvert.
- Identify important design and construction considerations that will need to be addressed during bid preparation and construction.

The baseline conditions contained herein are not an expressed or implied warranty that the baselines represent actual conditions. The baselines do however represent a Contractual standard that the Owner and the Contractor will agree to use when administering the Differing Site Conditions clause in the Contract. The bidders should review the geotechnical and groundwater data included within the reference documents because in some instances, baselines reflect conditions that are more or less onerous than conditions indicated by the available data.

1.2 Geotechnical Baseline Applicability

The geotechnical data baselines are applicable to the BTC (open cut) and assumed ATC option. The ATC option is assumed to be a tunnel constructed with sequential excavation methods (SEM) and is addressed separately in Section 3 Sequential Excavation Method Design and Construction Considerations. Other ATCs may be considered for approval.

1.2.1 Plan Area

The provided baselines are applicable to an area along the length of the proposed BTC alignment with dimensions that extend 75 ft perpendicular to the proposed BTC alignment, in an approximate north – south direction.

1.3 Sources of Geotechnical and Geologic Information

The geotechnical baselines should be read in conjunction with the Geotechnical Data Report (GDR) which contains observed geotechnical information from the field investigations and laboratory testing completed for this specific project. Other sources of information include

- Lyndon – IM 091 – 3(53) Geotechnical Data Report, Prepared by HNTB Corporation, Dated. June 26, 2023

- State of Vermont Department of Highways, Proposed Improvements, Towns of Lyndon -Wheelock- Sheffield – Glover – Barton, Counties of Caledonia – Orleans, Interstate Rout 91. No. I-91-3(10) Dated November 22, 1967. Sheets 1, 2, 8, 79-85B, 121-124, 131 and 152
- VTrans Lyndon IM 091-3(53) Project Area Groundwater Conditions, Prepared by VHB, Dated May 3, 2023

1.4 Design-Builders Means and Methods

The behavior of the geologic materials will be influenced by the Design-Builder's selected means and methods. Bidders should take the information in this report into consideration when assessing the impacts that the ground and groundwater conditions will have upon their selected construction operations and means and methods.

2 Project Description

The project is located on Interstate 91 approximately 1.2 miles north of Exit 24 and includes the replacement of bridge 96-3N and bridge 96-3S that carry an unnamed tributary to the Passumpsic River. Each existing bridge consists of a corrugated galvanized metal plate pipe (CGMPP) that extends beneath the existing roadway embankments to an exposed center median.

- 96-3N - 8’ diameter x 366’ long under an average fill depth of 70’
- 96-3S - 8’ diameter x 308’ long under an average fill depth of 55’

The proposed culverts are anticipated to be reinforced concrete buried structures with bank full width of approximately 20 feet.

2.1 Previous Construction Information

The existing culverts and embankments were installed during the construction of the highway in 1973. The referenced 1967 drawings illustrate the existing watercourse, existing grade, and proposed highway construction. The existing culverts were installed in approximately the location and elevation of an existing water course that flows from the east side of the interstate to the west side. Upstream of the eastern most inlet is a steep valley eroded in the water course to boulders and bedrock. Downstream of the western outlet, the ground drops away more gradually and the water course is eroded to cobbles and boulders.

The existing culvert is exposed in the median and is covered by two parallel highway embankments. The embankments are up to 75 feet in height and are likely constructed of material that was cut in the adjacent interstate highway corridor and dumped in this location. Section 2.2 describes the constituents of the embankment fill.

Based on the historical drawings it is likely that existing cobbles and boulders were displaced from the existing culvert alignments and granular fill was placed around the existing culverts as a bedding layer. It is anticipated the cobbles and boulders exist in higher density immediately adjacent to the granular fill bedding.

2.2 Ground Characterization

The existing ground in the area of the proposed project consists of embankment granular fill, embankment fill, glacial till and bedrock. Appendix A Geological Cross Sections provides the limits of each identified stratum.

2.2.1 Granular Fill

The granular fill bedding exists directly around the existing culverts. It consists of medium dense sand with silt.

The grain size testing of the granular fill indicates that the composition within the defined area averages 26% Silt and Clay (fines), 72% Sand, and 2% Gravel. Figure 1 provides the anticipated grain size distribution. Fines were not further tested for silt and clay constituent percentages.

The corrected and uncorrected N-values presented within the Geotechnical Data Report are plotted in Figure 2 to illustrate the range of in-situ soil density within the embankment fill. Based

on commentary from the driller, the single N-value greater than 100 is assumed to be the existing culvert, the boring was terminated and offset. It is anticipated the extent of the granular fill was placed immediately around the existing culverts note the extents within the figures in Appendix A.

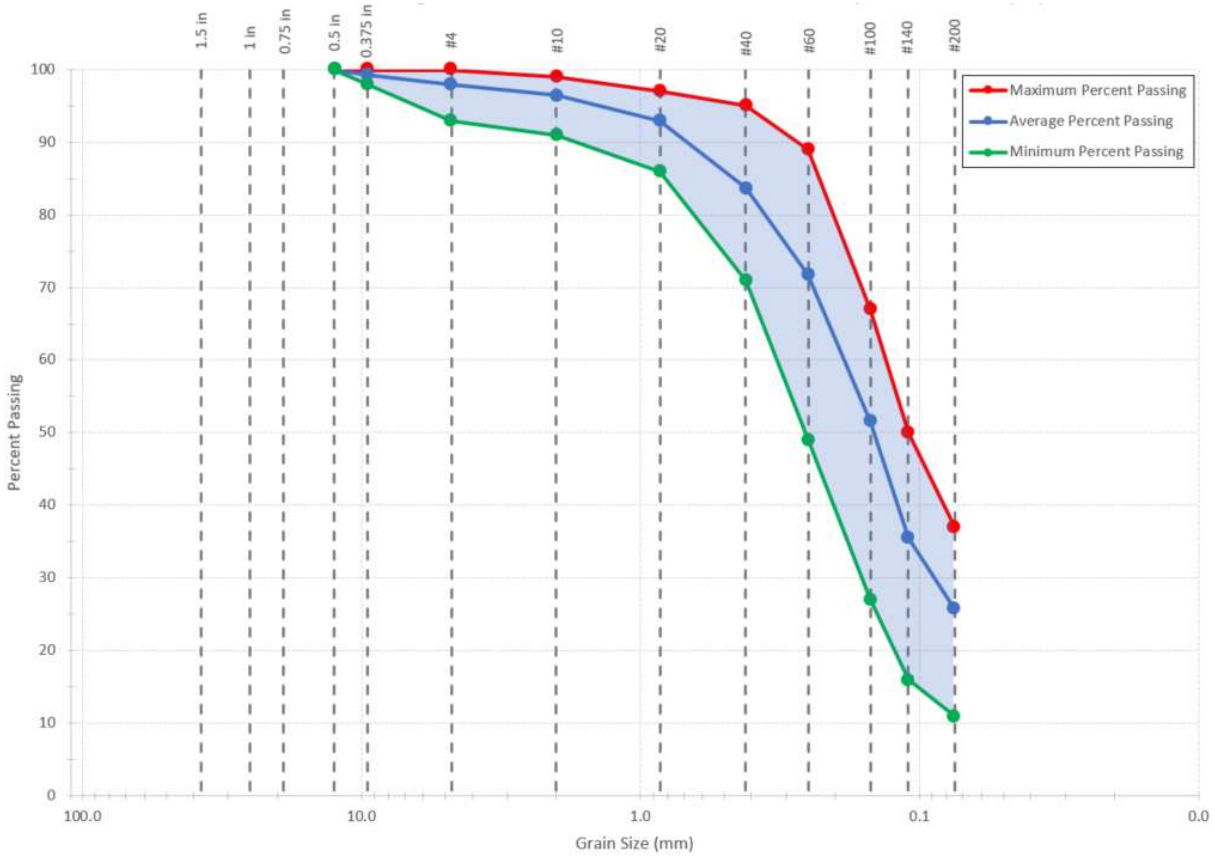


Figure 1 Maximum, Minimum and Average Grain Size Distribution for Granular Fill

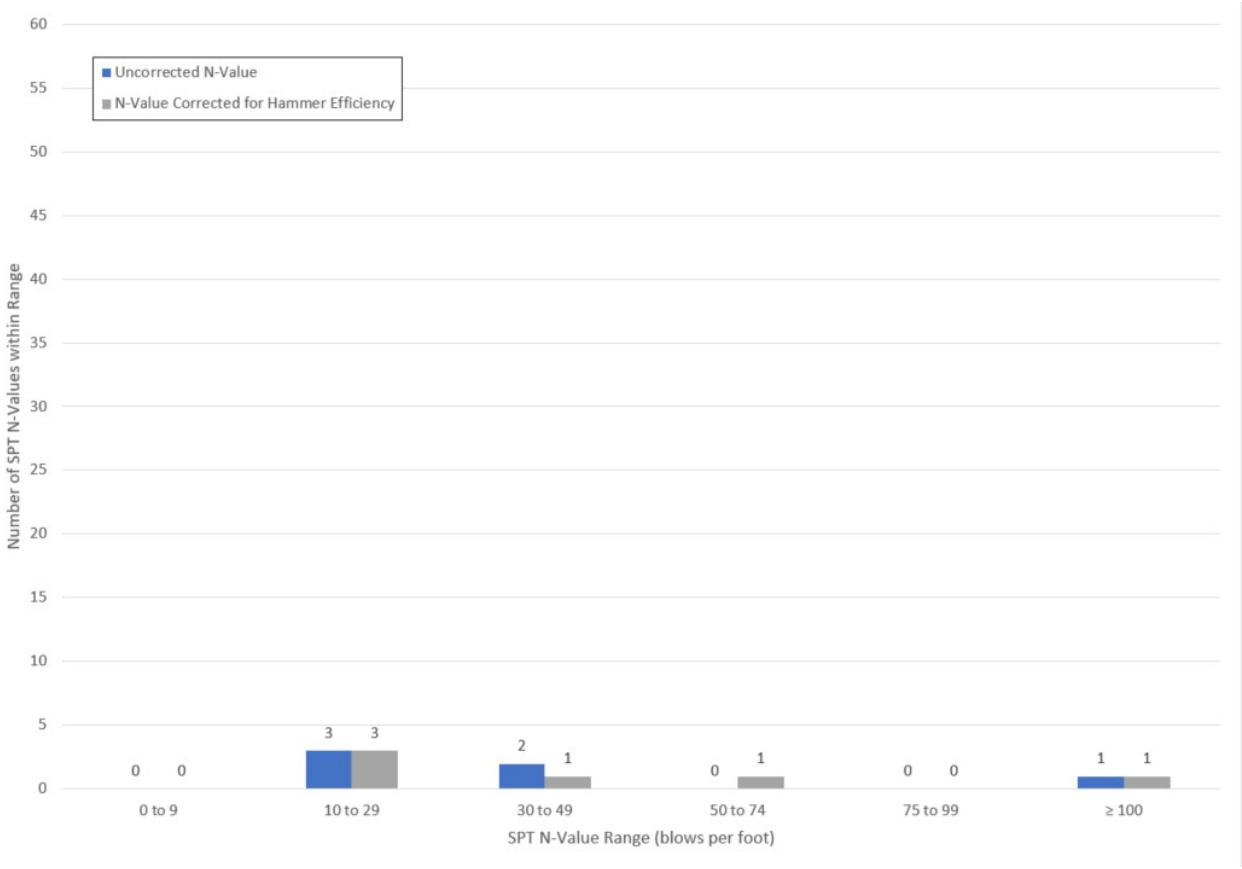


Figure 2 SPT N-Value Distribution for Granular Fill

2.2.2 Embankment Fill

The embankment fill consists of medium dense to very dense coarse to fine silty sand and sandy clayey silt with varying amounts of gravel and boulders. Cobbles and boulders were periodically encountered during sampling.

The grain size testing of the embankment fill indicates that the fill composition within the defined area averages 36% Silt and Clay, 49% Sand, and 15% Gravel. Figure 3 provides the anticipated grain size distribution. Fines content largely consists of low plasticity silts with less than 15% clay.

The corrected and uncorrected N-values presented within the Geotechnical Data Report are plotted in Figure 4 to illustrate the range of in-situ soil density within the embankment fill. It can be noted that there are a significant number of N-values greater than 100 blows per foot (bpf). In most instances, these are reflective of obstructions to the sampler and not soil densities.

Presence of obstructions is noted in Section 2.3.

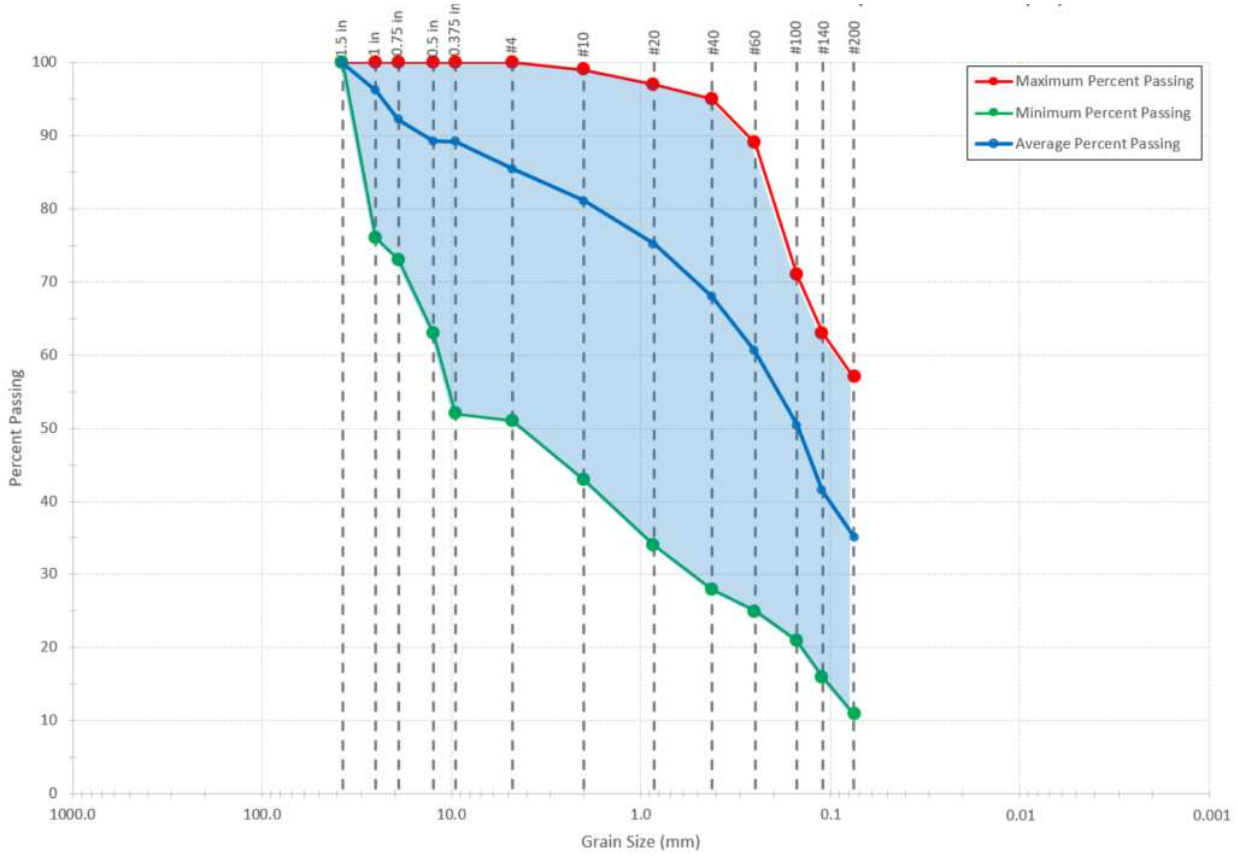


Figure 3 Maximum, Minimum and Average Grain Size Distribution for Embankment Fill

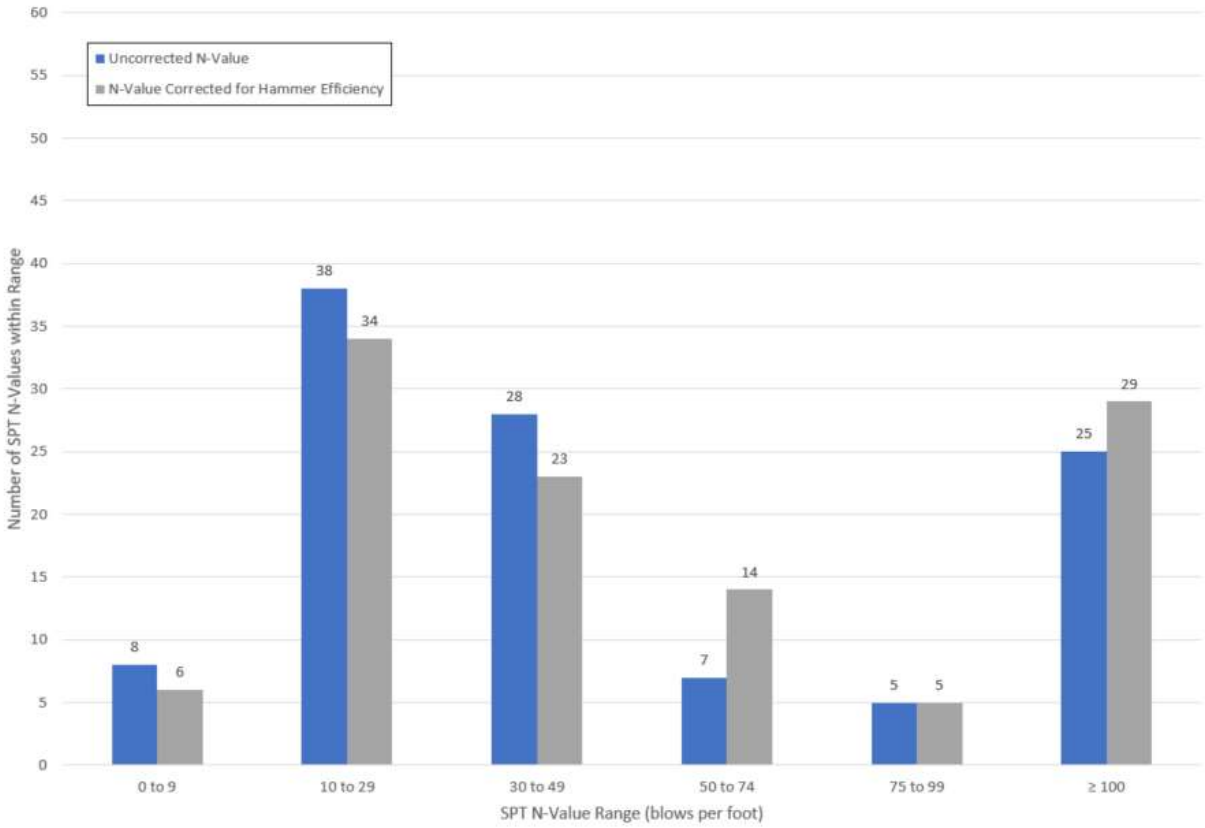


Figure 4 SPT N-Value Distribution for Embankment Fill

2.2.3 Glacial Till

The glacial till consists of a well sorted, medium dense to very dense sand silt clay and gravel mixture. Cobbles and boulders were also periodically encountered during drilling and both a roller bit and rotary percussive drilling were used to advance the borings.

The grain size testing indicates that the layer composition within the defined area averages 49% Silt and Clay (fines), 41% Sand, and 10% Gravel. Figure 5 provides the anticipated grain size distribution. Fines content largely consists of low plasticity silts with less than 20% clay.

The corrected and uncorrected N-values presented within the Geotechnical Data Report are plotted in Figure 6 to illustrate the range of in-situ soil density within the embankment fill. It can be noted that there are a significant number of N-values greater than 100 bpf. In most instances, these are reflective of obstructions to the sampler and not soil densities.

Presence of obstructions is noted in Section 2.3.

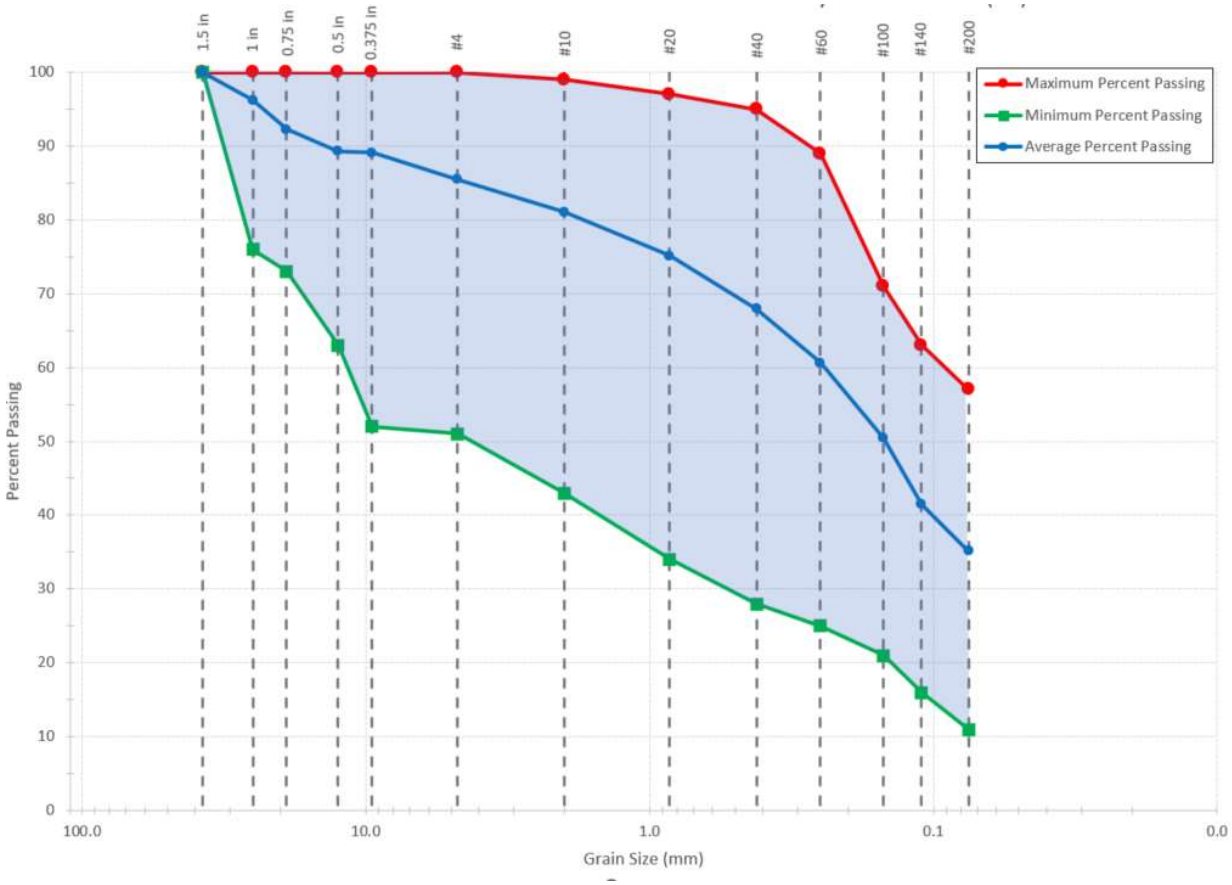


Figure 5 Maximum and Minimum Grain Size Distribution for Glacial Till

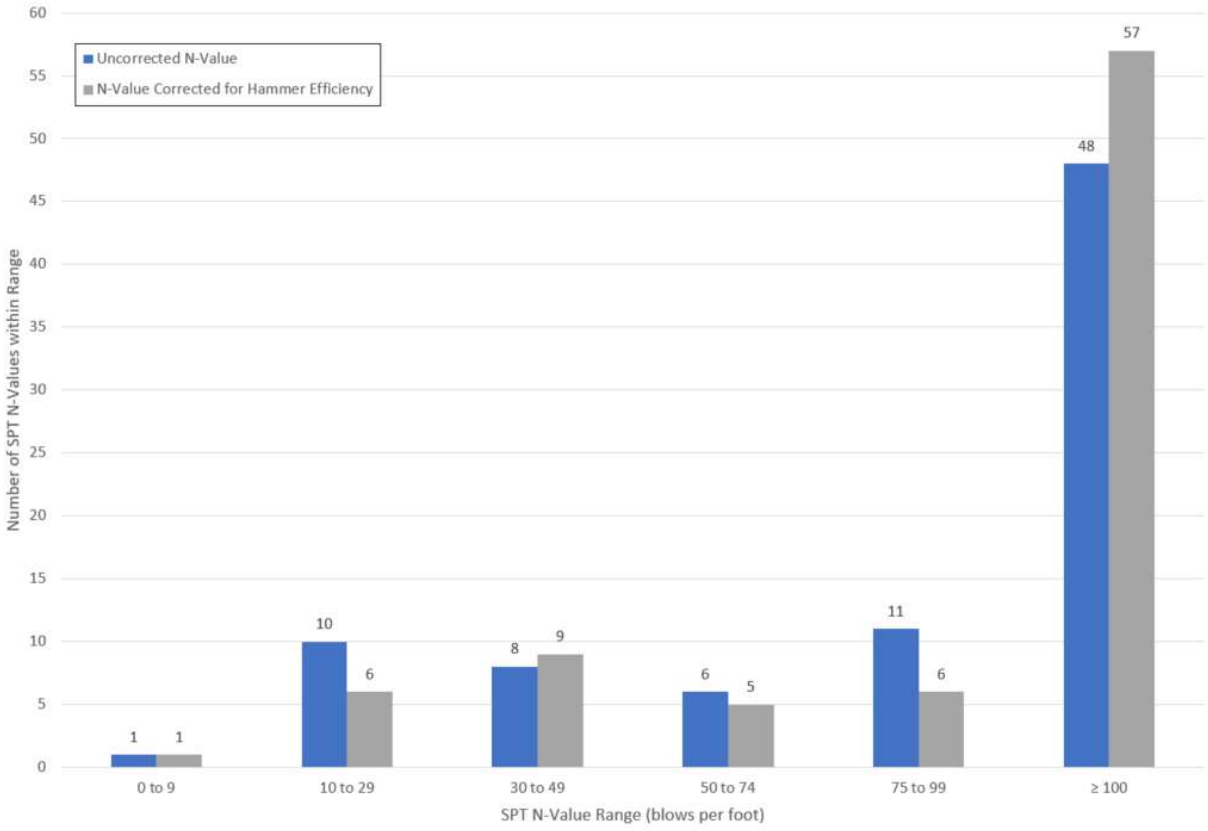


Figure 6 SPT N-Value Distribution for Glacial Till

2.2.4 Bedrock

The bedrock in the project area is classified as carbonaceous phyllite that is medium to moderately hard and unweathered to slightly weathered. One instance of granite thinly overlaying the phyllite was encountered. The cores from the project borings were logged for rock quality designation (RQD).

Of nine samples the rock quality designation ranged from 39 to 97 with an average of 78.

Unconfined compressive strength (UCS) testing was performed on selected core samples in accordance with ASTM D7012. Each result indicated “intact material failures.” The UCS values ranged between 8,209 psi and 18,129 psi and averaged 14,367 psi. For baseline purposes assume that bedrock encountered during tunnel excavation will have a UCS strength of 25,000 psi.

Bedrock is anticipated within the BTC alignment, Appendix A Geological Cross Sections provides the baselined bedrock elevations.

2.3 Boulders / Obstructions

As detailed in Section 4.0 of the GDR, steel drill casing remains in the ground at B-8, B-8C and B-9A.

Practical refusal was encountered routinely during sampling. Both a roller bit and rotary percussive drilling were used to advance the boring to the next sampling location. Additionally, cobbles and boulders can be visually observed along the slopes of the embankment.

Assume that excavation within the entire defined area will encounter cobbles and boulders within the embankment fill as well as the underlying glacial till

The boulders are assumed to be either from the local geology or obtained from adjacent highway cuts, or of glacial origin. For baseline purposes assume that boulders encountered during excavation will have a UCS strength of 25,000 psi.

2.4 Groundwater

The project site and surrounding terrain has significant differences in ground elevation and groundwater was encountered at various elevations during the exploration program. Groundwater elevation is influenced by recharge from adjacent features and is susceptible to seasonal variation. Further information on the groundwater regime including permeability testing can be found in Reference Document: VTrans Lyndon IM 091-3(53) Project Area Groundwater Conditions.

Appendix A Geological Cross Sections provides baselined groundwater elevations.

3 Sequential Excavation Method Design and Construction Considerations

The following design and construction consideration apply to ATCs that include sequential excavation methods as a construction alternative to installing the proposed culverts.

3.1 Anticipated Ground Behavior for SEM

The ground behavior is evaluated based on commentary provided within FHWA NHI 10-034 Technical Manual for Design and Construction of Road Tunnels – Civil Elements. Ground behavior classifications are based on Terzaghi and Heuer's "Tunnelman's Ground Classification for Soils" referenced from FHWA NHI 10-034 Table 7.1 and Table 7.3. This resource identifies soil behavior classifications and defines them in terms of type of soil and specific ground conditions. The soil behavior classifications have become standard terms in the field of tunneling to describe open face tunneling conditions. They will give indications to stability, stand-up time, and groundwater conditions.

All classifications assume that the Design-Builder implements dewatering and successfully reduces the groundwater to the invert of the proposed tunnel.

3.1.1 Granular Fill

This deposit is anticipated to be stable on initial exposure due to apparent cohesion but will require support soon after excavation to prevent desiccation and sloughing. The stand-up time will be limited due to the poor gradation. The Contractor should consider this ground to be cohesive running above the water table.

3.1.2 Embankment Fill

This deposit is anticipated to be stable on initial exposure but will require support soon after excavation to prevent desiccation and sloughing. The stand-up time will vary depending on the localized groundwater conditions, permeability, and grain size distribution of the deposits. The Contractor should consider this ground to be rapid raveling above the water table.

3.1.3 Glacial Till

This deposit is anticipated to be stable on initial exposure but will require support soon after excavation to prevent desiccation and sloughing. The stand-up time will vary depending on the localized groundwater conditions, permeability, and grain size distribution of the deposits. The Contractor should consider this ground to be slowly raveling above the water table.

LEGEND:

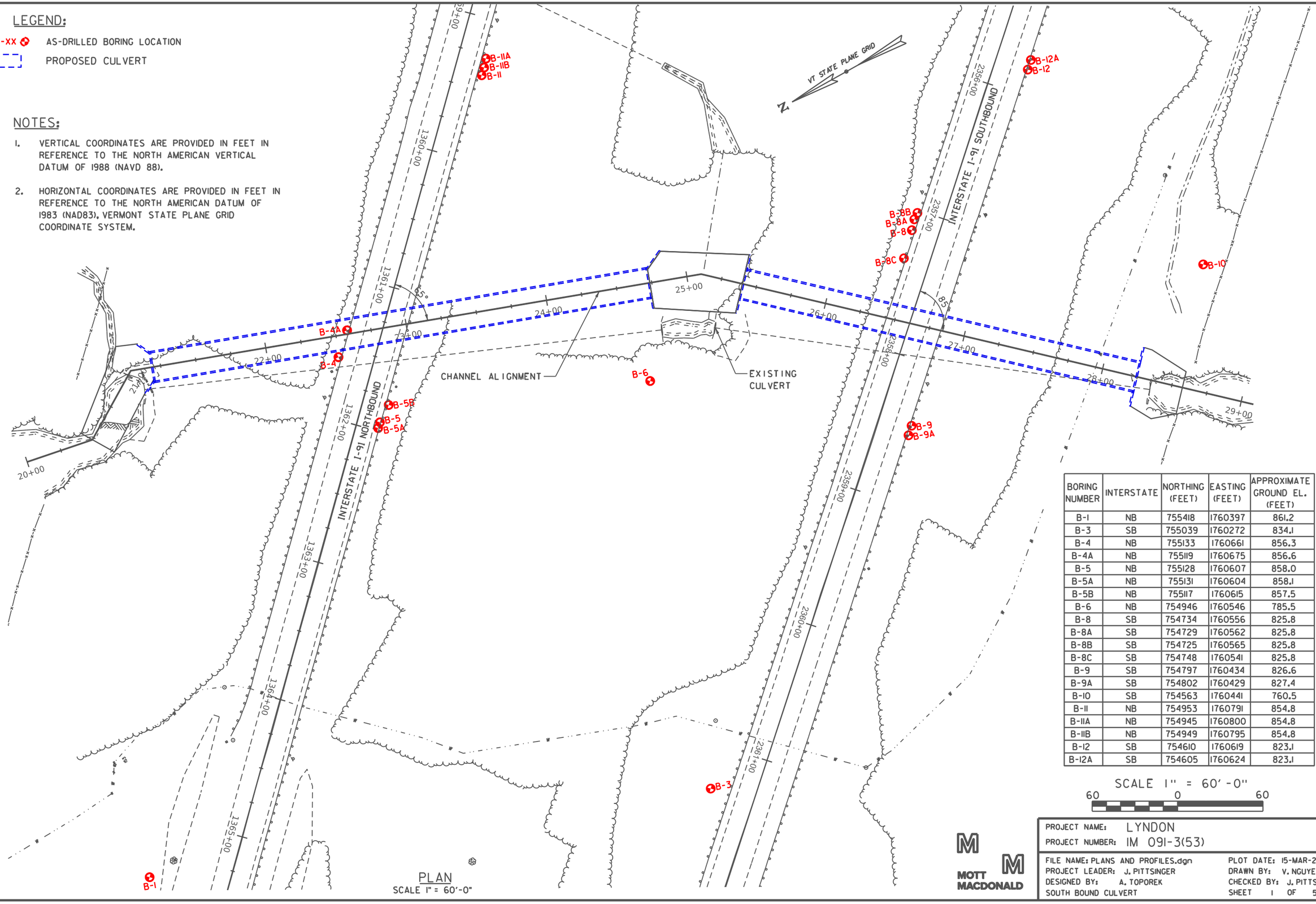
B-XX ⊕ AS-DRILLED BORING LOCATION

PROPOSED CULVERT

NOTES:

1. VERTICAL COORDINATES ARE PROVIDED IN FEET IN REFERENCE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).

2. HORIZONTAL COORDINATES ARE PROVIDED IN FEET IN REFERENCE TO THE NORTH AMERICAN DATUM OF 1983 (NAD83), VERMONT STATE PLANE GRID COORDINATE SYSTEM.



PLAN
SCALE 1" = 60'-0"

BORING NUMBER	INTERSTATE	NORTHING (FEET)	EASTING (FEET)	APPROXIMATE GROUND EL. (FEET)
B-1	NB	755418	1760397	861.2
B-3	SB	755039	1760272	834.1
B-4	NB	755133	1760661	856.3
B-4A	NB	755119	1760675	856.6
B-5	NB	755128	1760607	858.0
B-5A	NB	755131	1760604	858.1
B-5B	NB	755117	1760615	857.5
B-6	NB	754946	1760546	785.5
B-8	SB	754734	1760556	825.8
B-8A	SB	754729	1760562	825.8
B-8B	SB	754725	1760565	825.8
B-8C	SB	754748	1760541	825.8
B-9	SB	754797	1760434	826.6
B-9A	SB	754802	1760429	827.4
B-10	SB	754563	1760441	760.5
B-11	NB	754953	1760791	854.8
B-11A	NB	754945	1760800	854.8
B-11B	NB	754949	1760795	854.8
B-12	SB	754610	1760619	823.1
B-12A	SB	754605	1760624	823.1

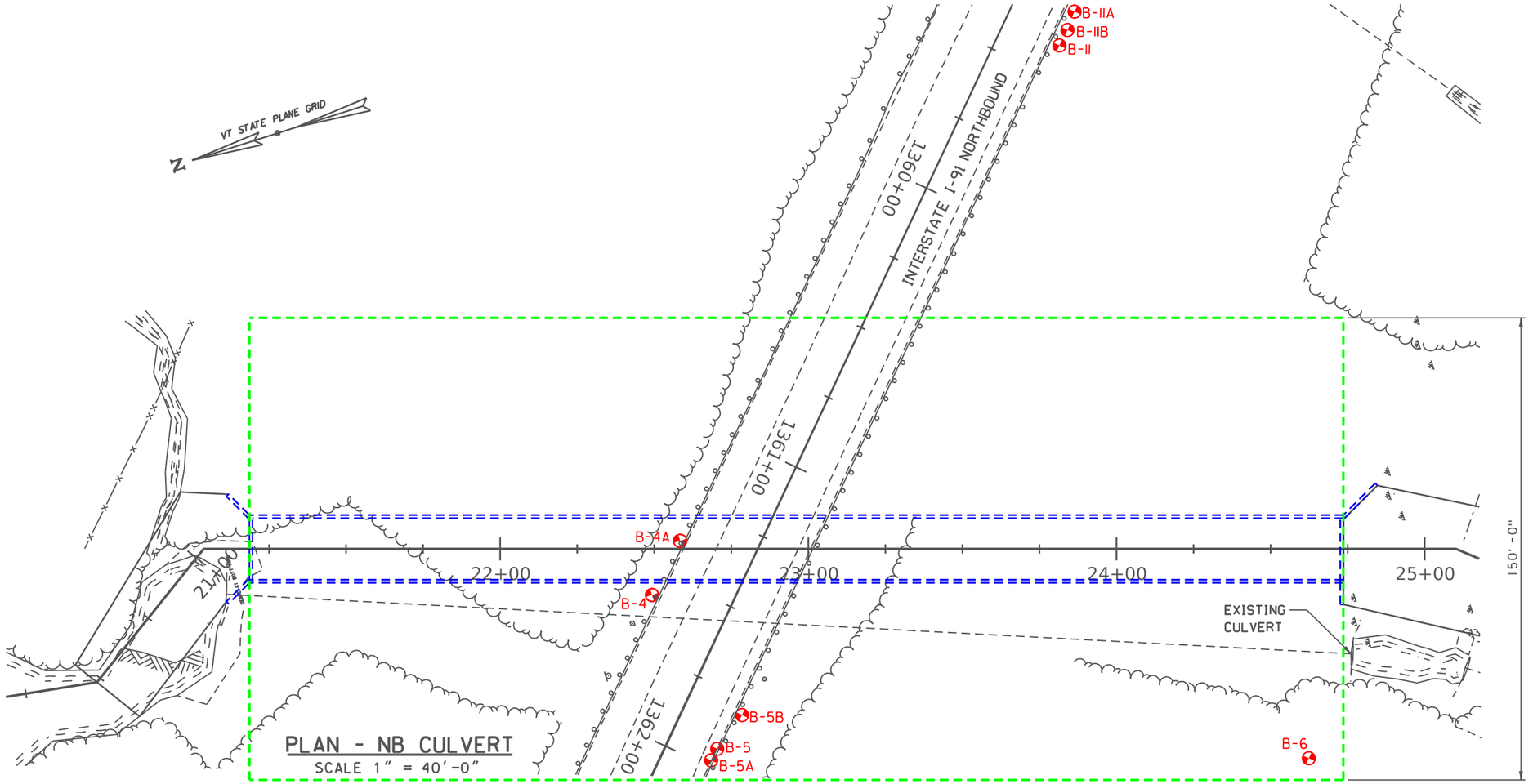
SCALE 1" = 60'-0"
60 0 60

MOTT MACDONALD

PROJECT NAME: LYNDON
PROJECT NUMBER: IM 091-3(53)

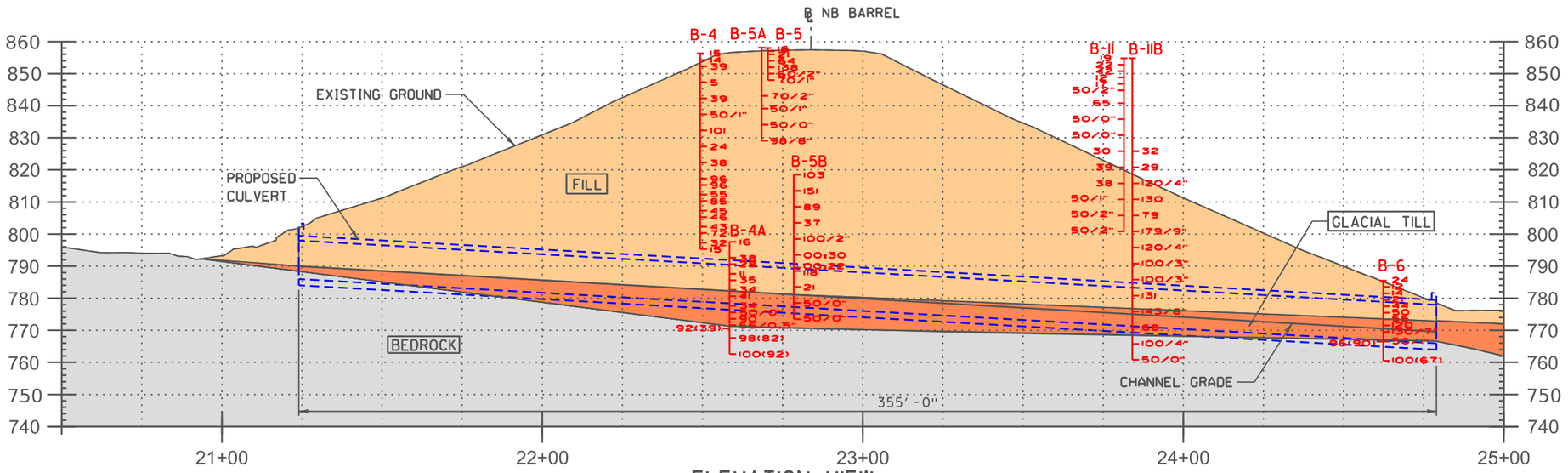
FILE NAME: PLANS AND PROFILES.dgn
PROJECT LEADER: J. PITTSINGER
DESIGNED BY: A. TOPOREK
SOUTH BOUND CULVERT

PLOT DATE: 15-MAR-2023
DRAWN BY: V. NGUYEN
CHECKED BY: J. PITTSINGER
SHEET 1 OF 5



PLAN - NB CULVERT

SCALE 1" = 40'-0"



ELEVATION VIEW

SCALE 1" = 40'-0"

LEGEND:

- B-XX — AS-DRILLED BORING LOCATION
- 51 — N-VALUE AS DETERMINED BY THE GEOTECHNICAL DATA REPORT
- 96(90) — CORE RECOVERY % (RQD%)
- FILL
- GLACIAL TILL
- BEDROCK
- PROPOSED CULVERT
- BASELINED LOCATION

SCALE 1" = 40'-0"

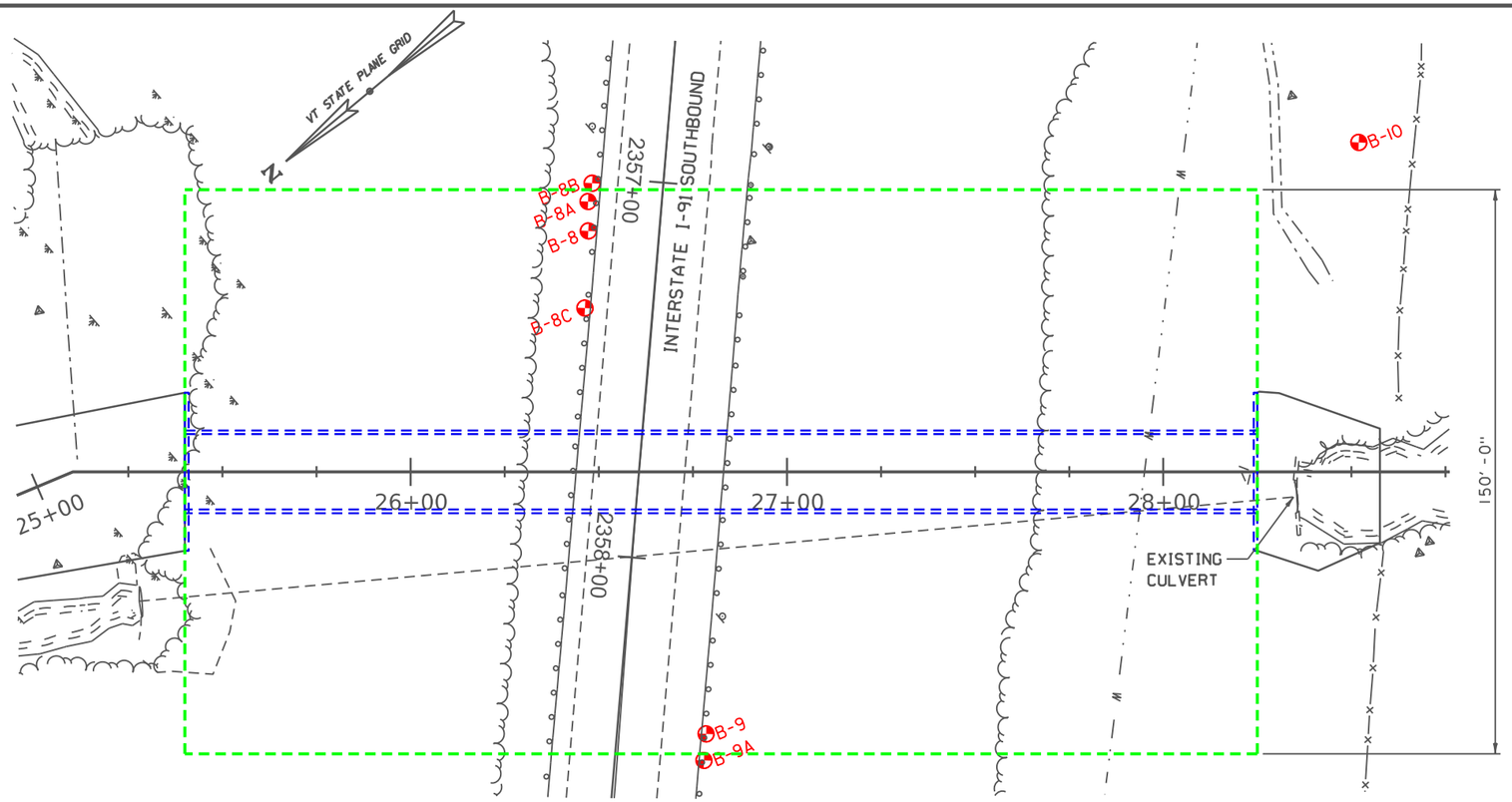
40 0 40

MOTT MACDONALD

PROJECT NAME: LYNDON
PROJECT NUMBER: IM 091-3(53)

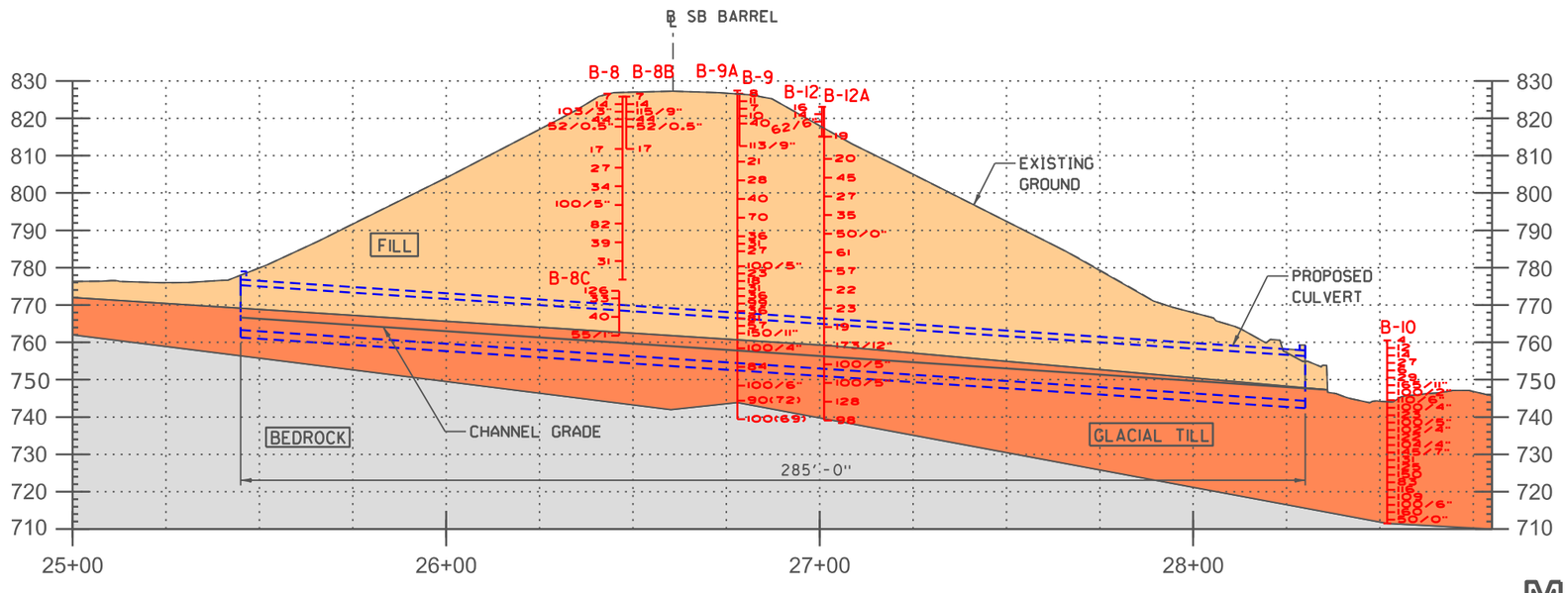
FILE NAME: PLANS AND PROFILES.dgn
PROJECT LEADER: J. PITTSINGER
DESIGNED BY: A. TOPOREK
NORTH BOUND CULVERT

PLOT DATE: 15-MAR-2023
DRAWN BY: V. NGUYEN
CHECKED BY: J. PITTSINGER
SHEET 2 OF 5



PLAN - SB CULVERT

SCALE 1" = 40'-0"



ELEVATION VIEW

SCALE 1" = 40'-0"

LEGEND:

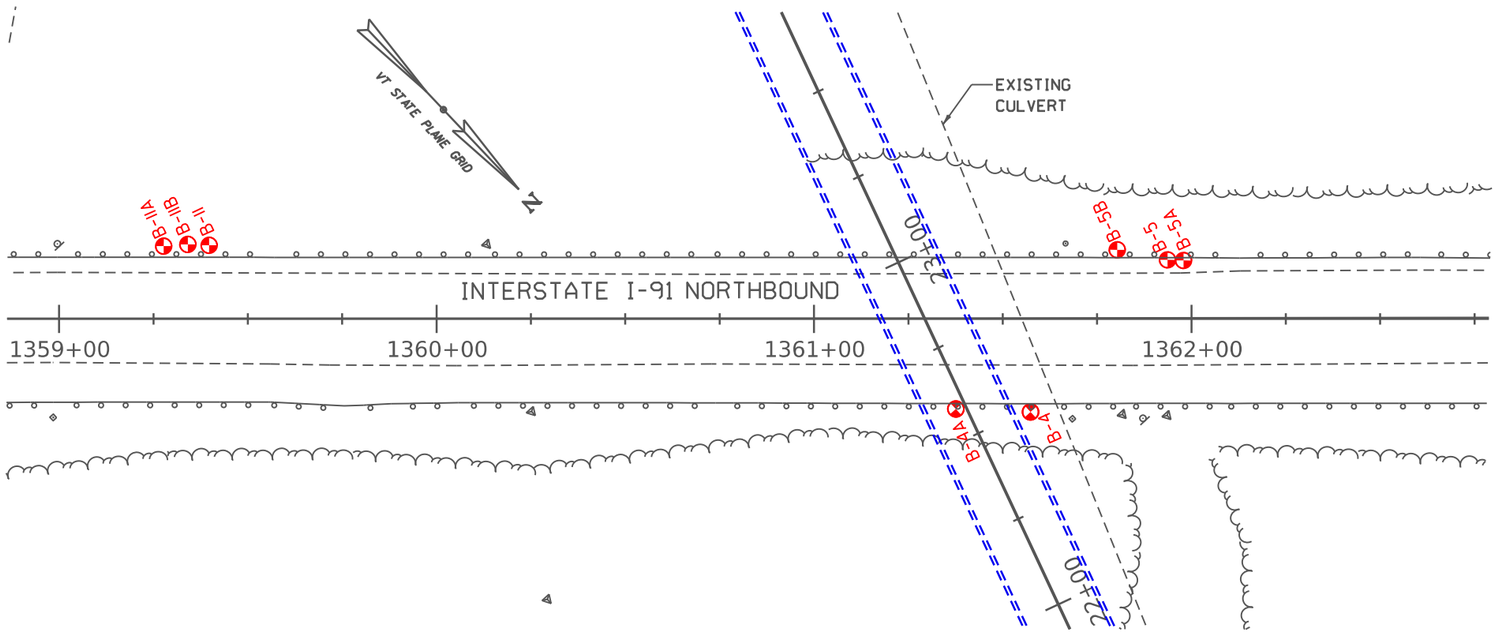
- B-XX — AS-DRILLED BORING LOCATION
- 51 — N-VALUE AS DETERMINED BY THE GEOTECHNICAL DATA REPORT
- 96(90) — CORE RECOVERY % (RQD%)
- FILL
- GLACIAL TILL
- BEDROCK
- PROPOSED CULVERT
- BASELINED LOCATION

SCALE 1" = 40'-0"

40 0 40

MOTT MACDONALD

PROJECT NAME:	LYNDON
PROJECT NUMBER:	IM 091-3(53)
FILE NAME: PLANS AND PROFILES.dgn	PLOT DATE: 15-MAR-2023
PROJECT LEADER: J. PITTSINGER	DRAWN BY: V. NGUYEN
DESIGNED BY: A. TOPOREK	CHECKED BY: J. PITTSINGER
SOUTH BOUND CULVERT	SHEET 3 OF 5



PLAN - I-91 NB
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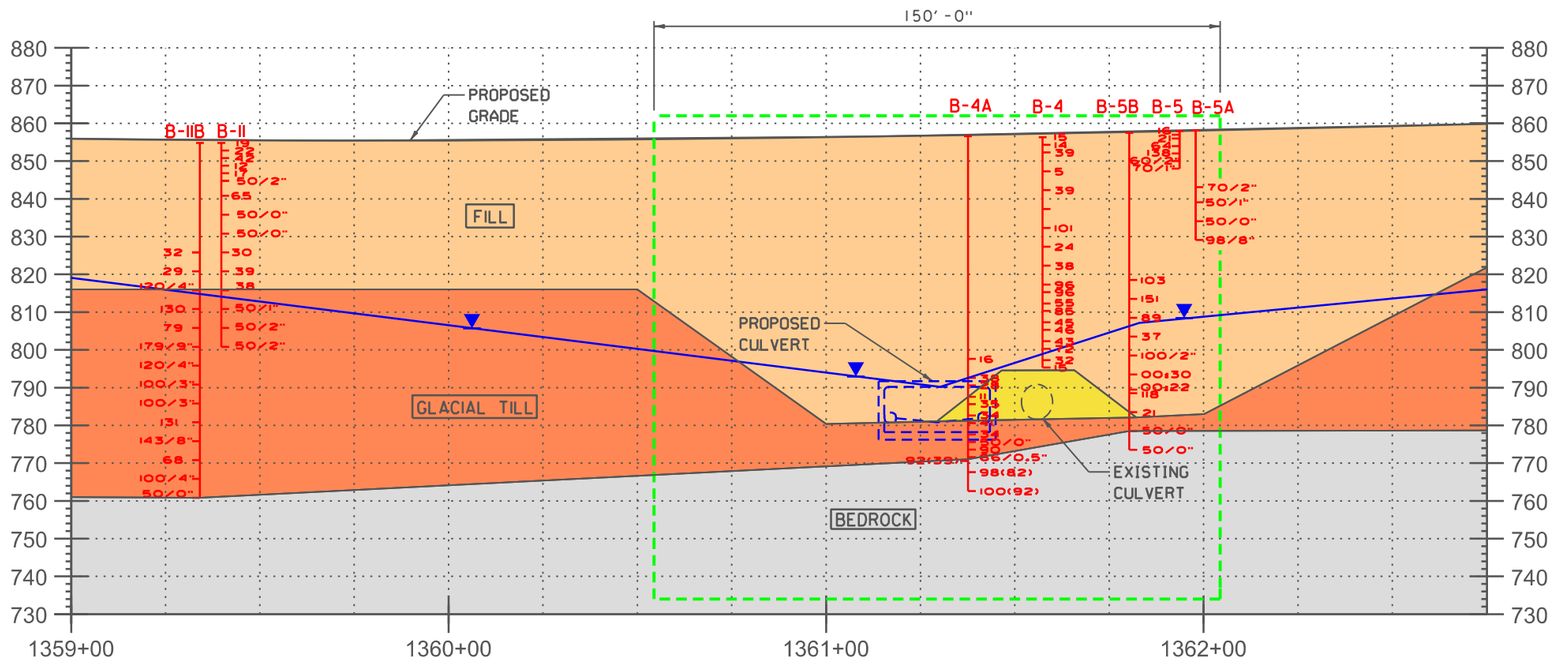


ELEVATION VIEW
SCALE 1" = 40'-0"

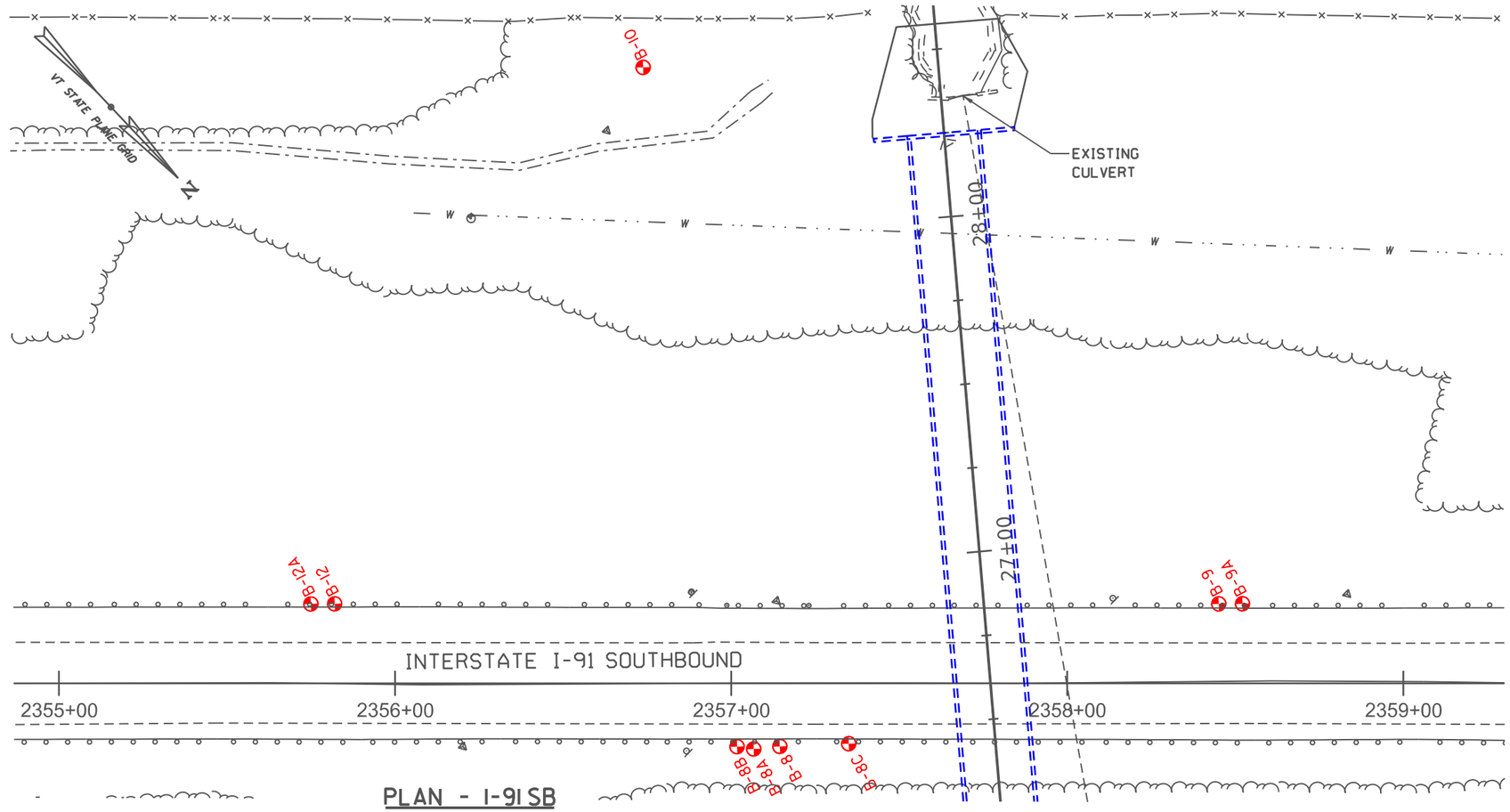
LEGEND:

- B-XX — AS-DRILLED BORING LOCATION
- GROUNDWATER ELEVATION
- 51 — N-VALUE AS DETERMINED BY THE GEOTECHNICAL DATA REPORT
- 96(90) — CORE RECOVERY % (RQD%)
- FILL
- GLACIAL TILL
- BEDROCK
- PROPOSED CULVERT
- BASELINED LOCATION
- GRANULAR BACKFILL

SCALE 1" = 40'-0"
40 0 40

MOTT MACDONALD

PROJECT NAME:	LYNDON
PROJECT NUMBER:	IM 091-3(53)
FILE NAME: PLANS AND PROFILES.dgn	PLOT DATE: 15-MAY-2023
PROJECT LEADER: J. PITTSINGER	DRAWN BY: V. NGUYEN
DESIGNED BY: A. TOPOREK	CHECKED BY: J. PITTSINGER
I-91 NORTH BOUND	SHEET 4 OF 5



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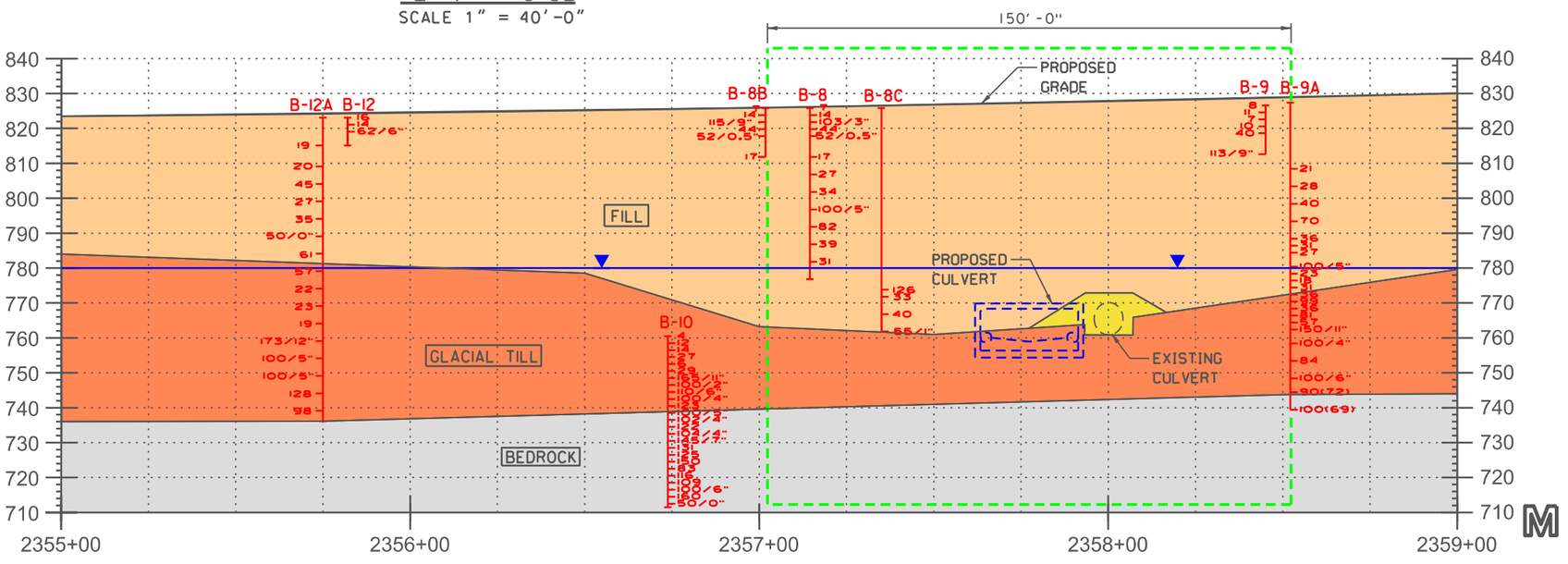

ELEVATION VIEW
SCALE 1" = 40'-0"

LEGEND:

- B-XX — AS-DRILLED BORING LOCATION
- GROUNDWATER ELEVATION
- 51 — N-VALUE AS DETERMINED BY THE GEOTECHNICAL DATA REPORT
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- BASELINED LOCATION
- GRANULAR BACKFILL

SCALE 1" = 40'-0"
40 0 40

MOTT MACDONALD

PROJECT NAME:	LYNDON
PROJECT NUMBER:	IM 091-3(53)
FILE NAME: PLANS AND PROFILES.dgn	PLOT DATE: 15-MAY-2023
PROJECT LEADER: J. PITTSINGER	DRAWN BY: V. NGUYEN
DESIGNED BY: A. TOPOREK	CHECKED BY: J. PITTSINGER
I-91 SOUTH BOUND	SHEET 5 OF 5