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Solving today's problems with tomorrow in mind

April 1, 2016

Daniel J. Parsons
Project Manager - Planning & Engineering
Infrastructure Support
Eastern Health
300 Prince Philip Drive
St. John's, NL A1B 3V6

Dear Mr. Parsons:

RE: Leary's Brook Investigation
Final Report

In 2013, CBCL Limited completed the Rennies River Catchment Stormwater Management Plan (RRCSMP) for the City of St. John's. The outcome of this study was a list of flood protection improvements that could be implemented along the Rennies River system. The Health Sciences Centre (HSC) is located north of a section of Leary's Brook, which is part of the Rennies River system (Figure 1 in Appendix A). The RRCSMP recommends that two flood protection improvements be implemented in the vicinity of the HSC: a flood control weir at the bottom of Long Pond and berms located along the south and north banks of Leary's Brook just upstream of the Clinch Crescent East Bridge.

In 2014, Eastern Health, as the agency responsible for the HSC, engaged CBCL Limited to review potential flooding issues around the HSC in more detail. The analysis completed as part of the RRSCMP forms the basis for this assignment.

The original scope of work for this assignment includes the following:

- Determine the effect that the existing Clinch Crescent East Bridge has on the upstream water level during the 1:100 AEP flood event (as provided in the RRCSMP). The XPSWMM model prepared for the City of St. John's will be used to ascertain the increase in water level.
- If required, recommend upgrades that could be implemented at the bridge to reduce upstream water levels during peak flow events. The XPSWMM model prepared for the City of St. John's will be used to develop recommendations.
- Determine the effect that the 1:100 AEP flood event has on existing sanitary and storm sewers in the vicinity of the section of Leary's Brook that is adjacent to the Health Sciences Centre.
- If required, recommend upgrades that could be implemented to reduce the effect that flooding has on the existing sewers.
- Investigate the potential effect of flooding on the utility tunnel located downstream from the Clinch Crescent East Bridge.
- If required, recommend upgrades for the tunnel.

In addition to the above items, we have also reviewed the effect that the proposed flood control weir at the bottom of Long Pond would have on water levels in the immediate vicinity of the HSC.

The results of our analysis and recommendations for flood control improvements at the HSC are presented herein.

Hydrologic/Hydraulic Analysis

The modeling software XPSWMM, Version 13 (with Service Pack 1 installed), was used to create a hydrologic model of the study area. The 1:100 AEP flood flows for Leary's Brook were estimated under the calculated design event.

The purpose of the hydraulic analysis is to translate the 1:100 AEP flood flows, estimated during the hydrologic analysis, into floodplain mapping. Hydraulic modeling was carried out using 2D XPSWMM model. 2D modeling has the advantage that it can resolve various surface water paths, with varying velocities, including splitting of flows, circulation and rejoining of various flow branches, which is typical in floodplains of urban areas. Hydraulic structures such as culverts and bridges were modelled as a 1D network nested within the 2D domain representing the floodplain; the domain consisted of a mesh of 5x5 m cells.

Proposed Flood Control Improvements (from the RRCSMP)

The proposed weir at the bottom of Long Pond consists of a rectangular opening in an earth berm that extends across the upstream side of the Allandale Road Bridge. It was designed based on the following criteria:

- A maximum surface water elevation at Long Pond of 55.7 metres.
- A width of approximately 30 metres at the weir location.

Our analysis indicates that a 6-metre wide weir presents the best performance. It significantly reduces flows downstream of Allandale Road, with upstream surface water elevations less than 55.7 metres.

Options for flood mitigation measures at the HSC include new flood protection berms along the south and north sides of the river section from Clinch Crescent East to Clinch Crescent West.

Clinch Crescent East Bridge Investigation

Clinch Crescent East Bridge has a 23-metre span. The depth from the underside of the bridge deck to the river bottom ranges from 2.5 metres to 3.0 metres. For evaluation purposes, open-bottom box culverts of various spans were added to the hydraulic model at Clinch Crescent East to simulate an increase in the overall hydraulic capacity of the road crossing. Referring to Figure 2A, the estimated water levels upstream (Location 10) and downstream (Location 9) of the bridge for flow generated by a 1:100 AEP design rainfall event are presented in Table 1.

Table 1: Culvert Size Assessment during the 1:100 AEP Flow

	Secondary Culvert Size	Upstream Water Level(m)	Downstream Water Level(m)
Existing condition	No Culvert	56.92	56.75
	3m	56.91	56.75
	6m	56.90	56.75
	10m	56.88	56.74
With proposed flood control weir at Long Pond	No Culvert	56.92	56.75
	3m	56.92	56.75
	6m	56.90	56.75
	10m	56.88	56.75
With weir and berms located on the south and north sides of Leary's Brook	No Culvert	57.08	56.81
	3m	57.07	56.81
	6m	57.06	56.81
	10m	57.00	56.81

With the existing state of the bridge and flows from Long Pond regulated by the proposed weir, the maximum water level at the upstream side would be 56.92 metres. With an additional 10-metre wide culvert, the maximum water level would decrease by 0.04 metres to 56.88 metres. However, regardless of the size of culvert, water levels in the downstream section remained unchanged. The modelling therefore suggests that an extra culvert would not reduce the flood risks significantly.

Table 2: Water Levels along Leary's Brook during the 1:100 AEP Event

Location	Existing Condition (m)	Future Condition with Weir at Long Pond (m)	Future Condition with Weir and Berm (m)
Location1	55.03	54.60	54.60
Location2	55.24	54.66	54.66
Location3	55.14	55.64	55.65
Location4	55.17	55.64	55.66
Location5	55.18	55.65	55.66
Location6	55.19	55.65	55.67
Location7	55.19	55.65	55.67
Location8	55.25	55.67	55.69
Location9	56.75	56.75	56.81
Location10	56.92	56.92	57.08
Location11	57.21	57.21	57.44
Location12	57.66	57.66	57.78
Location13	58.05	58.05	58.08
Location14	59.16	59.16	59.24

Water Surface Profiles

Table 2 describes the change in water levels upstream of the flood control weir at Long Pond. Locations for the water surface profile can be found on Figures 2A and 2B.

From Table 2, it can be observed that with the proposed weir at the outlet of Long Pond, the peak water level in Long Pond would increase by 0.5 metres during the 1:100 AEP storm event, and then gradually diminish further upstream. Water levels remain the same along the river section from Clinch Crescent East to Clinch Crescent West with or without the weir. In the 1:100 AEP design event, berms are able to successfully contain water to the river, but the ponding of water behind the berm would cause an increase in water level in Leary's Brook, mainly at Location 10 and upstream (between 0.08 and 0.16 metres), but also downstream, albeit by a very small amount (0.06 metres or less).

Figures 2A and 2B shows the water surface profiles (From Location 1 to Location 14) for the scenarios with the weir proposed at Long Pond. It considers the conditions:

- Existing channel with weir at the outlet of Long Pond.
- Existing channel with weir at Long Pond and berms at the HSC for flood mitigation.
- Existing channel with weir at Long Pond and extra culvert (10 m wide) at Clinch Crescent east.
- Existing channel with combined flood protection options which include weir at Long Pond, culvert at Clinch Crescent east, and berm at HSC.

From Figures 2A and 2B, it can be observed that additional culverts have very limited impact on the water levels, which infers that the existing Clinch Crescent East Bridge has the same capacity as the existing channel.

Sanitary and Storm Sewer Investigation

Survey data containing finished floor elevations and existing sewer drawings were provided by Eastern Health. The finished floor elevations and sewer locations are shown on Figure 1 (Appendix A).

During the fall of 2015, Eastern Health constructed a new access road and 26 stall parking lot at the southwest entrance of the HSC, as shown in Figure 3 (Appendix A). Portions of the new parking lot, as well as the gravel walking trail, are in conflict with the location of the berm proposed in the RRCSMP Study, and the draft report submitted for this study. In addition, a new storm sewer outlet was constructed near the Leary's Brook duck pond; its location is shown on Figure 3. The condition of the outlet is shown in Figure 4. The new catch

Figure 4: New Storm Sewer Outlet

basin upstream of this outlet will require the installation of a backwater valve to prevent stormwater from surcharging the catch basin during the 1:100 AEP flood. This may result in some localized flooding near the new catch basins during extreme rain events.

Figure 5: Existing Culvert Outlet

Also during CBCL's field investigations an existing culvert was identified to the south of the Health Sciences Centre, immediately upstream of the Leary's Brook duck pond. The approximate location of the culvert outlet is shown on Figure 3 and Figure 5 illustrates its current condition. It is unclear where this culvert originates; therefore, it must be checked during the detailed design of the berms.

Tunnel Investigation

On May 28, 2015, Greg Sheppard and Jennifer Bursey of CBCL conducted a site investigation at the existing HSC utility tunnel that crosses under Leary's Brook just downstream of the Clinch Crescent East Bridge. The purpose of the investigation was to carry out a visual assessment of the tunnel condition with an emphasis on gathering evidence of water intrusion; a structural assessment was not completed.

The utility tunnel contains the cables that provide electrical power to the Health Sciences Complex and numerous ducts and mechanical piping. Access to the utility tunnel is provided in the Health Sciences Complex at the southwest end of the tunnel and at the Utilities Annex at the north end. Drawings provided by Eastern Health (Appendix B) show that the low point of the tunnel is located under the brook.

Photos taken during the site visit (Appendix C) show that water appears to enter the tunnel on a regular basis. There is a sump pump at the low point that removes water when it reaches a set level in the sump. It is our understanding that this pump is designed to remove groundwater that regularly enters the tunnel, and is not designed to handle an extreme rainfall event.

To ascertain whether the tunnel would flood during an extreme rainfall event, we checked locations where water could enter the tunnel from the ground surface against the limits of the 1:100 AEP flood. Figure 1 shows that these locations, including the finished floor of the HSC in the vicinity of the utility tunnel, the existing ventilation hatch, and the finished floor of the Utility Annex are outside of the current flooding limits.

We understand that the tunnel has flooded in the past (email from Eastern Health contained in Appendix D). The flooding may have been due to storm water runoff entering the

ventilation hatch during an extreme rainfall event; however, it is very unlikely that water ever entered the utility tunnel as a result of the river overtopping its banks.

Recommendations

We recommend that Eastern Health construct the earth berm on the north side of Leary's Brook as originally recommended in the RRCSMP. We would welcome an opportunity to further discuss this recommendation at a meeting regarding this final report.

Please contact Jennifer or Greg to discuss any aspect of the foregoing or to arrange a meeting to discuss our analysis and recommendation.

Yours truly,

CBCL Limited

Prepared by:
Jennifer Bursey, P. Eng.
Civil Engineer
Direct: 709-364-8623, ext. 241
E-Mail: jenniferb@cbcl.ca

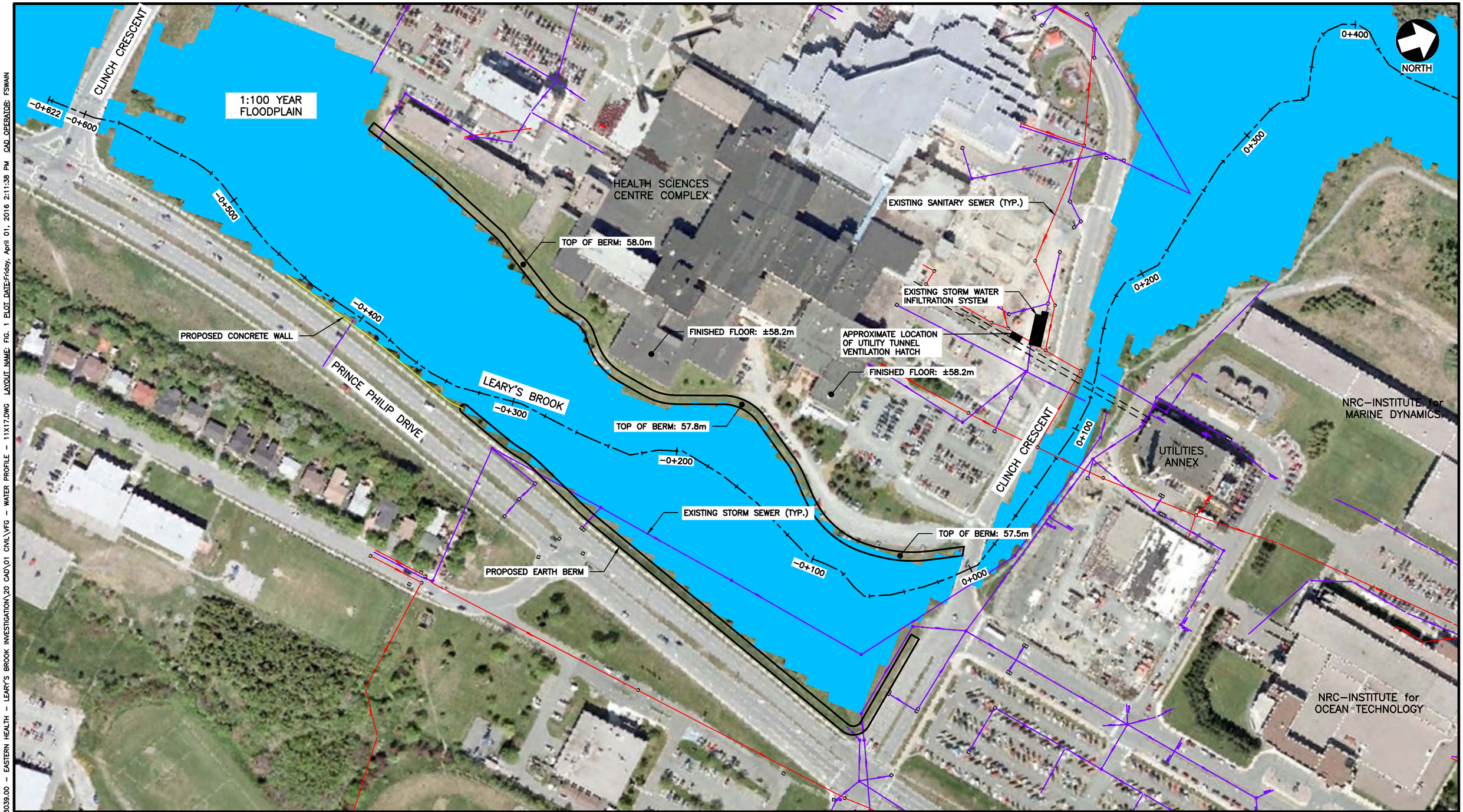
Reviewed by:
Greg Sheppard, P. Eng.
Project Manager

cc. Joe Dunford, M. Eng. P. Eng., Eastern Health, Regional Director – Infrastructure Support

Project No: 153039.00

APPENDIX A

Figures



PLAN
1:2000

No.	Description

Date	Scale	Designed	Drawn	Checked	Approved	CBCL No.	Contract
29 JUL 2015	AS NOTED	Y.O.	C.M.	–	G.S.	153039.00	–

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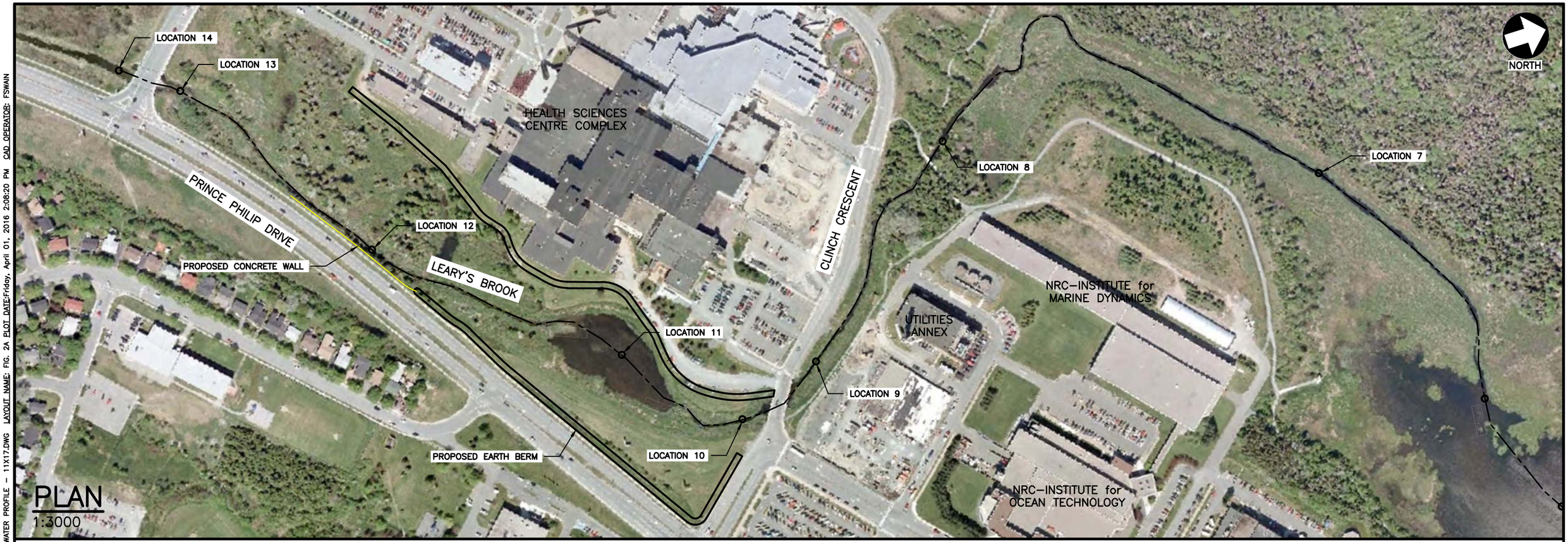
EASTERN HEALTH

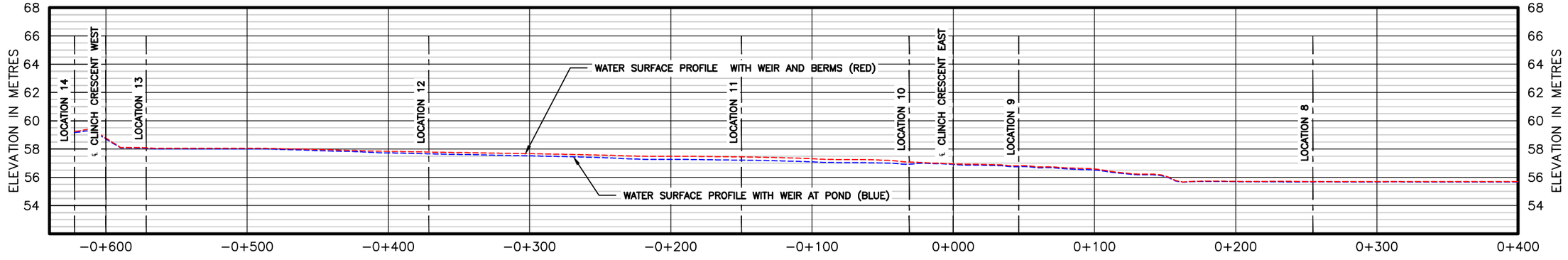
LEARY'S BROOK INVESTIGATION

Drawing
FIG. 1

DRAWING NAME: L:\JOBS\2015\153039.00 – EASTERN HEALTH – LEARY'S BROOK INVESTIGATION\20 CAD\01 CIVIL\VFG – WATER PROFILE – 11X17.DWG LAYOUT NAME: FIG. 1 PLOT DATE: Friday, April 01, 2016 2:11:38 PM CAD OPERATOR: FSWAIN



PLAN
1:3000



PROFILE
1:3000 [H] 1:300 [V]

No.	Description

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29 JUL 2015	AS NOTED	Y.O.	C.M.	–	G.S.	153039.00	–

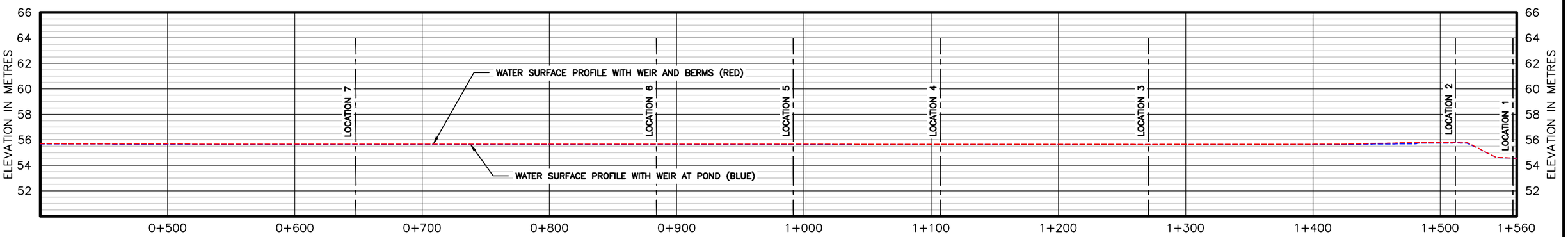
EASTERN HEALTH

LEARY'S BROOK INVESTIGATION

Drawing
FIG. 2A

DRAWING NAME: L:\JOBS\2015\153039.00 – EASTERN HEALTH – LEARY'S BROOK INVESTIGATION\20 CAD\01 CIVIL\VFG – WATER PROFILE – 11X17.DWG LAYOUT NAME: FIG. 2A PLOT DATE:Friday, April 01, 2016 2:08:20 PM CAD OPERATOR: FSWAIN

PLAN
1:3000



PROFILE
1:3000 [H] 1:300 [V]

No.	Description

Date	Scale	Designed	Drawn	Checked	Approved	CBCL No.	Contract
29 JUL 2015	AS NOTED	Y.O.	C.M.	–	G.S.	153039.00	–

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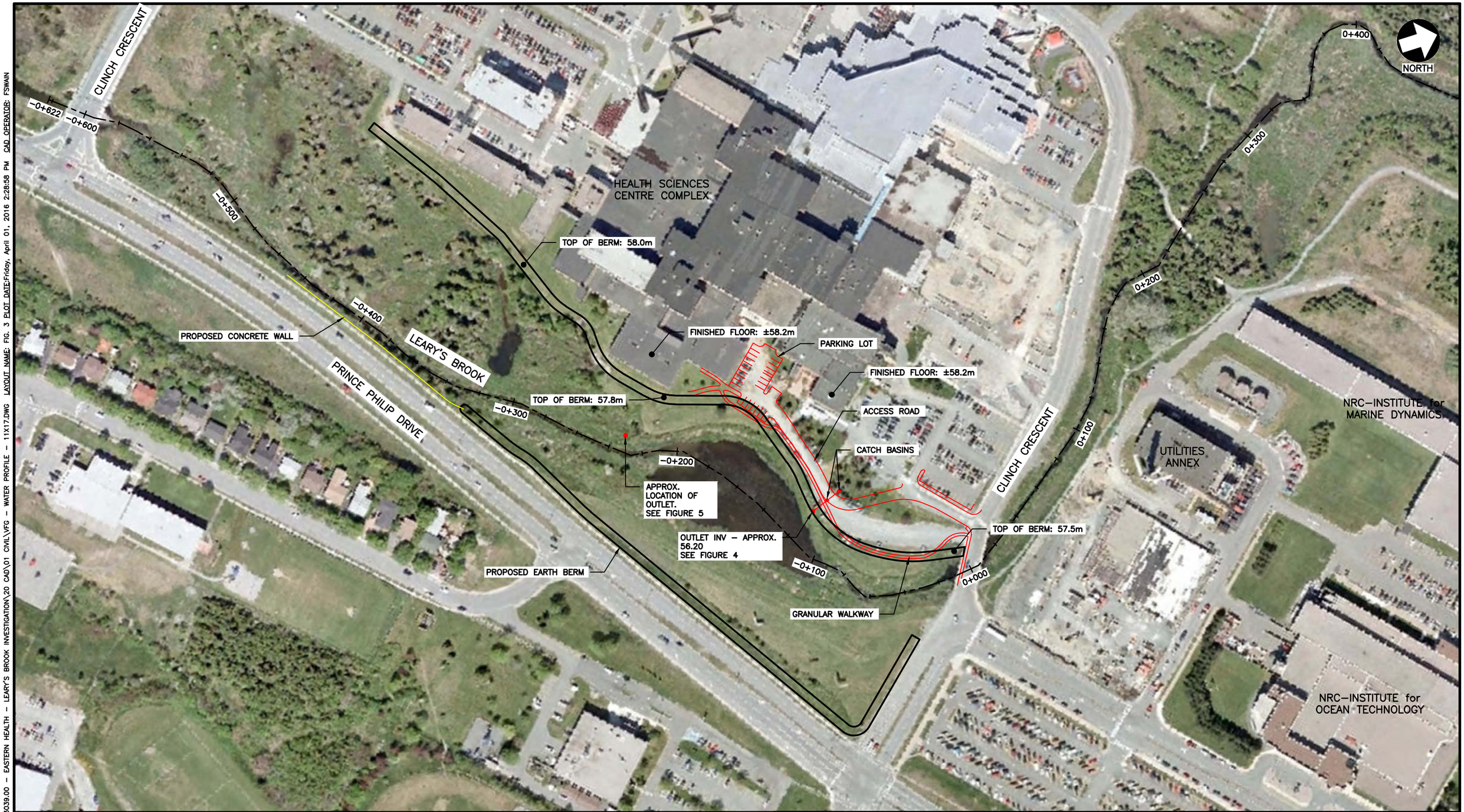
EASTERN HEALTH

LEARY'S BROOK INVESTIGATION

Drawing
FIG. 2B

DRAWING NAME: L:\JOBS\2015\153039.00 – EASTERN HEALTH – LEARY'S BROOK INVESTIGATION\20 CAD\01 CIVIL\VFG – WATER PROFILE – 11X17.DWG LAYOUT NAME: FIG. 2B PLOT DATE:Friday, April 01, 2016 2:04:45 PM CAD OPERATOR: FSWAIN



PLAN
1:2000

No.	Description

Date	Scale	Designed	Drawn	Checked	Approved	CBCL No.	Contract
1 APR 2016	AS NOTED	J.B.	F.S.	–	G.S.	153039.00	–

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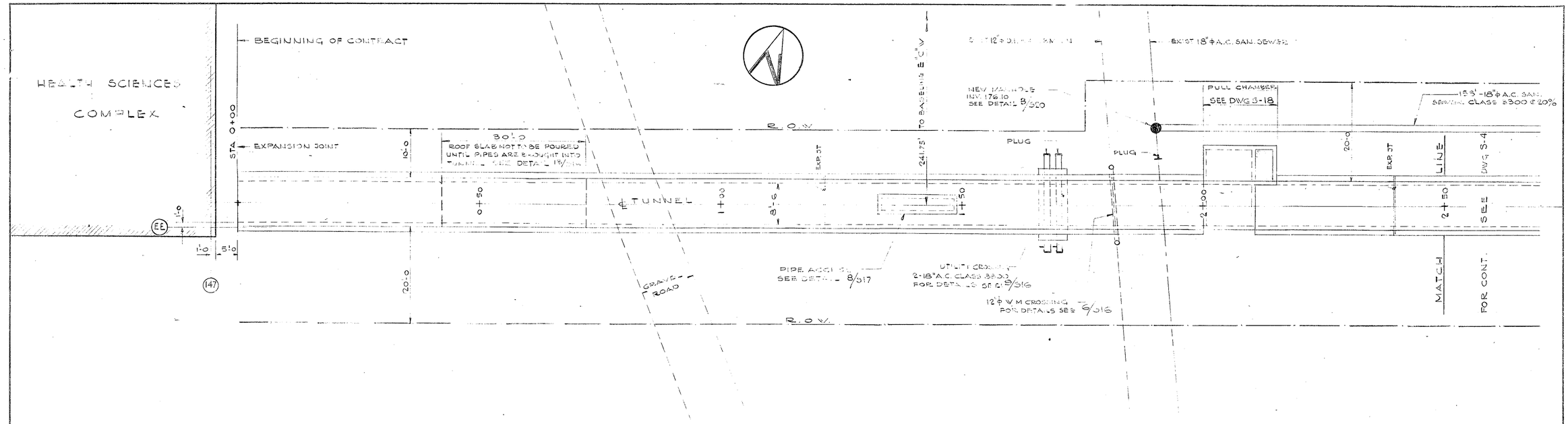
EASTERN HEALTH

LEARY'S BROOK INVESTIGATION

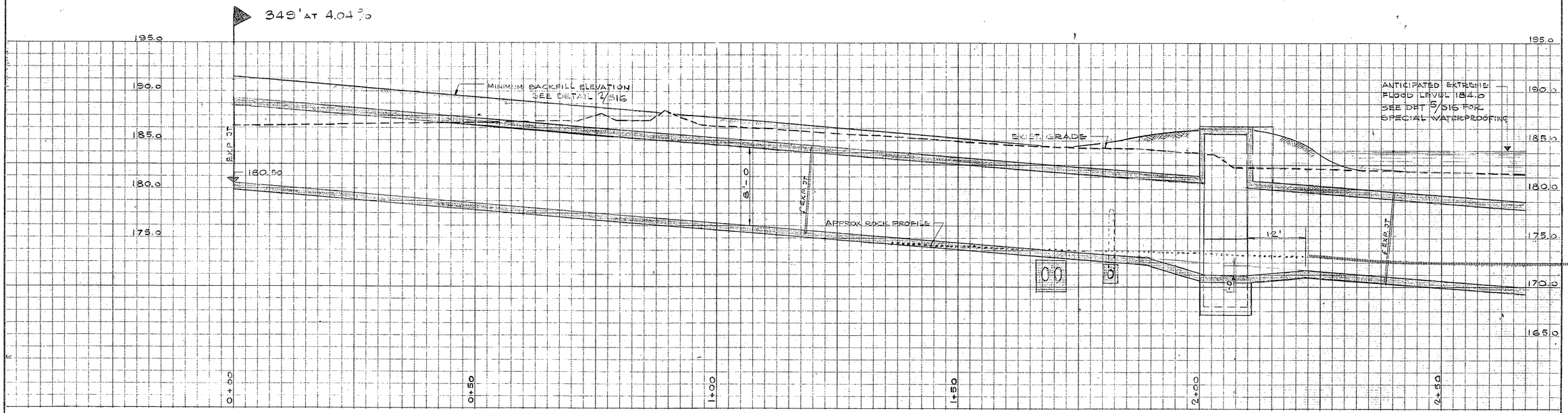
Drawing
FIG. 3

APPENDIX B

Utility Tunnel Drawings



FOR TUNNEL SECTIONS & DETAILS SEE DWGS S-15 & S-16



NOTE:
ALL STATIONS & DIMENSIONS SHOWN ARE VERTICAL & HORIZONTAL

No.	DATE	REVISION	BY

R. R. Dewhirst
REGISTERED ENGINEER
PROVINCE OF NEWFOUNDLAND

ASSOCIATION OF PROFESSIONAL ENGINEERS PROVINCE OF NEWFOUNDLAND
A. B. JOHNS
LICENCE TO PRACTICE

SCRIVENER PROJECTS NEWFOUNDLAND LIMITED

MORRISON, HERSHFIELD, BURGESS & HUGGINS, LTD.
CONSULTING ENGINEERS – TORONTO, ONT.

HEALTH SCIENCES COMPLEX & NORTH CAMPUS DEVELOPMENT
ST. JOHN'S NEWFOUNDLAND

UTILITIES TUNNELS
PLAN & PROFILE STA 0+00 to 2+50

SCALE: HOR 1"=10' VERT 1"=5' | DATE: SEPT - 28 - 72

DESIGNED: C.B.L
DRAWN: R.L
PROJ. ENG.: H.W.
APPROVED: R.B.D
DRAWING No.: S-3

1303

FOR CONT. SEE DWG S-3

MATCH LINE

NEW MANHOLE SEE B/S20

INV 175.79

INV 175.74

EXP. JT

241.75' TO BASELINE E.C.W.

BROOK

LEARY'S

R.O.W.

20'-0

10'-0

8'-6"

℄ TUNNEL

2+50

3+00

3+50

4+00

4+50

5+00

5+31

STA

EXP. JT

HEAVY TRUCKING AREA 50'-0 ±

NOTE: SEE SECT 1A/S15 FOR REINF. GRANULAR BACKFILL COMPACTED TO 95% MODIFIED PROCTOR DENSITY IN THIS AREA

30'-0

ROOF SLAB NOT TO BE PLACED UNTIL PIPES ARE BROUGHT INTO TUNNEL. SEE DETAIL 13/S16

EXPANSION JOINT

CROSSING FOR C.I.P. 14GA 2-24" ϕ SEE DETAIL 9/S16

PLUG

5'

1'-4

9"

NOTE: TUNNEL CONT. AT STA 7+16 DWG S-5

UTILITY ANNEX BLDG

(1)

(B)

20'

10'

147' - 18" ϕ A.C. SAN. SEWER

175.44

EXIST. MANHOLE

67' AT 20.27%

67' AT 0.78%

48' LEVEL

MIN. BACKFILL ELEVATION

ANTICIPATED EXTREME FLOOD LEVEL 184.0

SEE DETAIL 5/S16 FOR SPECIAL WATERPROOFING

EXIST. GRADE

NORMAL WATER LEVEL EL 178.8 ±

177.5

175.22

APPROX ROCK PROFILE

166.4

165.6 ±

10'-0

P.I.T.

179.98

180.5

5'-0

195.0

190.0

185.0

180.0

175.0

170.0

165.0

160.0

NOTE:
ALL STATIONS & DIMENSIONS SHOWN ARE VERTICAL & HORIZONTAL

No.	DATE	REVISION	BY

ASSOCIATION OF PROFESSIONAL ENGINEERS PROVINCE OF NEWFOUNDLAND

A. P. JOHNS

LICENCE TO PRACTICE

SCRIVENER PROJECTS NEWFOUNDLAND LIMITED

MORRISON, HERSHFIELD, BURGESS & HUGGINS, LTD.
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HEALTH SCIENCES COMPLEX & NORTH CAMPUS DEVELOPMENT
ST. JOHN'S NEWFOUNDLAND

UTILITIES TUNNELS

PLAN & PROFILE STA 2+50 TO 5+31

SCALE HOR. 1"=10' VERT 1"=5'

DATE: SEPT-28-72

DESIGNED C.B.L.
DRAWN R.L.
PROJ. ENG. H.V.U.
APPROVED: R.B.D.

DRAWING NO.: S-4

180.3

APPENDIX C

Utility Tunnel Photos

Photo 1 – Tunnel floor

Photo 2 – Tunnel ceiling (observed in only one location)

Photo 3 – Hose from sump pump

Photo 4 – Sump pump beneath ventilation hatch

Photo 5 – Ventilation hatch from inside tunnel

Photo 6 – Ventilation hatch from surface

APPENDIX D

Correspondence

From:	Daniel Parsons
To:	Sheppard, Greg
Cc:	Bursey, Jennifer
Subject:	FW: HSC - Tunnel
Date:	May-29-15 9:12:09 AM

Greg,

Please see comment from Jason.

Regards,
Daniel

From: Daniels, Jason [mailto:jdaniels@mun.ca]
Sent: May-28-15 4:28 PM
To: Daniel Parsons
Subject: RE: HSC - Tunnel

As are we. Stantec was here all morning.
All we have it the 100 yr flood line that CBCL prepared.
My understanding is that the HSC tunnel entrance would be at risk of water directly entering if Level 1 flooded.
That said, during periods of high water the pumps in the tunnel cannot handle the water ingress and the tunnel has "flooded" in the past.
In the words of the former power engineer, "right to the lights" was the amount of water.
The pumps are duty pumps meant to handle normal seepage.

I think that the risk of flooding is high however the really question should be what is the risk of a utility failure when flooded.
The fluid lines are pretty stable. Electrically, I'm told the cables are immiscible but not submersible. I translate this to mean they can be wet and get wet but are not meant to be directly installed in water. This makes sense as most duct banks are not dry and often flood or fill with water.

Don't know if this helps at all.

Jason Daniels, P.Eng., M.A.Sc., P.M.P.
Manager, Facilities Engineering & Development
Memorial University of Newfoundland
Tel: 709 864 8272
Fax:709 864 2215
Email: jdaniels@mun.ca

From: Daniel Parsons [mailto:Daniel.Parsons@easternhealth.ca]
Sent: Thursday, May 28, 2015 4:21 PM
To: Daniels, Jason
Subject: HSC - Tunnel

Jason,

Do you have details on the tunnel? I am looking into the risk of flooding in the event of a 100 year storm and any information you have would be helpful.

Daniel

Daniel J. Parsons, B.Eng
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