



City of St. John's Rennies River Flood Mitigation Portugal Cove Road to Kings Bridge Road Environmental Preview Report



ST. JOHN'S

Project No. 213032 • September 2022

Appendix B

Flood Mitigation Studies



CBCL LIMITED

Consulting Engineers

March 2, 2020

Scott Winsor, P.Eng.
Director of Engineering
Planning, Engineering and Regulatory Services
City of St. John's
P.O. Box 908
St. John's, NL A1C 1J3

Dear Mr. Winsor:

RE: Rennie's River Flood Mitigation – Phase 2A Additional Analysis
DRAFT REPORT

Background

In 2014 CBCL completed the Rennie's River Catchment Stormwater Management Plan (RRCSMP) Study for the City of St. John's. The study included hydrologic modelling of the catchment to determine flood flows for existing and future land uses, considering up-to-date rainfall data as well as rainfall representative of climate change conditions. A hydraulic model was then created to examine the extent of the floodplain resulting from the flood flows. The flood selected for design of flood protection improvements was the 1:100 annual exceedance probability (AEP) flow associated with future land development and climate change conditions.

Scope of Work

The scope of work for this current assignment includes hydraulic modelling of Rennie's River from Wicklow Street to Quidi Vidi Lake for the following scenarios:

1. Without the Long Pond weir in place, determine the effect on flooding if the improvements downstream of Portugal Cove Road bridge, as identified in Figure 2 of the Rennie's River Flood Mitigation – Phase 2A Draft Final Report, dated September 17, 2019, are removed.
2. Determine the climate change design storm that can be accommodated by the existing river.
3. Determine the climate change design storm that can be accommodated without the Long Pond weir in place and with downstream improvements as recommended in Figure 2 of the September 17, 2019 Report.
4. Compare the floodplain for the existing river system (i.e. without improvements) to floodplains with the proposed berms at the Health Sciences, with and without Long Pond weir, and with and without the proposed downstream improvements as presented in Figure 2 and Figure 7 of the September 17, 2019 Report.

Analysis

This scope of work builds on the analysis presented in the September 17, 2019 Report. It should be noted that, during the course of the hydraulic modeling for the scope of work listed above, a software bug was identified. It was noticed that a road which did not overtop in previous versions of the software did overtop in XPSWMM version 2018.2.1 (and version 2019.1). This software bug was brought to the attention of XPSolutions, the supplier of the XPSWMM software. XPSolutions determined that the problem was related to the bridge links. When the bridge geometry is entered in XPSWMM through the bridge link the

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program creates tables of depth, area, wetted perimeter, and surface width. There were errors in these tables which lead to the program incorrectly determining the amount of water through the bridge links. XPSolutions recommended changing the bridge links to multilinks, creating the depth, area, wetted perimeter and surface width tables outside of XPSWMM, and entering this data in the multilinks. These changes were made to the model and the 1:100 AEP Climate Change (CC) flow was simulated. The results were compared to the original RRCSMP study floodplain. In general, the 1:100 AEP CC floodplain produced from the 1D-2D model compared well to the original 2D-2D RRCSMP 1:100 AEP CC floodplain. However, the water level upstream of Clinch Crescent West is higher than modeled in the RRCSMP study and results in Clinch Crescent west being overtopped to the north of the bridge.

For item 1, the improvements proposed downstream of Portugal Cove Road in Figure 2 of the September 17, 2019 Report were removed, and the 1:50 AEP without climate change flow was simulated. The resulting floodplain was compared to Figure 2 of the September 17, 2019 Report. This comparison is presented in Figure 1. Without the downstream improvements the peak water level just upstream of Portugal Cove Road is reduced by approximately 0.3m. Therefore, the height of the proposed segmental concrete block wall and cast-in-place concrete wall just upstream of Portugal Cove Road may be reduced. However, further upstream the difference in peak water level is negligible.

For item 2, the hydrologic model which was created for the RRCSMP study was used to simulate climate change hyetographs for 2, 5, 10, 20, 50 and 100 year return periods. The peak flows from each of the sub-watersheds (identified in Figure 2) were extracted and compared to the peak flows corresponding to the 20, 50 and 100 year return periods without climate change. This data is presented in Table 1. It should be noted that the flows presented are **not** river flows (i.e. are not cumulative and do not include the attenuating effects of Long Pond), but rather runoff from each sub-watershed. It was found that a 1:2 AEP CC event cannot be fully contained by the existing river system, particularly at Portugal Cove Road. This is not surprising when the 1:2 AEP CC flows are compared to other storm events. As can be seen from the table the 1:2 and 1:5 AEP CC flows are similar to the 1:20 AEP without climate change flows. The RRCSMP study illustrated that the 1:20 AEP flow for existing climate conditions cannot be contained in the river. The floodplain for the 1:2 AEP CC flow is presented in Figure 3.





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Table 1: Peak Flows by Sub-Watershed

Sub-Watershed #	Peak Sub-Watershed Flow (m ³ /s)								
	1:2 CC	1:5 CC	1:10 CC	1:20 CC	1:50 CC	1:100 CC	1:20	1:50	1:100
1	3.1	4.3	5.2	6.1	7.3	8.2	4.2	5.1	5.8
2	4.8	6.7	8.1	9.4	11.2	12.6	6.5	7.7	8.7
3	2.4	3.5	4.2	4.9	6.0	6.8	3.4	4.2	5.0
4	5.9	8.2	9.8	11.5	13.7	15.4	7.9	9.4	10.6
5	9.2	13.0	15.7	18.4	22.0	24.9	12.7	15.3	17.3
6	8.9	12.6	15.2	17.8	21.3	24.1	12.6	15.2	17.2
7	8.6	12.0	14.4	16.9	20.2	22.7	11.6	13.9	15.7
8	4.0	5.5	6.6	7.6	9.1	10.1	5.2	6.2	7.0
9	9.0	12.9	15.6	18.4	22.1	25.0	13.9	16.9	19.2
10	11.0	15.5	18.5	21.6	25.7	28.9	15.0	17.9	20.1

The analysis for the Rennies River Flood Mitigation – Phase 2A Draft Final Report, dated September 17, 2019 found that the 1:50 AEP flow without climate change could be accommodated without the Long Pond weir in place and with downstream improvements. For item 3, various return period climate change flows were simulated in the model. The 1:20 AEP CC can be accommodated with berm and concrete wall heights less than those proposed in Figure 2 of the September 17, 2019 report. The 1:50 AEP CC event can be accommodated by increasing berm and wall heights proposed in Figure 2 of the September 17, 2019 Report by approximately 0.2-0.4 m. Figure 4 presents the improvements required to accommodate the 1:50 AEP CC event without Long Pond weir in place. Berm heights may change from those presented in Figure 4 during detailed design when survey of the alignment is collected.

For item 4, the scenarios described in Table 2 were simulated for the 1:100 AEP CC event and compared to the 1:100 AEP CC existing conditions. The following sections describe the results of the simulation runs. Figures 5 to 12 present the floodplain for each scenario compared to the existing 1:100 AEP CC floodplain.





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Table 1: Scenarios for Floodplain Comparison to Existing 1:100 AEP CC

Scenario	Figure No.	Health Science Centre	Long Pond Weir	Downstream Improvements
1	5	HSC Berms	No Long Pond weir	No D/S improvements
2	6	HSC Berms	No Long Pond weir	D/S improvements as per figure 2 of the Sept 17, 2019 report
3	7	HSC Berms	No Long Pond weir	D/S improvements as per figure 2 of the Sept 17, 2019 report - deleting improvements D/S of Portugal Cove Road Bridge
4	8	HSC Berms	No Long Pond weir	D/S improvements as per figure 7 of the Sept 17, 2019 report
5	9	HSC Berms	With Long Pond weir	No D/S improvements
6	10	HSC Berms	With Long Pond weir	D/S improvements as per figure 2 of the Sept 17, 2019 report
7	11	HSC Berms	With Long Pond weir	D/S improvements as per figure 2 of the Sept 17, 2019 report - deleting improvements D/S of Portugal Cove Road Bridge
8	12	HSC Berms	With Long Pond weir	D/S improvements as per figure 7 of the Sept 17, 2019 report

Scenario 1, Figure 5: 1:100 AEP CC Health Sciences Berms

As expected, the floodplain for scenario 1 is similar to the floodplain for the 1:100 AEP CC existing river conditions, with the exception of the and floodplain extent between Clinch Crescent West and Clinch Crescent East where the proposed Health Sciences Centre (HSC) Berms are to be constructed. It should be noted that although there is flooding on Prince Philip Drive in the vicinity of the south HSC berm, this flow is not due to overtopping the south berm, but rather flow which overtops the right bank upstream of Clinch Crescent west.

Scenario 2, Figure 6: 1:100 AEP CC Health Sciences Berms and Downstream Berms

The floodplain for scenario 2 cannot be contained by the improvements as proposed in Figure 2 of the September 17, 2019 Report. The water level upstream of Portugal Cove Road will exceed the height of the proposed improvements. Similarly, portions of the proposed downstream improvements will be overtopped.

Scenario 3, Figure 7: 1:100 AEP CC Health Sciences Berms and Berms Downstream of Portugal Cove Road Removed

Removing the berms downstream of Portugal Cove Road will result in the Fieldian Grounds & Riverdale Tennis Club being flooded during the 1:100 AEP CC event. Without berms in the left bank upstream of Kings Bridge Road the floodplain will extend north toward Winter Avenue, over Kings Bridge Road and onto the King George V soccer field.

Scenario 4, Figure 8: 1:100 AEP CC Health Sciences Berms and Alternative Flood Protection Scheme

With the berms downstream of Portugal Cove Road removed but maintaining the berms upstream of King’s Bridge Road, the Fieldian Grounds & Riverdale Tennis Club will be





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flooded during the 1:100 AEP CC event. However residential property will be protected during the 1:100 AEP CC event.

Scenario 5, Figure 9: 1:100 AEP CC Health Sciences Berms and Long Pond Weir

Including the weir at Long Pond does not reduce the flow enough to prevent flooding downstream. Flooding will still occur upstream of Portugal Cove Road toward Pringle Place, and onto Fieldian Grounds & Riverdale Tennis Club.

Scenario 6, Figure 10: 1:100 AEP CC Health Sciences Berms, Long Pond Weir and Downstream Berms

The 1:100 AEP CC event was simulated with the HSC berms and Long Pond weir in place with the downstream improvements as presented in Figure 2 of the September 17, 2019 report. The resulting floodplain is presented in Figure 10.

Scenario 7, Figure 11: 1:100 AEP CC Health Sciences Berms & Long Pond Weir – Berms Downstream of Portugal Cove Road Removed

With this configuration there will still be some flooding toward Winter Avenue for the 1:100 AEP CC event.

Scenario 8, Figure 12: 1:100 AEP CC Health Sciences Berms, Long Pond Weir and Alternative Flood Protection Scheme

The resulting floodplain for scenario 8 is similar to that for scenario 4. The Fieldian Grounds & Riverdale Tennis Club property will be flooded, however, the residential properties will be protected.

Yours truly,

CBCL Limited

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Project No: 193030.00

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Figure 1: Comparison of 1:50 AEP Floodplains With and Without Improvements Downstream of Portugal Cove Road



Figure 2: Subcatchment Delineation

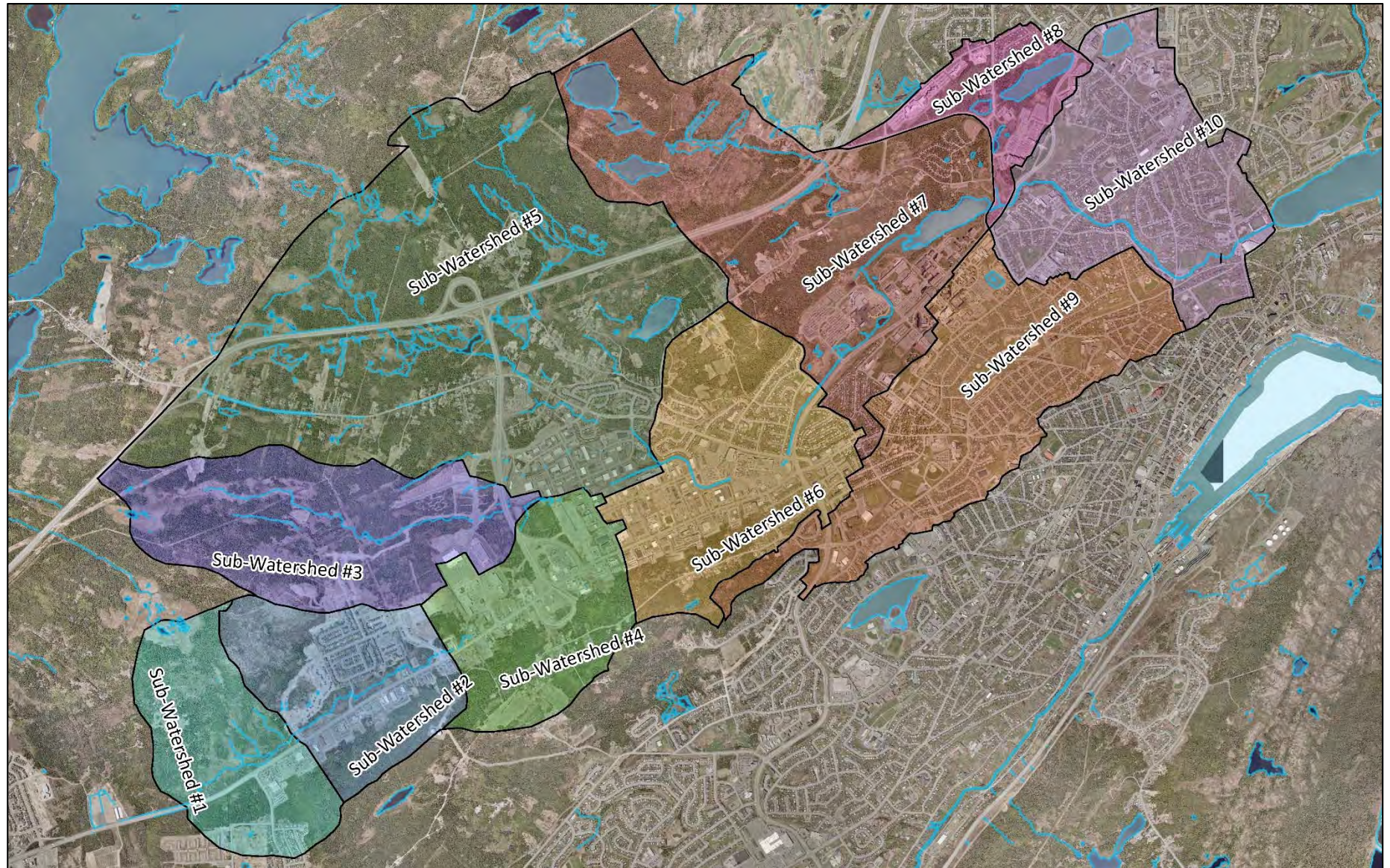


Figure 3: 1:2 AEP Climate Change Floodplain for Existing River System

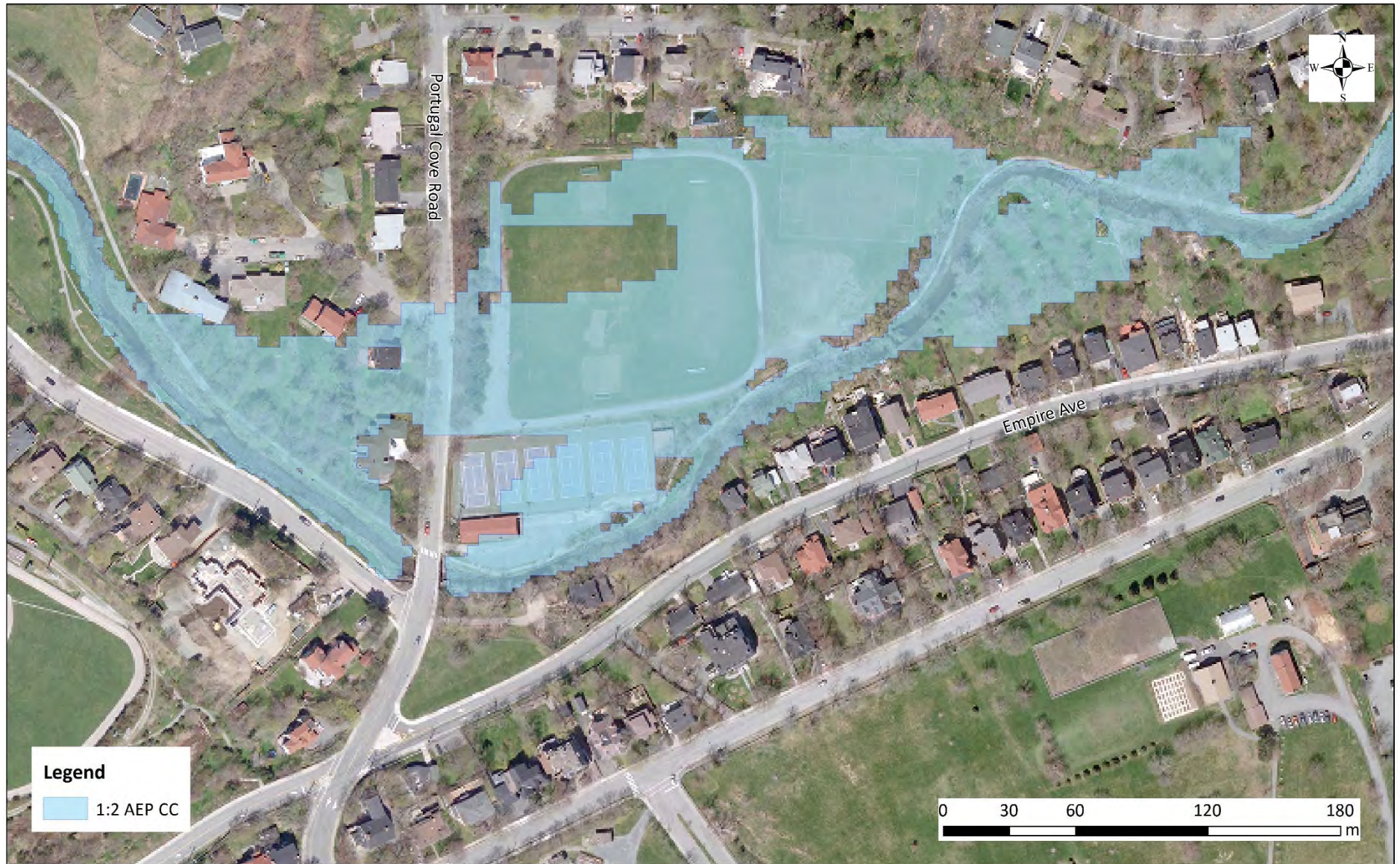
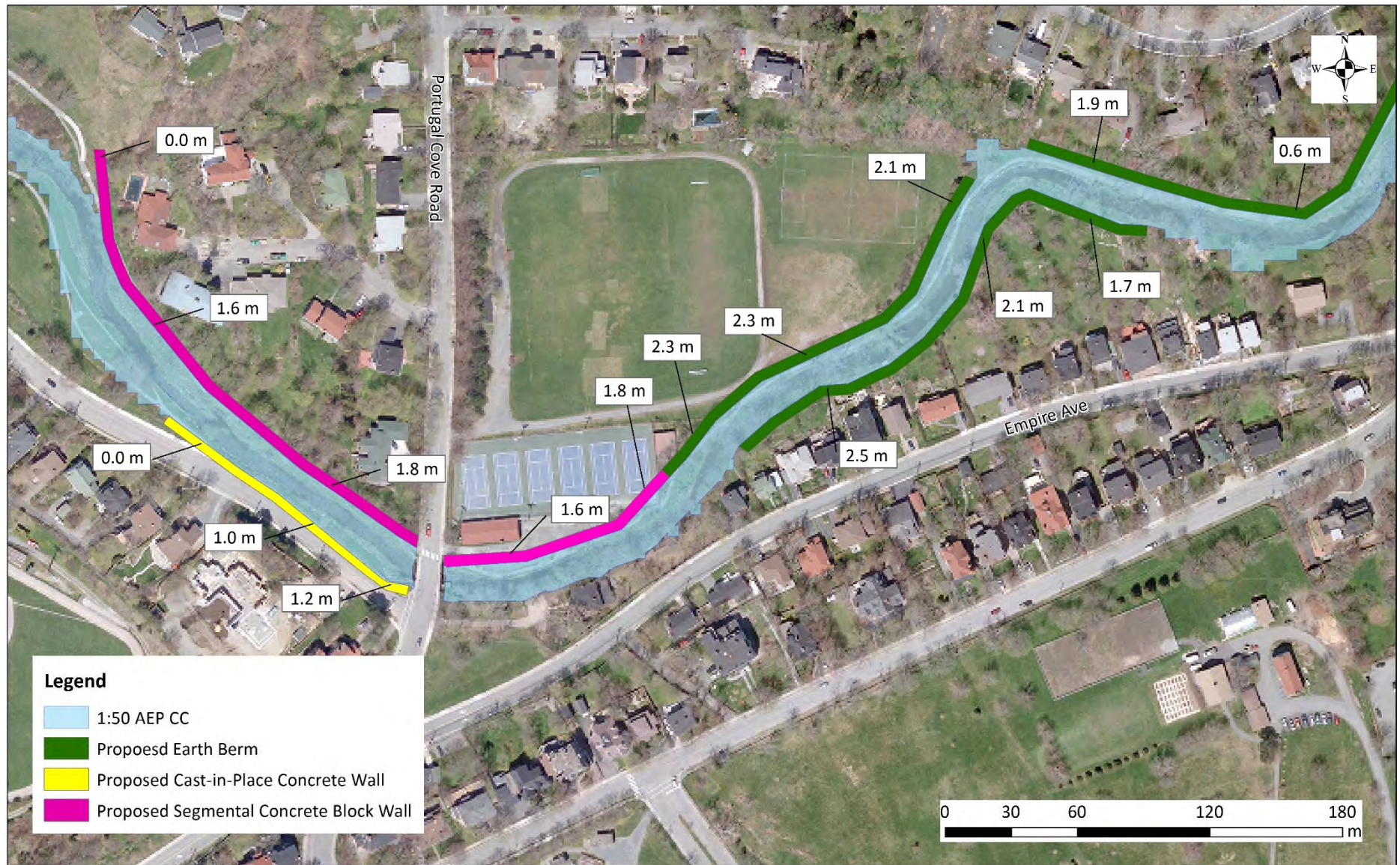
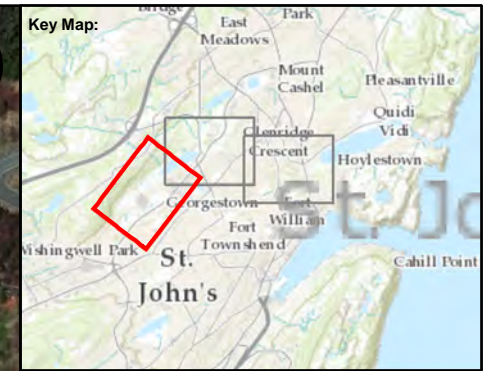
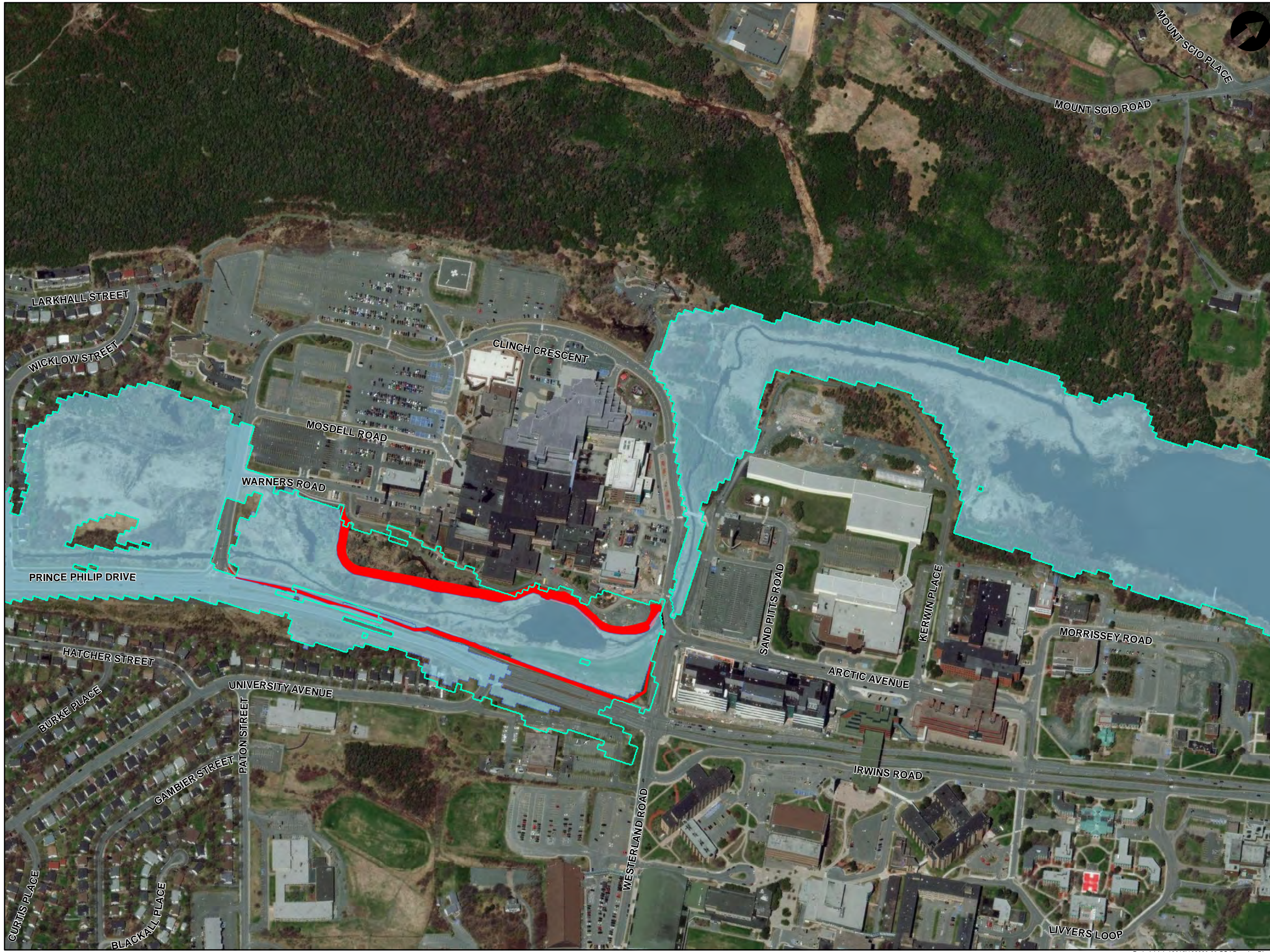


Figure 4: Proposed Heights of Flood Protection Without Long Pond Weir – 1:50 AEP Climate Change





- Legend:
- 100 AEP CC Existing
 - 100 AEP CC HSC Berms
 - Proposed Earth Berm
 - Proposed HSC Berms

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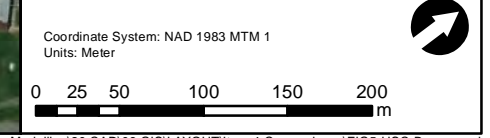
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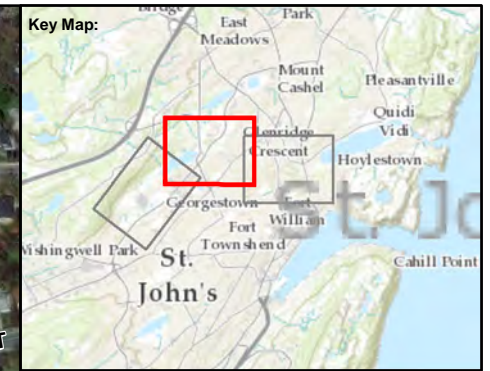
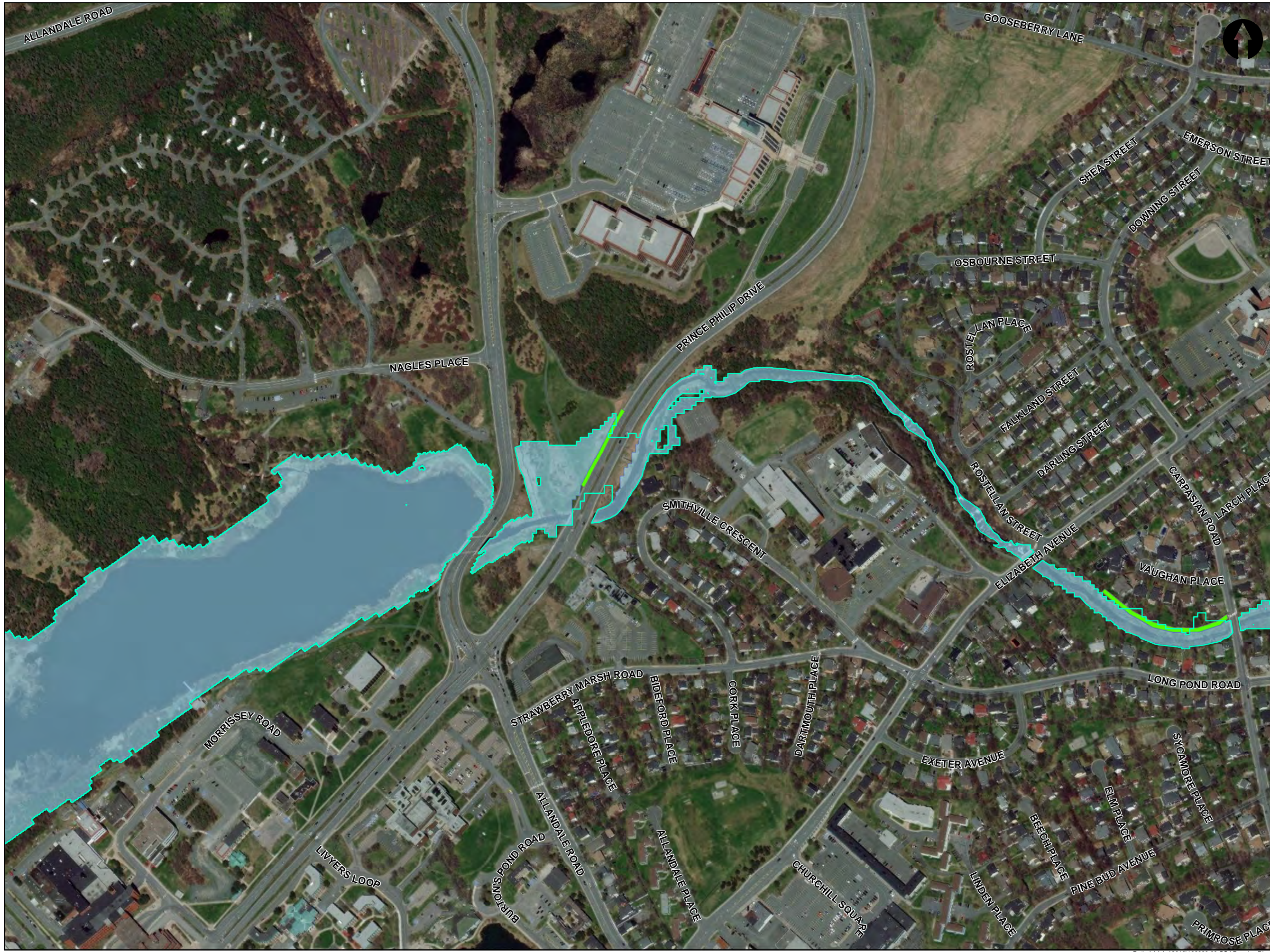
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 1:100 AEP CC Health Sciences Berms



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- Legend:
- 100 AEP CC Existing
 - 100 AEP CC HSC Berms
 - Proposed Earth Berm
 - Proposed HSC Berms

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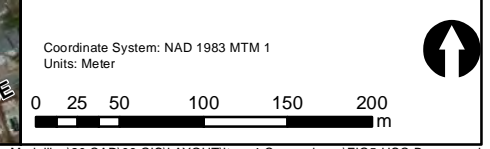
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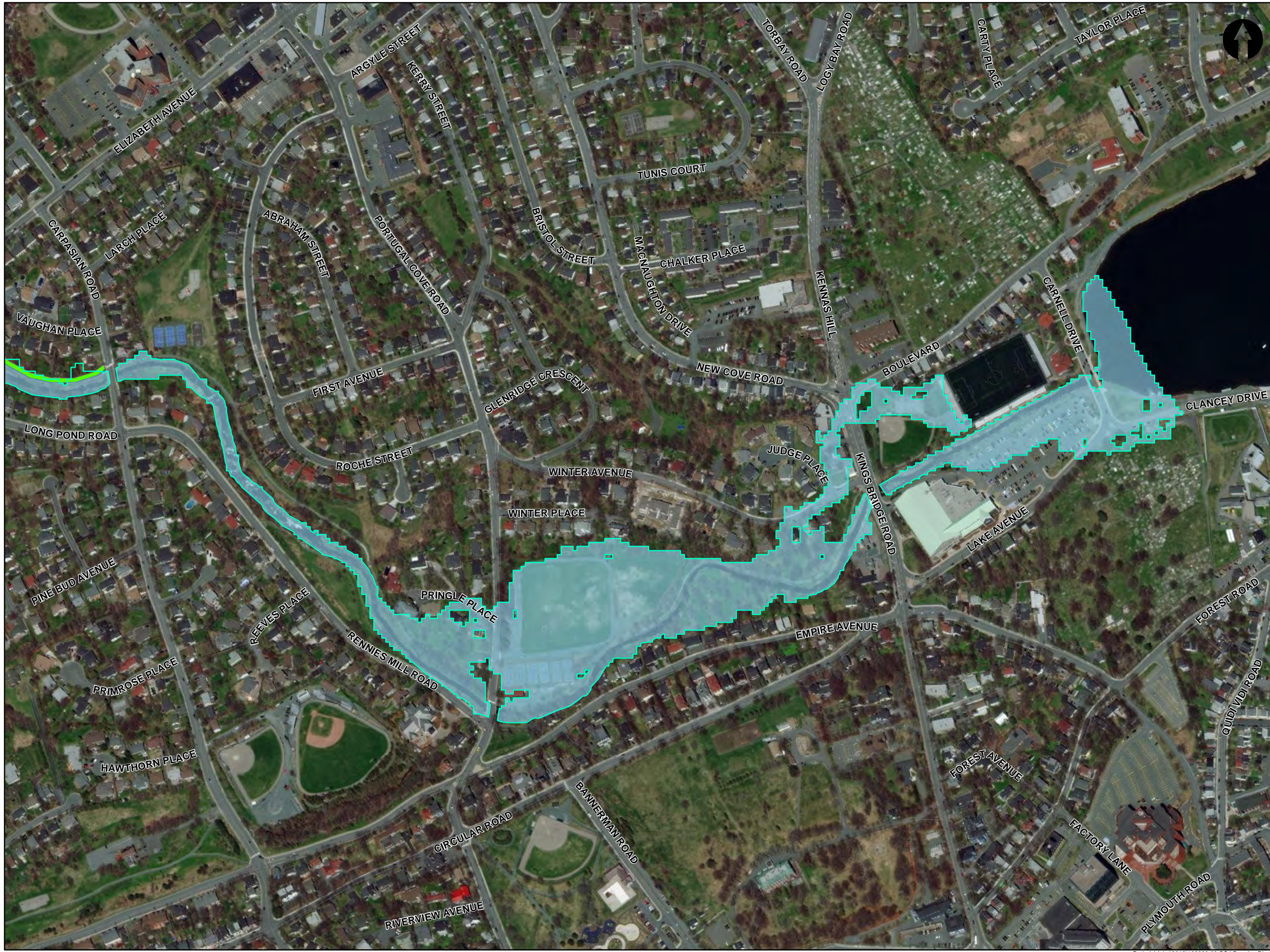
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 - Proposed HSC Berms

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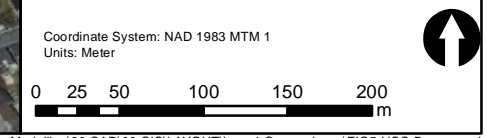
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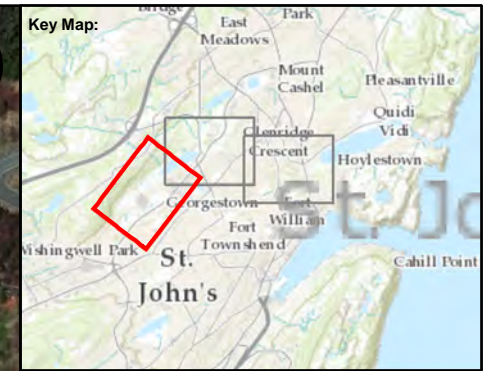
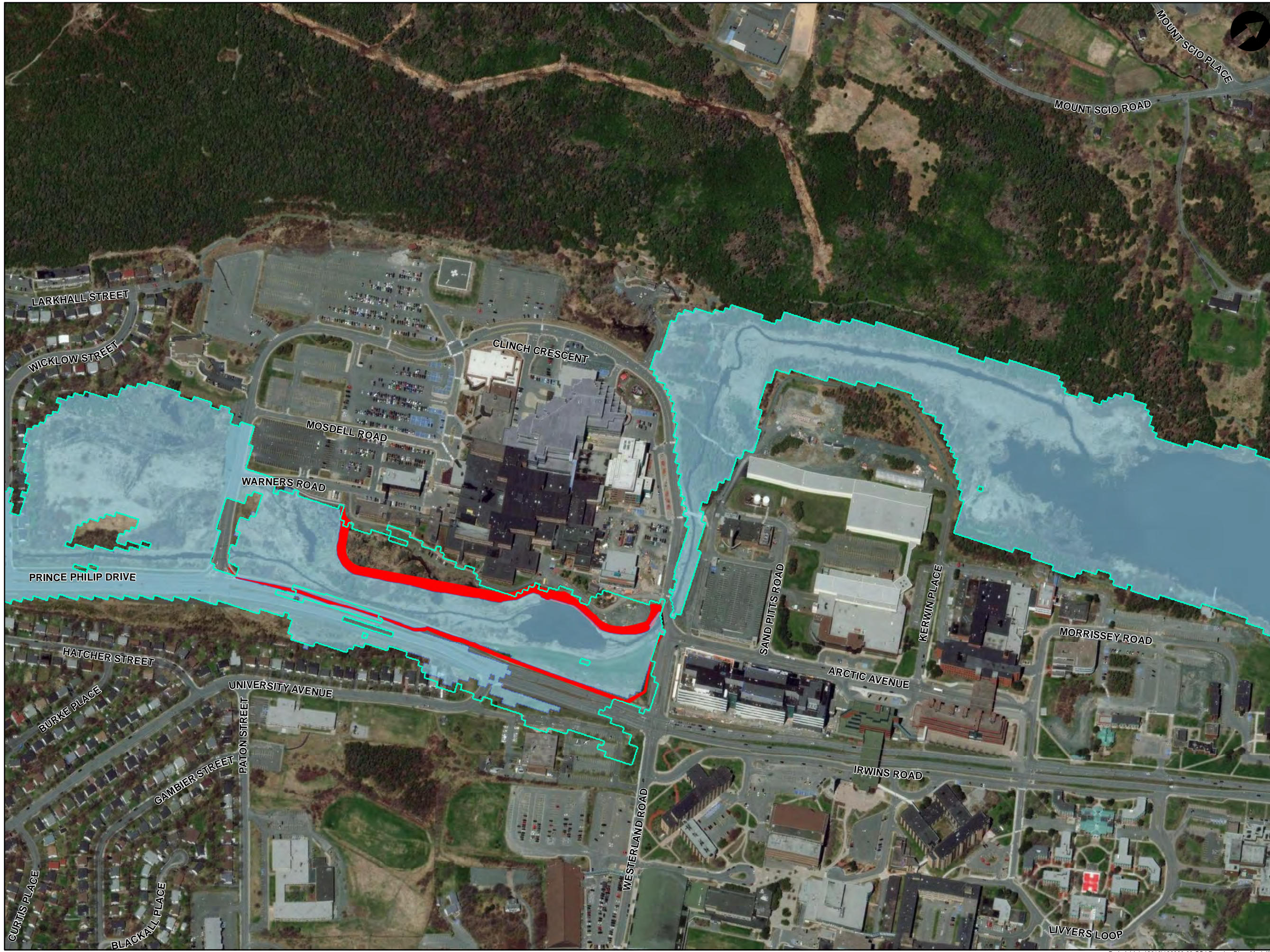
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Legend:

- 100 AEP CC Existing
- 100 AEP CC HSC and Downstream Berms
- Proposed HSC Berms
- Proposed Cast-in-Place Concrete Wall
- Proposed Segmental Concrete Block Wall
- Proposed Earth Berm

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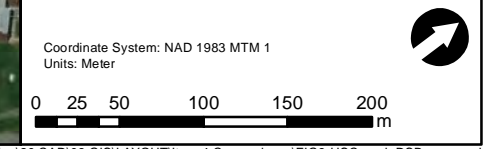
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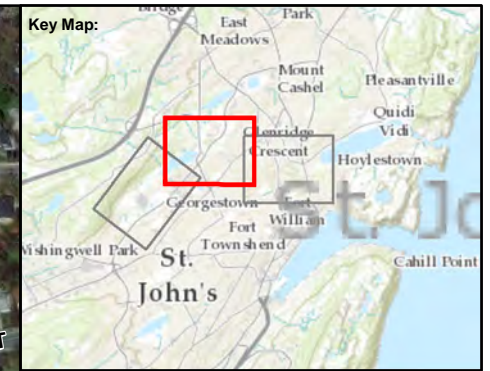
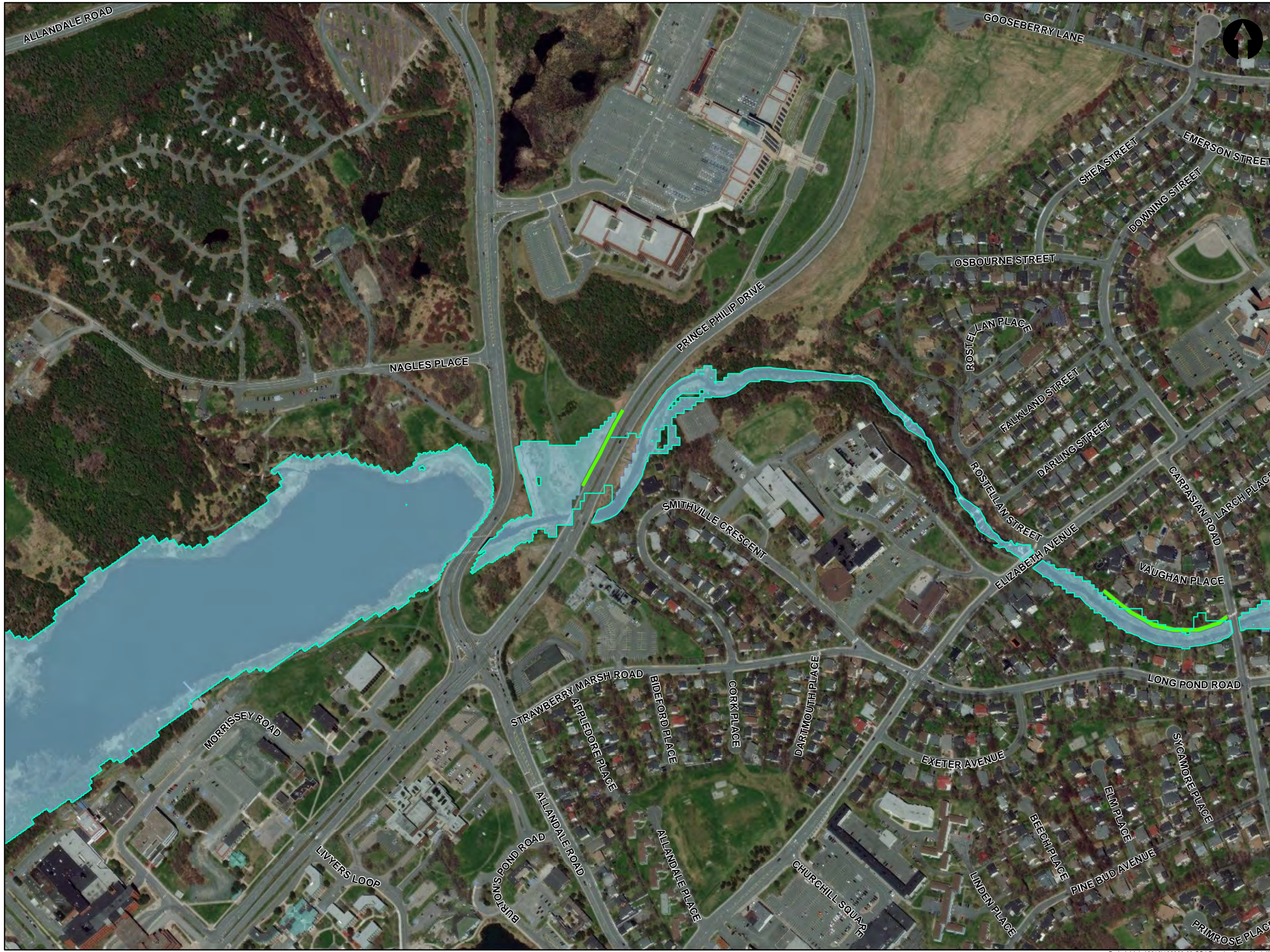
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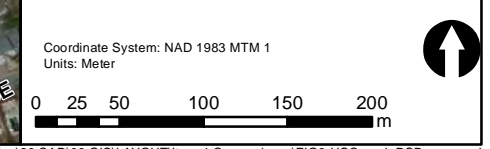
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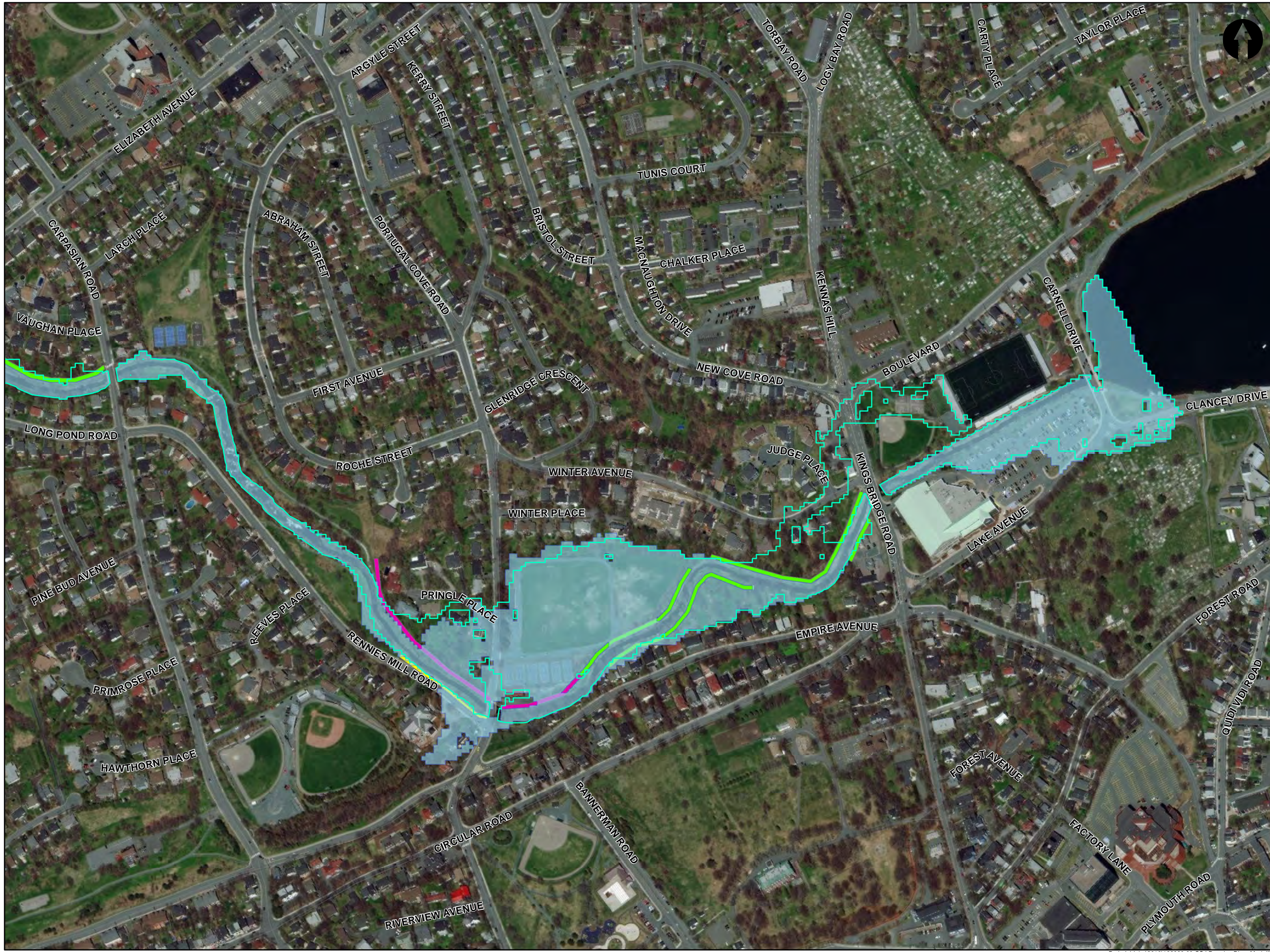
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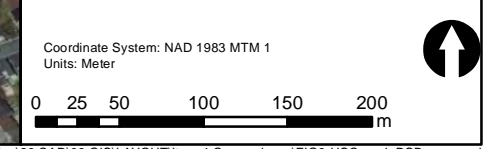
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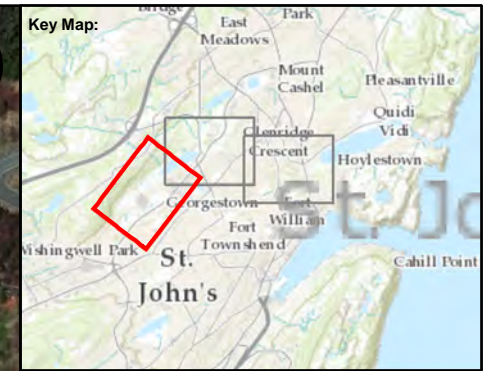
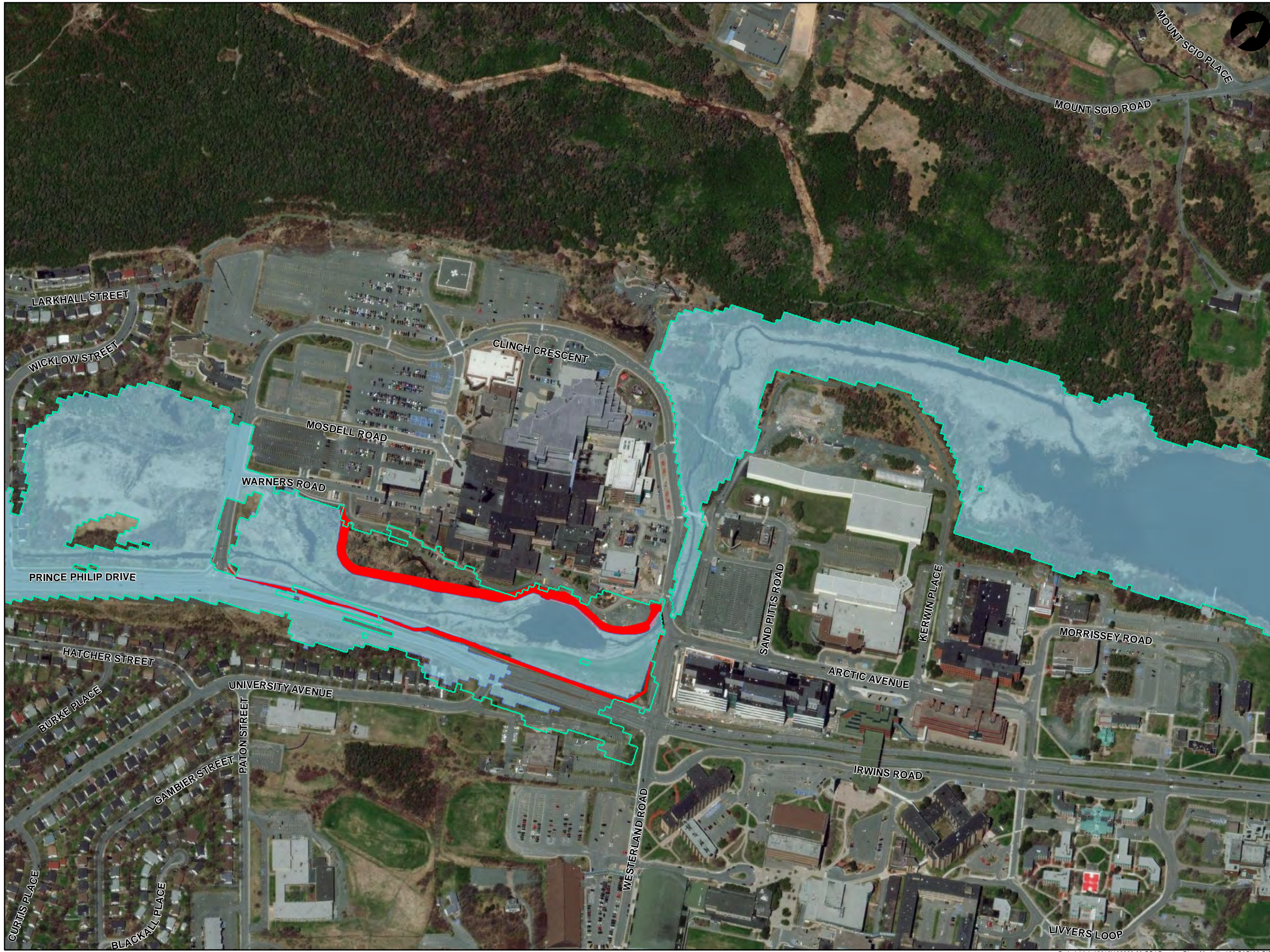
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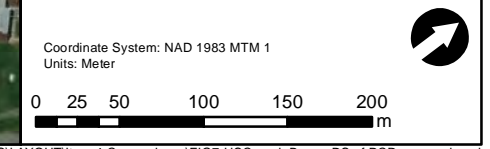
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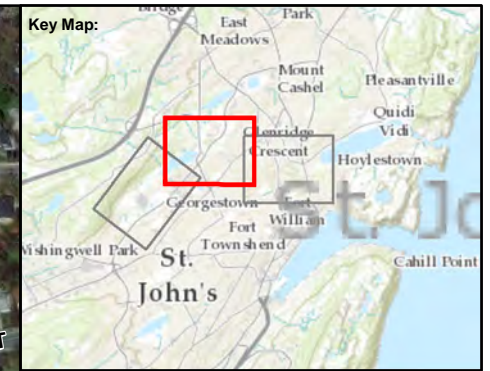
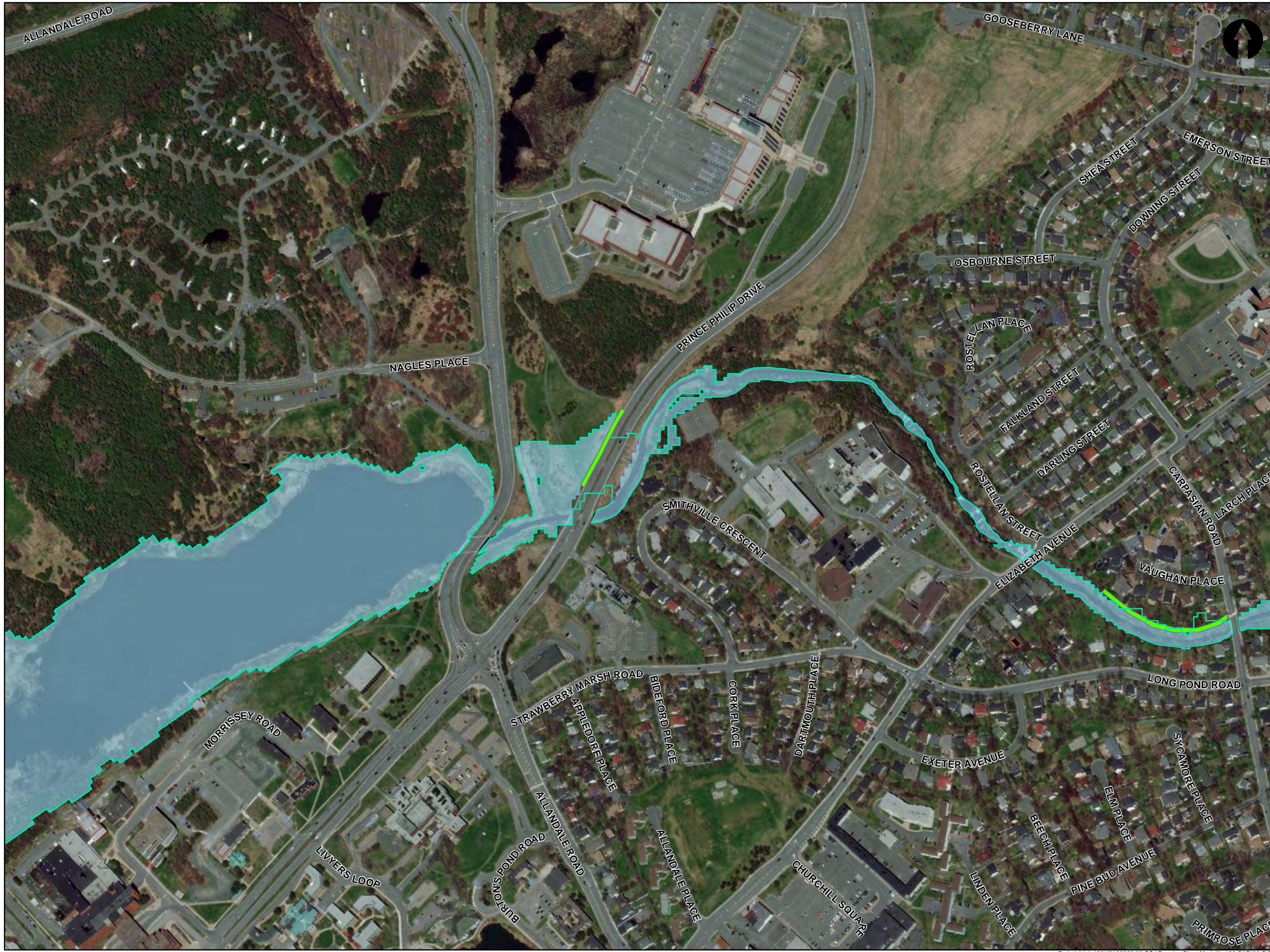
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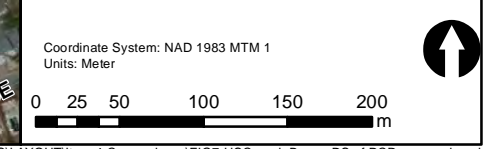
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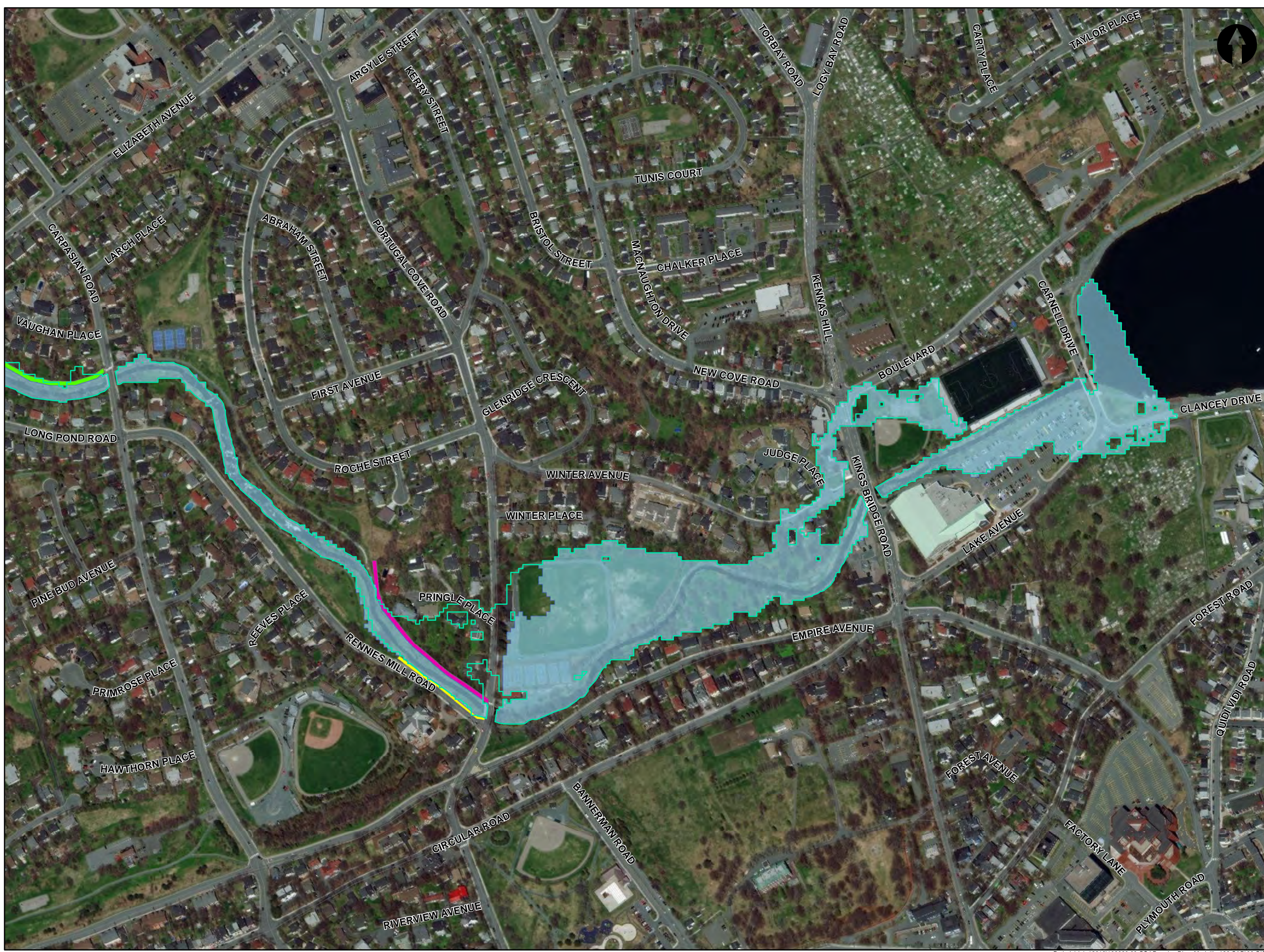
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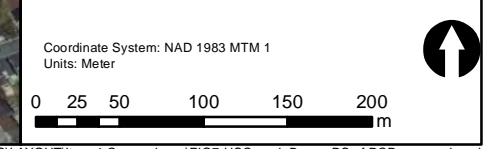
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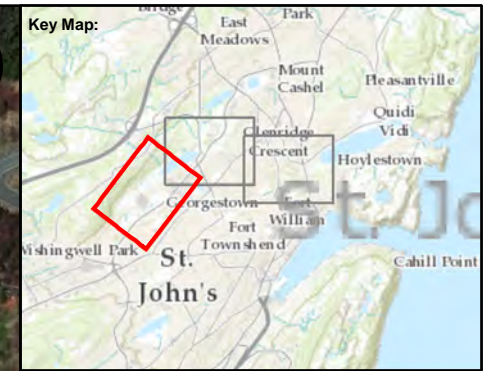
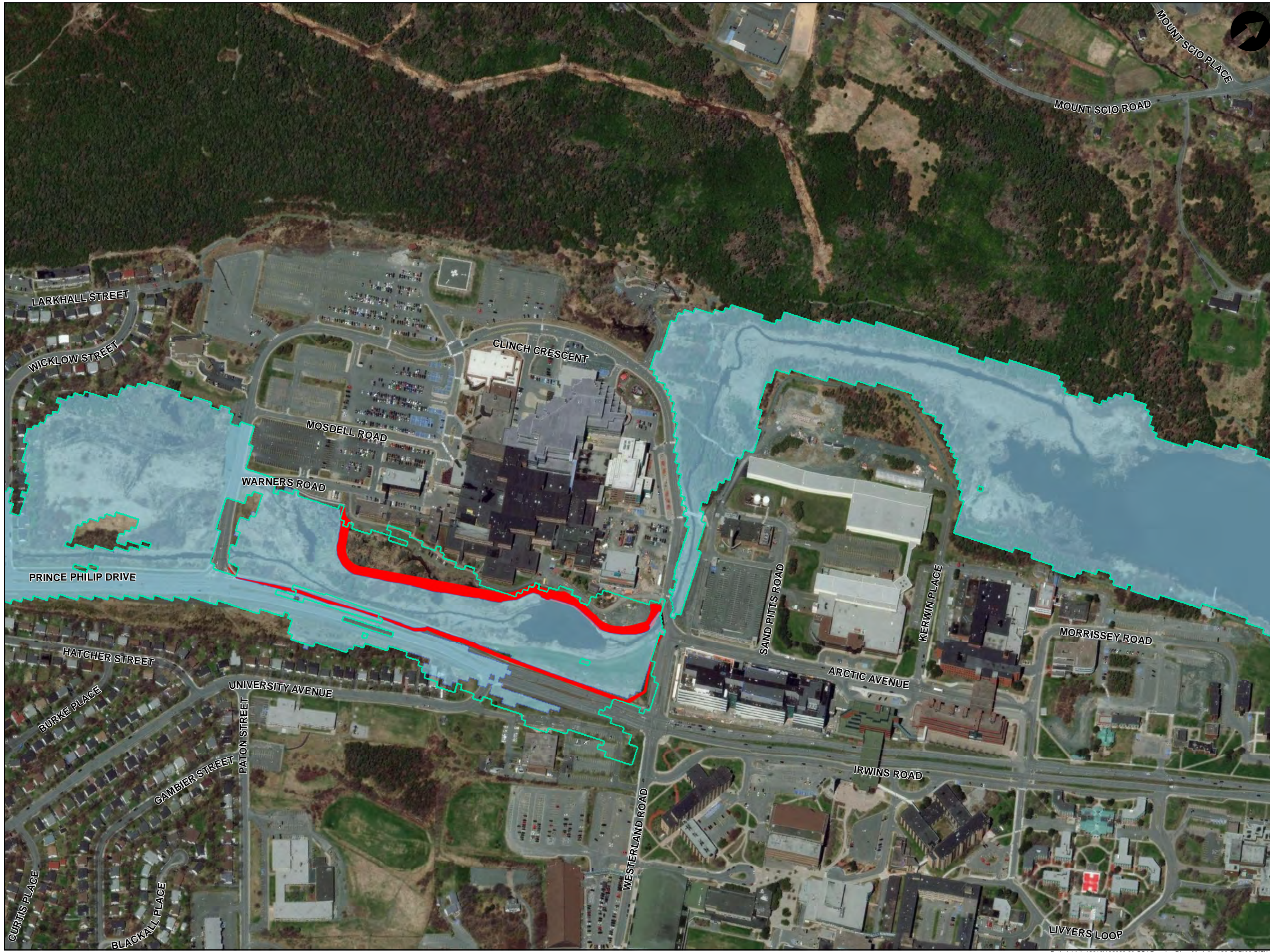
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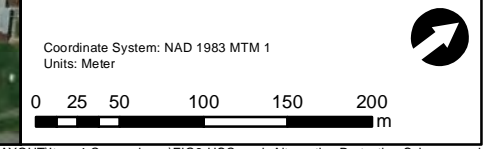
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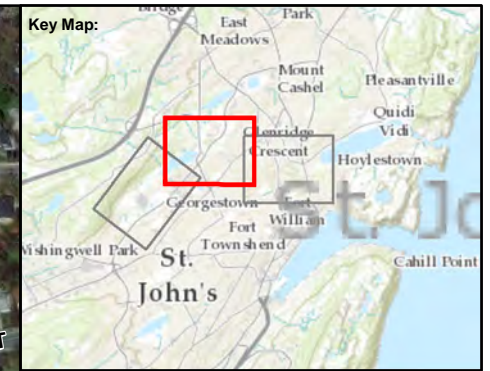
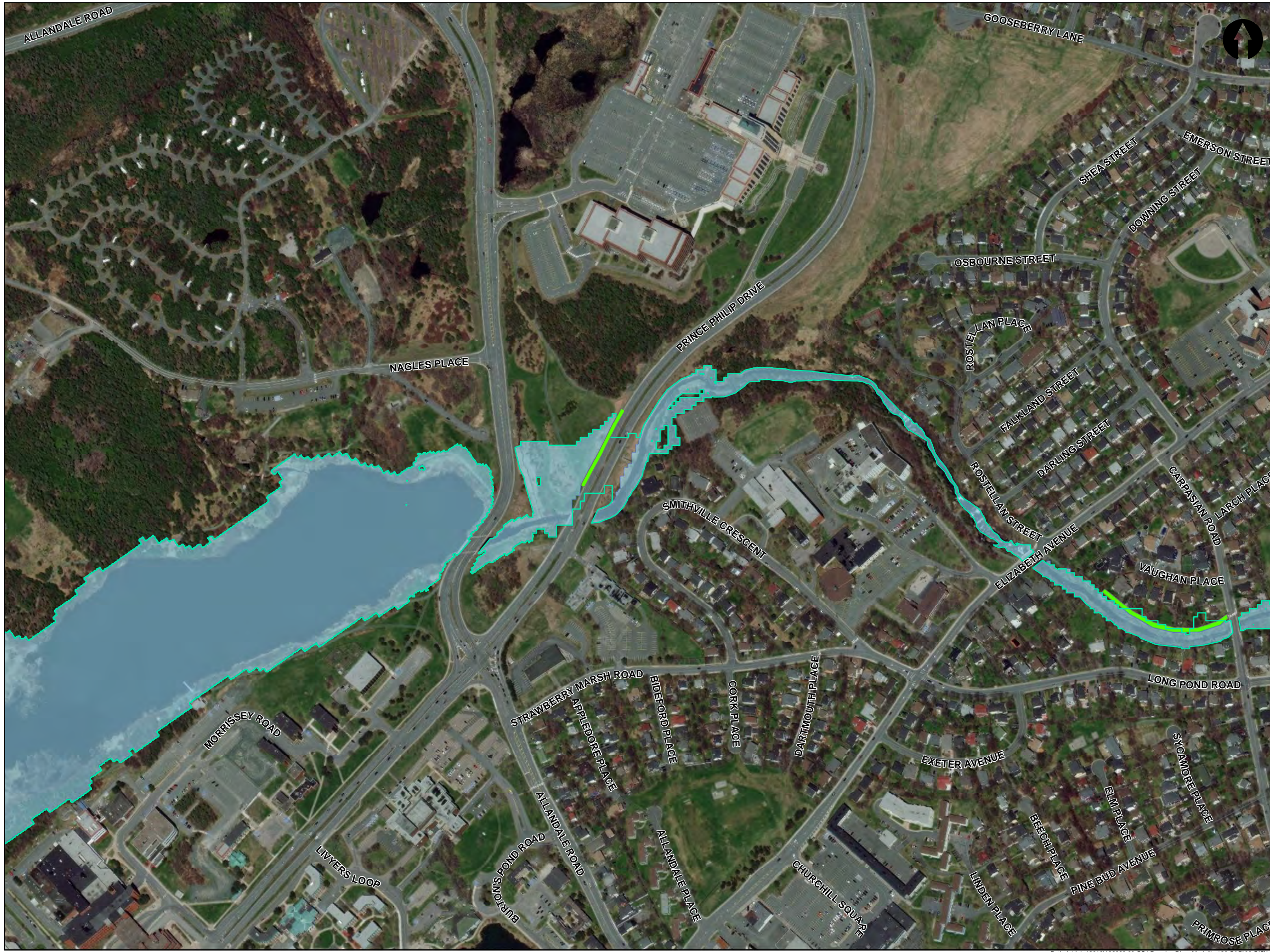
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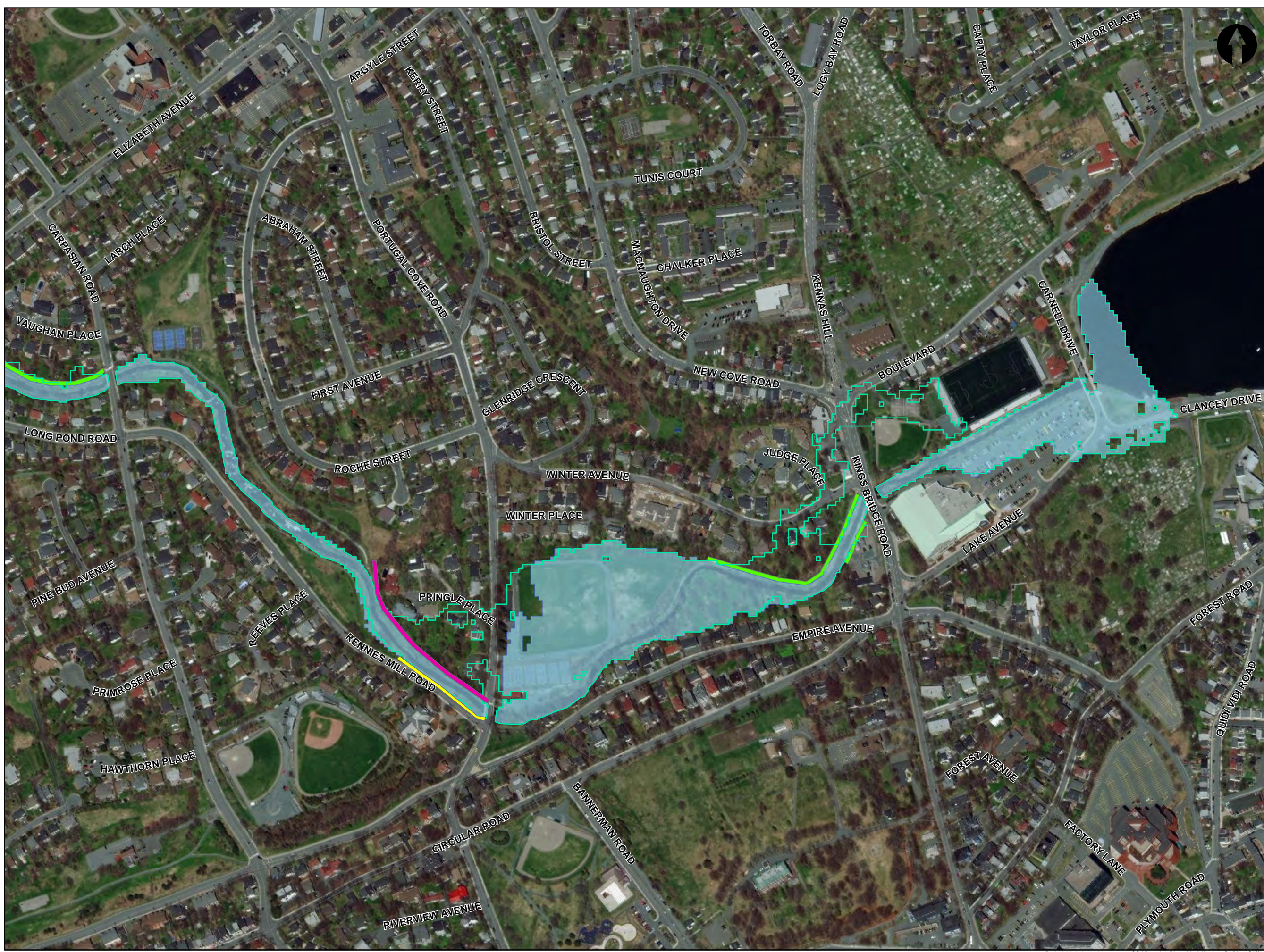
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Approved: GS	Scale @ 11"x17" : 1:4,500

Coordinate System: NAD 1983 MTM 1
 Units: Meter



Legend:

- 100 AEP CC Existing
- 100 AEP CC HSC - Alternative Flood Protection DS
- Proposed HSC Berms
- Proposed Cast-in-Place Concrete Wall
- Proposed Segmental Concrete Block Wall
- Proposed Earth Berm

ST. JOHN'S

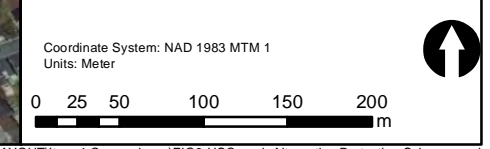
Project:
Rennie's River Flood Mitigation Phase 2A Additional Analysis

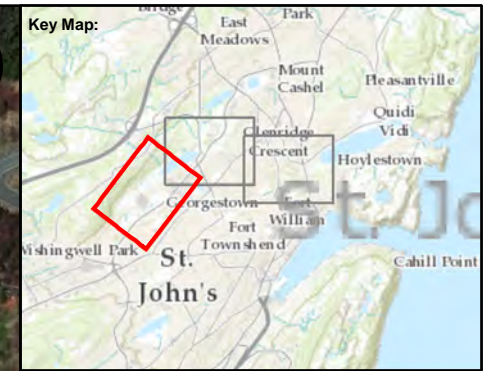
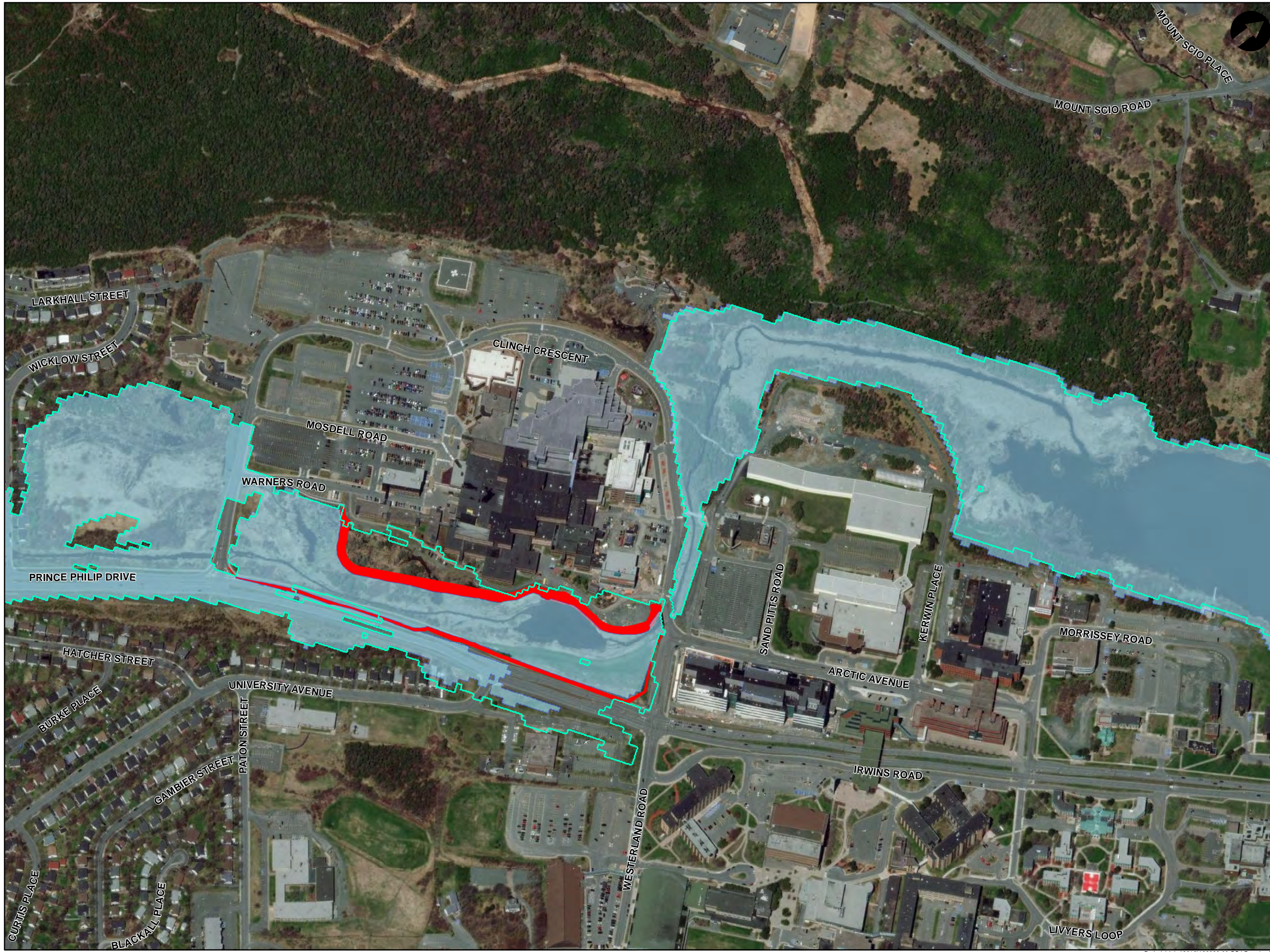
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 1:100 AEP CC Health Sciences Berms and Alternative Flood Protection Scheme



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- Legend:
- 100 AEP CC Existing
 - 100 AEP CC HSC and Long Pond Weir
 - Proposed HSC Berms
 - Proposed Earth Berm

ST. JOHN'S

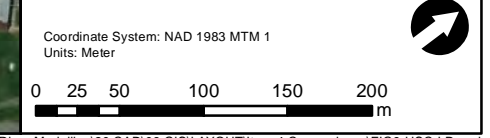
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 Phase 2A Additional Analysis**

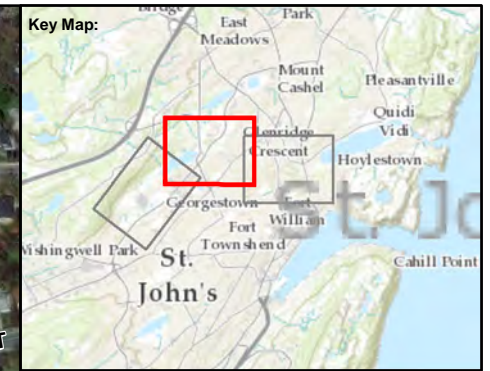
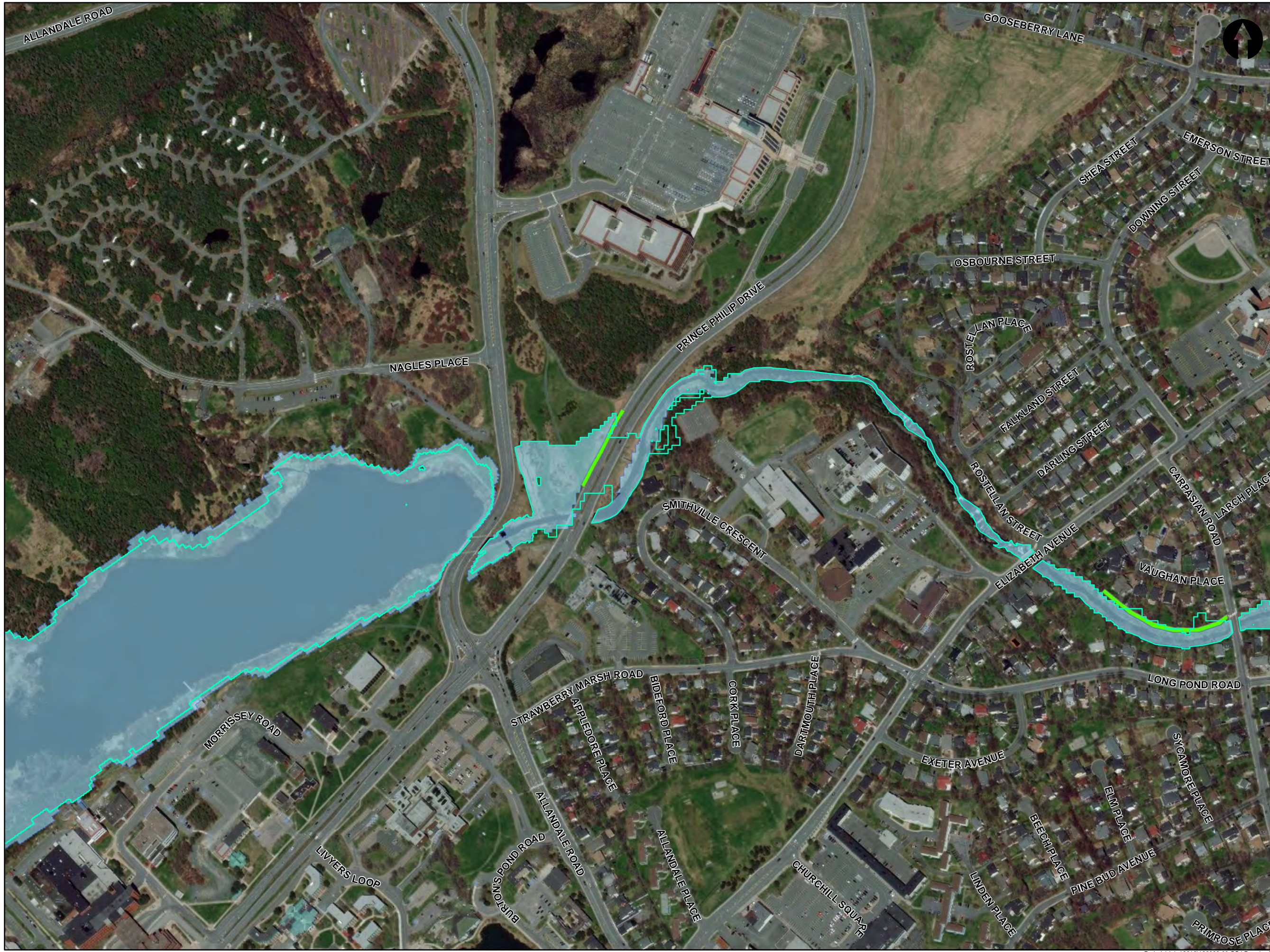
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 1:100 AEP CC Health Sciences Berms
 and Long Pond Weir



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Drawn: JB	Date: 02/03/2020
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- Legend:
- 100 AEP CC Existing
 - 100 AEP CC HSC and Long Pond Weir
 - Proposed HSC Berms
 - Proposed Earth Berm

ST. JOHN'S

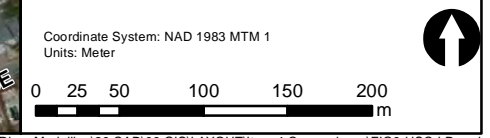
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 Phase 2A Additional Analysis**

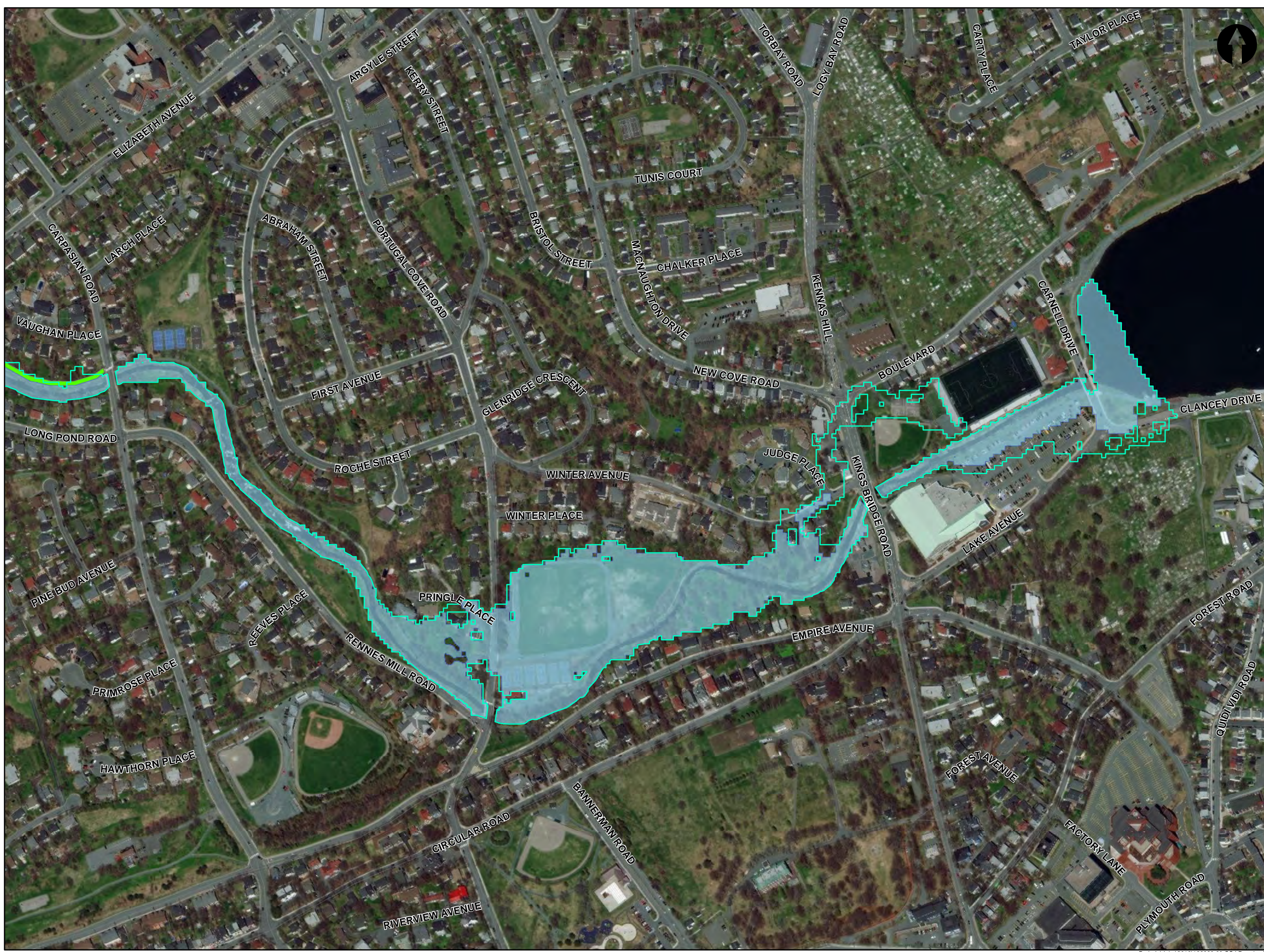
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 1:100 AEP CC Health Sciences Berms
 and Long Pond Weir



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Legend:

- 100 AEP CC Existing
- 100 AEP CC HSC and Long Pond Weir
- Proposed HSC Berms
- Proposed Earth Berm

ST. JOHN'S

Project:
**Rennie's River Flood Mitigation
 Phase 2A Additional Analysis**

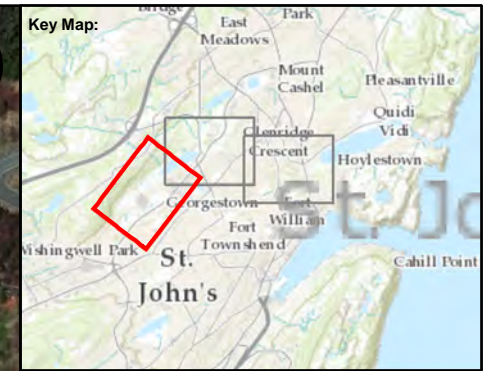
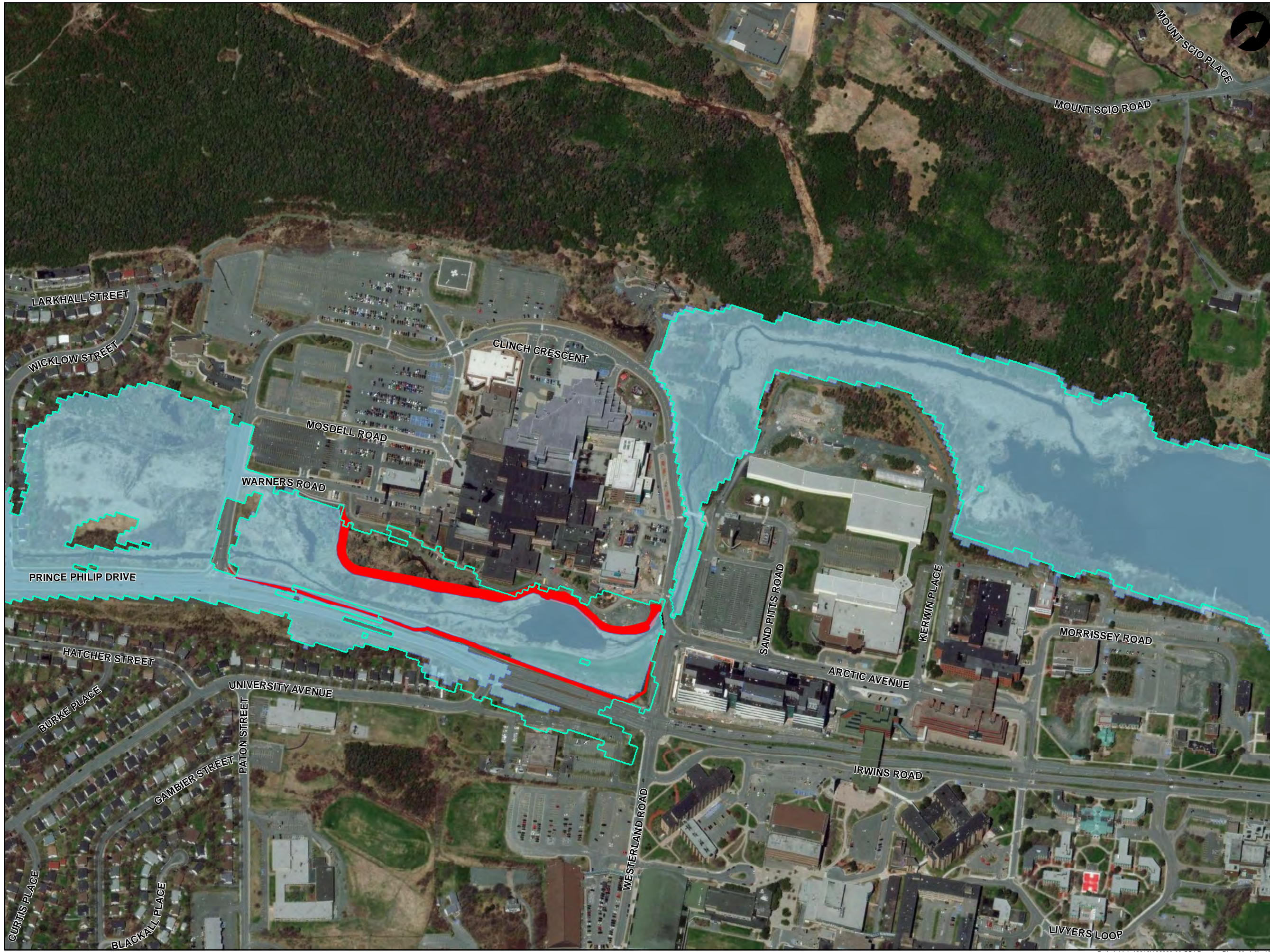
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 1:100 AEP CC Health Sciences Berms
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Coordinate System: NAD 1983 MTM 1
 Units: Meter



Legend:

	100 AEP CC Existing
	100 AEP CC HSC, Long Pond Weir & Downstream Berms
	Proposed HSC Berms
	Proposed Cast-in-Place Concrete Wall
	Proposed Segmental Concrete Block Wall
	Proposed Earth Berm

ST. JOHN'S

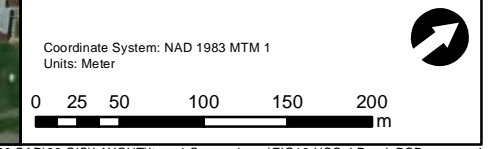
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Rennies River Flood Mitigation Phase 2A Additional Analysis

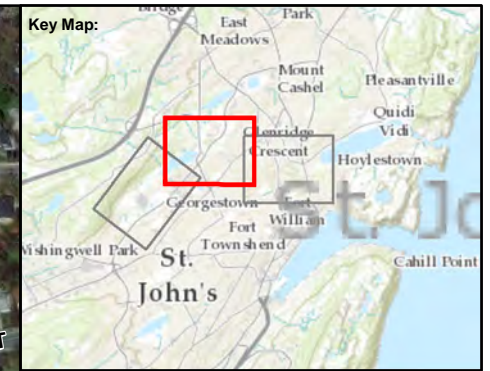
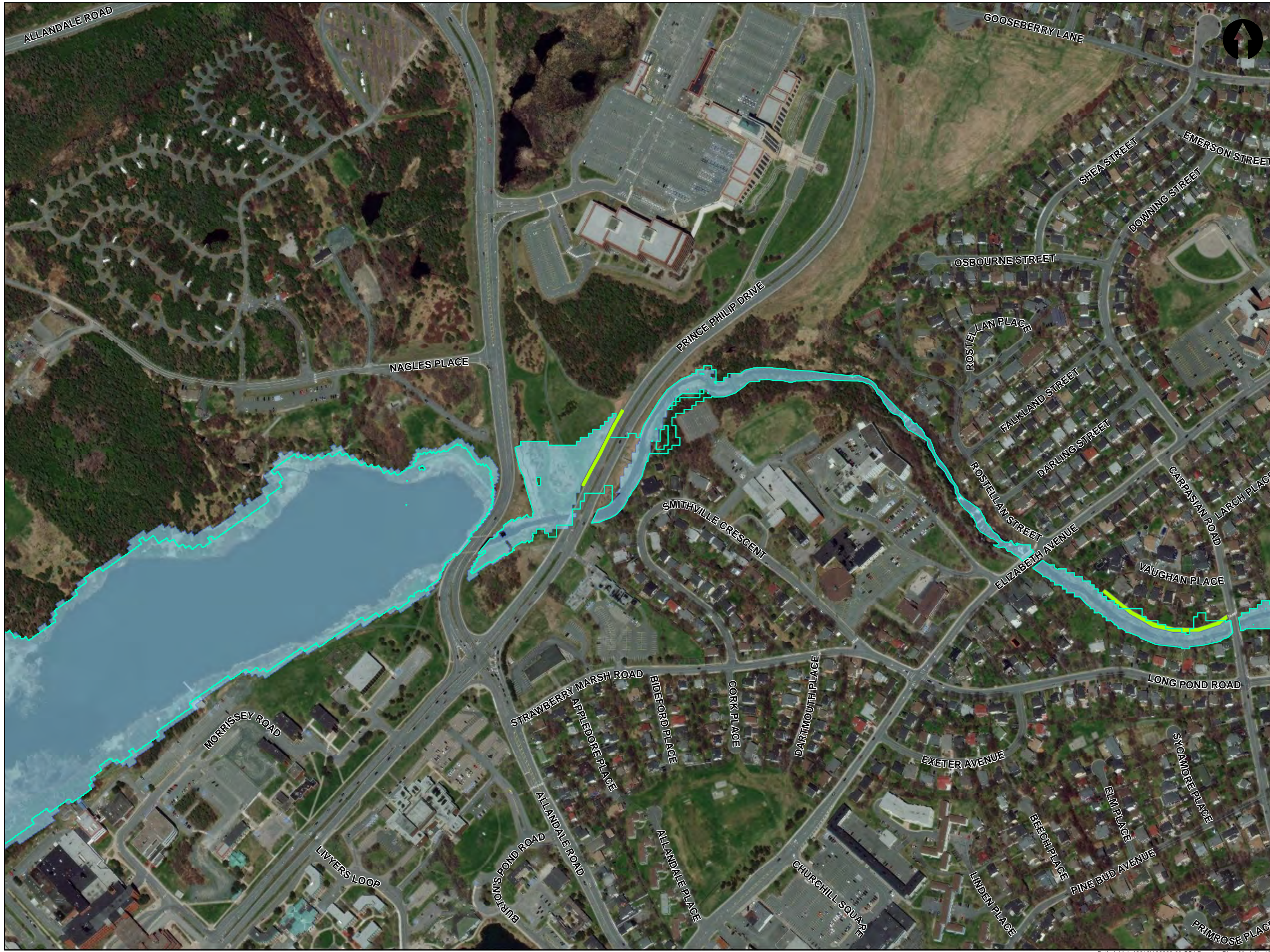
Figure Title:
 Figure 10:
 1:100 AEP CC Health Sciences Berms, Long Pond Weir and Downstream Berms



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Drawn: JB	Date: 02/03/2020
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Legend:

- 100 AEP CC Existing
- 100 AEP CC HSC, Long Pond Weir & Downstream Berms
- Proposed HSC Berms
- Proposed Cast-in-Place Concrete Wall
- Proposed Segmental Concrete Block Wall
- Proposed Earth Berm

ST. JOHN'S

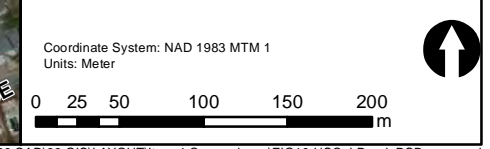
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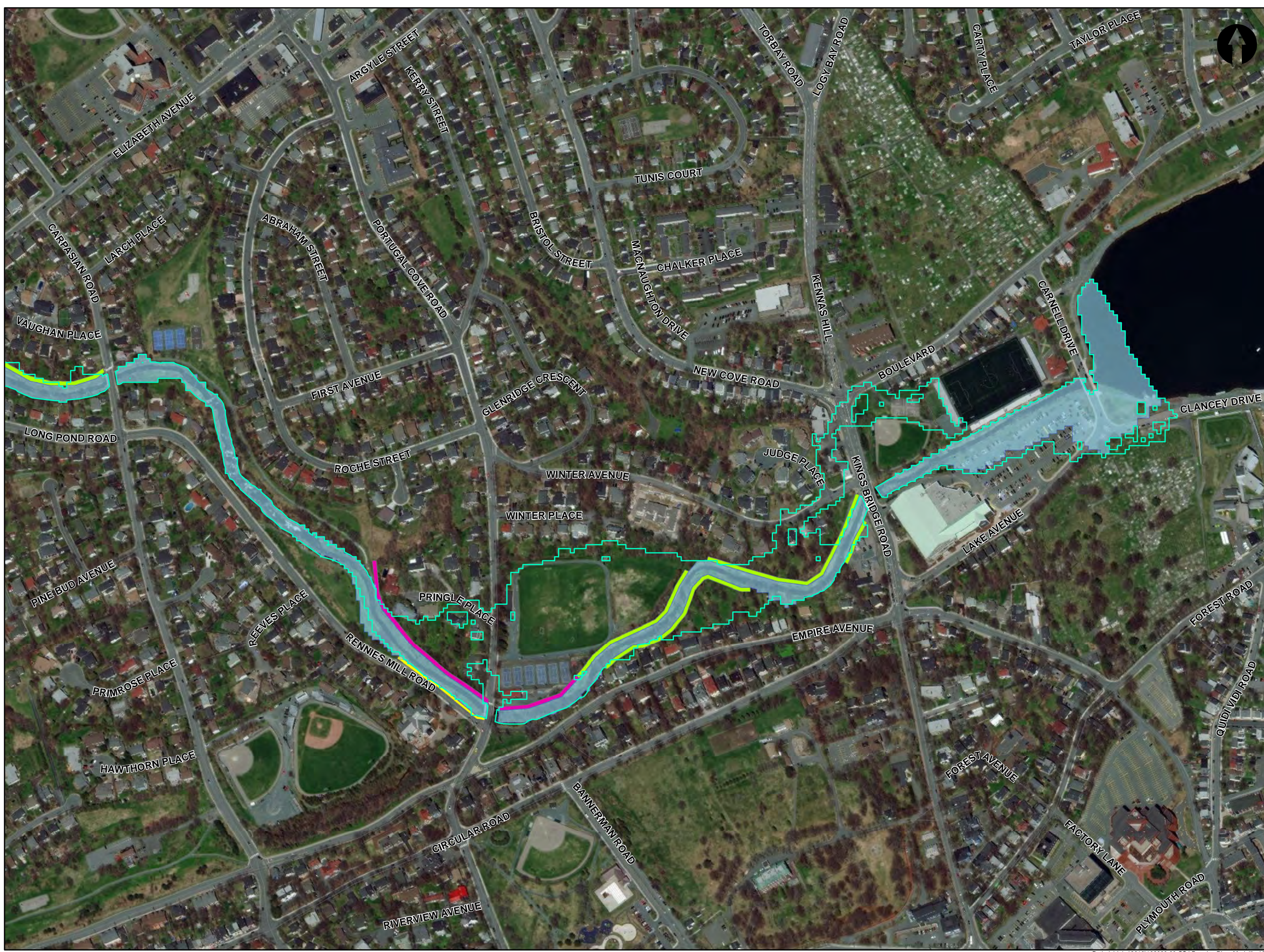
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 1:100 AEP CC Health Sciences Berms, Long Pond Weir and Downstream Berms



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Legend:

- 100 AEP CC Existing
- 100 AEP CC HSC, Long Pond Weir & Downstream Berms
- Proposed HSC Berms
- Proposed Cast-in-Place Concrete Wall
- Proposed Segmental Concrete Block Wall
- Proposed Earth Berm

ST. JOHN'S

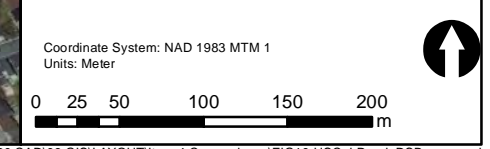
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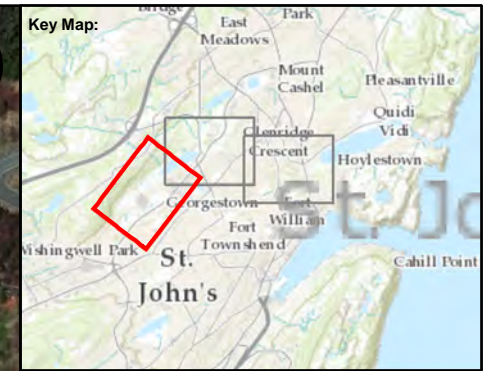
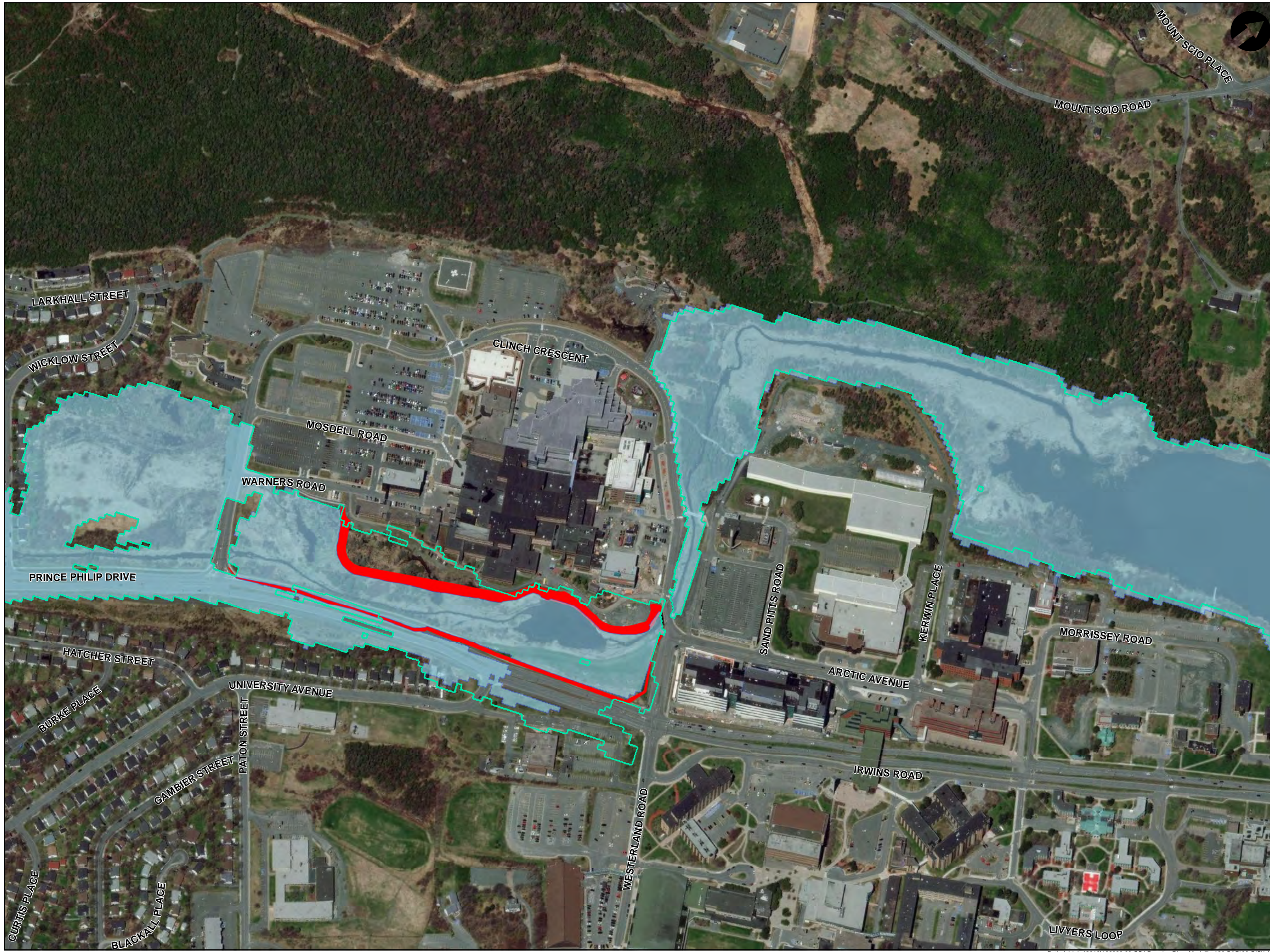
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 1:100 AEP CC Health Sciences Berms, Long Pond Weir and Downstream Berms



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- Legend:**
- 100 AEP CC Existing
 - 100 AEP CC HSC & Long Pond Weir - No Berms DS of Portugal Cove Road
 - Proposed HSC Berms
 - Proposed Cast-in-Place Concrete Wall
 - Proposed Segmental Concrete Block Wall
 - Proposed Earth Berm

ST. JOHN'S

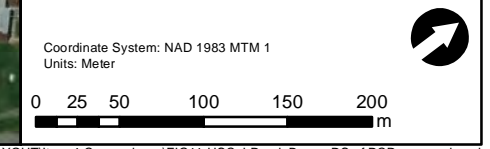
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 Phase 2A Additional Analysis**

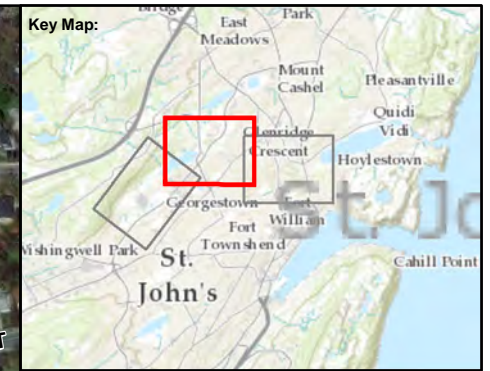
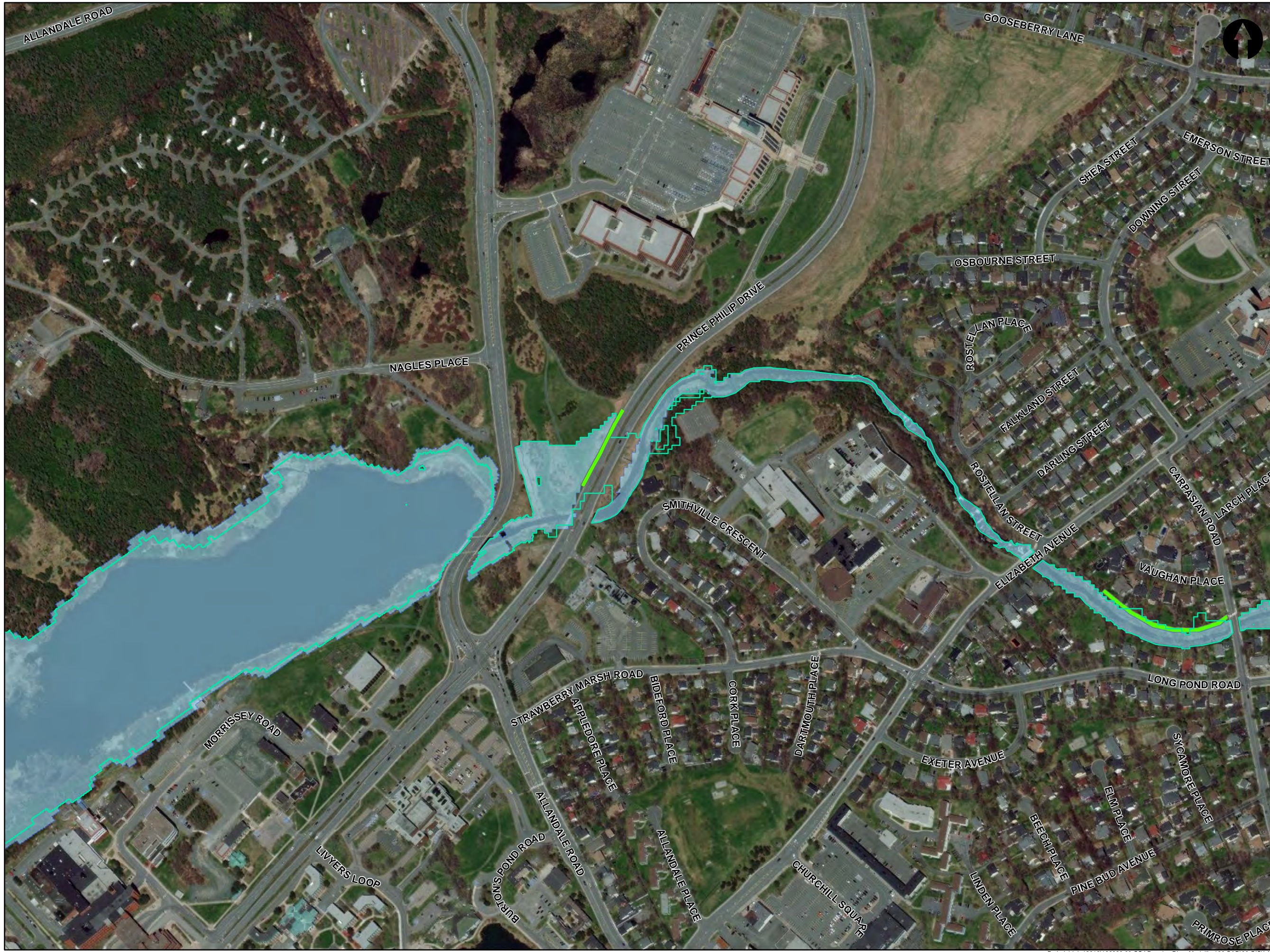
Figure Title:
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 1:100 AEP CC Health Sciences Berms
 & Long Pond Weir - Berms Downstream
 of Portugal Cove Road Removed



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Legend:

	100 AEP CC Existing
	100 AEP CC HSC & Long Pond Weir - No Berms DS of Portugal Cove Road
	Proposed HSC Berms
	Proposed Cast-in-Place Concrete Wall
	Proposed Segmental Concrete Block Wall
	Proposed Earth Berm

ST. JOHN'S

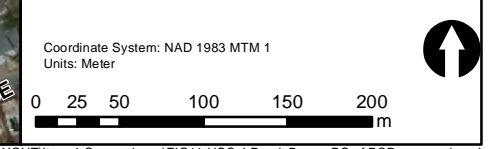
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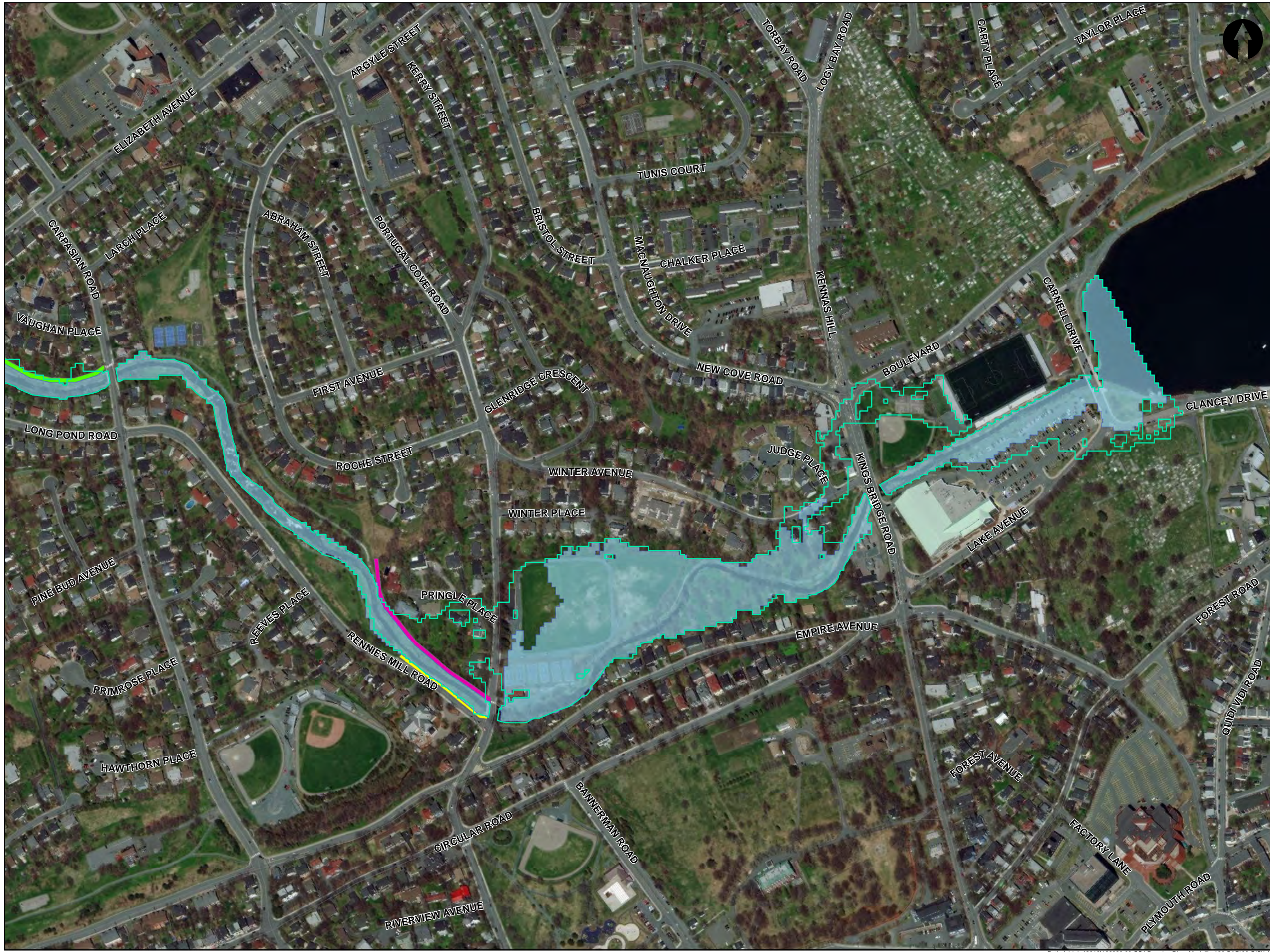
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 Figure 11:
 1:100 AEP CC Health Sciences Berms & Long Pond Weir - Berms Downstream of Portugal Cove Road Removed



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Legend:

- 100 AEP CC Existing
- 100 AEP CC HSC & Long Pond Weir - No Berms DS of Portugal Cove Road
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- Proposed Segmental Concrete Block Wall
- Proposed Earth Berm

ST. JOHN'S

Project:
Rennie's River Flood Mitigation Phase 2A Additional Analysis

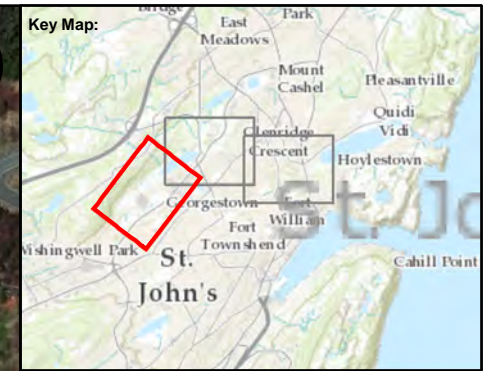
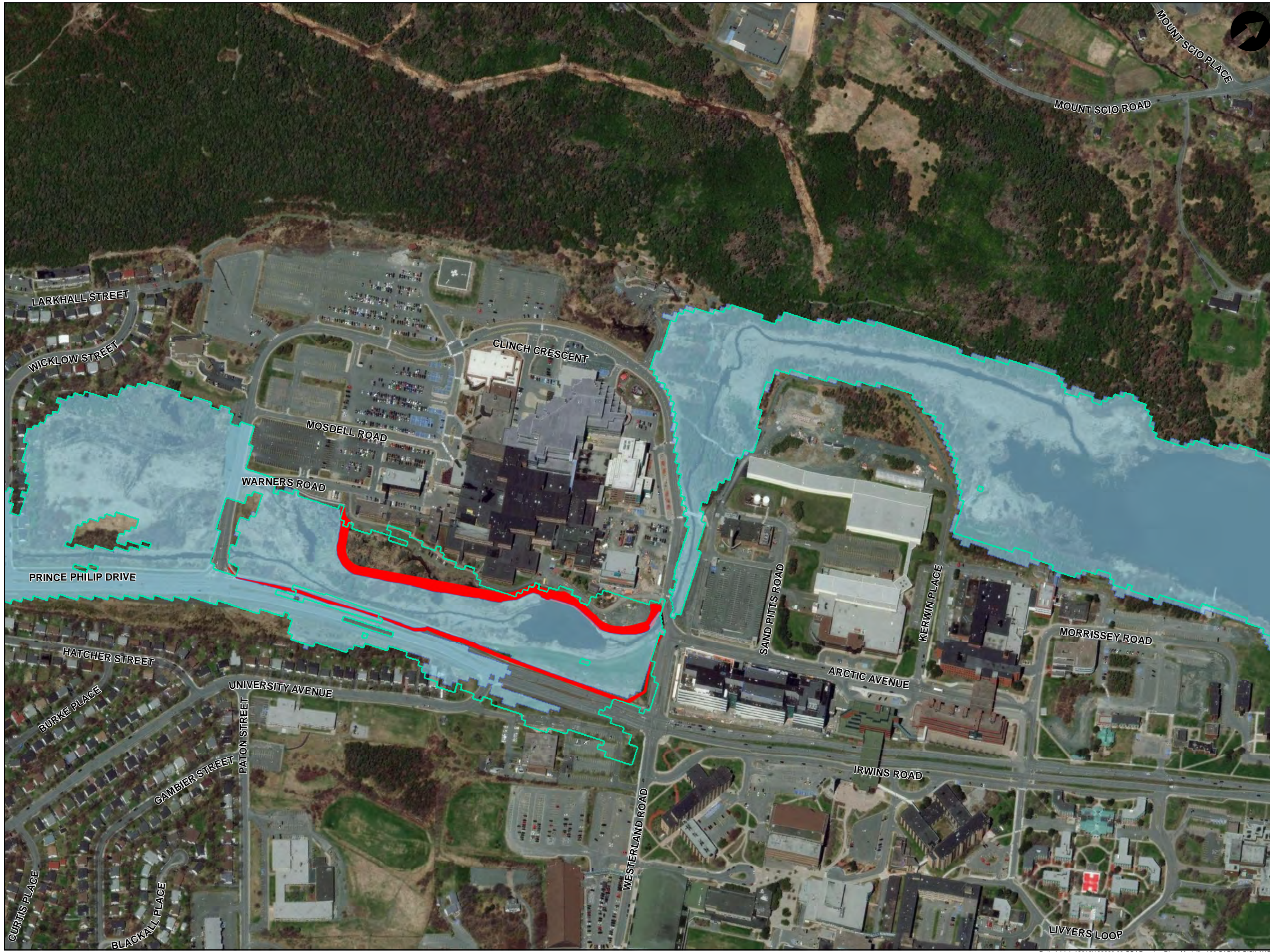
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 1:100 AEP CC Health Sciences Berms & Long Pond Weir - Berms Downstream of Portugal Cove Road Removed



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- Legend:**
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ST. JOHN'S

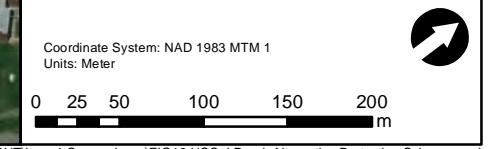
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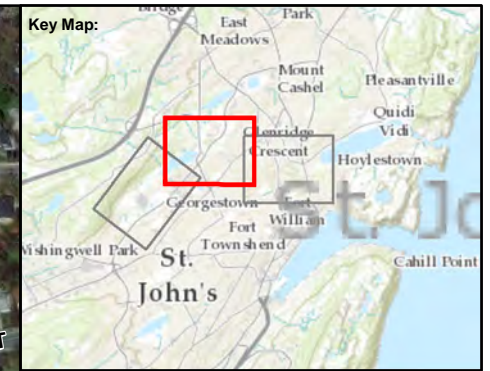
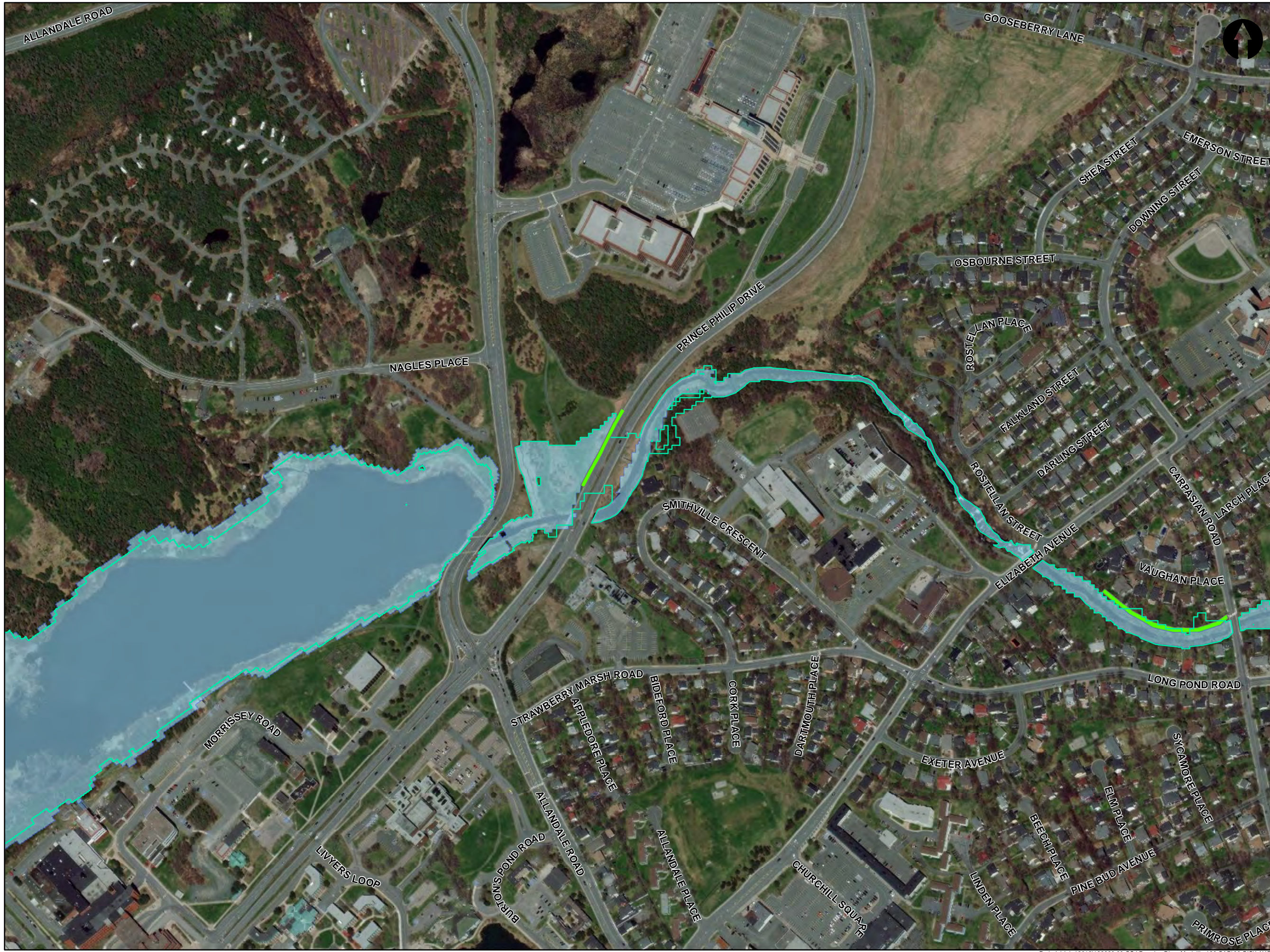
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 1:100 AEP CC Health Sciences Berms, Long Pond Weir and Alternative Flood Protection Scheme



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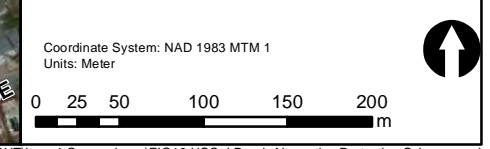
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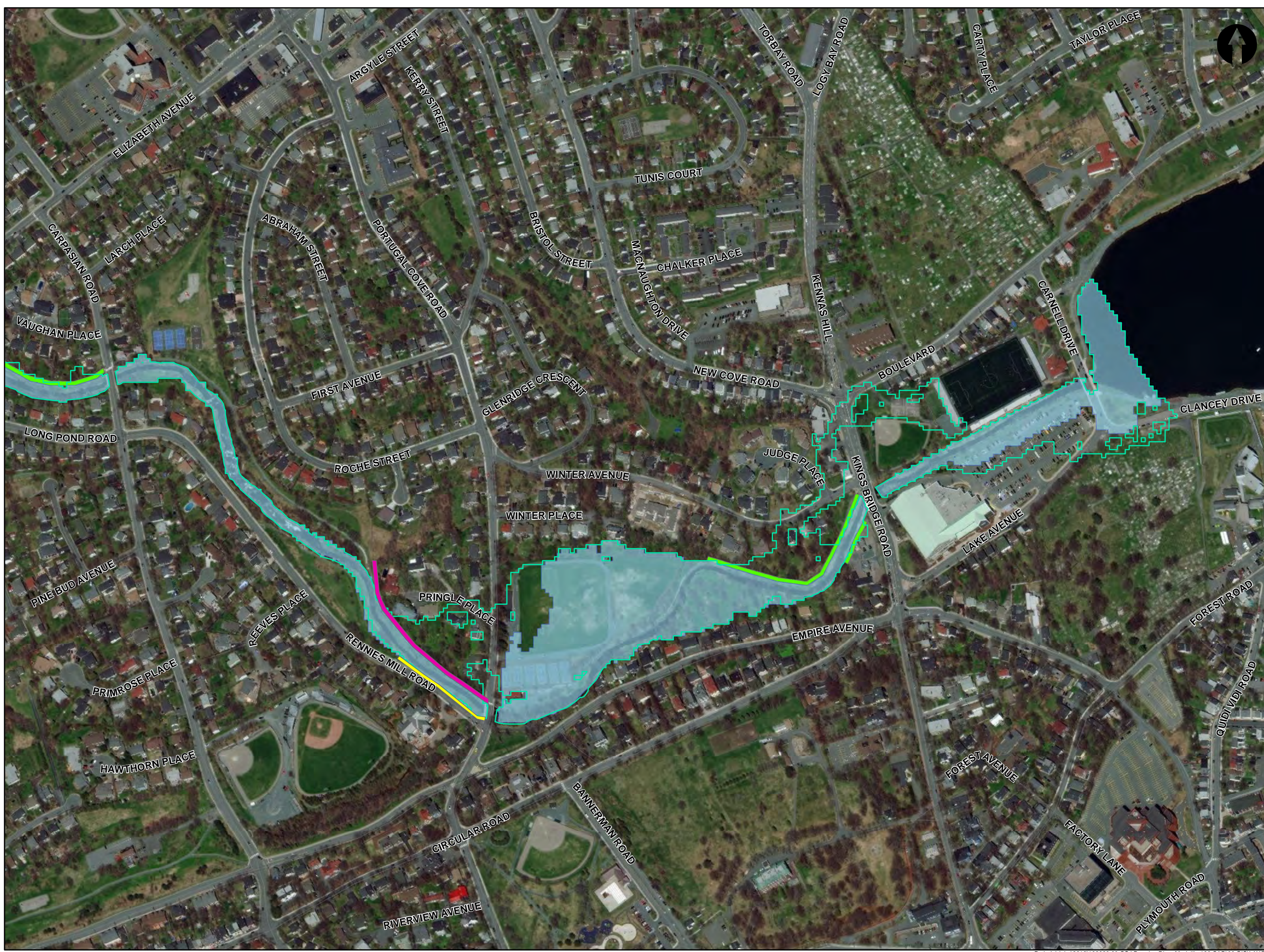
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ST. JOHN'S

Project:
Rennie's River Flood Mitigation Phase 2A Additional Analysis

Figure Title:
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 1:100 AEP CC Health Sciences Berms, Long Pond Weir and Alternative Flood Protection Scheme



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