Interim Report

Conceptual Design

Training Wall Reconstruction

Le Goulet Harbour

Le Goulet, NB

by:

Valron Engineers Inc.

November 12, 2013

Valron File: 13209

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INTERIM REPORT

Conceptual Design – Training Wall Reconstruction
Le Goulet Harbour, Le Goulet, NB

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INTERIM REPORT

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Le Goulet Harbour, Le Goulet, NB

INTRODUCTION:

Further to directions from PWGSC, as sub-consultant to GEMTEC, conceptual design has been carried out on various options currently being considered for the reconstruction of the channel training wall at the Le Goulet Harbour.

Initially, the mandate for this work was scoped out as follows:

1.0 Evaluate the viability of the primary option, involving the installation of a concrete encasement/cope wall on the present steel sheet pile walls of Structures 302 and 304. Assess construction methods to advance this option considering safety, contractor risk, and exposure to the sea. This conceptual design to address:
   a) use of temporary cofferdams to protect work,
   b) alternative arrangement of cope wall, i.e can cope wall be installed on the inside face of the SSP ?,
   c) priority of construction,
   d) initial construction cost estimates.

2.0 Provide a comparison of the cost and life span between the concrete encasement cope wall and a new SSP wall on the seaward side of the structures.

On September 26, the initial results of the study were presented at a meeting with PWGSC and SCH-DFO. Based on these findings, as per Meeting No.1 minutes, it was agreed that the concept design development should focus on the following reconstruction options:

Option 1: The construction of a concrete cope wall on both sides of the existing structures, complete with pinning and scour protection at the toe of the existing SSP wall.

Option 2: The installation of a new SSP face on both sides of the existing structures.

Option 3: The installation of a new SSP face on the channel side and a cope wall on the harbour side of the existing structures.

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Option 4: The installation of armour stone revetment on the harbour side of the existing structures where berthing is not required. (For evaluation purposes, it was assumed that revetment extends for one half the length of Structure 302).

It is understood that the NRC modelling for the training wall is based on a channel depth of – 4.0 metres Chart Datum and a vertical flat wall on the channel face of the structures. Confirmation of original design dredge depth is required to determine if this depth is feasible in respect to the concrete encasement reconstruction option. The original structures may not all have been designed for this, or the current channel dredge depth.

The condition assessment of Structures 302 and 304 in 2012 determined that reconstruction using concrete encasement was feasible, from a structural perspective, based on the locations and extent of deterioration of the SSP. The reconstruction of the structures with concrete encasement could extend the life of the SSP for a further 20 years, based on historic rates of corrosion. However, due to the high currents and severe weather conditions, this option for reconstruction may not be the best approach. Alternative reconstruction using SSP is another option that bears consideration due to increased life expectancy and potential lower risks due to difficulties of construction, and safety. The use of concrete encasement on the shallower, more protected harbour side, and SSP on the channel side may be cost effective. Introduction of rock revetment along a portion of the harbour side of the structure may also result in potential cost savings.

For comparison purposes, the consideration of the use of SSP with a targeted design life of 25 years was made in the costing of this option using alternative means of corrosion protection; sacrificial material thickness, concrete encasement of the splash zone down to below low water, and cathodic protection.

As agreed at the review meeting, the above options for the reconstruction were developed further and costing prepared. This was to be based on geotechnical information as obtained from the original construction drawings.

ORIGINAL CONDITIONS:

Confirmation of the original design was carried out by evaluating the various depths of SSP sections in relation to the soil conditions indicated by the borehole logs shown on the construction drawings. As conditions and toe depths vary along the length of the structure, this involved multiple analyses. The results of this evaluation are presented graphically on drawing A1. This shows the maximum design depth of channel based on a corrosion allowance for material loss of 0.3 mm per year at the critical sections for a 25 year original design life. As can be seen, the evaluation analysis confirmed that the original design provided adequate stability along the entire length of the structure, with the maximum allowable design depth at the most

.../3

critical section determined to be just below the original channel depth of – 2.13 m (- 7.0 feet). Based on the above, costing of Option 1, involving the concrete encasement of the existing SSP, allowed for a build-up of the sea bottom along the face of the wall.

Drawing A2 shows the maximum design depth of channel based on extending the design life by 20 years, (from time of evaluation in 2012). This is based on the historic rates of corrosion determined from the loss of section since original construction.

In order to provide a channel dredge depth of – 4.0 metres for reconstruction as per Option 1, the seabed in front of the steel sheet pile will have to be built up to provide an adequate factor of safety against kick-out. This is indicated by the shaded areas on drawing A2. In order to reconstruct the training wall by adding concrete encasement to the existing SSP wall, this additional measure must be included to address the wall stability.

ADDITIONAL GEOTECHNICAL INFORMATION:

Borehole logs are shown on the original construction drawings for both the 1967 and 1969 structures. However, their locations are not shown on the site plan. Due to recollections made from conditions of driving, and also discrepancies in the SSP toe elevations as shown in respect to the soils information indicated by the borehole logs, additional geotechnical testing is being carried out. The final geotechnical report was not available at the time of this evaluation. However, draft borehole log results provided indicate some discrepancies when compared to those found on the construction drawings.

The enclosed drawings B1 and B2, indicate the bedrock location, based on the results of the latest geotechnical study, compared to the information shown on the original construction drawings. These results would explain why there is a recollection that driving of the original SSP wall was much harder than anticipated as these latest bore holes identified sound rock at a higher elevation than the original records show.

Due to the questionable condition of the existing structure, boreholes for the most recent study were taken along the harbour side of the breakwater. The top of bedrock profile as determined along this back face is higher in some places than the dredged channel bottom along the channel face. This would suggest that the rock dips slightly from the harbour side to the channel.

The information from the recent geotechnical investigation may require re-examination of the proposed options for the training wall reconstruction and other alternatives may have to be evaluated.

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CONSTRUCTION COST ESTIMATES:

Cost estimates are presented in Appendix 'D' of this report. As can be seen from the following summary, the cathodic protected SSP option, with or without the incorporation of partial rock revetment, has a slightly lower cost than the concrete encasement.

The costing of the options assumed the replacement/installation of a concrete deck on the entire length of Structure 302. Structure 304 costs do not include a concrete deck in the construction estimate. Incorporation of a deck to prevent loss of granular material due to wave overtopping on Structure 304 is estimated at $ 260,000.00.

An allowance was carried for electrical to cover the installation of a conduit to feed navigation lights at the north and south ends of the training wall.

Construction Cost Estimates	
Option 1: Concrete Encasement – Channel and Harbour Sides	$ 8.8M
Option 2: Steel Sheet Piling – Channel and Harbour Sides	
A – Heavier Section for corrosion Protection	$ 9.5M
B – Concrete Cope Wall for corrosion protection	$11.0M
C – Cathodic System for corrosion protection	$ 8.5M
Option 3: Steel Sheet Piling – Channel Side / Concrete Encasement – Harbour Side	$ 8.5M
Option 4: Steel Sheet Piling – Channel Side / Steel Sheet Piling and Partial Rock Revetment – Harbour Side	$ 7.9M

DISCUSSION OF FINDINGS:

Option 1: Concrete Encasement – Channel and Harbour Side:

This approach is shown for the three typical structural sections, (1967, 1969 and 1987 construction), on drawings S1, S2, and S3. Due to the depth to reach sound steel for attachment to the SSP on the channel faces, the costs for this option increase from that seen for sites with lower wall heights. This option is estimated to cost $8.8M to construct. The high currents, severe weather and ice conditions would require a temporary protective enclosure structure for concrete forming and diving operations. This temporary works becomes problematic as the present structure is not considered suitable to work off of for this construction.

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In addition, the original structure was not designed for the current channel, (or future), dredge depths, requiring raising of the sea bed along the bottom of the channel side SSP, in order to provide an acceptable factor of safety for toe kick-out. Because of the shorter service life, the higher risks for construction delays and safety, and no apparent cost benefit to this option, the temporary works for its installation have not been developed further at this time.

Option 2: Steel Sheet Piling – Channel and Harbour Side:

Typical sections for this option are shown on drawings S4, S5 and S6. This option has been designed for a 25 year life. Three alternatives were explored to address corrosion protection. Increased section thickness was evaluated with an allowance for a loss of steel of 0.3 mm thickness per year at the critical sections in the splash and low water zones. A second option of protection of these critical zones using concrete encasement was also evaluated. A third option considered was the utilization of cathodic protection that would allow for use of a lighter SSP section. This lighter section may not be suitable as sound rock has been identified at a higher elevation and driving may require a heavier section. This will require further evaluation. Additional future costs associated with the cathodic protection alternative would be monitoring, maintenance, and periodic replacement of sacrificial anodes.

Installation of the SSP system would require construction operations to be operated off of a barge on the harbour side of Structure 302, or working outward from the south end of Structure 304. For the latter, the interior and exterior walls would be built concurrently and backfilled to provide a stable base for the pile driving equipment. A driving template would be utilized to control the SSP installation. This would be anchored ahead of the crane position. Reconstruction of the training wall utilizing SSP will increase the width of the structure by 2.5 to 3.0 metres to allow space between the new and old wall for installation of the waler system and tie-rods. Construction cost estimates developed for this option indicate a range of $ 8.5 M to $ 11.0 M, depending on the method of corrosion protection utilized.

This approach to the reconstruction offers the benefit of being the least affected by the weather. SSP can be installed much faster than the concrete encasement and provides for a longer service life. The replacement steel sheet piling can be repaired at the end of the 25 year period which would not be the case with the existing SSP if its life is extended by concrete encasement.

Option 3: Steel Sheet Piling – Channel Side / Concrete Encasement – Harbour Side:

A combination of a steel sheet pile wall on the channel side and concrete encasement on the harbour side was considered as a means of potential cost savings, (See drawings S7 and S8). This was found not to be the case. Construction estimates determined this to be of similar cost to the corrosion protected SSP at $ 8.5 M.

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The introduction of the two methods of construction will slow up construction. In addition, a new waler system may have to be incorporated along the harbour side if tie-rods cannot be fitted into the existing space between walers. The concurrent construction of harbour side and channel side would be slower than the use of SSP on both faces as the casting of the concrete encasement would be the slower operation.

Option 4: Steel Sheet Piling – Channel Side / Steel Sheet Piling and Partial Rock Revetment – Harbour Side:

Should it be determined that the entire length of the harbour side of Structure 302 is not required for berthing and other fishing operations, then it is possible that rock revetment could be installed as a potential cost savings. The costs of this option, assuming rock revetment for half of the length of Structure 302, is estimated at $ 7.9 M.

This option narrows up the harbour entrance and may pose a hazard to the boats entering and existing. It also prevents the option of berthing in the future should harbour operations change.

SUMMARY

Based on the above, it is our determination that the Steel Sheet Pile option for the reconstruction of structures 302 and 304 provides the most cost-effective solution of the options studied. This evaluation was based on the geotechnical information available from the 'as-constructed' drawings provided. Preliminary indications from the geotechnical investigation just being completed suggests that the actual conditions are not as originally anticipated with sound bedrock at a significantly higher elevation. Once the rock properties and design requirements are established, the viability of the SSP wall will have to be evaluated further. In order to meet the – 4.0 metre channel design depth, it is possible that difficult driving conditions will require a review of alternate wall systems such as a 'Combi-Wall' or a 'Berlin Wall', (a system of soldier piles and precast concrete wall panels).

Selection of the most appropriate reconstruction option for the training wall structures must also take into account the following:

1. The original design of the 1967 section of Structure 302 did not provide for surcharge loads from truck traffic.

2. The original design of Structure 302 appears to have been based on a design channel dredge elevation of approximately – 2.13 metres, (– 7.0 feet), chart datum.

3. The future design dredge depth is – 4.0 metres. To provide a vertical wall of this depth with a flat surface for the training action required by NRC modelling, does not allow for the stabilization of the toe by adding materials along the harbour bottom.

.../7

4. The findings of the Oct. 18, 2013 geotechnical investigation brings into question the SSP toe elevations as indicated on the original construction drawings as it would have been difficult to drive the SSP into bedrock to the depths indicated.

5. The deck of structure 304 is subject to significant wave action. Currently, wash from breaking waves appears to be eroding the surface of the gravel deck. A concrete deck may be a consideration for this portion of the structure.

Respectfully Submitted by:
VALRON ENGINEERS INC.

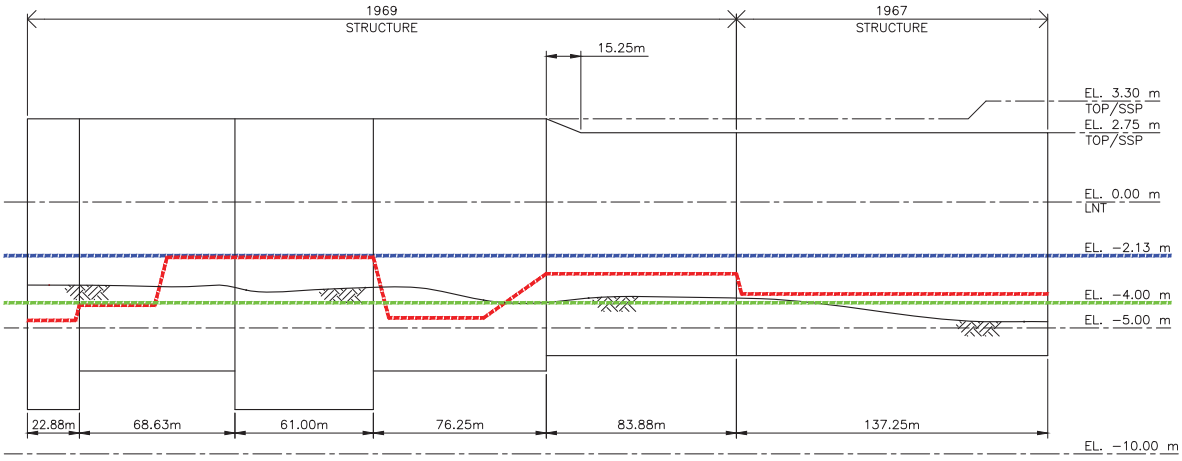
Robert Vale, P.Eng.

Appendix ‘A’

Drawings

A1 – SSP Analysis Results – Maximum Channel Depth at Wall – Original Design Conditions

A2 – SSP Analysis Results – Maximum Channel Depth at Wall – Option 1 - Future Conditions



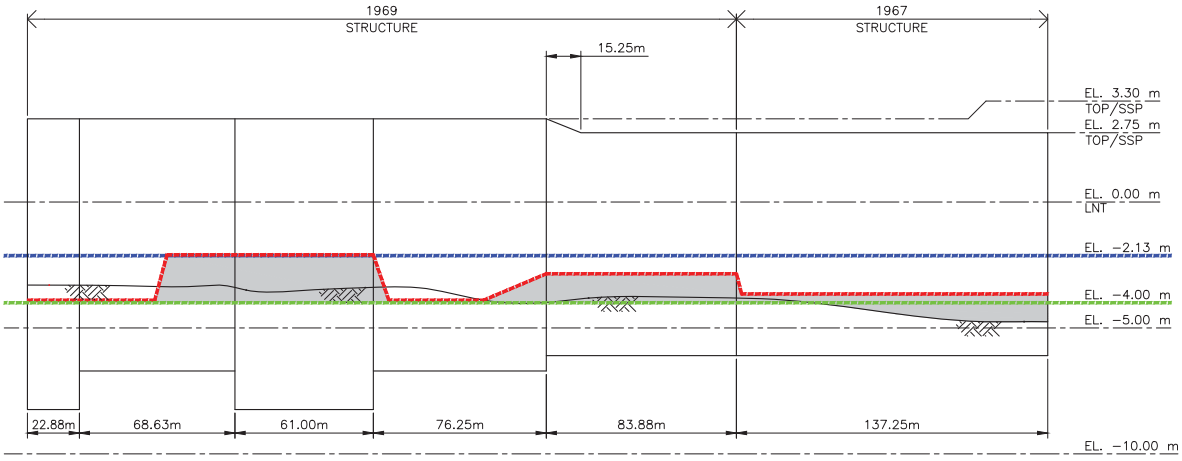
LEGEND

- APPROXIMATE CHANNEL BOTTOM (2013)
- CHANNEL DEPTH (1967)
- FUTURE CHANNEL DESIGN DEPTH
- MAXIMUM DESIGN DEPTH OF CHANNEL BASED ON ORIGINAL CONDITIONS (25 YEAR CORROSION ALLOWANCE ON SSP)

STRUCTURE 302 ELEVATION – CHANNEL SIDE

VALRON

Drawn By: RK	Checked By:
Calculations By:	Checked By:
Date: OCT., 2013	
Project: LE GOULET TRAINING WALL RECONSTRUCTION	
Drawing: SSP ANALYSIS RESULTS MAXIMUM CHANNEL DEPTHS AT WALL ORIGINAL DESIGN CONDITIONS	
Scale: N.T.S.	
File No.: 13209	Drawing: A1 / Revision No.: 0



LEGEND

- APPROXIMATE HARBOUR BOTTOM (2013)
- CHANNEL DEPTH (1967)
- FUTURE CHANNEL DESIGN DEPTH
- MAXIMUM DESIGN DEPTH OF CHANNEL OPTION 1 – CONCRETE ENCASEMENT 20 YEAR EXTENDED LIFE OF SSP
- REQUIRED INCREASE IN SEA FLOOR ELEVATION IN FRONT OF SSP (BASED ON ORIGINAL BOREHOLE INFORMATION AND SSP TOE ELEVATIONS)

STRUCTURE 302 ELEVATION – CHANNEL SIDE

VALRON

Drawn By: RK	Checked By:
Calculations By:	Checked By:
Date: OCT., 2013	

Project:
LE GOULET TRAINING WALL
RECONSTRUCTION

Drawing:
SSP ANALYSIS
RESULTS
MAXIMUM CHANNEL DEPTHS
AT WALL
OPTION 1 - FUTURE CONDITIONS

Scale: N.T.S.

File No.	Drawing	Revision No.
13209	A2	0

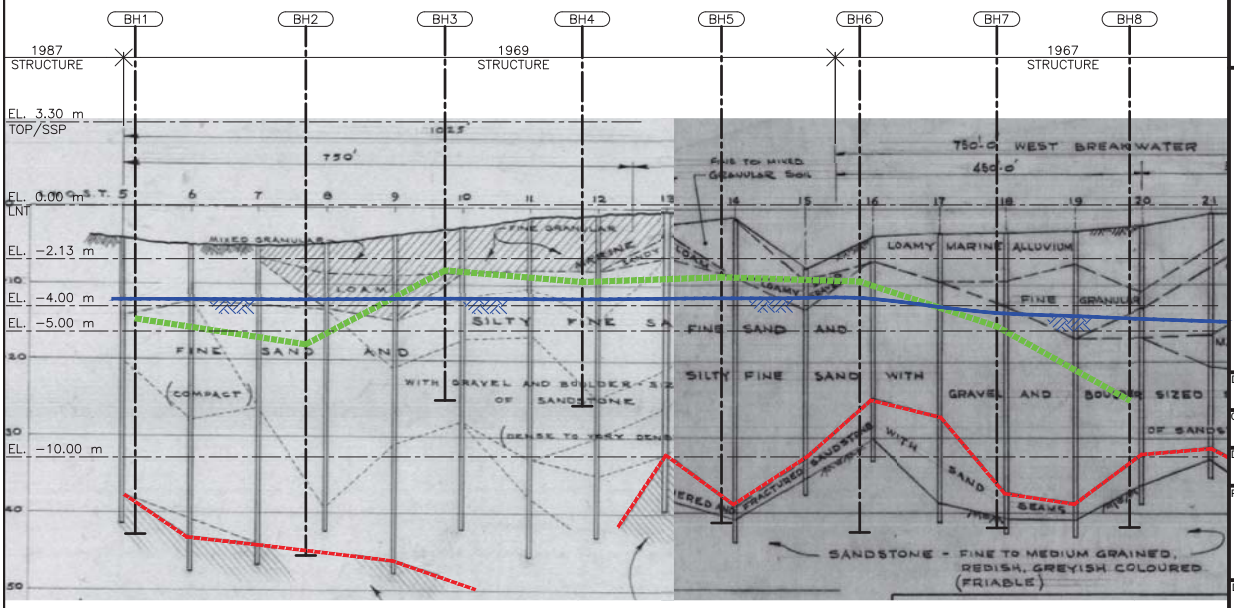
Appendix 'B'

Drawings

B1 – Structure 302 – SSP Wall Channel Side – Bedrock Profiles
1967/1969 Borehole Logs – 2013 Geotechnical Investigation

B2 – Structure 302 – SSP Wall Channel Side and Bedrock Profiles

B3 – Partial Site Plan – 1967 Channel



LEGEND

- BH1 — BOREHOLE RESULTS FROM Oct. 18, 2013 GEOTECHNICAL INVESTIGATION (DRAFT BOREHOLE LOG RECORDS)
- SANDSTONE BEDROCK (Oct. 18, 2013) HARBOUR SIDE (DRAFT BOREHOLE LOG RECORDS)
- BEDROCK – 1967/1969 BOREHOLE LOGS FROM ORIGINAL CONSTRUCTION DRAWINGS
- EXISTING CHANNEL BOTTOM (Oct. 18, 2013)

VALRON

Drawn By: RK	Checked By:
Calculations By:	Checked By:

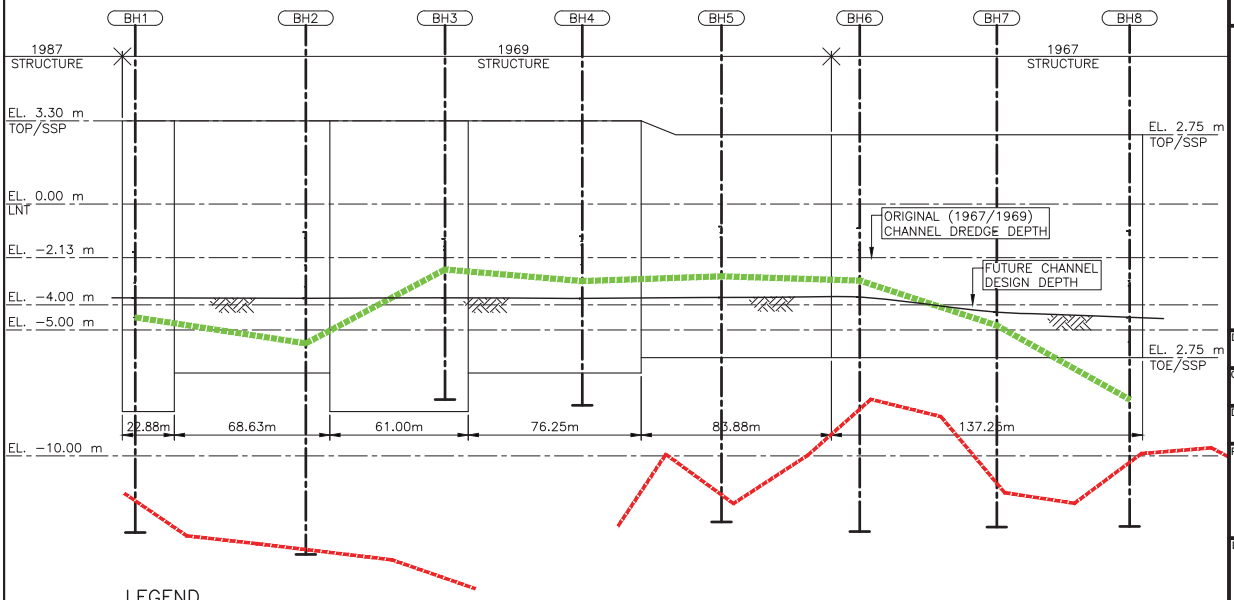
Date: OCT., 2013

Project: LE GOULET TRAINING WALL RECONSTRUCTION

Drawing: STRUCTURE 302
SSP WALL CHANNEL SIDE
BEDROCK PROFILES
1967/1969 BOREHOLE LOGS
2013 GEOTECHNICAL INVESTIGATION

Scale: N.T.S.

File No.	Drawing	Revision No.
13209	B1	0

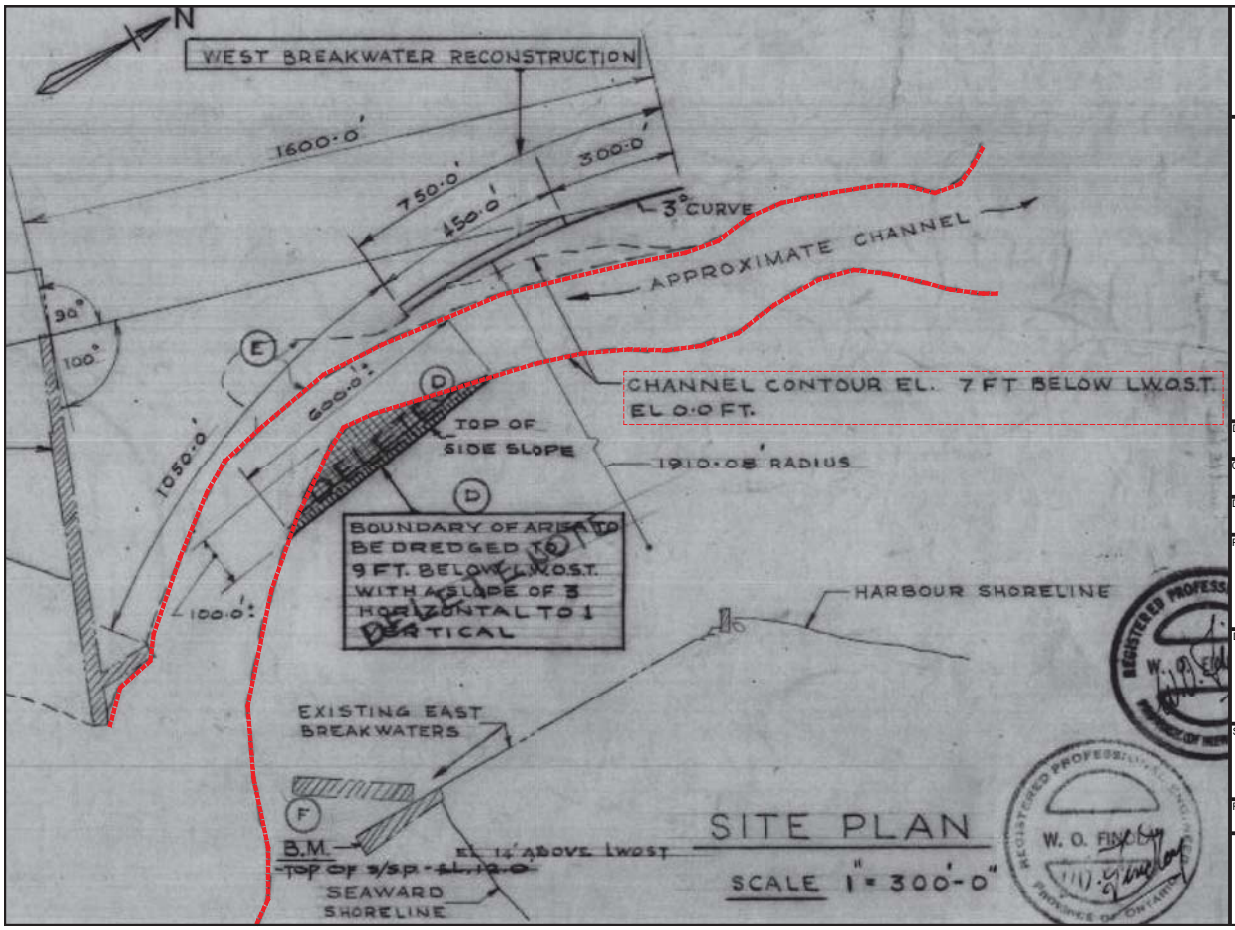


LEGEND

- BH1 — BOREHOLE RESULTS FROM Oct. 18, 2013 GEOTECHNICAL INVESTIGATION
- SANDSTONE BEDROCK (Oct. 18, 2013) HARBOUR SIDE BOREHOLES
- BEDROCK – 1967/1969 BOREHOLE LOGS FROM ORIGINAL CONSTRUCTION DRAWINGS
- EXISTING CHANNEL BOTTOM (Oct. 18, 2013)

VALRON

Drawn By: RK	Checked By:
Calculations By:	Checked By:
Date: OCT., 2013	
Project: LE GOULET TRAINING WALL RECONSTRUCTION	
Drawing: STRUCTURE 302 SSP WALL CHANNEL SIDE AND BEDROCK PROFILES	
Scale: N.T.S.	
File No.: 13209	Drawing: B2 / Revision No.: 0



VALRON

NOTE: FROM 1967
`AS CONSTRUCTED'
DRAWINGS

Drawn By	Checked By
RK	
Calculations By	Checked By

Date: OCT., 2013

Project: LE GOULET TRAINING WALL RECONSTRUCTION

Drawing: PARTIAL SITE PLAN 1967 CHANNEL

Scale: N.T.S.

File No.	Drawing	Revision No.
13209	B3	0

Appendix ‘C’

Drawings

S1 – Option 1 – Concrete Encasement – 1967 Structure

S2 – Option 1 – Concrete Encasement – 1969 Structure

S3 – Option 1 – Concrete Encasement – 1987 Structure

S4 – Option 2 – Steel Sheet Pile Wall – 1967 Structure

S5 – Option 2 – Steel Sheet Pile Wall – 1969 Structure

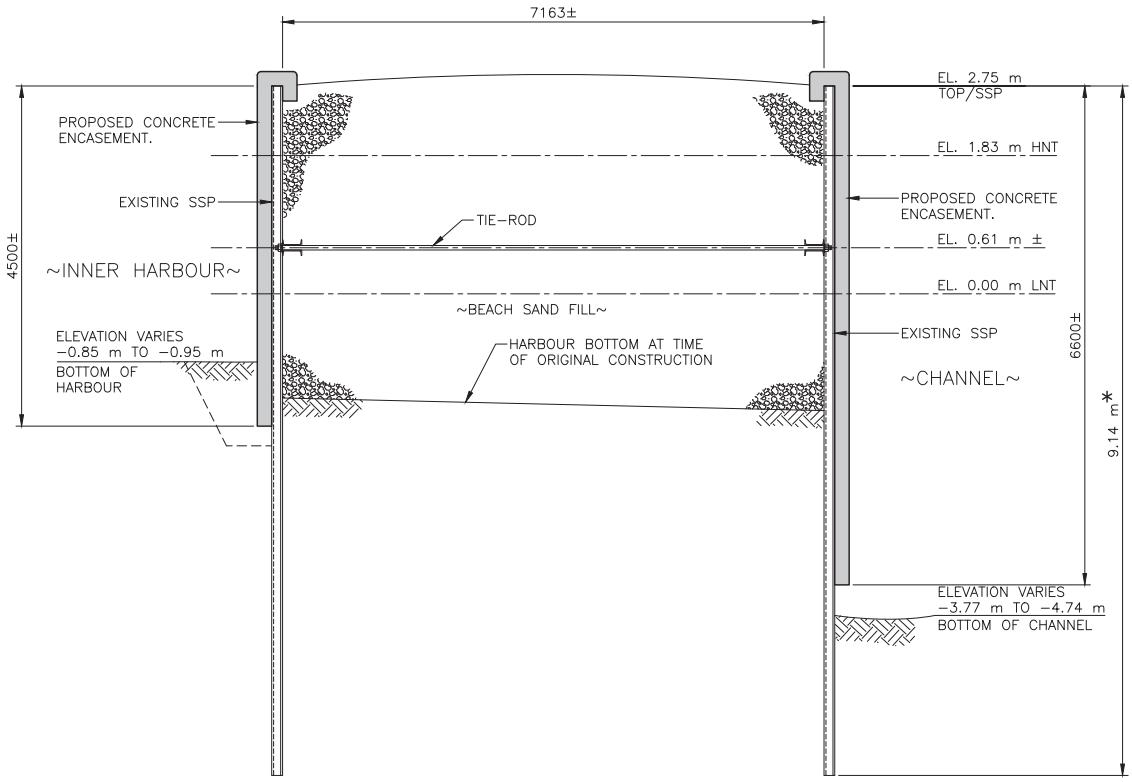
S6 – Option 2 – Steel Sheet Pile Wall – 1987 Structure

S7 – Option 3 – Concrete Encasement / Steel Sheet Pile Wall – 1967 Structure

S8 – Option 3 – Concrete Encasement / Steel Sheet Pile Wall – 1969 Structure

S9 – Option 4 – Rock Revetment / Steel Sheet Pile Wall - 1967 Structure

S10 – Option 4 – Rock Revetment / Steel Sheet Pile Wall - 1969 Structure



PROPOSED SECTION – 1967 STRUCTURE

SCALE/ÉCHELLE: 1:50

0m 1m 2m 3m 4m 5m

*AS INDICATED ON ORIGINAL CONSTRUCTION DRAWINGS.

VALRON

Drawn By: RK	Checked By:
Calculations By:	Checked By:

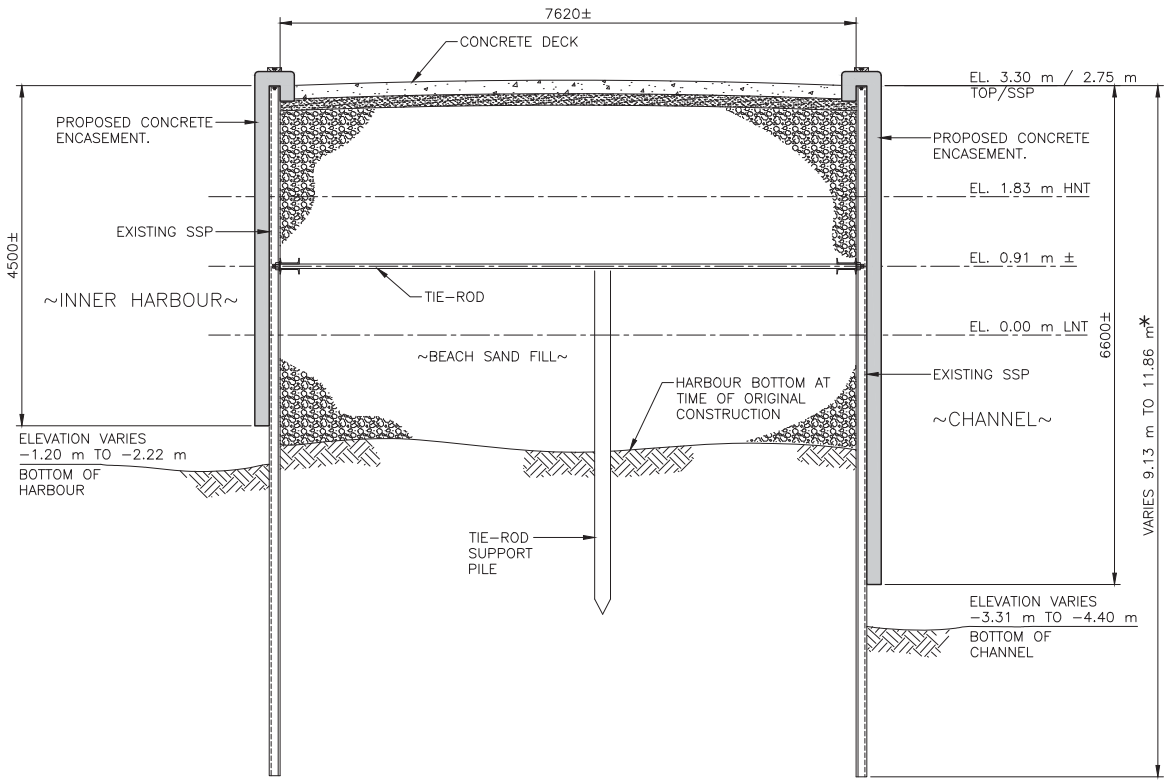
Date: OCT., 2013

Project: LE GOULET TRAINING WALL RECONSTRUCTION

Drawing: OPTION 1 - CONCRETE ENCASEMENT 1967 STRUCTURE

Scale: AS NOTED

File No.	Drawing	Revision No.
13209	S1	0



PROPOSED SECTION – 1969 STRUCTURE

SCALE/ÉCHELLE: 1:50

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*AS INDICATED ON ORIGINAL CONSTRUCTION DRAWINGS.

VALRON

Drawn By: RK	Checked By:
Calculations By:	Checked By:

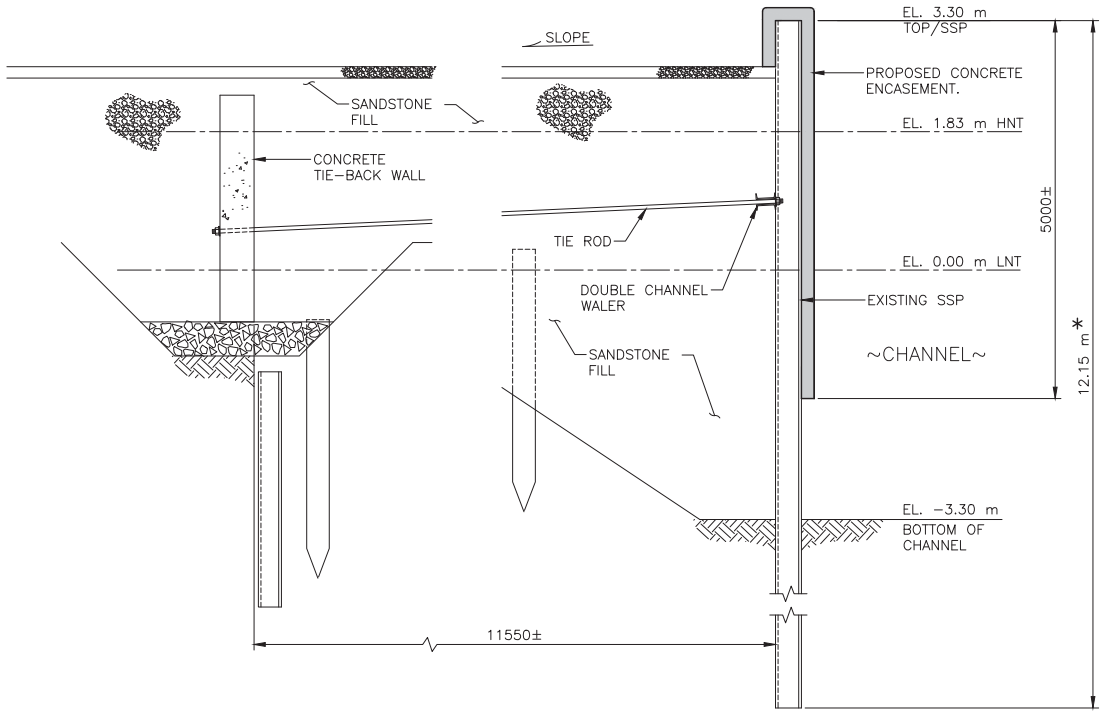
Date: OCT., 2013

Project: LE GOULET TRAINING WALL RECONSTRUCTION

Drawing: OPTION 1 - CONCRETE ENCASEMENT 1969 STRUCTURE

Scale: AS NOTED

File No.	Drawing	Revision No.
13209	S2	0



PROPOSED SECTION – 1987 STRUCTURE

SCALE/ÉCHELLE: 1:50

0m 1m 2m 3m 4m 5m

*AS INDICATED ON ORIGINAL CONSTRUCTION DRAWINGS.

VALRON

Drawn By: RK	Checked By:
Calculations By:	Checked By:

Date: OCT., 2013

Project: LE GOULET TRAINING WALL RECONSTRUCTION

Drawing: OPTION 1 - CONCRETE ENCASEMENT 1987 STRUCTURE

Scale: AS NOTED

File No.	Drawing	Revision No.
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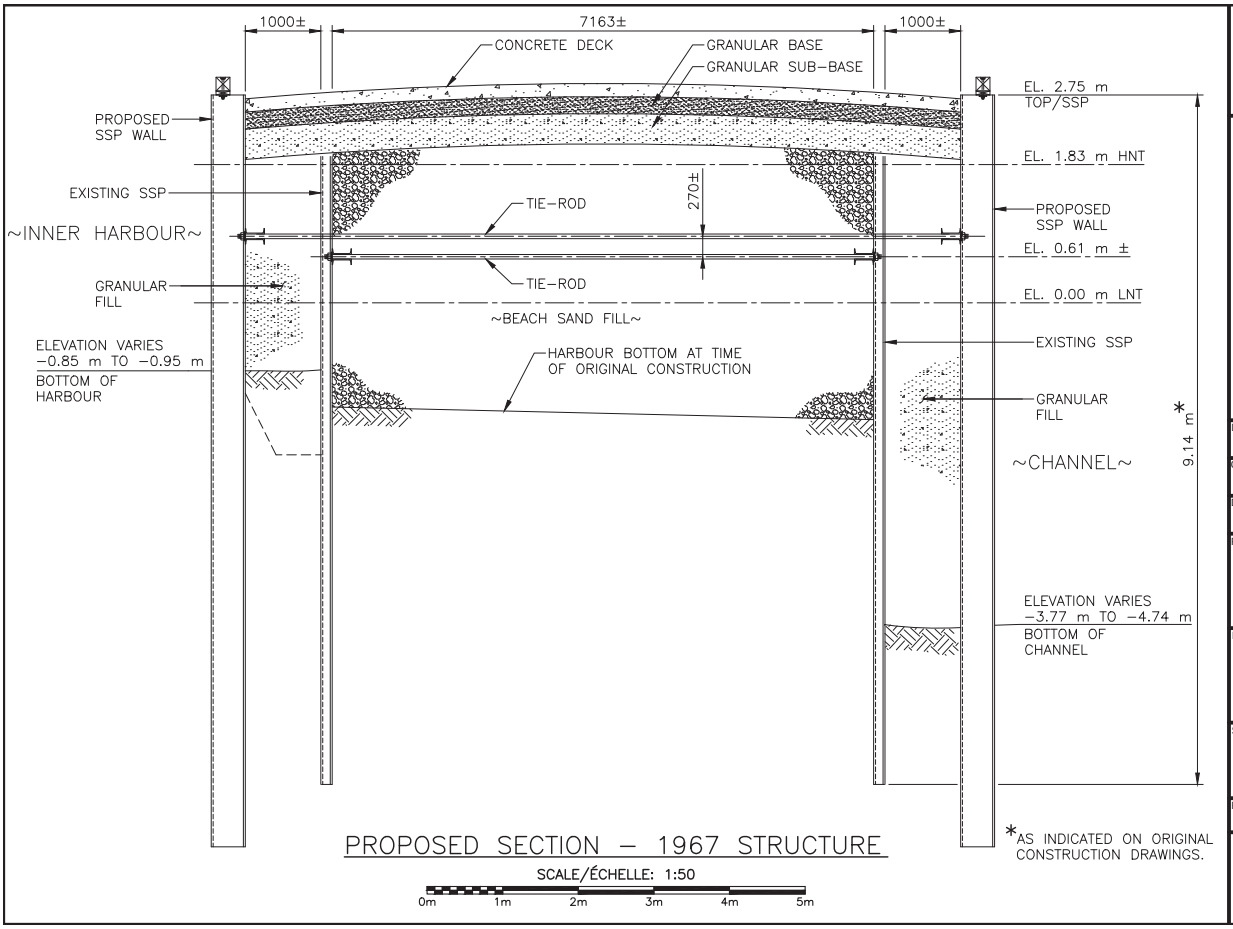


PROPOSED SECTION – 1967 STRUCTURE

SCALE/ÉCHELLE: 1:50

0m 1m 2m 3m 4m 5m

VALRON

Drawn By: RK	Checked By:
Calculations By:	Checked By:

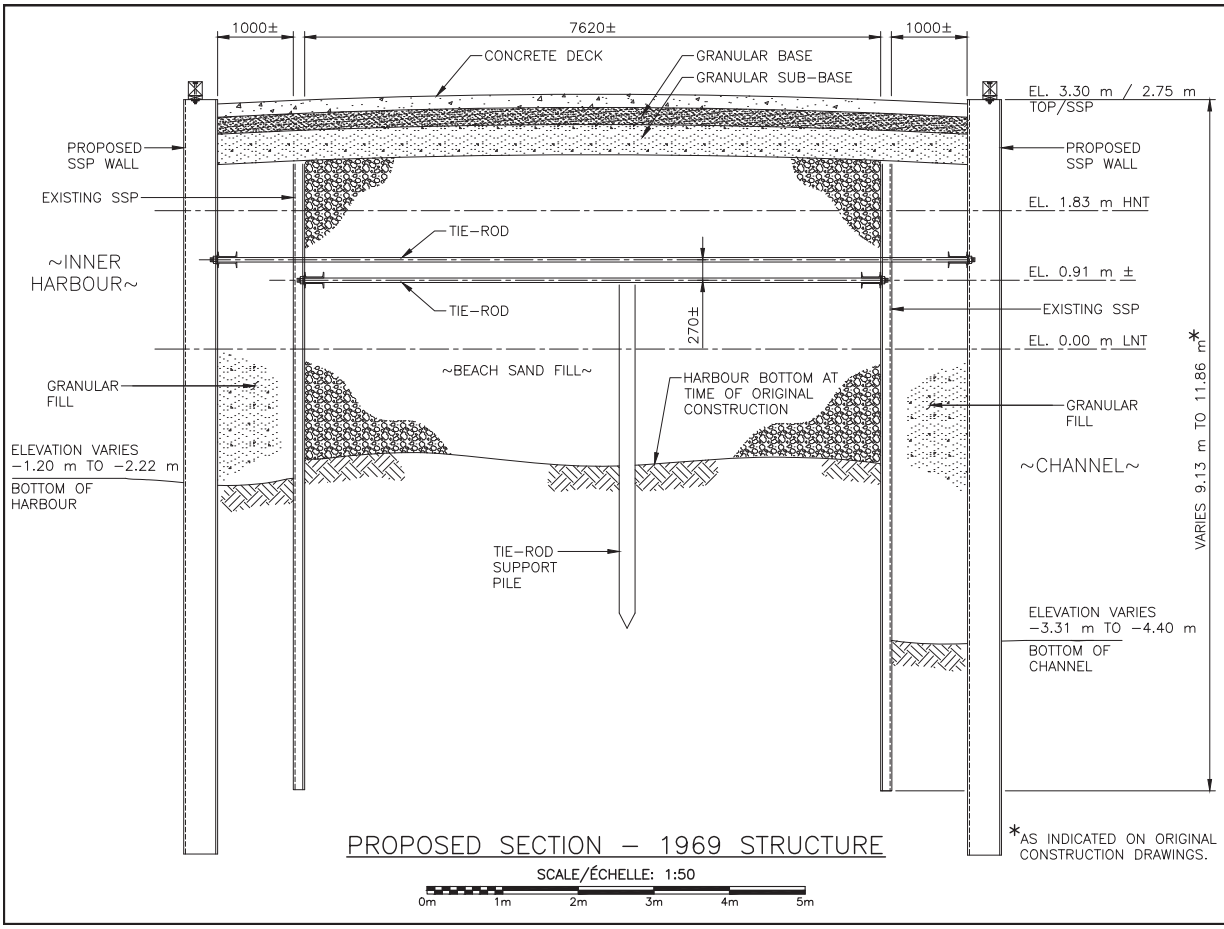
Date: OCT., 2013

Project: LE GOULET TRAINING WALL RECONSTRUCTION

Drawing: OPTION 2 - STEEL SHEET PILE WALL 1967 STRUCTURE

Scale: AS NOTED

File No.	Drawing	Revision No.
13209	S4	0



VALRON

Drawn By: RK	Checked By:
Calculations By:	Checked By:

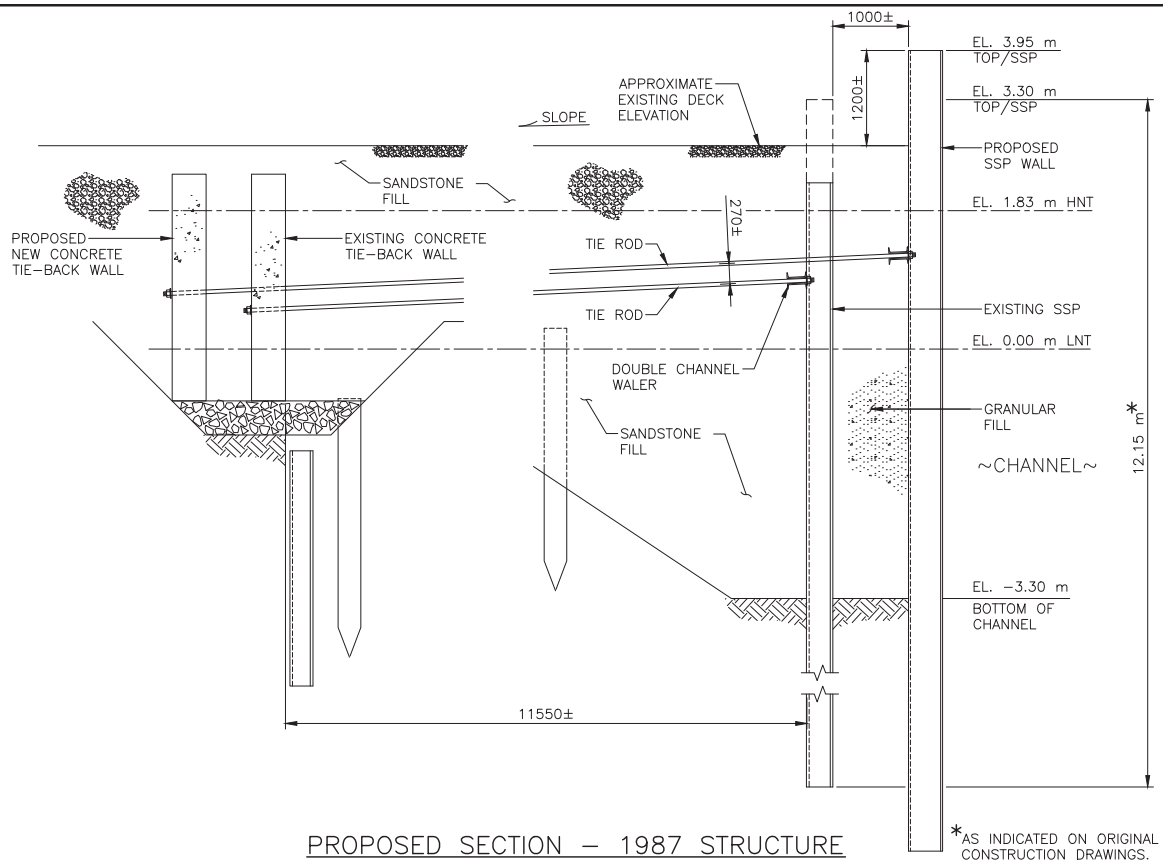
Date: OCT., 2013

Project: LE GOULET TRAINING WALL RECONSTRUCTION

Drawing: OPTION 2 - STEEL SHEET PILE WALL 1969 STRUCTURE

Scale: AS NOTED

File No.	Drawing	Revision No.
13209	S5	0



PROPOSED SECTION – 1987 STRUCTURE

SCALE/ÉCHELLE: 1:50

0m 1m 2m 3m 4m 5m

*AS INDICATED ON ORIGINAL CONSTRUCTION DRAWINGS.

VALRON

Drawn By: RK	Checked By:
Calculations By:	Checked By:

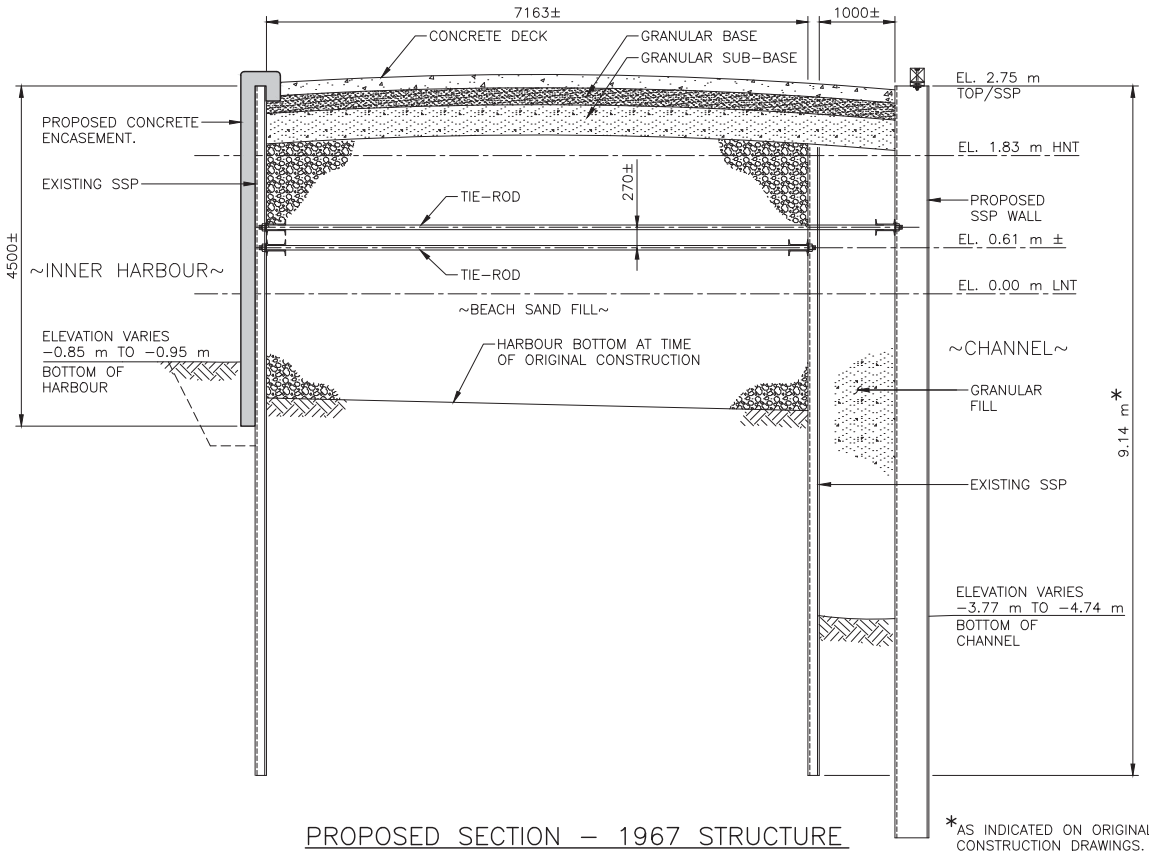
Date: OCT., 2013

Project: LE GOULET TRAINING WALL RECONSTRUCTION

Drawing: OPTION 2 - STEEL SHEET PILE WALL 1987 STRUCTURE

Scale: AS NOTED

File No.	Drawing	Revision No.
13209	S6	0



PROPOSED SECTION – 1967 STRUCTURE

SCALE/ÉCHELLE: 1:50

0m 1m 2m 3m 4m 5m

VALRON

Drawn By: RK	Checked By:
Calculations By:	Checked By:

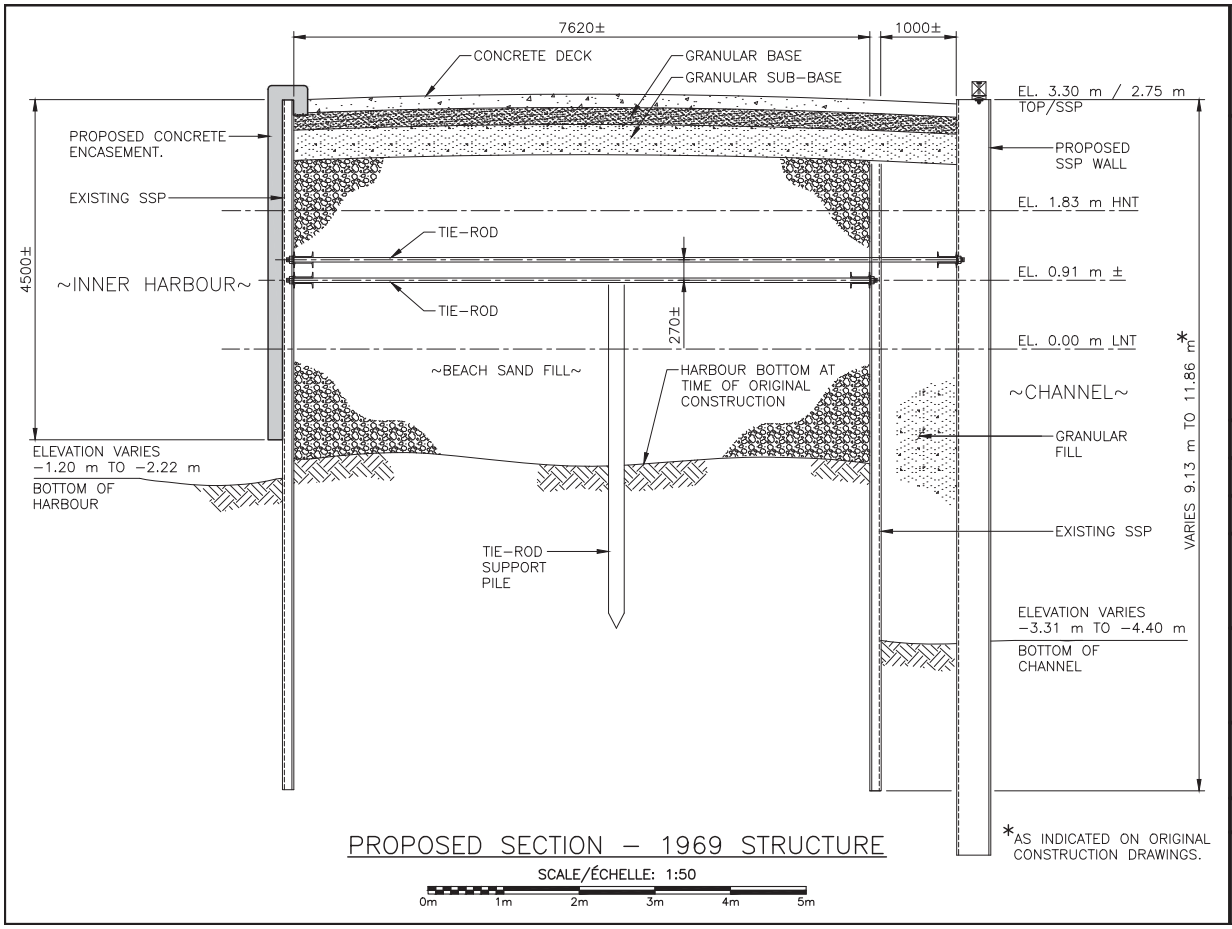
Date: OCT., 2013

Project: LE GOULET TRAINING WALL RECONSTRUCTION

Drawing: OPTION 3 - CONCRETE ENCASEMENT / STEEL SHEET PILE WALL 1967 STRUCTURE

Scale: AS NOTED

File No.	Drawing	Revision No.
13209	S7	0



PROPOSED SECTION – 1969 STRUCTURE

SCALE/ÉCHELLE: 1:50

0m 1m 2m 3m 4m 5m

VALRON

Drawn By: RK	Checked By:
Calculations By:	Checked By:

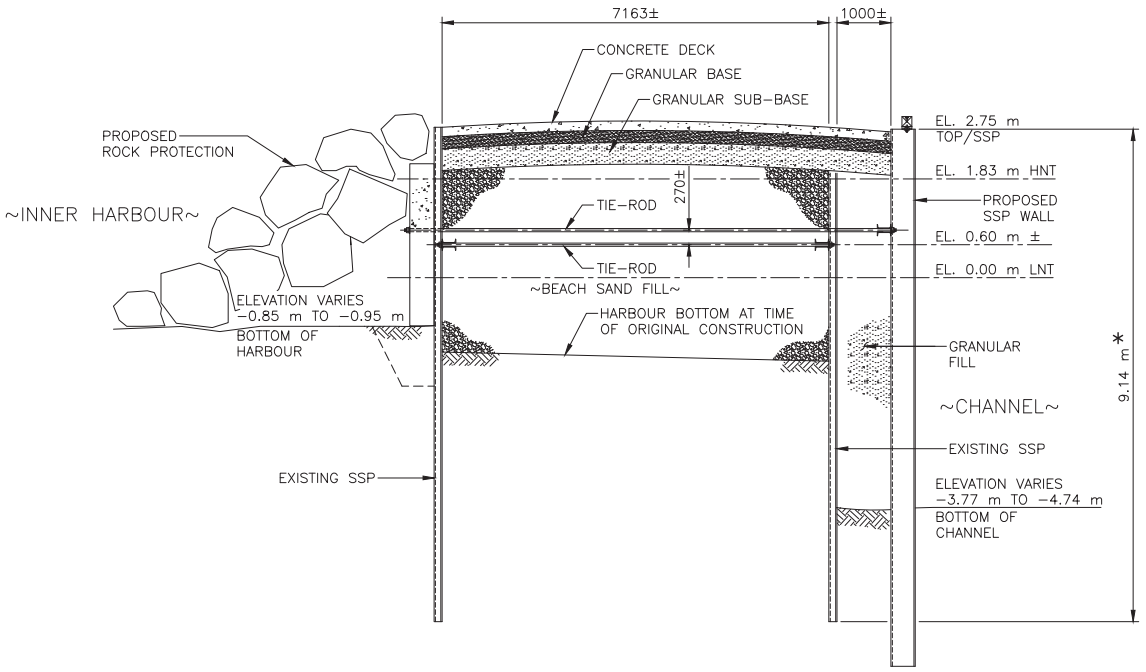
Date: OCT., 2013

Project: LE GOULET TRAINING WALL RECONSTRUCTION

Drawing: OPTION 3 - CONCRETE ENCASEMENT / STEEL SHEET PILE WALL 1969 STRUCTURE

Scale: AS NOTED

File No.	Drawing	Revision No.
13209	S8	0



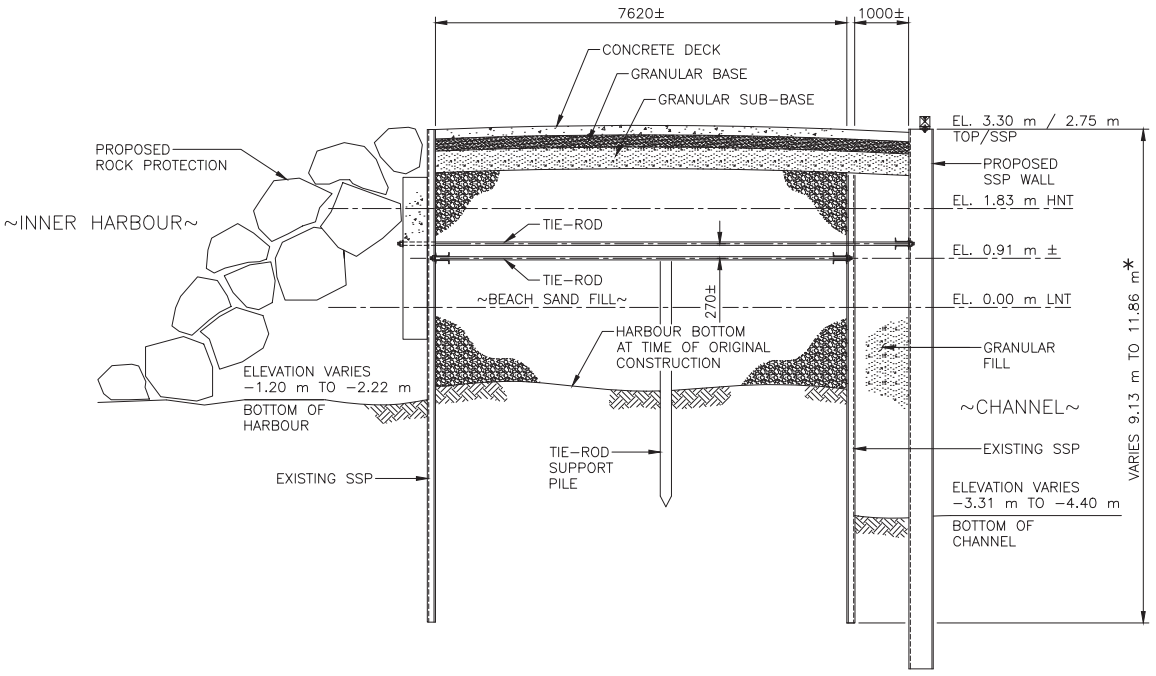
PROPOSED SECTION – 1967 STRUCTURE

SCALE/ECHELLE: N.T.S.

*AS INDICATED ON ORIGINAL CONSTRUCTION DRAWINGS.

VALRON

Drawn By: RK	Checked By:
Calculations By:	Checked By:
Date: OCT., 2013	
Project: LE GOULET TRAINING WALL RECONSTRUCTION	
Drawing: OPTION 4 - ROCK REVETMENT / STEEL SHEET PILE WALL 1967 STRUCTURE	
Scale: AS NOTED	
File No.: 13209	Drawing: S9 / Revision No.: 0



PROPOSED SECTION – 1969 STRUCTURE

SCALE/ECHELLE: N.T.S.

*AS INDICATED ON ORIGINAL CONSTRUCTION DRAWINGS.

VALRON

Drawn By: RK	Checked By:
Calculations By:	Checked By:

Date: OCT., 2013

Project: LE GOULET TRAINING WALL RECONSTRUCTION

Drawing: OPTION 4 - ROCK REVETMENT / STEEL SHEET PILE WALL 1969 STRUCTURE

Scale: AS NOTED

File No.	Drawing	Revision No.
13209	S10	0

Appendix 'D'

Construction Cost Estimates

D1 – Option 1 – Concrete Encasement – Channel and Harbour Side

D2 – Option 2 – Steel Sheet Piling – Channel and Harbour Side
A – Heavier Section for Corrosion Protection
B – Concrete Cope Wall for Corrosion Protection
C – Cathodic System for Corrosion Protection

D3 – Option 3 – Steel Sheet Piling – Channel Side / Concrete Encasement – Harbour Side

D4 – Option 4 – Steel Sheet Piling – Channel Side / Partial Rock Revetment – Harbour Side / Steel Sheet Piling – Remainder