☎ 877.635.1566 ✉ fundy@fundyeng.com www.fundyeng.com

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

COMMUNITY OF VICTORIA,
PRINCE EDWARD ISLAND
SEAWALL REPLACEMENT PROJECT

HABITAT ASSESSMENT & GEOTECHNICAL INVESTIGATION

Prepared for:

Administrator
Community of Victoria
P.O. Box 7
Victoria, PE
C0A 2G0

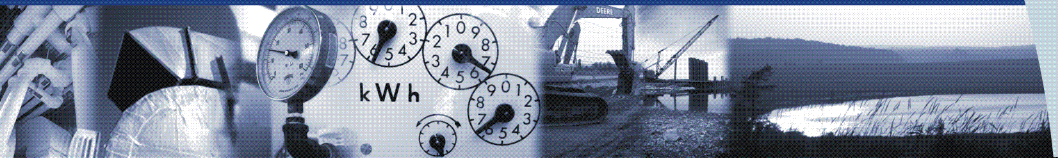
20 September 2017

Project No: 17-12374

FUNDY Engineering

Serving Our Clients' Needs First

SAINT JOHN CHARLOTTETOWN HALIFAX



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1.0 INTRODUCTION

The Community of Victoria in Prince Edward Island has identified replacing the current deteriorating seawall (Figure 1) on the waterfront as a community priority. It has been proposed that the existing concrete seawall will be replaced with a rubble mound seawall, which is expected to provide better protection against erosion and wave action; thus, protecting property and important infrastructure within the community for many years to come. While continuing to offer an aesthetically pleasing look along the popular waterfront, the Project is proposed to incorporate a pedestrian walkway as shown in Figure 2.

Prior to undertaking the final design and environmental permitting for the seawall replacement project, Fundy Engineering and Consulting Ltd. (hereafter Fundy) was hired by the Community of Victoria to undertake three studies of the project site; a habitat survey, a geotechnical investigation and a topographic survey; these are described below.

Figure 1. View of the current deteriorating concrete seawall on the Community of Victoria, PE waterfront as viewed from the wharf in April 2017.

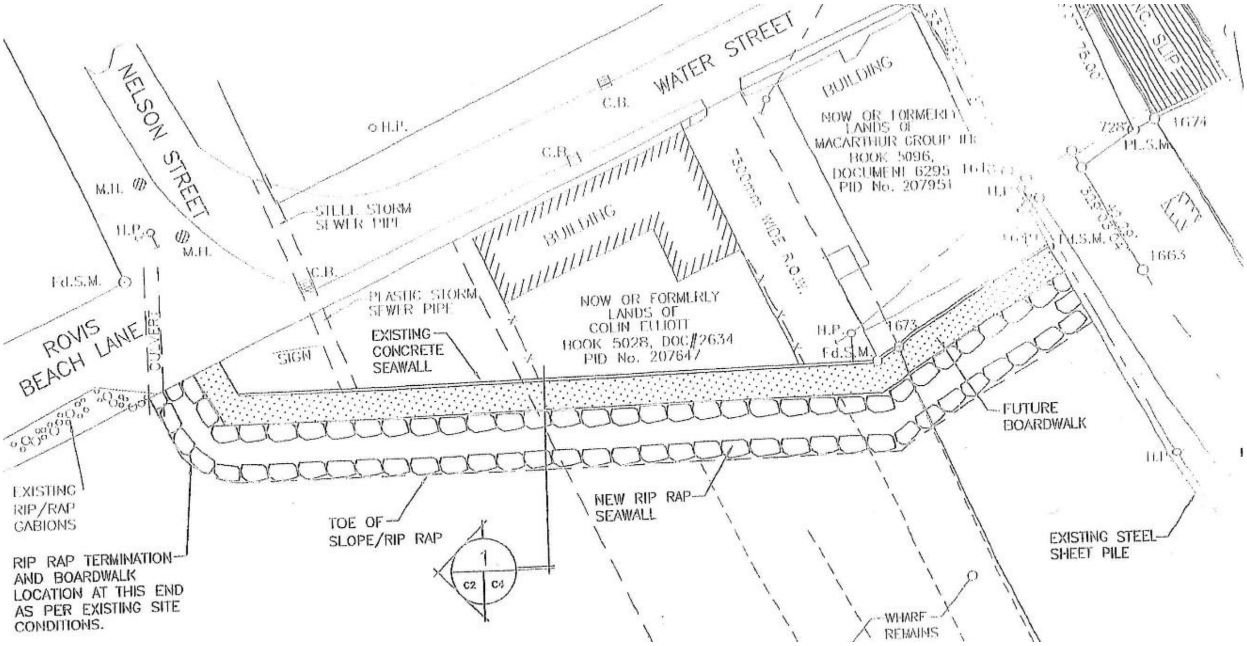


Figure 2. Bird's-eye view of the proposed rubble mount seawall design for the Community of Victoria, PE waterfront. Note: the design is by others.

2.0 HABITAT SURVEY

2.1 PURPOSE

The purpose of the habitat survey portion of this Project was to (1) provide a detailed description of the biological characteristics (*i.e.,* habitat types and flora & fauna observed in each habitat) that occur within the footprint of the proposed rubble mound seawall and immediately surrounding it (*i.e.,* the Key Study Area; Figure 3), and (2) describe how unique the habitats observed within the Key Study Area are as compared to the surrounding area.

This habitat survey will be a valuable resource when applying for the environmental permits that will be required before construction on this Project can occur (*e.g.,* Department of Fisheries and Oceans Fisheries Act Authorization, Transport Canada Navigation Protection Program application, etc.).

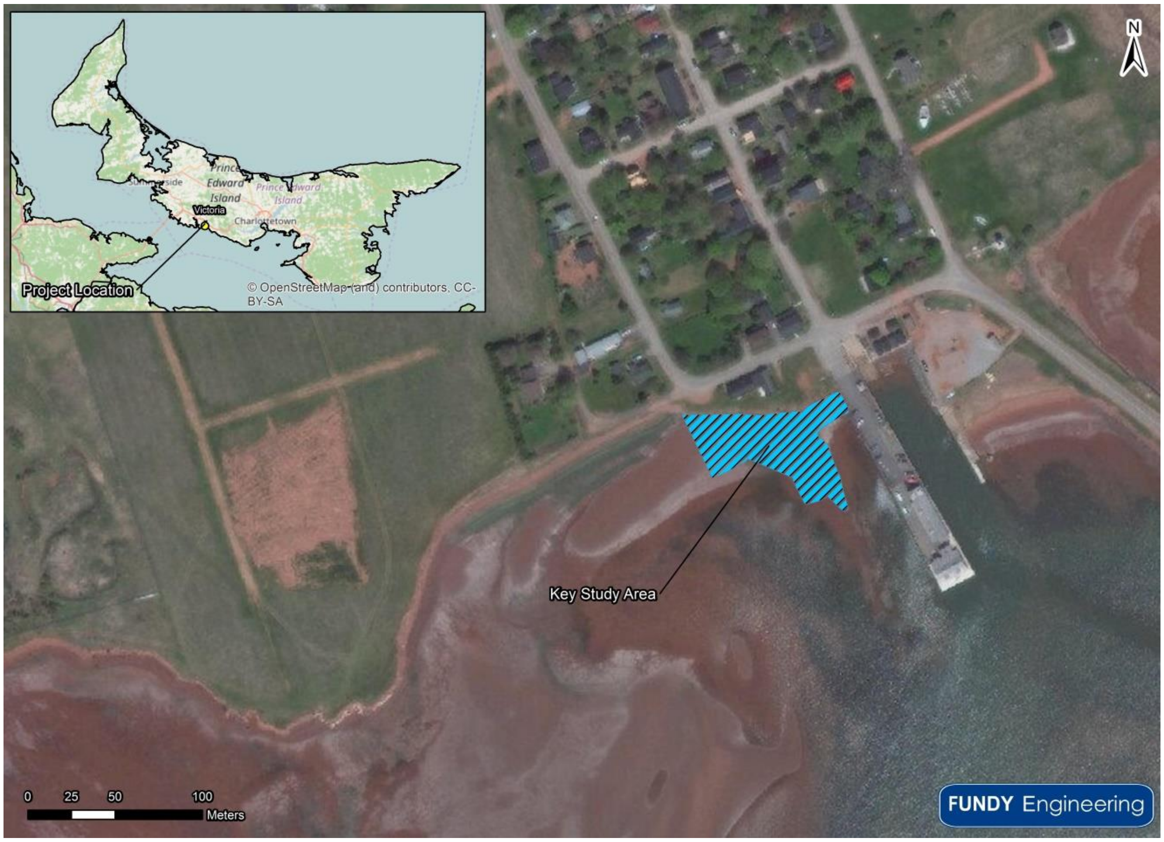
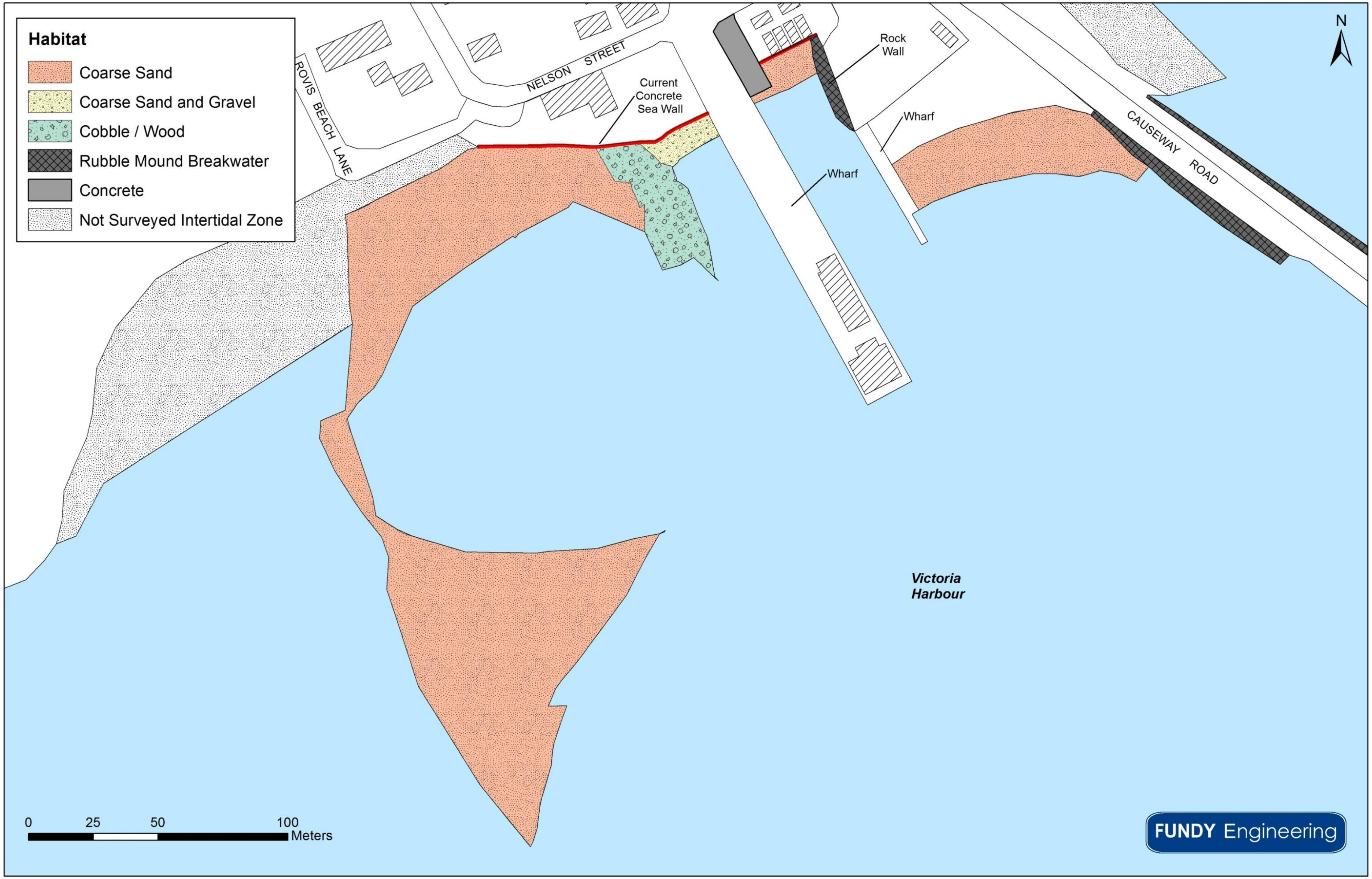


Figure 3. The Key Study Area for the habitat survey on the Community of Victoria, PE waterfront.

2.2 HABITAT TYPES

Three habitat types were observed within the Key Study Area: Coarse Sand, Coarse Sand and Gravel, and Cobble and Wood. In addition, the larger surveyed area also included two other habitats, a concrete launch ramp and rubble mound breakwater. An overall view of the habitat types within the survey area at the Community of Victoria waterfront is found in Figure 4, and detailed descriptions of the substrate, and flora and fauna observed in each habitat are described in detail below.

Figure 4. (On next page)The location of each of the habitat types within the surveyed area of the Community of Victoria waterfront in April 2017.


Habitat
Coarse Sand
Coarse Sand and Gravel
Cobble / Wood
Rubble Mound Breakwater
Concrete
Not Surveyed Intertidal Zone
ROVIS BEACH LANE
NELSON STREET
Current Concrete Sea Wall
Rock Wall
Wharf
Wharf
CAUSEWAY ROAD
N
Victoria Harbour
0 25 50 100 Meters
FUNDY Engineering

Course Sand

In both the Key Study Area (Figure 3) and the general area (Figure 4) course sand was the most predominant habitat type. The sand was visually uniform in size, consistent in colour across the site, and was firm and dry in the intertidal zone (Figure 5).

Figure 5. A representation of the course sand habitat observed at the Community of Victoria waterfront in April 2017.

Generally uniform sand beaches are not productive habitats, and this was the case for the three separate course sand areas within the study area.

The only live flora and fauna observed were clustered around rocks, which were predominantly found higher in the intertidal. Common periwinkles (*Littorina littorea*), which are a very common species in Atlantic Canada found in a wide variety of habitats, were observed on or around rocks (Figure 6). Spiral wrack (*Fucus spiralis*), a very common marine algae species in Atlantic Canada was found with their holdfasts attached to rocks and other hard surfaces (*i.e.,* wood, etc) (Figure 6).

Figure 6. Live species observed within the course sand habitat observed at the Community of Victoria waterfront in April 2017: Common periwinkles (*Littorina littorea*) [on left], spiral wrack (*Fucus spiralis*) [on right].

In addition to the live species observed, indications that other species lived in the region were observed. This included common oyster (*Crassostrea virginica*), hard clam (*Mercenaria mercenaria*) and razor clam (*Ensis directus*) shells (Figure 7); no live bivalves or any siphon holes were observed within any of the three course sand areas surveyed. As well spiral wrack (*Fucus spiralis*) and eelgrass (*Zostera marina*) were observed washed up on the beach (Figure 8); no live eelgrass was observed in the course sand habitat.

Figure 7. Bivalve shells observed within the course sand habitat observed at the Community of Victoria waterfront in April 2017: common oyster (*Crassostrea virginica*) [top left], hard clam (*Mercenaria mercenaria*) [top right] and razor clam (*Ensis directus*) [bottom].

Figure 8. Washed up eelgrass (*Zostera marina)* observed within the course sand habitat observed at the Community of Victoria waterfront in April 2017.

Course Sand and Gravel

The course sand and gravel section was a small habitat which is located directly adjacent to the wharf (Figure 4). While this habitat likely started off as a course sand beach, it is now covered with gravel, rocks, broken pieces of seawall and broken pieces of asphalt (Figure 9).

Figure 9. A view of the course sand and gravel habitat observed at the Community of Victoria waterfront in April 2017.

Both common periwinkles (*Littorina littorea*) and spiral wrack (*Fucus spiralis*), were observed on the rocks within the course sand and gravel habitat (Figure 6). Many smashed bivalve shells were also observed.

Cobble and Wood

The cobble and wood habitat observed on the Community of Victoria, PE waterfront appears to be manmade, and a review of historical aerial photographs back to 1935 (Appendix 1) suggests that it was an old wharf or breakwater that is now destroyed and lies entirely below the high water mark (Figure 10). This habitat consists of a wood lattice structure filled with cobbles (Figure 11) and supports a variety of marine invertebrates due to all the hard surfaces to which they can attach.

Figure 10. A view of the cobble and wood habitat, presumably a manmade former wharf or breakwater based upon a review of historical aerial photographs, from the wharf at the Community of Victoria waterfront in April 2017.

Figure 11. A close-up view of the cobble and wood habitat, presumably a manmade former wharf or breakwater based upon a review of historical aerial photographs.

The cobble and wood habitat supported a variety of species (Figure 11 & Figure 12), including the northern rock barnacle (*Balanus balanoides*) which is a common and abundant species in Atlantic Canada, common periwinkles (*Littorina littorea*), and blue mussels (*Mytilus edulis*) which is a common species in Atlantic Canada. As well, a single common oyster (*Crassostrea virginica*) was observed.

Figure 12. A view of the species located within the cobble and wood habitat, including the northern rock barnacle (*Balanus balanoides*), common periwinkles (*Littorina littorea*), and blue mussels (*Mytilus edulis*).

Concrete Launch Ramp

The concrete launch ramp is located directly adjacent to the wharf (Figure 13). This habitat supported a large population of common periwinkles (*Littorina littorea*), which were observed in any cracks in the concrete (Figure 14). As well common periwinkles (*Littorina littorea*), blue mussels (*Mytilus edulis)* and common oysters (*Crassostrea virginica*) were observed on the steel retaining wall of the wharf (Figure 14).

Figure 13. View of the concrete launch ramp adjacent to the wharf on the Community of Victoria, PE waterfront.

Figure 14. Species observed on the concrete launch ramp and the adjacent steel breakwater of the wharf on the Community of Victoria, PE waterfront. Common periwinkles (*Littorina littorea*), were observed in any cracks in the concrete [on left]. As well common periwinkles (*Littorina littorea*), blue mussels (*Mytilus edulis)* and common oysters (*Crassostrea virginica*) were observed at the base of the seawall [on right].

Rubble Mound Breakwater

Within the larger study area (Figure 4) there were two sections of rubble mound breakwater that were observed (Figure 15), which is similar to the habitat that will be created if the proposed rubble mound seawall is constructed as planned (Figure 2).

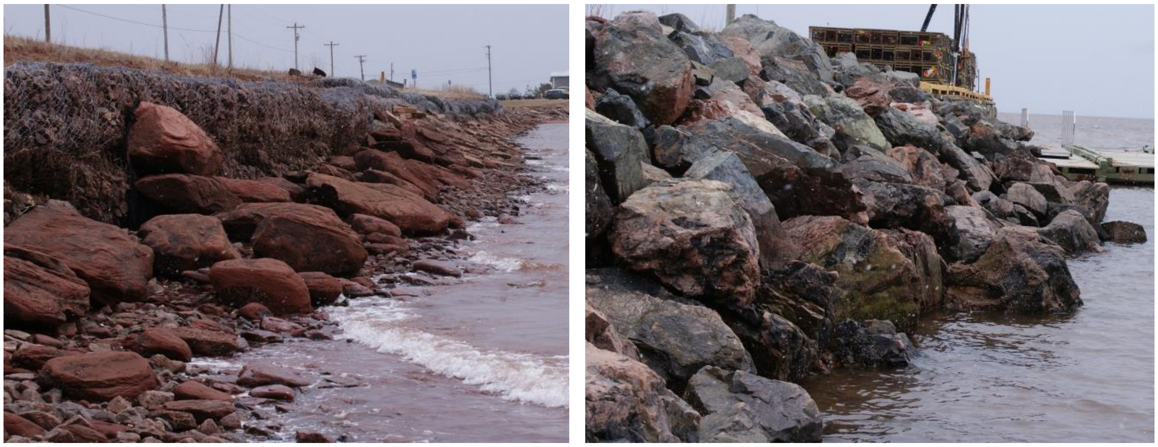


Figure 15. Two sections of rubble mound breakwater observed on the Community of Victoria, PE waterfront. One section was a combination of cobbles and boulders, which was adjacent to hwy 116 [on left], the other was adjacent to the concrete launch ramp and the smaller wharf [on right].

The rocks of the rubble mound breakwaters supported a variety of species, including the northern rock barnacle (*Balanus balanoides*), common periwinkles (*Littorina littorea*), blue mussels (*Mytilus edulis)* and common oysters (*Crassostrea virginica*) were observed on the rubble mound breakwaters (Figure 16).

Figure 16. A close up of a protected area between a couple of large boulders that make up the rubble mound breakwater on the Community of Victoria, PE waterfront. While the northern rock barnacle (*Balanus balanoides*) was most common, common periwinkles (*Littorina littorea*), blue mussels (*Mytilus edulis)* and common oysters (*Crassostrea virginica*) were also observed.

2.3 CONCLUSION

Overall, no species or habitats observed within the Key Study Area (Figure 3) were rare or unique as compared to both the larger study area (Figure 4) and the southern Gulf of St. Lawrence around Prince Edward Island. Based upon this study we can conclude that no important fish (including shellfish) or fish habitats will be impacted if the proposed rubble mound breakwater were to be constructed, due to the small footprint of the proposed wall as well as the habitats which would be impacted. Based on the observations of all the different habitats around the Community of Victoria, PE waterfront, changing a portion of the course sand habitat into rubble mound breakwater habitat may actually result in an increase in species abundance in the area.

4.0 GEOTECHNICAL INVESTIGATION

4.1 PURPOSE

The objective of the geotechnical investigation was to assess the subsurface conditions of the intertidal zone adjacent to the current seawall (Figure 17); within the footprint of the proposed seawall project. Additionally, this geotechnical information will be used to make recommendations for the geotechnical component of the proposed seawall project.

Figure 17 – Digging a test pit at the Community of Victoria seawall project site, August 30, 2017.

4.2 SITE WORK COMPLETED

On August 30th, 2017, four (4) test pits were completed using a track mounted excavator provided by Curran & Briggs Limited under the direction of Alex Mouland, *P.Eng., PMP*, of Fundy Engineering. The test pit locations were distributed evenly along the seaward side of the seawall such that an overall understanding of the subgrade could be attained (Figure 18).

The test pits were extended until bedrock was encountered; this occurred at a maximum depth of 3.05 metres below the ground surface.

Figure 18 – The location of the four test pits, and the height above Mean Low Water of each, at the Community of Victoria Seawall site.

4.3 SOILS ENCOUNTERED

Soils encountered in this geotechnical investigation can generally be described as **Loose Red SAND and GRAVEL with Cobbles** over **Loose Black Silty SAND with Wood Debris** over **Compact Red COBBLES and BOULDERS with some Sand** over **Red Sandstone BEDROCK** (Figure 19, Figure 20).

Figure 19 - Wood Debris from Old Wharf encountered in a test pit at the Community of Victoria proposed seawall site.

Figure 20 - Typical soils encountered at the Community of Victoria proposed seawall site.

4.4 BEDROCK

Bedrock was encountered in all of the test pits at depths of between 2.70 and 3.05 metres below the ground surface. Details of the bedrock depth at each test pit can be found in Appendix 3.

4.5 GROUNDWATER

Groundwater was encountered in test pits one and two at a depth of 1.52 and 1.22 metres respectively below ground surface. Groundwater was not encountered in test pits three and four.

4.6 RECOMMENDATIONS

4.6.1 GENERAL

Based on the observations made during the geotechnical investigation and our understanding of the proposed seawall project, at a minimum, the removal of the **Loose Red SAND and GRAVEL with Cobbles** and **Loose Black Silty SAND with Wood Debris** will be required**.** Any materials which are suspected to have been part of a previous wharf structure should be removed.

4.6.2 SITE PREPARATION

Once the excavation has reached the required elevation it is recommended that a Geotechnical Engineer inspect the site to confirm that all unsuitable materials have been removed.

The insitu soil is frost susceptible and should be protected from freezing during construction. Equipment travel and standing water on any exposed insitu soils within the foundation footprints should be limited as they can soften when moisture contents are elevated.

Surface water should be directed away from excavations to prevent any disturbance of the bearing soils which may be susceptible to water softening. Construction traffic should also be minimized within the excavated areas as the bearing surface is approached to prevent the mobilization of the bearing material at the surface.

Prior to placement of any engineered Fills and after the excavation of unsuitable materials, the insitu subgrade should be proof rolled under the supervision a geotechnical engineer.

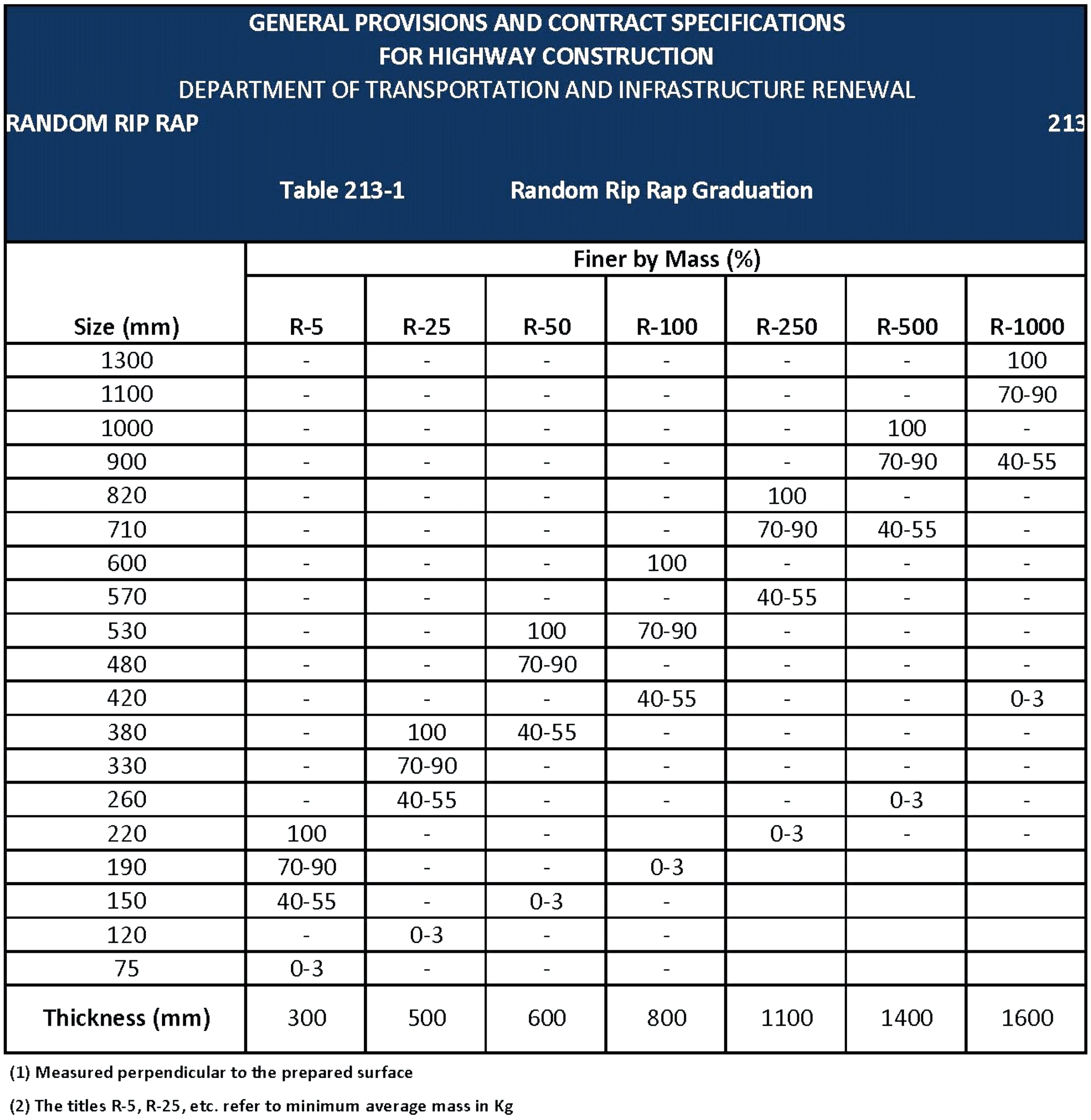
4.6.3 RUBBLE SEA WALL CONSTRUCTION

Based on the observations made in the field, the recommended bearing soils for the reconstructed sea wall is **Red Sandstone Bedrock or Compact Red Silty SAND**.

Any soft areas that are identified should be removed and replaced with compacted **Structural Fill**.

Recommended Structural Fill materials (Figure 21) for the construction of the sea wall are:

- Armour stone (PEIDTIE Table 213-1 Random Rip Rap R-500)
- Filter Stone (PEIDTIE Table 213-1 Random Rip Rap R-100)
- Sandstone Fill (PEIDTIE Table 213-1 Random Rip Rap R-5)



GENERAL PROVISIONS AND CONTRACT SPECIFICATIONS
FOR HIGHWAY CONSTRUCTION
DEPARTMENT OF TRANSPORTATION AND INFRASTRUCTURE RENEWAL
RANDOM RIP RAP **213**

Table 213-1 **Random Rip Rap Graduation**

	Finer by Mass (%)						
Size (mm)	**R-5**	**R-25**	**R-50**	**R-100**	**R-250**	**R-500**	**R-1000**
1300	-	-	-	-	-	-	100
1100	-	-	-	-	-	-	70-90
1000	-	-	-	-	-	100	-
900	-	-	-	-	-	70-90	40-55
820	-	-	-	-	100	-	-
710	-	-	-	-	70-90	40-55	-
600	-	-	-	100	-	-	-
570	-	-	-	-	40-55	-	-
530	-	-	100	70-90	-	-	-
480	-	-	70-90	-	-	-	-
420	-	-	-	40-55	-	-	0-3
380	-	100	40-55	-	-	-	-
330	-	70-90	-	-	-	-	-
260	-	40-55	-	-	-	0-3	-
220	100	-	-		0-3	-	-
190	70-90	-	-	0-3			
150	40-55	-	0-3	-			
120	-	0-3	-	-			
75	0-3	-	-	-			
Thickness (mm)	300	500	600	800	1100	1400	1600

(1) Measured perpendicular to the prepared surface

(2) The titles R-5, R-25, etc. refer to minimum average mass in Kg

Figure 21 - PEIDTIE Table 213-1 Random Rip-Rap Gradation

All Structural Fill material placed within the foundation footprint should be compacted in lifts to 95% of its Standard Proctor Maximum Dry Density. The lift thickness must be compatible with the compaction equipment used. A maximum lift thickness of 300 mm is recommended for any Sandstone Fill materials placed within the seawall.

A non-woven geofabric such as a Terrafix 270R (or equivalent) is recommended as a silt barrier between the insitu soils, the Sandstone Fill and the Armour & Filter Stone layers. It should be installed as per the manufacture's recommendations and as shown in Figure 22 and attached in Appendix 4.

It is recommended that removal of all unsuitable materials and the placement of Structural Fills be monitored continuously by a Geotechnical Engineer.

If construction is completed during freezing conditions refer to Appendix 5, “Geotechnical Guidelines/Recommendations for Winter Construction” for details on winter construction recommendations.

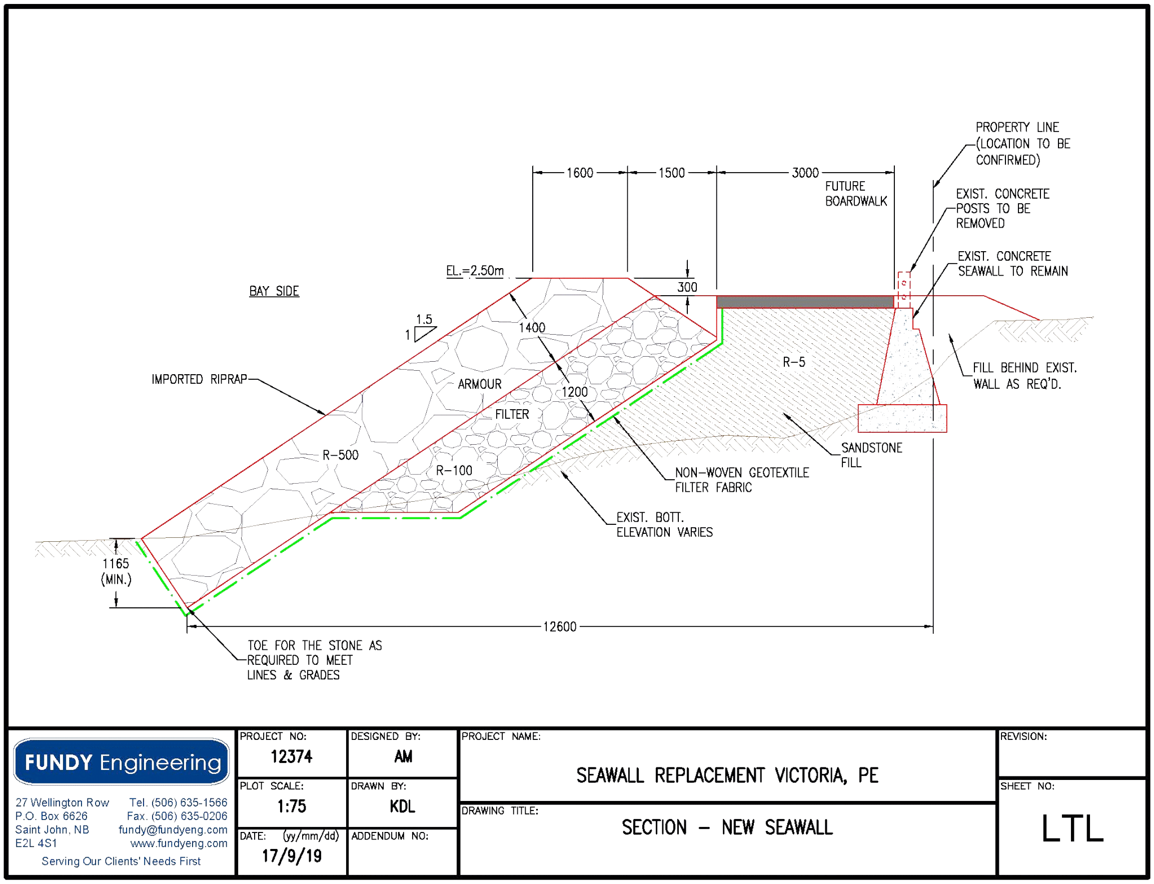


Figure 22 – Proposed Seawall Cross Section

4.7 LIMITATIONS

The observations made and facts presented in this report are based on site visits carried out in August, 2017. 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.

5.0 TOPOGRAPHIC SURVEY

A topographic survey was completed using a differential GPS provided by Curran & Briggs Limited under the direction of Donnie Taweel, of Fundy Engineering. The topographic survey collected location and elevation data along the seaward and landward sides of the seawall such that an overall understanding of the site topography could be understood. A site plan illustrating the approximate elevation contours of the subject site is included below (Figure 23).

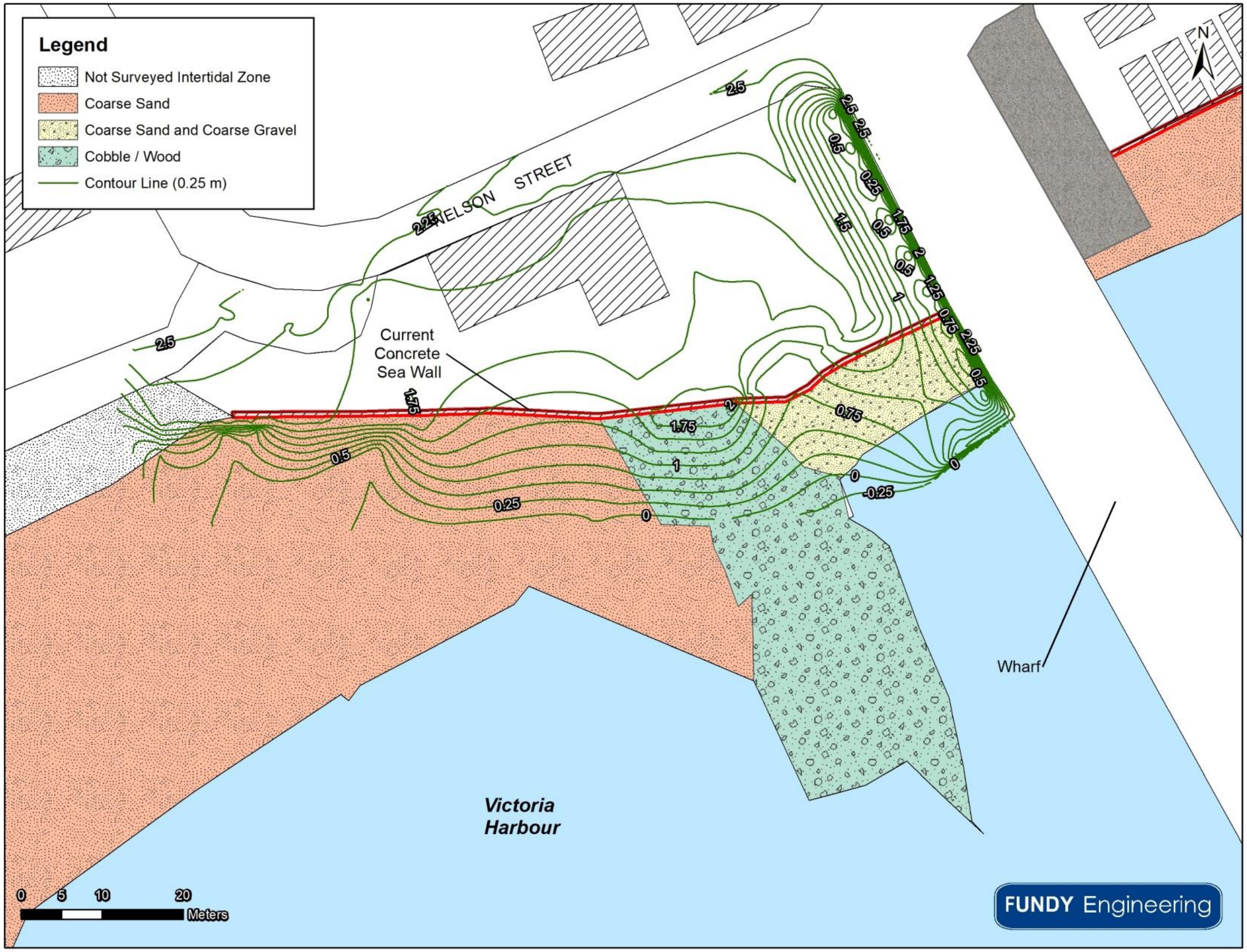


Figure 23 – Topographic survey results for the Community of Victoria Seawall Site. Existing deteriorating seawall is indicated in red.

6.0 CLOSING

We trust this report of the biological and geotechnical survey conducted at the Community of Victoria proposed seawall site 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 was jointly prepared by Mr. Bryan Morse, *M.Sc., BSc, EPt,* and Mr. Alex Mouland, *P.Eng., PMP*, of Fundy Engineering.

Respectfully submitted,

THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF PRINCE EDWARD ISLAND
VALID FOR THE YEAR 2017
G. Alex Mouland
No. 1730
DATE: Sept. 20/2017
LICENSED PROFESSIONAL ENGINEER
PROVINCE OF PRINCE EDWARD ISLAND

Alex Mouland, *P.Eng., PMP*

Bryan Morse, *M.Sc., BSc, EPt*

Appendix 1 – Historical Aerial Photographs

1935 Aerial Photograph of the Community of Victoria, PE Waterfront

1958 Aerial Photograph of the Community of Victoria, PE Waterfront

1974 Aerial Photograph of the Community of Victoria, PE Waterfront

1990 Aerial Photograph of the Community of Victoria, PE Waterfront

2000 Aerial Photograph of the Community of Victoria, PE Waterfront

Appendix 2 – 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

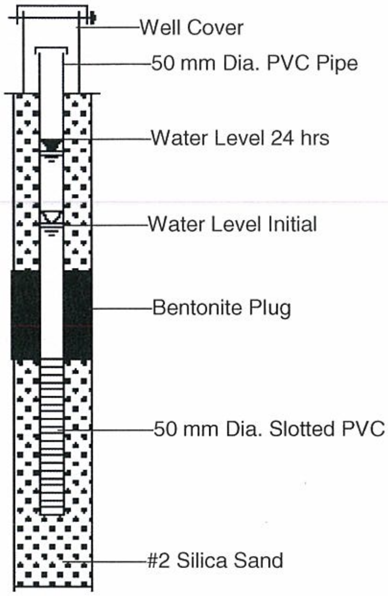
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer test, unconfined compression tests, or occasionally by standard penetration tests.

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 3 – Test Pit Logs

FUNDY Engineering

BOREHOLE LOG
No. TP1

PROJECT: Victoria Seawall Test Pit **PROJECT NO.:** 12374

CLIENT: Community of Victoria

PROJECT LOCATION: Victoria Seaawall **ELEVATION:** .808 m

DRILLING CONTRACTOR:

LOGGED BY: Devan Thomas **CHECKED BY:** Al Mouland

DRILLING METHOD: Truck Mounted Excavator **DATE:** 30/08/17

DEPTH TO - WATER> INITIAL: ▽ 1.52 **AFTER 24 HOURS:** ▼ **CAVING>** C

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

Depth (meters)	Depth (feet)	Description	Graphic	Sample Type	Sample No.	Sample Rec. (cm)	Blow Counts (N value)	RQD (%)	Undrained Shear Strength (kPa)	% < #200	TEST RESULTS SUMMARY
0	0	Loose Red SAND and GRAVEL with Cobbles									
0.32											
	1.28										
0.64		Loose Black Silty SAND with Wood Debris from Old Wharf									
	2.56										
0.96											
	3.84										
1.28											
	▽										
	5.12										
1.6											
1.92											
	6.4										
		Compact Red COBBLES with some Sand									
2.24											
	7.68										
2.56											
	8.96	Red Sandstone BEDROCK									
2.88											
		Boring terminated at 3 m.									

TEST RESULTS SUMMARY

Bedrock Core Recovery (%) ⌖

RQD (%) ▲

Plastic Limit ├──┤ Liquid Limit

Water Content - ●

SPT N Values - ■

20 40 60 80

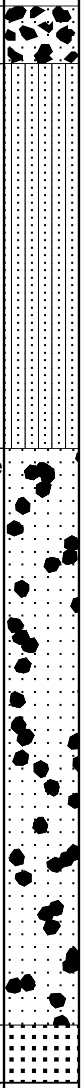
FUNDY Engineering

BOREHOLE LOG
No. TP2

PROJECT: Victoria Seawall Test Pit
PROJECT NO.: 12374
CLIENT: Community of Victoria
PROJECT LOCATION: Victoria Seaawall
ELEVATION: .515 m
DRILLING CONTRACTOR:
LOGGED BY: Devan Thomas
CHECKED BY: Al Mouland
DRILLING METHOD: Truck Mounted Excavator
DATE: 30/08/17
DEPTH TO - WATER> INITIAL: ∇ 1.22
AFTER 24 HOURS: ▼
CAVING> C

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

Depth (meters)	Depth (feet)	Description	Graphic	Sample Type	Sample No.	Sample Rec. (cm)	Blow Counts (N value)	RQD (%)	Undrained Shear Strength (kPa)	% < #200
0	0	Loose Red SAND and GRAVEL with some Cobbles								
0.32	1.28	Loose Red and Black Silty SAND with Wood Debris from Old Wharf								
0.64	2.56									
0.96										
	3.84	Loose Red COBBLES with some Sand								
1.28										
1.6	5.12									
1.92	6.4									
2.24	7.68									
2.56										
	8.96	Red Sandstone Bedrock at 2.65m								
		Boring terminated at 2.8 m.								



TEST RESULTS SUMMARY

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

20 40 60 80

FUNDY Engineering

BOREHOLE LOG No. TP3

PROJECT: Victoria Seawall Test Pit **PROJECT NO.:** 12374
CLIENT: Community of Victoria
PROJECT LOCATION: Victoria Seaawall **ELEVATION:** .478 m
DRILLING CONTRACTOR:
LOGGED BY: Devan Thomas **CHECKED BY:** Al Mouland
DRILLING METHOD: Truck Mounted Excavator **DATE:** 30/08/17
DEPTH TO - WATER> INITIAL: ∇ **AFTER 24 HOURS:** ▼ **CAVING>** C

TEST RESULTS SUMMARY
Bedrock Core Recovery (%) ⌖
RQD (%) ▲
Plastic Limit |——| Liquid Limit
Water Content - ●
SPT N Values - ■
20 40 60 80

Depth (meters)	Depth (feet)	Description	Graphic	Sample Type	Sample No.	Sample Rec. (cm)	Blow Counts (N value)	RQD (%)	Undrained Shear Strength (kPa)	% < #200	TEST RESULTS SUMMARY
0 0.32	0 1.28	Loose Red SAND with Black Sand seams and some Gravel and Cobbles	▨								
0.64 0.96 1.28 1.6 1.92 2.24 2.56	2.56 3.84 5.12 6.4 7.68 8.96	Compact Red Silty SAND with some Gravel and Cobbles Red Sandstone BEDROCK	▨								
2.88		Red Sandstone Bedrock	▨								
		Boring terminated at 2.9 m.									

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

FUNDY Engineering

BOREHOLE LOG
No. TP4

PROJECT: Victoria Seawall Test Pit **PROJECT NO.:** 12374
CLIENT: Community of Victoria
PROJECT LOCATION: Victoria Seaawall **ELEVATION:** .522
DRILLING CONTRACTOR:
LOGGED BY: Devan Thomas **CHECKED BY:** Al Mouland
DRILLING METHOD: Truck Mounted Excavator **DATE:** 30/08/17
DEPTH TO - WATER> INITIAL: ▽ **AFTER 24 HOURS:** ▼ **CAVING>** C

Depth (meters)	Depth (feet)	Description	Graphic	Sample Type	Sample No.	Sample Rec. (cm)	Blow Counts (N value)	RQD (%)	Undrained Shear Strength (kPa)	% < #200
0	0	Loose Red SAND	⁘							
		Loose Black Silty SAND with Gravel and Cobbles	⁞							
		Compact Red Silty SAND with Gravel and Cobbles	⁞							
		Red Sandstone Bedrock	⁙							
		Boring terminated at 3.15 m.								

Depth (meters): 0, 0.32, 0.64, 0.96, 1.28, 1.6, 1.92, 2.24, 2.56, 2.88

Depth (feet): 0, 1.28, 2.56, 3.84, 5.12, 6.4, 7.68, 8.96, 10.24

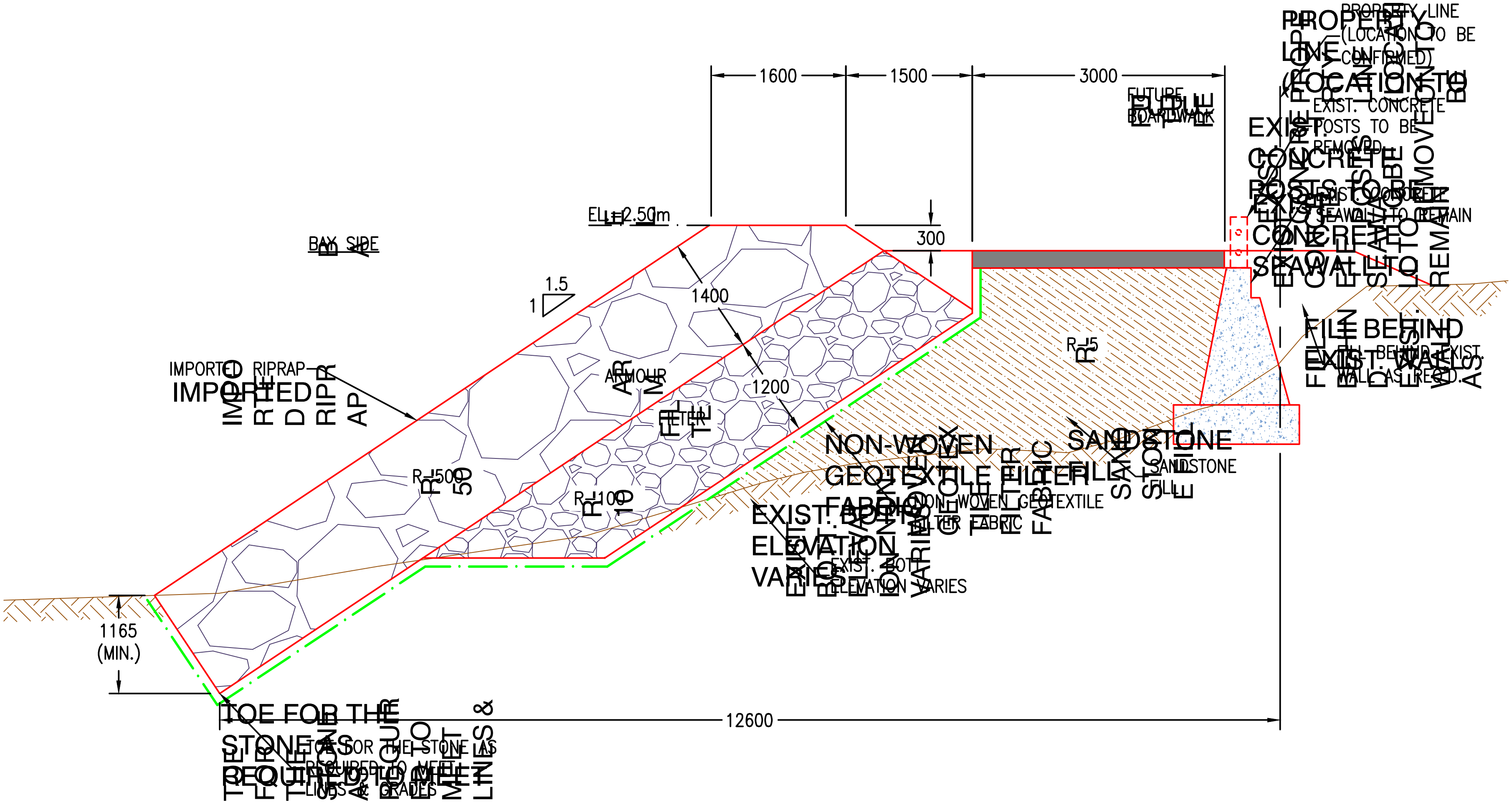
TEST RESULTS SUMMARY

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 4 – Proposed Seawall Cross Section



FUNDY Engineering

27 Wellington Row
P.O. Box 6626
Saint John, NB
E2L 4S1

Tel. (506) 635-1566
Fax. (506) 635-0206
fundy@fundyeng.com
www.fundyeng.com

Serving Our Clients' Needs First

PROJECT NO: 12374	DESIGNED BY: AM	PROJECT NAME: SEAWALL REPLACEMENT VICTORIA, PE	REVISION:
PLOT SCALE: 1:75	DRAWN BY: KDL		SHEET NO: LTL
DATE: (yy/mm/dd) 17/9/19	ADDENDUM NO:	DRAWING TITLE: SECTION - NEW SEAWALL	

Appendix 5 – Geotechnical Guidelines / Recommendations for Winter Construction

Geotechnical Guidelines/Recommendations for Winter Construction

Construction during winter months exposes a construction project to freezing temperatures and other weather events, such as snow, which can have a detrimental effect on Engineered Fill and concrete construction activities. Therefore it is recommended that some extra work be undertaken to protect these construction elements during winter construction.

The following sections outline a set of guidelines for concrete and earthwork construction activities in cold weather.

Excavation

Insitu soils, such as root mat or topsoil can act as natural insulators and can protect the underlying soils from frost. Therefore excavation activities should be limited to sections which can be filled over before the end of the working day.

It is **NOT** recommended that Fills to be used at a later date be stockpiled on site during freezing conditions. They should be placed and compacted immediately.

Fill Type

A well-graded material with sand content of 30% or over is **NOT** recommended for use as Fills in freezing temperatures. Clear stone or rock fills are not as susceptible to freezing and are therefore recommended as they will remain workable for a longer period of time.

Fill Placement Methods

Fill placement should be conducted in small areas such that it can be completed in the area by the end of the working day. The area should be small enough to allow for the subsequent lift to be placed over compacted unfrozen material.

Material that contains snow and/or ice should not be allowed to be placed in a Fill. If a snow event occurs during Fill procedures the snow should be removed before any additional material can be placed. It is recommended that the surface of the Fill under the snow should be removed to ensure that all the snow and ice has been removed.

For areas that will require additional Fill but must be left for a long period of time (ex. overnight) frost protection should be provided to the placed Fill in the form of straw, insulated blankets, or some other approved measure. If frost protection is not available then any frozen material at or near the top of the lift should be removed and wasted before fill placement resumes.

Underside of slabs, footings and any other ‘final’ Fill surface should be protected from frost. If frost protection is not possible then the soil should be thawed prior to placing footings, slabs, etc. I it is suspected that the soil is frozen then some limited excavations should be undertaken to determine the temperature prior to pouring concrete or placing additional Fills. Any areas that have been determined to be frozen should be removed and replaced with new compacted materials.

All slopes and edges of Fills should be tamped or compacted to reduce frost penetration.

During compaction of Fills the soil temperature should be greater than 2°C. Any Fills below this temperature will not achieve the theoretical maximum compaction density and should therefore be removed.

Footings

Building footings should **NEVER** be placed on frozen Fill.

If the foundation design recommends that footings be placed on insitu soils, but those soils are fine grained, it is recommended that below the footings an over-excavation of approximately 6 inches be completed to allow for a base of 25mm clear stone be placed.

Once the footings have been placed they should be protected from cold weather with insulated blankets, hay or some approved means. The frost protection should extend beyond the footings to also protect the surrounding bearing soils.

During cold weather the depth of interior footings should be dropped to 1.2 metres below ground surface for frost protection. If lowering the footings is not possible then some other approved method of protecting the interior footings is recommended.

Foundations should be backfilled with free-draining granular materials that will not hold moisture.

Inspection and Testing

The above document is intended as a set of guidelines for geotechnical winter construction in general. A strategy for winter construction will be required for each individual site. It is recommended that prior to beginning any winter earthwork construction the services of a qualified geotechnical engineering company be engaged to develop a customized plan a specific site. Testing and inspection services by a geotechnical engineering company are especially important during winter geotechnical construction activities. A plan developed with the expertise of a Geotechnical Engineer will reduce harmful procedures and mistakes and will allow construction activities to continue during cold weather without unexpected delays and costs.