APPENDIX A

Geotechnical Report

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Bio-Resources | Building Systems | Environmental | Geotechnical | Project Management

GEOTECHNICAL INVESTIGATION REPORT

Miller Brook Wharf
Miller Brook
New Brunswick

Prepared for:

Mr. Vidya Limaye, PhD., P.Eng.
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310-36 Solutions Drive
Halifax
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November 25, 2021

Project No: 15381

FUNDY Engineering

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SAINT JOHN CHARLOTTETOWN HALIFAX

JOB FILE:	15381		
PROJECT TITLE:	Geotechnical Investigation – Miller Brook Wharf		
VERSION	**ISSUANCE DATE**	**PREPARED BY**	**REVIEWED BY**
1.0	November 25, 2021	Gordon Mouland, M.Eng., P.Eng..	Alex Mouland, *P.Eng., PMP*

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PROFESSIONAL SEAL:

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1.0 INTRODUCTION

Fundy Engineering & Consulting Ltd. (Fundy Engineering) was retained by Dr. Vidya Limaye of SHM Canada Consulting (the Client) to undertake a geotechnical investigation for a proposed new wharf at Miller Brook, New Brunswick.

The area of interest for this investigation is located in the Miller Brook Harbour. The wharf is a replacement and extension of the existing marginal wharf. It is located on the West side of the harbour. (Figure 1).

Figure 1 - Subject Site

The objective of the geotechnical investigation was to assess the subsurface conditions for the replacement structure and make recommendations for the geotechnical components of construction.

In agreement with the Client, Fundy Engineering has completed the following scope of work:

- Clearance of all underground services prior to any site work;
- Three (3) Boreholes were extended to a depth necessary to provide the required soils and Bedrock information for the intended project.
- Prepare a geotechnical report containing findings, site plan of test borehole locations, laboratory results/interpretation and geotechnical recommendations for earthworks and foundation design.

1.2 LIMITATIONS

The observations made and facts presented in this report are based on the site visit carried out on October 15th and 16st, 2021. While every effort has been made to determine the geotechnical concerns pertaining to the subject site as defined herein, discovery or development of additional geotechnical concerns cannot be precluded. Further investigation may reveal additional information that may influence the recommendations included herein. Should such information be revealed, Fundy Engineering should be notified in a timely fashion so that any required amendments to our recommendations can be made.

These results are reported confidentially to the Client, who is advised to take appropriate action to rectify any areas of concern. No professional responsibility is assumed for the use or interpretation of these findings by others.

Fundy Engineering's investigation was limited to a total of three (3) boreholes.

2.0 BACKGROUND

2.1 SITE DESCRIPTION AND LOCATION

The subject site for this geotechnical investigation lies on relatively flat terrain, sloped slightly to the North near the edge of the original shoreline (Figure 1).

It is our understanding that the Project includes the replacement and extension of the existing marginal wharf using a Berlin Wall type of construction.

2.2 REGIONAL SOIL AND GEOLOGY

The bedrock geology of this area of New Brunswick consists of relatively flat lying sedimentary deposits that makes up a section of the Maritime Plane and lies within the Appalachian Mountain System. The deposits are generally comprised of conglomerate, sandstone, mudstone, shale and siltstone, from the Late Pennsylvanian to Early Permian ages (*i.e.,* formed 286 million years ago to 320 million years ago).

At Miller Brook bedrock is a Late Pennsylvanian Sandstone laying flat, cross bedded and contains more quartz than feldspar grains. It is not well cemented and readily disintegrates under wave action.

Bedrock is generally covered by a thin drift of Ground Moraine or Basal Till with occurrences of Residual, Ablation Till, and minor Glaciofluvial and Marine Deposits. Marine deposits are found along the shoreline.

3.0 SITE WORK COMPLETED

3.1 BOREHOLE INVESTIGATION

A geotechnical borehole investigation, was completed at the subject site to collect information pertaining to the soils and bedrock to assess their suitability for the project's geotechnical requirements.

On October 15th and 16st, Three (3) Boreholes were extended into bedrock, under the direction of Myles Munn*, P.Tech.,* of Fundy Engineering. Elevations are referenced to Chart Datum.

3.2 SOILS ENCOUNTERED

In general, the soils encountered can generally be described as **Loose to Compact Sandy Gravel or a Loose to Compact SAND and WOOD over a Compact Reddish Brown Silty Sand TILL.** These soils were found over a **Mudstone Bedrock**. A transition layer was encountered between the Till and the Mudstone consisting of Till and broken Mudstone. (Table 1).

A detailed description of the soils and bedrock encountered can be found on the Borehole Logs found in Appendix II.

3.3 BEDROCK

Bedrock was found to be a sedimentary deposit comprised of mudstone. Below is a summary of the materials encountered in the Boreholes.

Table 1 - Representative Soil and Bedrock Encountered

BH	BH1	BH2	BH3
Elevation (m, Chart Datum)	**3.13**	**3.28**	**3.20**
Material Description (Elevation, m, Chart Datum))	Loose to Compact Sandy Gravel Fill	Loose to Compact Sandy Gravel Fill	Loose to Compact Silty Sand and Wood Fill
	-1.57	-1.44	-2.87
	Dense Reddish-Brown Till	Dense Reddish-Brown Till	Dense Reddish-Brown Till
	-4.34	-2.40	-4.27
	Mudstone Rec. 100 RQD 62	Mudstone Rec. 100 RQD 51	Mudstone Rec. 100 RQD 64
	-7.70	-5.15	-7.68

The Mudstone bedrock, having a wide variation in rock properties, was encountered in all Boreholes. The recovery's and RQD's were reasonable for these types of sedimentary rocks. The Mudstone recovery ranged from 83 to 100% and an RQD ranging from 11 to 88% or very severely fractured to sound.

It is expected that 0 to 0.5 m of rock will be excavated to allow for the installation of the concrete panels. An un-confined compression test for a Mudstone sample was measured to be 11.0 MPa.

3.4 GROUNDWATER

Tidal

4.0 RECOMMENDATIONS

4.1 General

Based on the observations made during the geotechnical investigation it is recommended that heavy equipment fitted with at least a rock bucket, a ripper tooth and / or a hydraulic breaker be used to excavate to the proposed elevation for the bottom of the Berlin Wall panels.

4.2 Site Preparation

For the installation of the Berlin Wall facing and anchorage elements, all soils and existing wharfs elements above bedrock will be excavated or dredge to the required finished elevation. It is anticipated that on the immediate water side of the new structure no Class A (Bedrock) dredging will be required to achieve harbour depth. Information collection for the dredging for the remainder of the harbour was not included in the present scope of work.

In addition, a trench will be required to the bottom elevation of the concrete panels. The Boreholes indicate that the trench will be in Fill and Till with a chance of encountering Bedrock. This assumes an excavation depth for the panel of -2.4 m and an over excavation for bedding materials of -2.6 m.

To install the H piles below the bottom elevation of the concrete panel, they will be drilled through fills and Till to the mudstone Bedrock. Wood and creosote odour was observed in the boreholes at the surface of the Till. If encountered creosote timbers should be disposed as required by environmental regulations. The H piles socket will be drilled approximately 3.6 m into Bedrock. Typical diameter for the pre-drilled socket is 600 mm.

4.3 Wall Anchor Blocks and tie rods

Anchor blocks or an anchor wall is recommended. Blocks 2500 (w) x 1500 (h) with the bottom of the anchor at a depth of 2300 mm are recommended. The anchor should be located 10 m behind the face of the wall. The minimum depth of excavation between the anchor and the berlin wall is to be 2300 mm. Tie rods with a diameter of 64 mm are recommended. Tie rods should be placed as per the manufacture's recommendations. Tie rods and accessories should have corrosion protection, i.e., galvanized or other corrosion protection system.

4.4 Backfilling

Once the wall and anchors have been installed, fill should be placed on both sides of the anchor to finished grade. The minimum width of fill on the berlin wall side of the anchor should be 5 m before placing fill behind the Berlin wall.

The anchors should be backfilled with Fill consisting of an approved material which is free from Organics and deleterious materials. Fill material meeting the current NBDOT Standard Specification for a 63 mm crushed rock would be acceptable for use as backfill material.

All backfill is to be compacted in lifts to 98% of its Standard Proctor Density at optimum moisture content above Low water.

The excavation between the anchor backfill and the berlin wall should be backfilled with Fill consisting of an approved material which is free from Organics and deleterious materials. Fill material meeting the current NBDOT Standard Specification for an R5 material would be acceptable for use as backfill material. A non-woven filter fabric is recommended between the two types of fill to act as a separator.

All backfill behind the berlin wall, above low water, is to be compacted in lifts, as approved by a Geotechnical Engineer. Backfill should be placed evenly behind the wall. It is recommended that the placement of all backfill be monitored by a Geotechnical Engineer to observe compaction during placement.

A maximum lift thickness of 300 mm (12 inches) is recommended for Fill material placed as backfill. The actual thickness of the lifts will be dependent on the equipment used. Lift thickness determination should be made by a Geotechnical Engineer.

4.5 CONCRETE DECK

A concrete deck may be cast over Structural Fill prepared as described above. All concrete for the deck should be placed over a minimum of 200 mm of compacted clean coarse granular base material. Material meeting the specification for NBDOT 31.5 mm Crushed Stone would be acceptable for use as concrete slab base material. It is recommended all concrete be protected from freeze thaw with air entrainment as recommended in CSA A23.1.

4.6 WALL DRAINAGE

It is recommended that the Berlin wall have a drainage system installed near the low water level.

4.7 SEISMIC SITE CLASSIFICATION

Based on Table 4.1.8.4.A Site Classification for Seismic Site Response in the 2015 edition of the National Building Code of Canada (NBC) and a review of the soil and bedrock information, the Site Classification for the project area is "C".

5.0 CLOSING REMARKS

The recommendations herein have been devised based on the findings in this geotechnical investigation. These recommendations are based on our current knowledge and understanding of the site in its present state. If there are any changes or discoveries identified in the future that may pertain to the geotechnical aspects of this undertaking, we must be notified immediately to make any necessary changes or adjustments to our recommendations.

We trust that the information herein is sufficient for your present needs. Please feel free to contact the undersigned for any additional information or clarification that may be required. This report has been prepared by Gordon Mouland, *M.Eng., P.Eng.* and reviewed by Alex Mouland, *P.Eng., PMP*.

Sincerely,
Fundy Engineering & Consulting Ltd.

Mr. Gordon Mouland, M.Eng., P.Eng.

APPENDIX I

SYMBOLS AND TERMS

FUNDY ENGINEERING SYMBOLS AND TERMS
Borehole, Test Pit, and Monitoring Well Logs

SOIL DESCRIPTION

Behavioural properties (i.e. plasticity, permeability) take precedence over particle gradation in describing soils.

Terminology describing soil structure:

Desiccated.....having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured..... having cracks, and hence a blocky structure
Varved..... .....composed of regular alternating layers of silt and clay
Stratified.....composed of alternating layers of different soil types, e.g. silt and sand or silt and clay
Well Graded.....having wide range in grain sizes and substantial amounts of all intermediate particle sizes
Uniformly Graded.....predominantly of one grain size

Terminology used for describing soil strata based upon the proportion of individual particle sizes present:

Trace, or occasional.....less than 10%
Some.....10-20%
Adjective (e.g. silty or sandy).....20-35%
And (e.g. silt or sand.....35-50%

The standard terminology to describe cohesionless soils includes the relative density, as determined by laboratory test or by the Standard Penetration Test 'N' - value: the number of blows of 140 pound (64kg) hammer falling 30 inches (50.8mm) O.D. split spoon sampler one foot (305mm) into the soil.

RELATIVE DENSITY	N' VALUE	RELATIVE DENSITY %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer test, unconfined compression tests, or occasionally by standard penetration tests.

CONSISTENCY	UNDRAINED SHEAR STRENGTH		'N' VALUE
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25-0.5	12.5-25	2-4
Firm	0.5-1.0	25-50	4-8
Stiff	1.0-2.0	50-100	8-15
Very Stiff	2.0-4.0	100-200	15-30
Hard	>4.0	>200	>30

SOILS GRAPHIC LEGEND

Clay

Silt

Sand

Gravel

Boulders & Cobbles

Asphalt

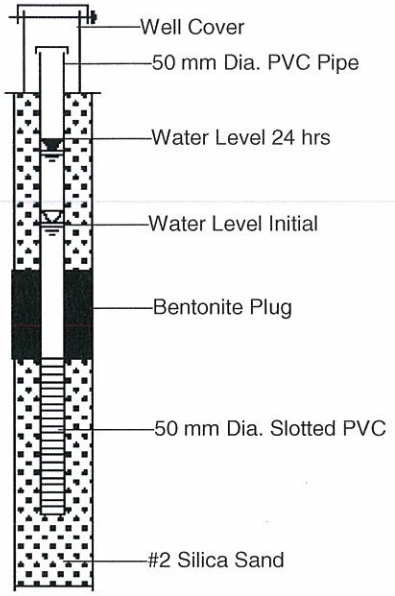
Topsoil & Root Mat

Till

Peat & Organic Silts

Fill

MONITORING WELL SCHEMATIC



BEDROCK GRAPHIC LEGEND

Sandstone

Limestone

Mudstone

Shale

Granite/Igneous

Metamorphic

SAMPLER SYMBOLS

Standard Penetration Test / Split Spoon

Rock Core

Auger / Grab

LABORATORY TESTS

MC	Moisture Content	P	Field Permeability	CD	Consolidation Drained Triaxial
SG	Specific Gravity	PF	Permeability Falling Head	CU	Consolidation Undrained Triaxial
HA	Hydrometer Analysis	PC	Permeability Constant Head	UU	Unconsolidated Undrained Triaxial
SA	Sieve Analysis	PR	Proctor	DS	Direct Shear

BEDROCK DESCRIPTION

The description of bedrock is based on the rock quality designation (RQD).

The classification is based on a modified core recovery percentage in which all pieces of sound core over 100mm long are expressed as a percentage of total recovery. The small pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. In most cases RQD is measured on NXL core.

RQD	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

APPENDIX II

BOREHOLE LOGS

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BOREHOLE LOG No. 1

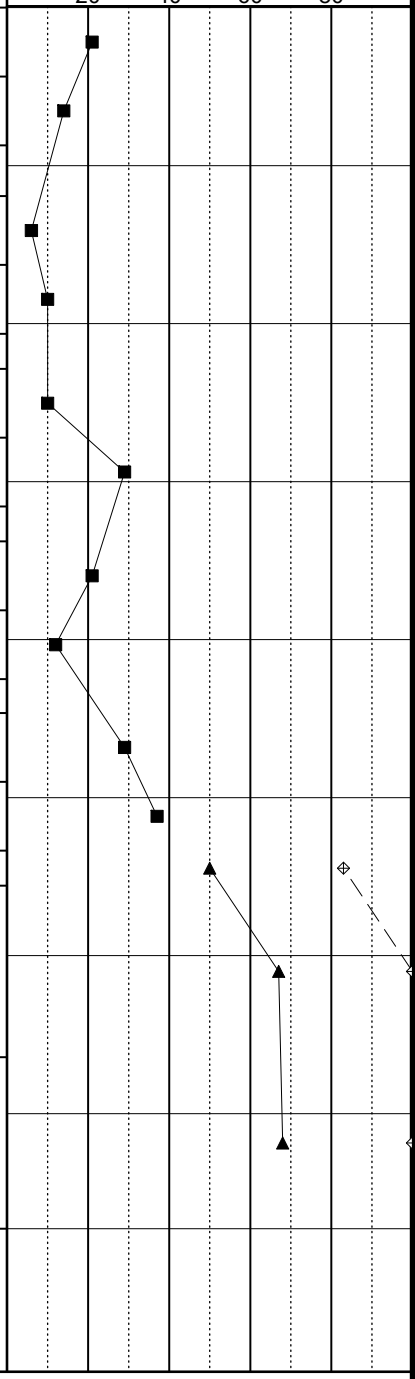
PROJECT: Miller Brook Wharf **PROJECT NO.:** 15381
CLIENT: SHM Canada Consulting Ltd. **DATUM:** Chart
PROJECT LOCATION: Miller Brook Wharf **ELEVATION (m):** 3.13m
DRILLING CONTRACTOR: Lantech Drilling
LOGGED BY: Myles Munn **CHECKED BY:** Gord Mouland
DRILLING METHOD: Track Mounted Drill **DATE:** Oct 15 and 16,
DEPTH TO - WATER> INITIAL: 2.28m **AFTER 24 HOURS:** **CAVING>**

Depth (meters)	Depth (feet)	Elevation (meters)	Description	Graphic	Sample Type	Core Recovery (%)	Sample Rec. (cm)	Blow Counts (N value)	RQD (%)	Rock Strength (MPa)
0	0	2.8	5 cm of Crushed Rock 25cm of Brown Sandy Gravel				41	13-11-10-12 (21)		
0.7		2.1	Loose to Compact Grey Sandy Gravel FILL				25	7-6-8-9 (14)		
1.4	5.6	1.4	Grey Sandy Gravel FILL				36	3-3-3-4 (6)		
2.1		0.7					25	12-6-4-2 (10)		
2.8		0					25	4-4-6-4 (10)		
3.5	11.2	-0.7	5 cm of Grey Sandy Gravel FILL 10 cm of WOOD Note: Odor of Creosote				15	3-25-4-4 (29)		
4.2		-1.4	Compact to Dense Reddish Brown Silt and Sand TILL				43	6-11-10-13 (21)		
4.9	16.8	-2.1					15	2-3-9-20 (12)		
5.6		-2.8					51	12-12-17-15 (29)		
6.3	22.4	-3.5	Reddish Brown Silt and Sand TILL to MUDSTONE				30	10-16-21-24 (37)		
7		-4.2	Fair MUDSTONE			83			50	
7.7	28	-4.9				100			67	
8.4		-5.6								
9.1	33.6	-6.3				100			68	
9.8		-7								
10.5			Boring Terminated at 10.82 m.							

TEST RESULTS SUMMARY

Bedrock Core Recovery (%)
RQD (%)
Plastic Limit — Liquid Limit
Water Content -
SPT N Values -

20 40 60 80



This information pertains only to this boring and should not be interpreted as being indicitive of the site.

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BOREHOLE LOG No. 2

PROJECT: Miller Brook Wharf **PROJECT NO.:** 15381
CLIENT: SHM Canada Consulting Ltd. **DATUM:** Chart
PROJECT LOCATION: Miller Brook Wharf **ELEVATION (m):** 3.28m
DRILLING CONTRACTOR: Lantech Drilling
LOGGED BY: Myles Munn **CHECKED BY:** Gord Mouland
DRILLING METHOD: Track Mounted Drill **DATE:** Oct 15 and 16,
DEPTH TO - WATER> INITIAL: ▽ 2.28m **AFTER 24 HOURS:** ▽ **CAVING>**

Depth (meters)	Depth (feet)	Elevation (meters)	Description	Graphic	Sample Type	Core Recovery (%)	Sample Rec. (cm)	Blow Counts (N value)	RQD (%)	Rock Strength (MPa)
0	0	2.8	5 cm of Crushed Rock 25cm of Brown Sandy Gravel				38	9-13-9-8 (22)		
0.7		2.1	Loose to Compact Grey Sandy Gravel FILL Note: Odor of Creosote @ 4.2m				30	7-5-4-9 (9)		
1.4	5.6	1.4								
2.1		0.7					15	2-1-1-1 (2)		
2.8		0					10	1-2-4-3 (6)		
3.5	11.2	-0.7								
4.2		-1.4					0	4-6-8-4 (14)		
4.9	16.8	-2.1	Compact Reddish Brown Silt and Sand TILL				20	0-2-11-3 (13)		
5.6		-2.8	Very Poor to Good MUDSTONE			100			11	
6.3	22.4	-3.5				100			65	
7		-4.2								
7.7		-4.9				100			78	
8.4	28		Boring Terminated at 8.68 m.							

TEST RESULTS SUMMARY

Bedrock Core Recovery (%) ⌖
RQD (%) ▲
Plastic Limit ⊢ Liquid Limit
Water Content - ●
SPT N Values - ■

20 40 60 80

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

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BOREHOLE LOG No. 3

PROJECT: Miller Brook Wharf **PROJECT NO.:** 15381
CLIENT: SHM Canada Consulting Ltd. **DATUM:** Chart
PROJECT LOCATION: Miller Brook Wharf **ELEVATION (m):** 3.20m
DRILLING CONTRACTOR: Lantech Drilling
LOGGED BY: Myles Munn **CHECKED BY:** Gord Mouland
DRILLING METHOD: Track Mounted Drill **DATE:** Oct 15 and 16,
DEPTH TO - WATER> INITIAL: 1.83 **AFTER 24 HOURS:** **CAVING>**

Depth (meters)	Depth (feet)	Elevation (meters)	Description	Graphic	Sample Type	Core Recovery (%)	Sample Rec. (cm)	Blow Counts (N value)	RQD (%)	Rock Strength (MPa)
0	0	2.8	Loose Grey Sandy Gravel FILL				25	9-2-4-9 (6)		
0.7		2.1	Loose Reddish Brown Silt and Sand TILL				25	4-3-6-9 (9)		
1.4	5.6	1.4								
2.1		0.7	Loose to Compact Silty Sand and Wood FILL				20	2-1-2-2 (3)		
2.8		0					30	2-1-3-3 (4)		
3.5	11.2	-0.7					61	1-1-3-4 (4)		
4.2		-1.4					2061	2-1-1-1 (2)		
4.9	16.8	-2.1					46	0-0-2-2 (2)		
5.6		-2.8					61	9-9-8-6 (17)		
6.3		-3.5	Reddish Brown Silt and Sand TILL				36	3-4-5-11 (9)		
7	22.4	-4.2	Reddish Brown Silt and Sand TILL to MUDSTONE				46	27-32-19 (51)		
7.7		-4.9	Poor to Good MUDSTONE			100			33	
8.4	28	-5.6				100			88	
9.1		-6.3								
9.8		-7				100			70	
10.5	33.6		Boring Terminated at 10.81 m.							

TEST RESULTS SUMMARY

Bedrock Core Recovery (%)
RQD (%)
Plastic Limit — Liquid Limit
Water Content -
SPT N Values -

20 40 60 80

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

APPENDIX III

BOREHOLE LOCATION PLAN

GENERAL NOTES

1. All dimensions in millimeters unless otherwise specified.
2. Topographical data is based on the following:
   - Source = Provincial LIDAR
   - Projection = NB Double Stereographic (NAD83 CSRS)
   - Vertical Datum = CGVD 2013
3. Elevations given are not geodetic and provided as a relational reference only.
4. This drawing is not a survey and any property boundaries are shown for reference only.

No.	REVISION/ISSUE	DATE

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Project:

GEOTECHNICAL INVESTIGATION
MILLER BROOK WHARF
BATHURST, NB

Drawing:

BOREHOLE LOCATION PLAN

Project No.	Designed	Date (yy/mm/dd)
15391	AM	21/10/28
Scale	**Drawn**	**Rev.**
1:400	RTH	

Sheet

C1.1

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