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WATER CANADA

HOSTS

Presented by:

Toronto and Region Conservation Authority

In association with:

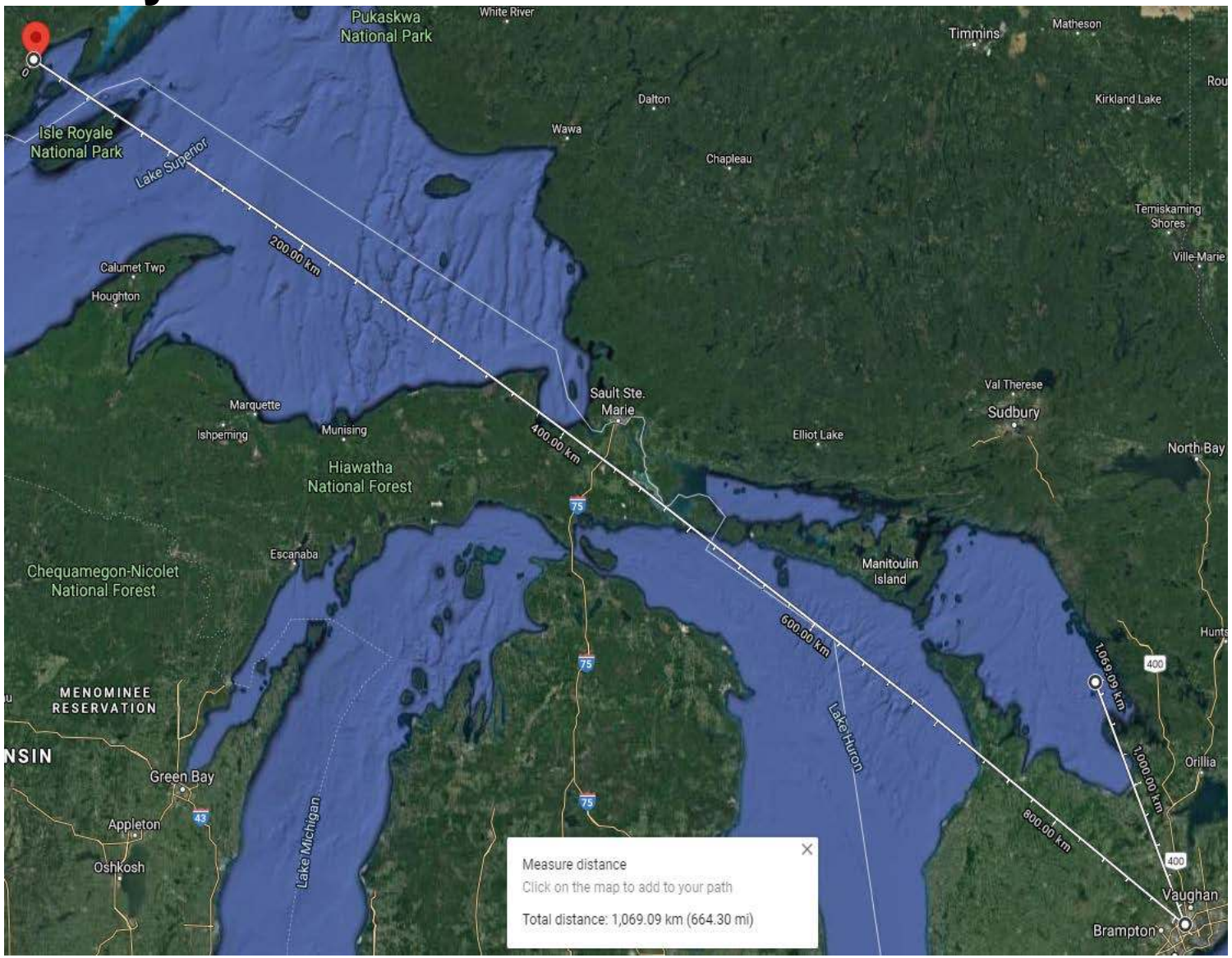
Lake Simcoe Region conservation authority

Credit Valley Conservation – inspired by nature

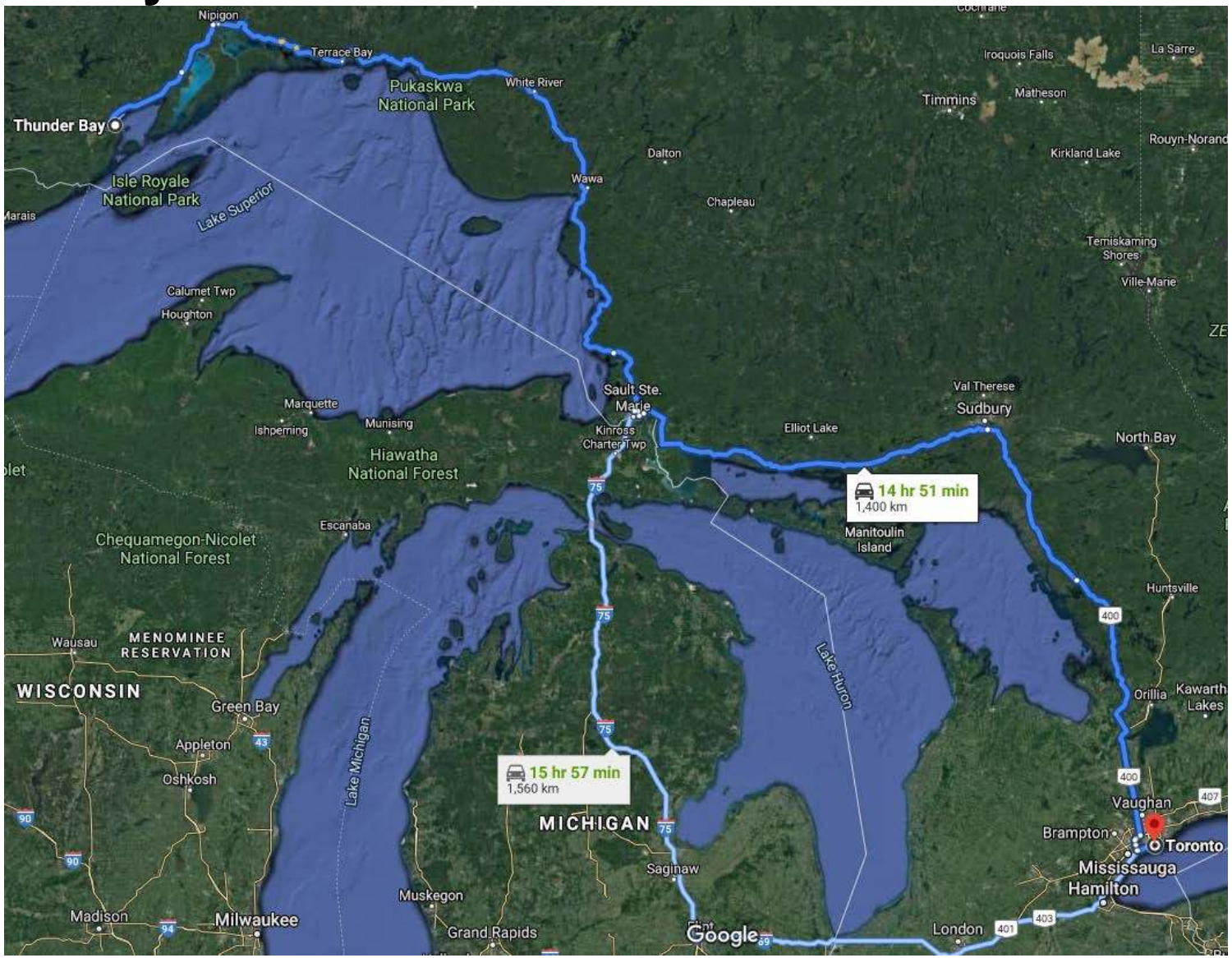
Green Infrastructure Initiatives in Thunder Bay – A Northern Approach

Aaron Ward, P. Eng.
Project Engineer
Engineering & Operations Division

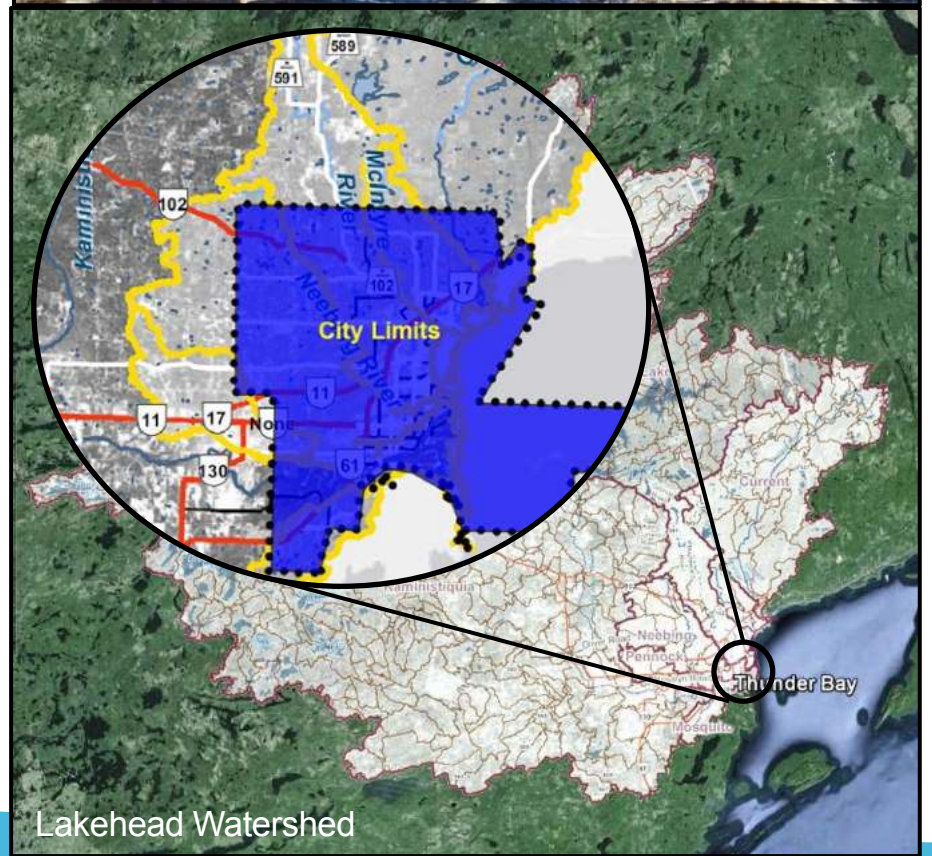
Thunder Bay – Where are we?



Thunder Bay – Where are we?



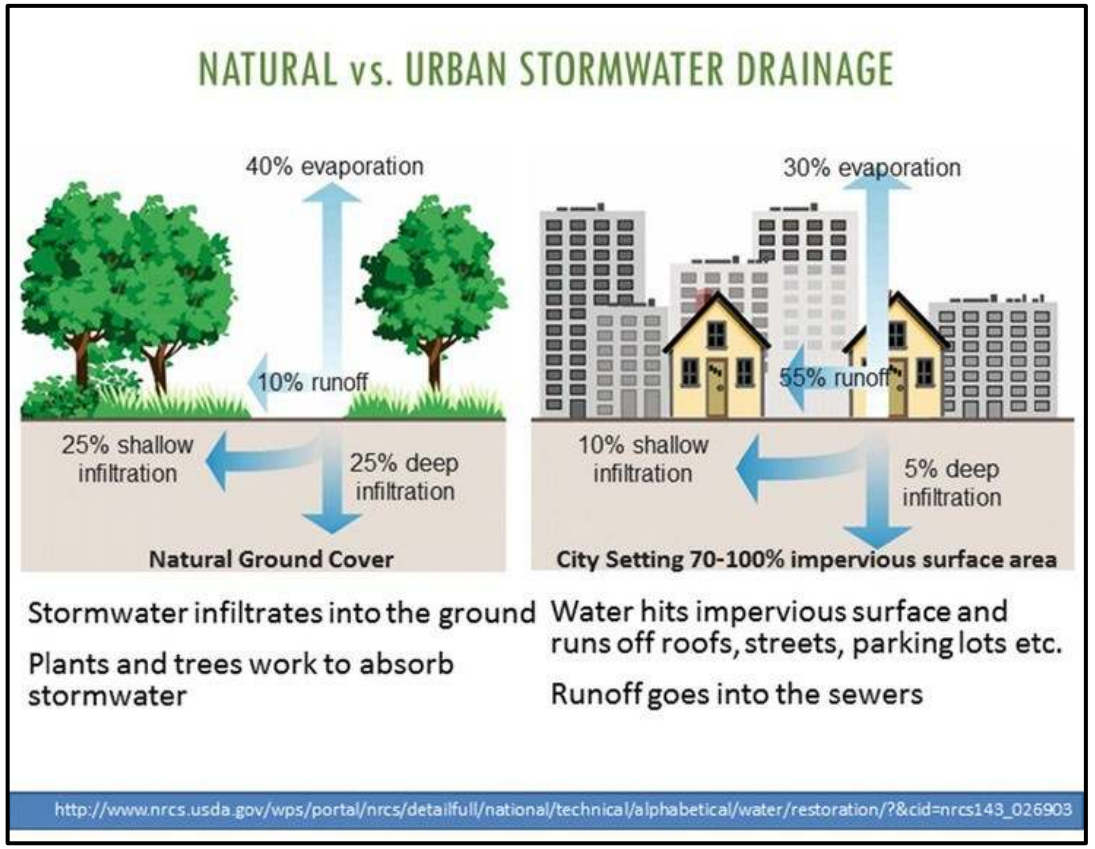
Thunder Bay – Overview



- 109,000 people (2011 census)
- Lakehead watershed – 8,930km^2
- 323km^2 total area of which 130km^2 is an urban developed area
- 8 sub-watersheds
  - Current River
  - Kaministiquia River
  - McVicar Creek
  - McIntyre River
  - Mosquito Creek
  - Neebing River
  - Pennock Creek
  - Waterfront Watershed
- 712mm annual precipitation
  - 559mm rainfall & 188cm snowfall

Why do we need Stormwater Management?

- In general, urban development typically results in 5x more runoff (or more) – assuming no stormwater controls on-site
- Increased pollution and impacts to rivers & environment
- Increased downstream flooding

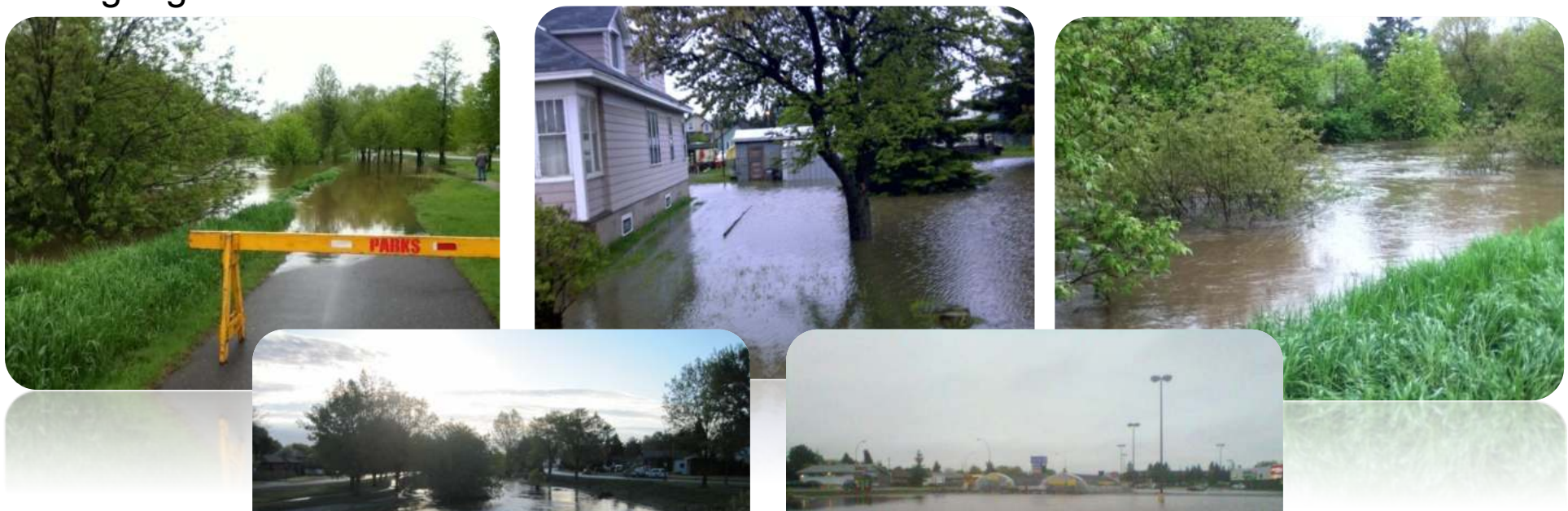


Thunder Bay

- No stranger to flooding & urban flooding
- Impacts felt throughout City in a variety of forms
- Climate change compounding the severity and frequency of events

Thunder Bay

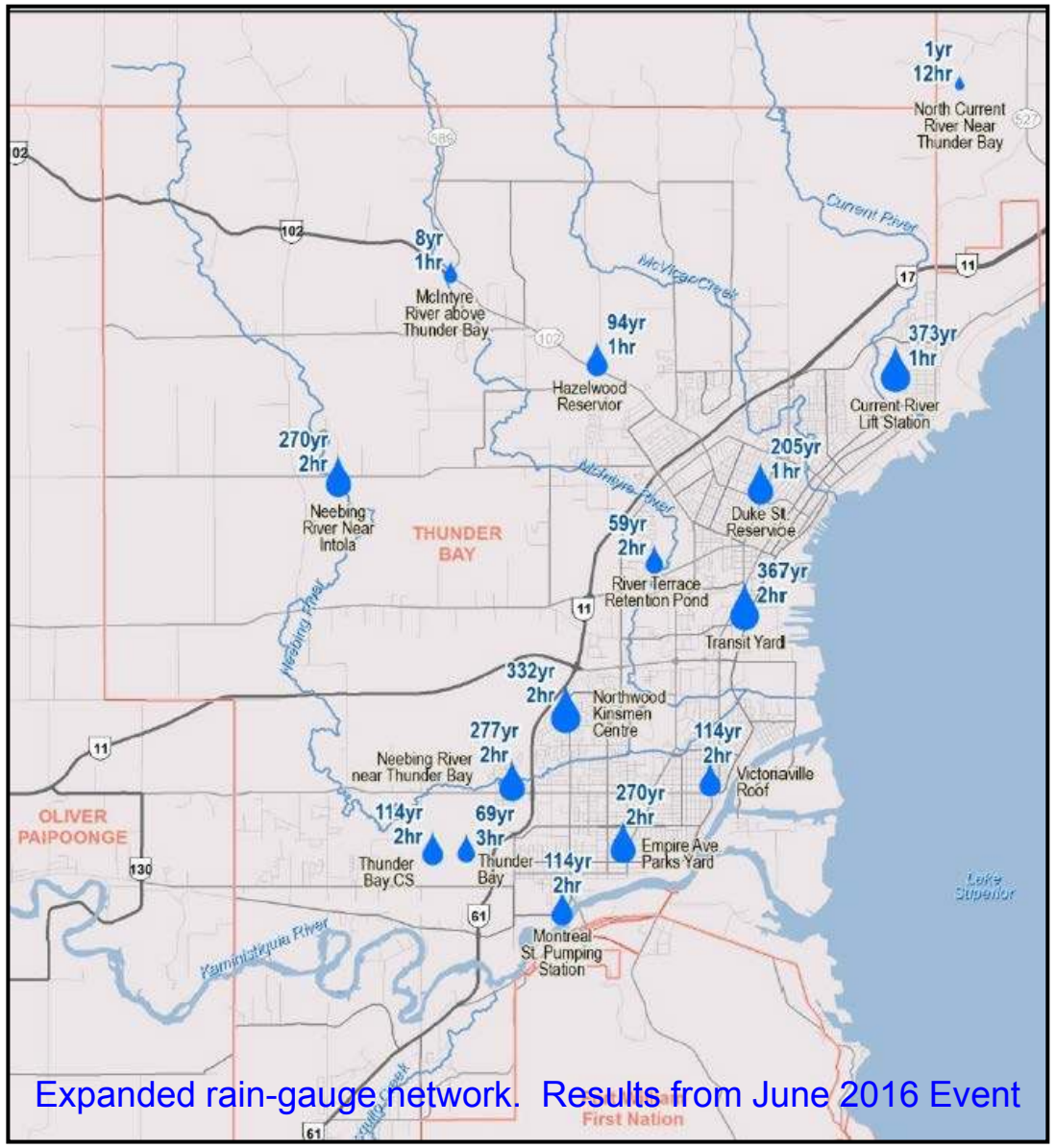
- May 2012 – Disaster and State of Emergency Declared
- Approximately 40 mm of rain fell on May 24
- May 28 - Series of heavy thunderstorms formed and re-formed over City. Environment Canada rain gauges recorded between 91 and 97 mm, LRCA rain gauge exceeded 110 mm



Thunder Bay

May 2012

Thunder Bay



Expanded rain-gauge network. Results from June 2016 Event

- Other major events in 2008, June & November 2016, and during the 2022 Spring melt
- Late fall / winter rains becoming more common

<u>June 2016</u>

- 25mm to 90mm rain – varied widely throughout City
- Majority within a 3-hour period

Thunder Bay

June 2016

Stormwater Management Infrastructure

– What is the City's Stormwater Infrastructure?


Storm sewers

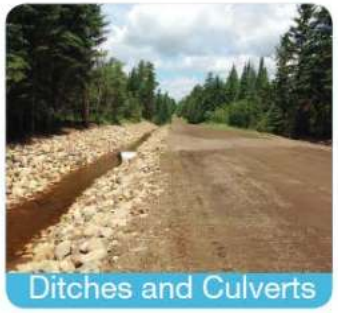

Catchbasins


Inlets and outlets


Oil-grit separators


Urban Forest


Bridges


Ditches and Culverts


Watercourse


Stormwater treatment facilities, including Green Infrastructure


Wetlands & Marshes

337km of sewers, 4,100 manholes, 11,000 catch basins, 486km ditches, 440 outfalls, 81 treatment facilities, 4 pumping stations, 1 major flood diversion system (1 dam & 5km of floodway channel)

Storwmater Management Plan

– Approved in Principle by Council in 2016. This plan will guide the City's stormwater management actions for the next 20 years, based on the following goals:

- ECOSYSTEM HEALTH
- WATERSHED QUALITY
- WATER QUANTITY
- OPERATIONS and MAINTENANCE
- MONITORING and DATA ASSESSMENT
- FUNDING and ORGANIZATION
- CLIMATE CHANGE
- REGULATION and ENFORCEMENT
- EDUCATION and OUTREACH

Storwmater Management Plan

Watershed	Total # of BMPs	Benefits		
		Total TP Removal (kg/yr)	Total TSS Removal (kg/yr)	Total Volume Reduction (m^3/yr)
Current	83	233	81,780	260,100
Kaministiquia	62	716	803,700	691,700
McIntyre	136	968	647,400	656,000
McVicar	27	17	4,922	19,350
Mosquito	17	5	1,359	12,590
Neebing	161	513	338,400	779,000
Pennock	9	3	1,273	8,347
Waterfront	57	311	169,200	355,800
Total	**552**	**2,765**	**2,048,034**	**2,782,887**

Range in Total Present Cost (CAD)	Number of BMPs
$0 – 10,000	39
$10,000 - $50,000	117
$50,000 - $100,000	108
$100,000 - $500,000	236
$500,000 - $1,000,000	36
$1,000,000 - $3,000,000	16

- In 2012, only had 12 City-owned stormwater facilities.
- By end of 2022, 81 City owned stormwater facilities, including 44 Oil-Grit Separators. Of remaining 37 facilities, 29 are considered Green Infrastructure (or LID) facilities.
- For Green Infrastructure, +/-28.4ha (70 acres) drain through these facilities

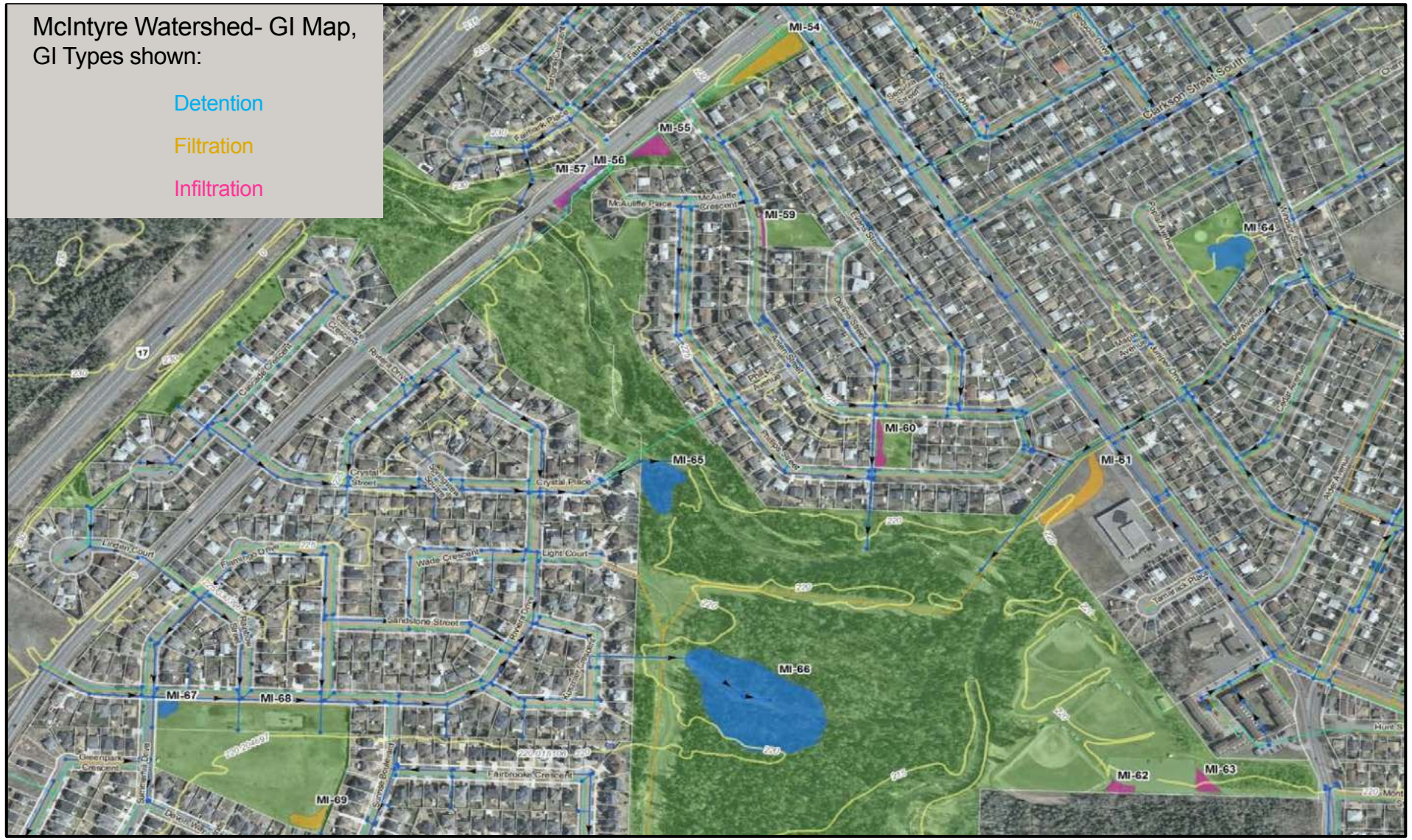
Storwmater Management Plan

McIntyre Watershed- GI Map,
GI Types shown:

Detention

Filtration

Infiltration



Storwmater Management Plan

ID	Watershed	BMP Category	Demonstration / Education	Footprint Area (m^2)	Water Quality Volume (m^3)	Drainage Area (ha)	Benefits: TP Removal (kg/yr)	Benefits: TSS Removal (kg/yr)	Benefits: Runoff Volume Reduction (m^3/yr)	Feasibility Cost (CAD)	50-year Present Costs in 2015 Canadian Dollars: Construction (CAD)	Design (CAD)	O & M (CAD)	Total (CAD)	Cost-Benefit Analysis: TP Removal (CAD/kg)	TSS Removal (CAD/kg)	Volume Reduction (CAD/m^3)
MI-62	McIntyre	Biofiltration	Yes	335	162	2.3	1.44	389	1,749	-	$ 97,485	$ 19,497	$ 5,849	$ 122,828	$ 4,262	$ 15.78	$ 3.51
MI-63	McIntyre	Biofiltration	Yes	479	218	3.2	1.94	525	2,359	-	$ 122,687	$ 24,537	$ 7,361	$ 154,585	$ 3,977	$ 14.73	$ 3.28
MI-64	McIntyre	Pond	Yes	1,643	2,003	17.6	8.30	5,294	3,762	$ 54,936	$ 294,166	$ 58,833	$ 13,237	$ 366,237	$ 2,206	$ 3.46	$ 4.87
MI-65	McIntyre	Pond	Yes	2,419	2,949	53.3	11.41	7,901	6,634	$ 67,177	$ 359,718	$ 71,944	$ 16,187	$ 447,849	$ 1,963	$ 2.83	$ 3.38
MI-66	McIntyre	Pond	Yes	14,240	17,361	314.1	49.07	49,618	39,063	$ 169,072	$ 905,337	$ 181,067	$ 40,740	$ 1,127,144	$ 1,149	$ 1.14	$ 1.44
MI-67	McIntyre	Pond	Yes	430	524	4.6	2.75	1,319	985	-	$ 146,381	$ 29,276	$ 6,587	$ 182,245	$ 3,308	$ 6.91	$ 9.26
MI-68	McIntyre	Tree Trench	Yes	389	108	0.8	0.58	246	324	-	$ 130,532	$ 26,106	$ 16,317	$ 172,955	$ 15,011	$ 35.16	$ 26.69
MI-69	McIntyre	Biofiltration	Yes	691	315	2.2	2.48	718	946	-	$ 162,577	$ 32,515	$ 9,755	$ 204,847	$ 4,135	$ 14.26	$ 10.82
MI-70	McIntyre	Biofiltration	No	559	255	3.7	2.27	612	2,751	-	$ 138,069	$ 27,614	$ 8,284	$ 173,967	$ 3,838	$ 14.21	$ 3.16
MI-71	McIntyre	Parking Lot Retrofit	Yes	220	61	0.9	0.33	166	658	-	$ 81,852	$ 16,370	$ 10,232	$ 108,454	$ 16,663	$ 32.59	$ 8.24
MI-72	McIntyre	Pond	No	1,058	1,290	23.3	5.78	3,354	2,902	-	$ 233,907	$ 46,781	$ 10,526	$ 291,214	$ 2,520	$ 4.34	$ 5.02
MI-73	McIntyre	Pond	No	3,448	4,204	76.0	15.28	11,410	9,458	-	$ 432,656	$ 86,531	$ 19,470	$ 538,657	$ 1,763	$ 2.36	$ 2.85
MI-74	McIntyre	Biofiltration	No	1,369	624	9.0	5.55	1,499	6,739	-	$ 274,939	$ 54,988	$ 16,496	$ 346,423	$ 3,120	$ 11.55	$ 2.57
MI-75	McIntyre	Parking Lot Retrofit	Yes	9,252	2,566	37.1	13.71	5,425	27,716	$ 345,803	$ 1,739,887	$ 347,977	$ 217,486	$ 2,305,350	$ 8,408	$ 21.25	$ 4.16
MI-76	McIntyre	Pond	Yes	5,717	6,970	126.1	23.16	19,271	15,683	$ 105,133	$ 562,962	$ 112,592	$ 25,333	$ 700,888	$ 1,513	$ 1.82	$ 2.23
MI-77	McIntyre	Biofiltration	Yes	401	183	2.6	1.63	440	1,976	-	$ 107,060	$ 21,412	$ 6,424	$ 134,896	$ 4,144	$ 15.35	$ 3.41
MI-78	McIntyre	Pond	Yes	273	333	6.0	1.90	825	750	$ 21,595	$ 115,633	$ 23,127	$ 5,203	$ 143,963	$ 3,793	$ 8.72	$ 9.60
MI-79	McIntyre	Pond	Yes	3,291	4,012	72.6	14.70	10,871	9,027	-	$ 422,266	$ 84,453	$ 19,002	$ 525,722	$ 1,788	$ 2.42	$ 2.91
MI-80	McIntyre	Pond	Yes	6,956	8,481	74.4	27.21	23,613	15,924	$ 116,433	$ 623,470	$ 124,694	$ 28,056	$ 776,220	$ 1,426	$ 1.64	$ 2.44
MI-81	McIntyre	Parking Lot Retrofit	Yes	126	35	0.2	0.19	80	105	-	$ 51,880	$ 10,376	$ 6,485	$ 68,741	$ 18,454	$ 43.23	$ 32.81
MI-82	McIntyre	Parking Lot Retrofit	No	143	40	0.3	0.21	91	120	-	$ 57,791	$ 11,558	$ 7,224	$ 76,573	$ 18,013	$ 42.20	$ 32.03
MI-83	McIntyre	Parking Lot Retrofit	No	108	30	0.2	0.16	68	90	-	$ 45,846	$ 9,169	$ 5,731	$ 60,746	$ 18,972	$ 44.44	$ 33.73
MI-84	McIntyre	Parking Lot Retrofit	No	98	27	0.2	0.15	62	82	-	$ 42,402	$ 8,480	$ 5,300	$ 56,182	$ 19,306	$ 45.23	$ 34.33
MI-85	McIntyre	Parking Lot Retrofit	No	89	25	0.4	0.13	72	266	-	$ 39,028	$ 7,806	$ 4,878	$ 51,712	$ 19,668	$ 36.15	$ 9.73
MI-86	McIntyre	Parking Lot Retrofit	No	67	19	0.3	0.10	55	200	-	$ 30,949	$ 6,190	$ 3,869	$ 41,007	$ 20,715	$ 37.35	$ 10.25
MI-87	McIntyre	Parking Lot Retrofit	No	36	10	0.1	0.05	31	109	-	$ 18,853	$ 3,771	$ 2,357	$ 24,980	$ 23,146	$ 40.03	$ 11.45
MI-88	McIntyre	Biofiltration	No	482	220	1.5	1.73	500	659	-	$ 123,125	$ 24,625	$ 7,388	$ 155,138	$ 4,496	$ 15.50	$ 11.77
MI-89	McIntyre	Pond	No	2,877	3,508	63.5	13.16	9,459	7,893	-	$ 393,754	$ 78,751	$ 17,719	$ 490,224	$ 1,862	$ 2.59	$ 3.11
MI-90	McIntyre	Pond	No	4,801	5,853	51.3	20.06	16,079	10,991	$ 95,994	$ 514,021	$ 102,804	$ 23,131	$ 639,957	$ 1,595	$ 1.99	$ 2.91
MI-91	McIntyre	Pond	No	9,108	11,104	97.4	33.97	31,225	20,852	$ 133,979	$ 717,423	$ 143,485	$ 32,284	$ 893,191	$ 1,315	$ 1.43	$ 2.14
MI-92	McIntyre	Pond	No	4,774	5,820	51.0	19.96	15,986	10,929	$ 95,714	$ 512,523	$ 102,505	$ 23,064	$ 638,091	$ 1,598	$ 2.00	$ 2.92
MI-93	McIntyre	Pond	No	3,600	4,389	38.5	15.83	11,933	8,242	-	$ 442,506	$ 88,501	$ 19,913	$ 550,920	$ 1,740	$ 2.31	$ 3.34
MI-94	McIntyre	Pond	No	8,001	9,755	85.5	30.54	27,301	18,317	$ 125,237	$ 670,611	$ 134,122	$ 30,178	$ 834,911	$ 1,367	$ 1.53	$ 2.28
MI-95	McIntyre	Pervious Pavement	No	2,474	603	4.2	3.22	1,376	1,813	$ 96,313	$ 484,596	$ 96,919	$ 60,574	$ 642,090	$ 9,960	$ 23.33	$ 17.71
MI-96	McIntyre	Pervious Pavement	No	2,521	615	4.3	3.28	1,402	1,847	$ 97,791	$ 492,032	$ 98,406	$ 61,504	$ 651,942	$ 9,926	$ 23.25	$ 17.65
MI-97	McIntyre	Pervious Pavement	No	571	139	1.0	0.74	318	418	-	$ 146,251	$ 29,250	$ 18,281	$ 193,782	$ 13,023	$ 30.51	$ 23.16
MI-98	McIntyre	Biofiltration	No	488	222	1.6	1.75	508	669	-	$ 124,492	$ 24,898	$ 7,470	$ 156,860	$ 4,481	$ 15.45	$ 11.73
MI-99	McIntyre	Biofiltration	No	1,306	595	4.2	4.68	1,358	1,789	-	$ 265,180	$ 53,036	$ 15,911	$ 334,127	$ 3,569	$ 12.31	$ 9.34
MI-100	McIntyre	Pond	Yes	1,350	1,646	14.4	7.06	4,316	3,090	-	$ 265,501	$ 53,100	$ 11,948	$ 330,549	$ 2,341	$ 3.83	$ 5.35
MI-101	McIntyre	Wetland	Yes	40,263	36,816	258.3	147.44	66,728	110,611	$ 127,042	$ 694,218	$ 138,844	$ 13,884	$ 846,946	$ 287	$ 0.63	$ 0.38
MI-102	McIntyre	Biofiltration	No	804	366	2.6	2.88	836	1,101	-	$ 182,603	$ 36,521	$ 10,956	$ 230,080	$ 3,993	$ 13.77	$ 10.45
MI-103	McIntyre	Biofiltration	No	1,348	614	4.3	4.83	1,400	1,845	-	$ 271,578	$ 54,316	$ 16,295	$ 342,188	$ 3,543	$ 12.22	$ 9.27
MI-104	McIntyre	Biofiltration	No	427	195	1.4	1.53	443	584	-	$ 112,203	$ 22,441	$ 6,732	$ 141,376	$ 4,623	$ 15.94	$ 12.10
MI-105	McIntyre	Pond	No	21,262	25,923	227.3	68.24	73,895	48,676	$ 208,308	$ 1,115,436	$ 223,087	$ 50,195	$ 1,388,718	$ 1,018	$ 0.94	$ 1.43
MI-106	McIntyre	Pond	Yes	5,407	6,592	57.8	22.12	18,186	12,377	$ 102,118	$ 546,818	$ 109,364	$ 24,607	$ 680,789	$ 1,539	$ 1.87	$ 2.75
MI-107	McIntyre	Biofiltration	No	1,849	843	5.9	6.63	1,922	2,532	-	$ 346,349	$ 69,270	$ 20,781	$ 436,399	$ 3,293	$ 11.35	$ 8.62
MI-108	McIntyre	Wetland	No	399	365	2.6	1.46	677	1,096	-	$ 53,733	$ 10,747	$ 1,075	$ 65,554	$ 2,243	$ 4.84	$ 2.99
MI-109	McIntyre	Pond	No	936	1,141	10.0	5.23	2,955	2,144	-	$ 219,490	$ 43,898	$ 9,877	$ 273,265	$ 2,614	$ 4.62	$ 6.37
MI-110	McIntyre	Subsurface Storage	No	2,588	3,155	22.1	10.04	6,726	4,741	-	$ 331,782	$ 66,356	$ 14,930	$ 413,069	$ 2,057	$ 3.07	$ 4.36
MI-111	McIntyre	Tree Trench	No	407	113	0.8	0.60	257	339	-	$ 135,481	$ 27,096	$ 16,935	$ 179,513	$ 14,886	$ 34.87	$ 26.47
MI-112	McIntyre	Biofiltration	No	57	26	0.2	0.21	59	78	-	$ 23,954	$ 4,791	$ 1,437	$ 30,182	$ 7,359	$ 25.38	$ 19.26

3rd Party Funding Sources for Green Infrastructure

Funding Program Name / Agency	
Clean Water and Wastewater Fund	Great Lakes Sustainability Fund
MNRF Great Lakes Protection Funding	Eco-Action Community Funding Program
Great Lakes Guardian Community Fund	CN Eco-Connexions From the Ground Up
Lake Superior Lakewide Action and Management Plan	Tree Canada
Canada-Ontario Great Lakes Agreement	TD Friends of the Environment Fund
Ontario Great Lakes Strategies	RBC Blue Water Project Community Action Grants
Federation of Canadian – Municipalities Green Municipal Fund	Federation of Canadian – Municipalities for Climate Innovation Program
National Disaster Mitigation Program	Green Communities Canada
Ontario Trillium Foundation	Disaster Mitigation & Adaptation Fund

Green Infrastructure Implementation

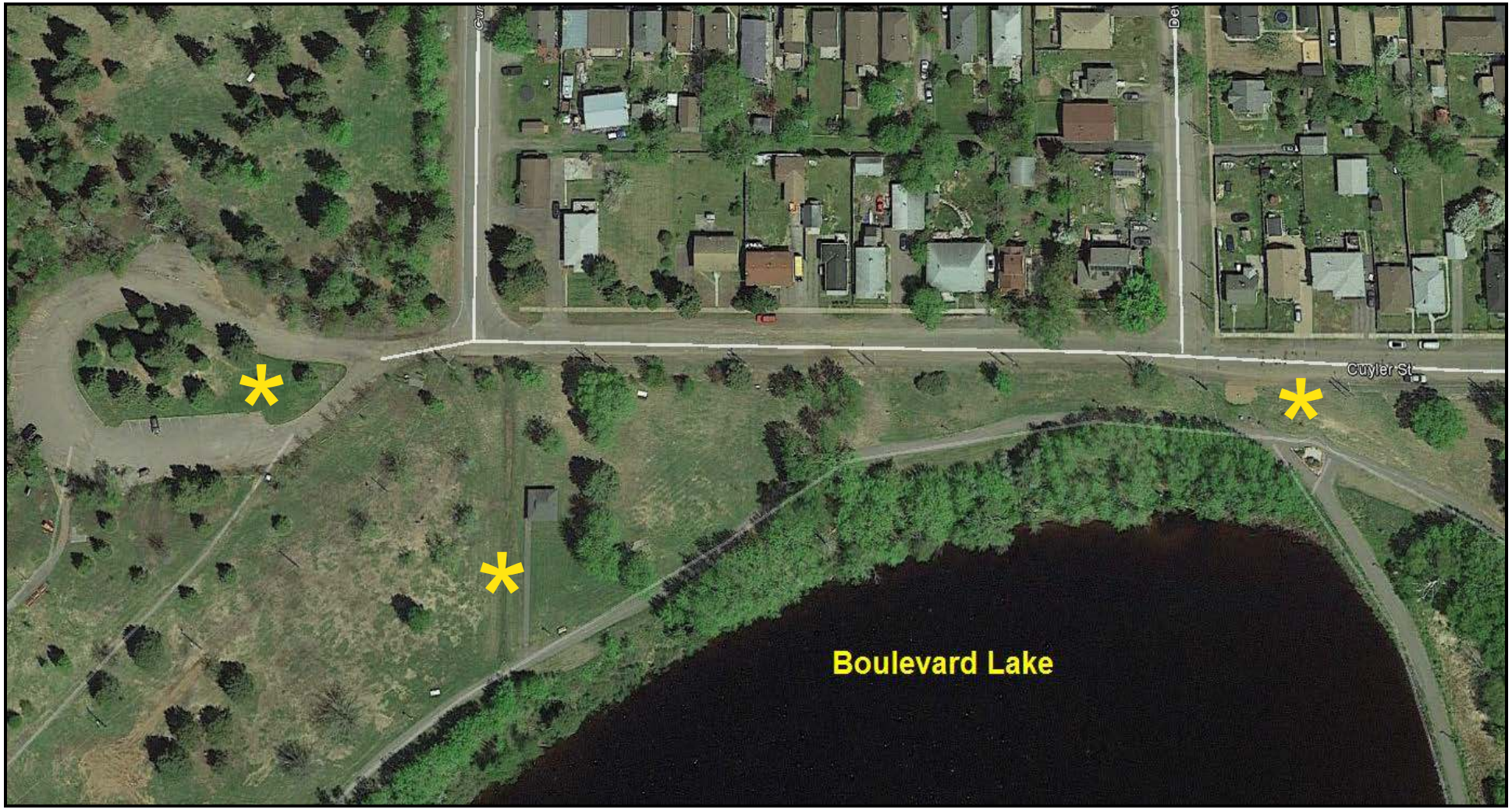

Edward & Parkway (2018)


Victoria & Walnut (2018)


Victoria & Tarbutt (2018)

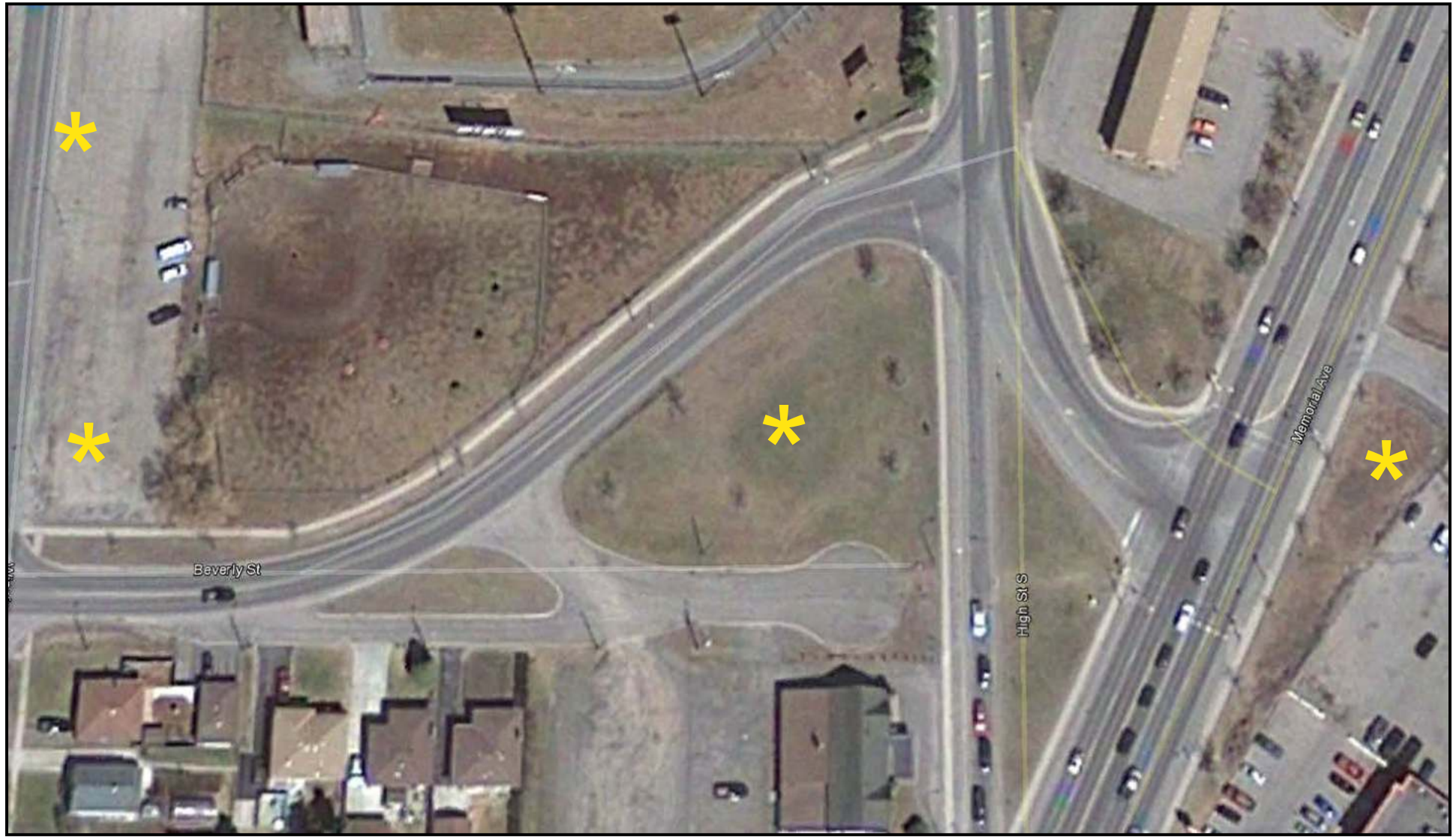

George Burke Park (2017)

Green Infrastructure Implementation



Green Infrastructure Implementation

Green Infrastructure Implementation



Green Infrastructure Implementation

Green Infrastructure Implementation

Beverly Street
(before)

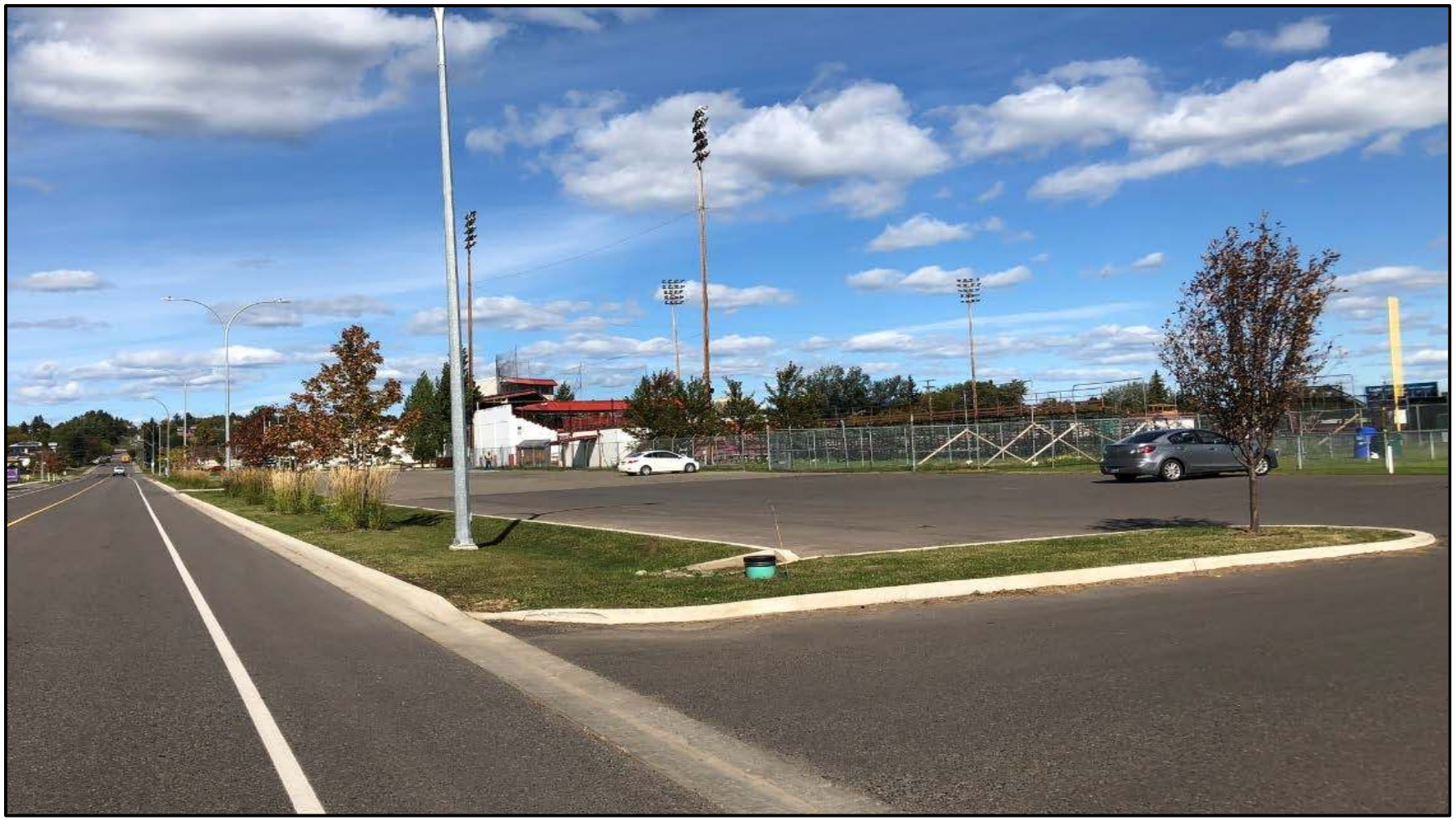
Green Infrastructure Implementation

Beverly Street (2018)

Green Infrastructure Implementation

Winnipeg Street
(before)

Green Infrastructure Implementation



Winnipeg Street (2018)

Green Infrastructure Implementation

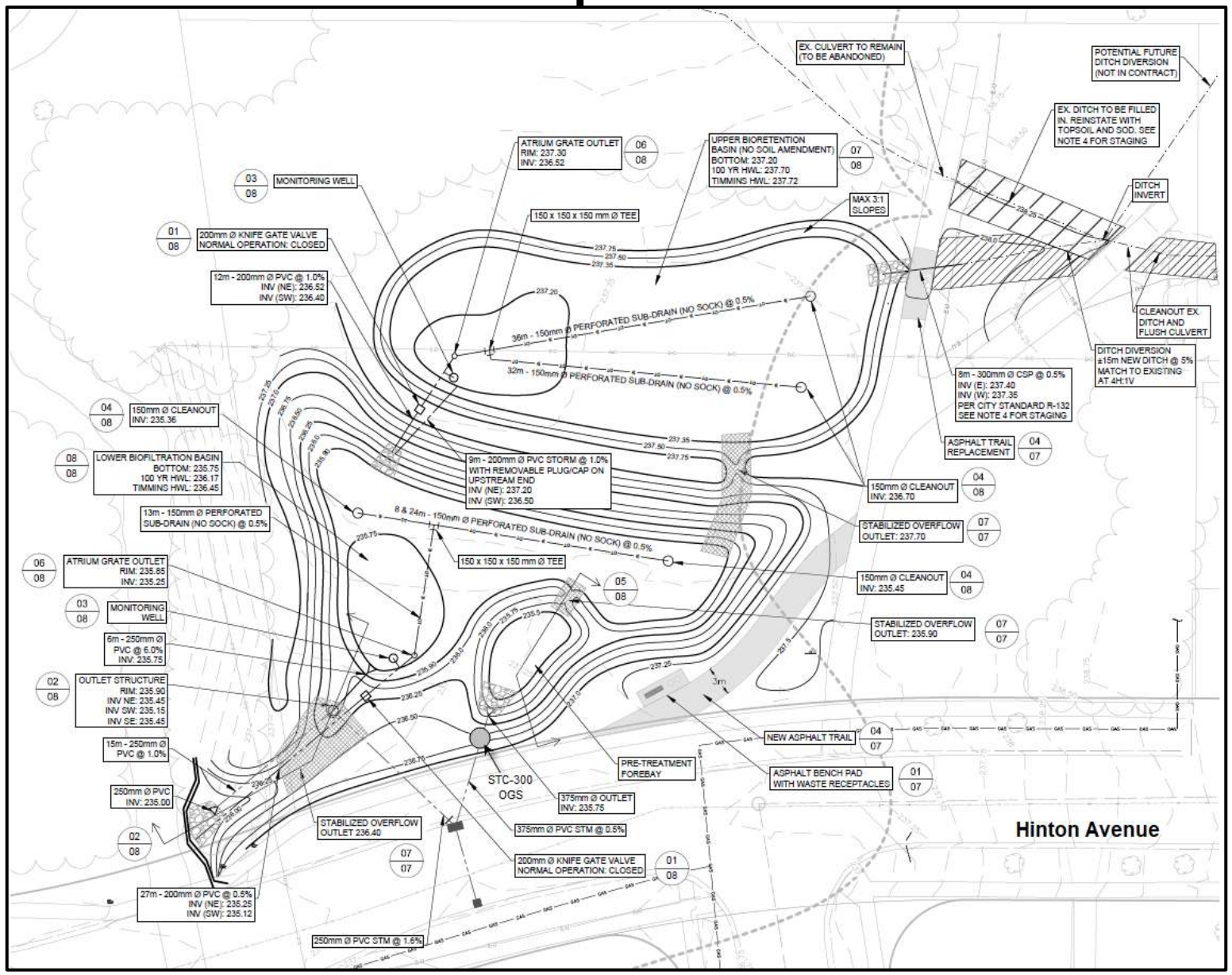
Hinton Avenue Facility (2019)

Green Infrastructure Implementation

Hinton Avenue Facility (2019)

- Completed parallel with an underground & road re-construction works.
- Footprint of 2,200sq.m. (0.54 acres)
- Total Catchment area of 2.58ha with composite imperviousness of 37%
  - Upper Basin – catchment of 1.74ha @ 25% imperviousness
  - Lower Basin – catchment of 0.84ha @ 61% imperviousness

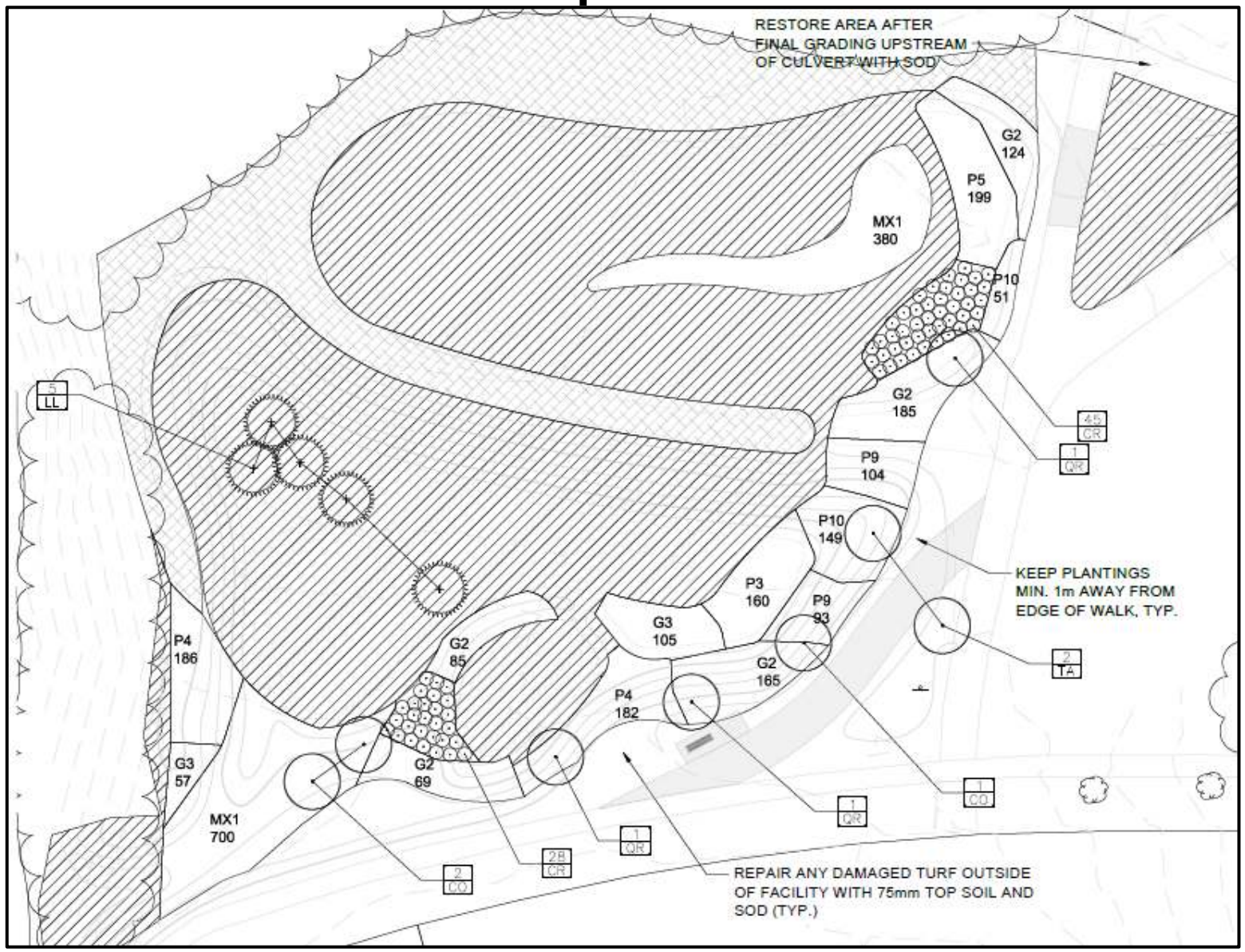
Green Infrastructure Implementation



Hinton Avenue Facility

- Upper Bio-Retention cell, Lower Bio-Filtration cell
- Includes Oil-Grit Separator for pre-treatment lower basin
- Total storage volume of 616m^3
- Estimated annual runoff volume treated / infiltrated → 7,500m^3
- Includes knife gate valves to adjust sub-drain discharge, monitoring wells, and by-pass for road-side drainage, if facility needs to be off-line.

Green Infrastructure Implementation



Hinton Avenue Facility

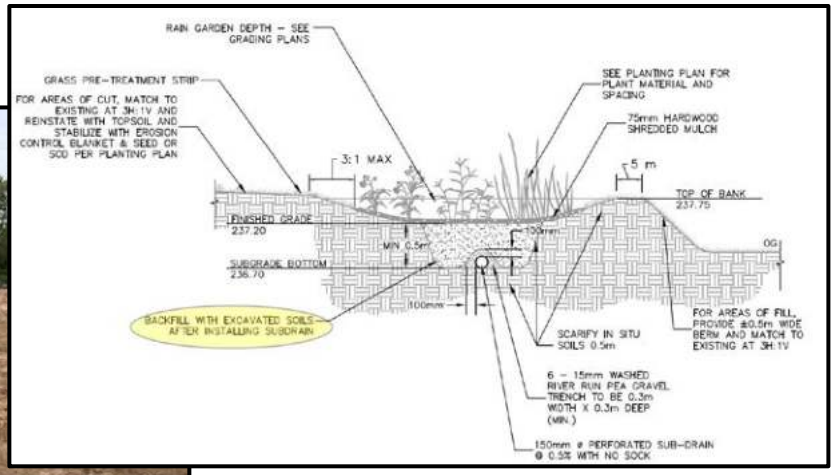
- Landscaping included:
  - 13 trees
  - 73 shrubs
  - 2994 perennials
  - Seed mixes
- Re-aligned trail system
- Benches, garbage / recycling bins
- Signage

Total cost of $226,000

(75% 3rd party funded)

Green Infrastructure Implementation

Hinton Avenue Facility



Green Infrastructure Implementation

Hinton Avenue Facility

Why?

By managing our water naturally, we are helping our great Lake stay Superior!

Green Infrastructure Implementation

- Need for on-going erosion control during construction
- Need for full-time inspection and trained inspection staff.
- Strong & clear contract documents

Lessons Learned – Construction

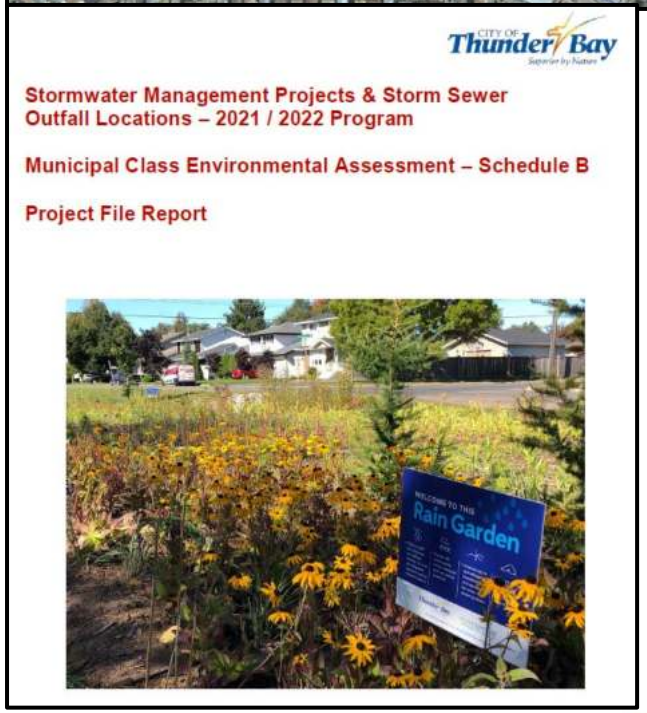
- Keep facility off-line until complete
- Engage & educate contractor & sub-contractors (temporary fencing & signage)

- Consistent soil testing before installation & after installation.
- Infiltration rate testing after installation, before planting.
- More thorough “planting” inspections & warranty works.

* As of 2020, City staff to complete all plantings & related landscaping warranty work

Green Infrastructure Design Process

- Annual Capital Budget Process
  - Forecast 3-years, but only next year in certain
- Review GIS map Complete site visit to determine feasibility
- For suitable sites, what information do we have vs. what is needed?
- What information or studies are needed?
  - Topographic survey, geotechnical, archaeological, environmental, MCEA
- Issue RFP for consultant design / studies - typically takes 6-months.
- Goal is to get ahead and have shovel ready projects to further maximize funding opportunity
  - Currently have 15 undergoing detailed design for future construction



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Green Infrastructure Inspections

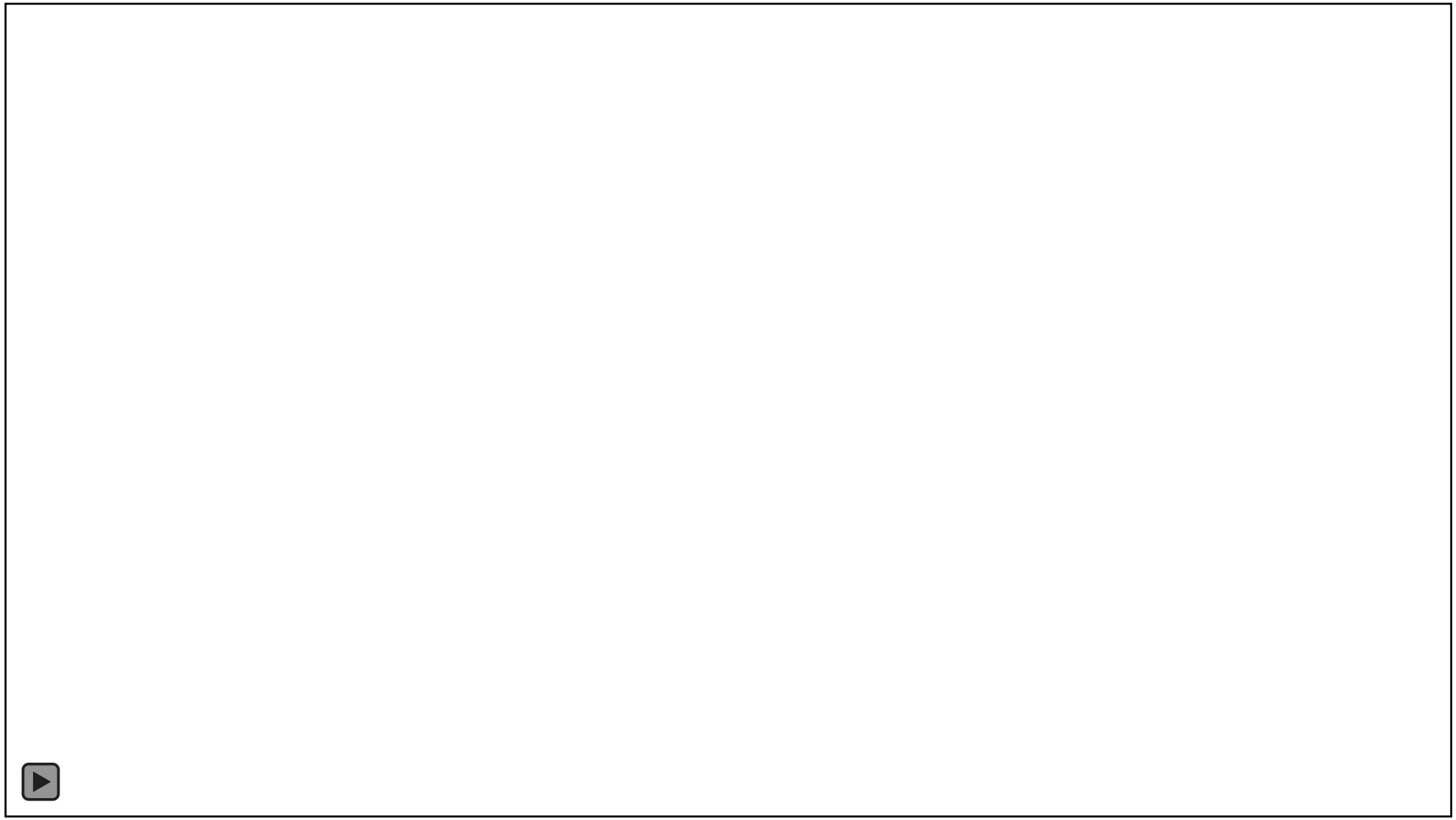
Green Infrastructure Inspections

Green Infrastructure Inspections

Tarbutt Street – July 3 2019 – 36mm rain

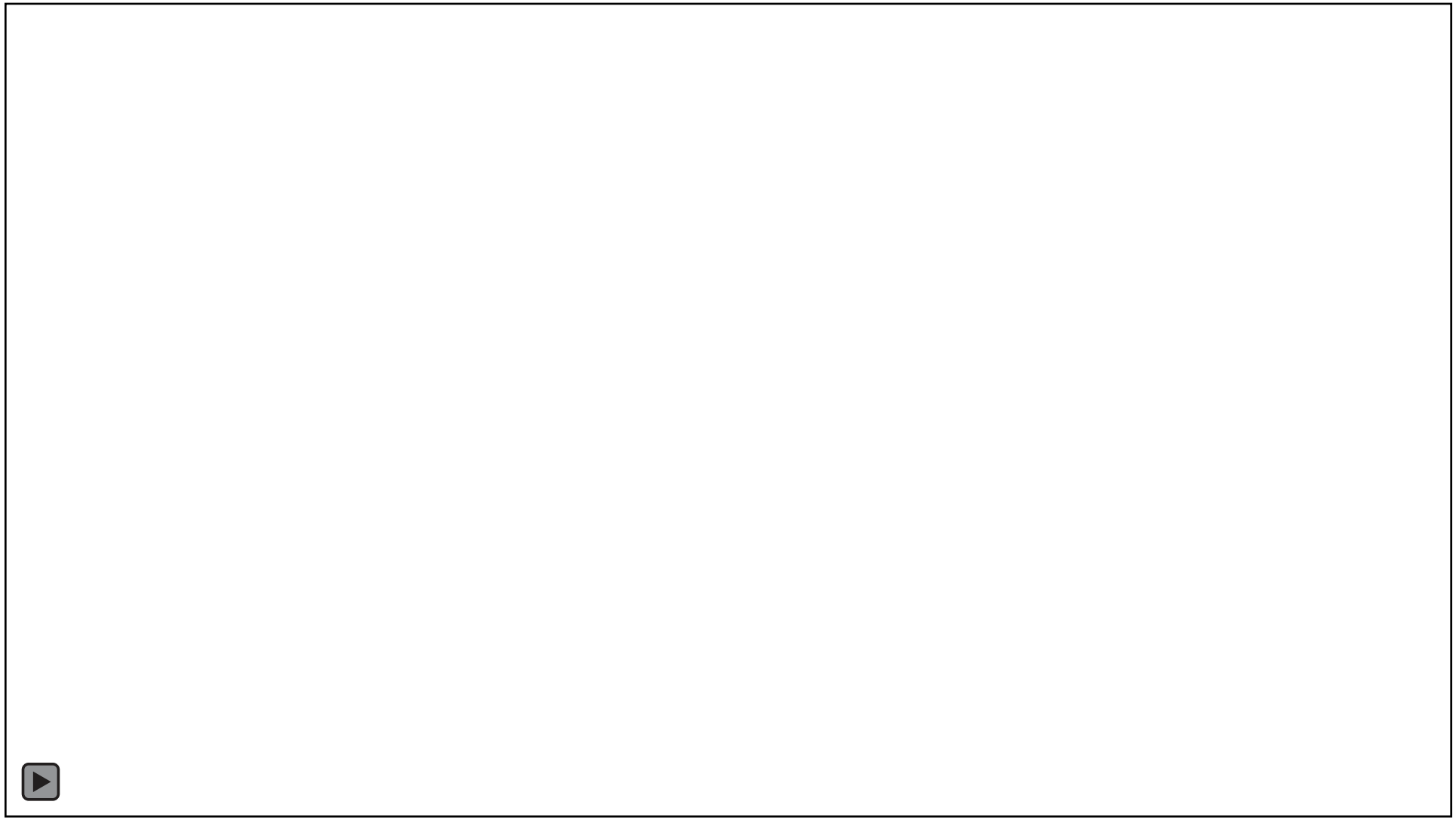
Green Infrastructure Inspections

Edward Street – July 3 2019 – 36mm rain



Green Infrastructure Inspections

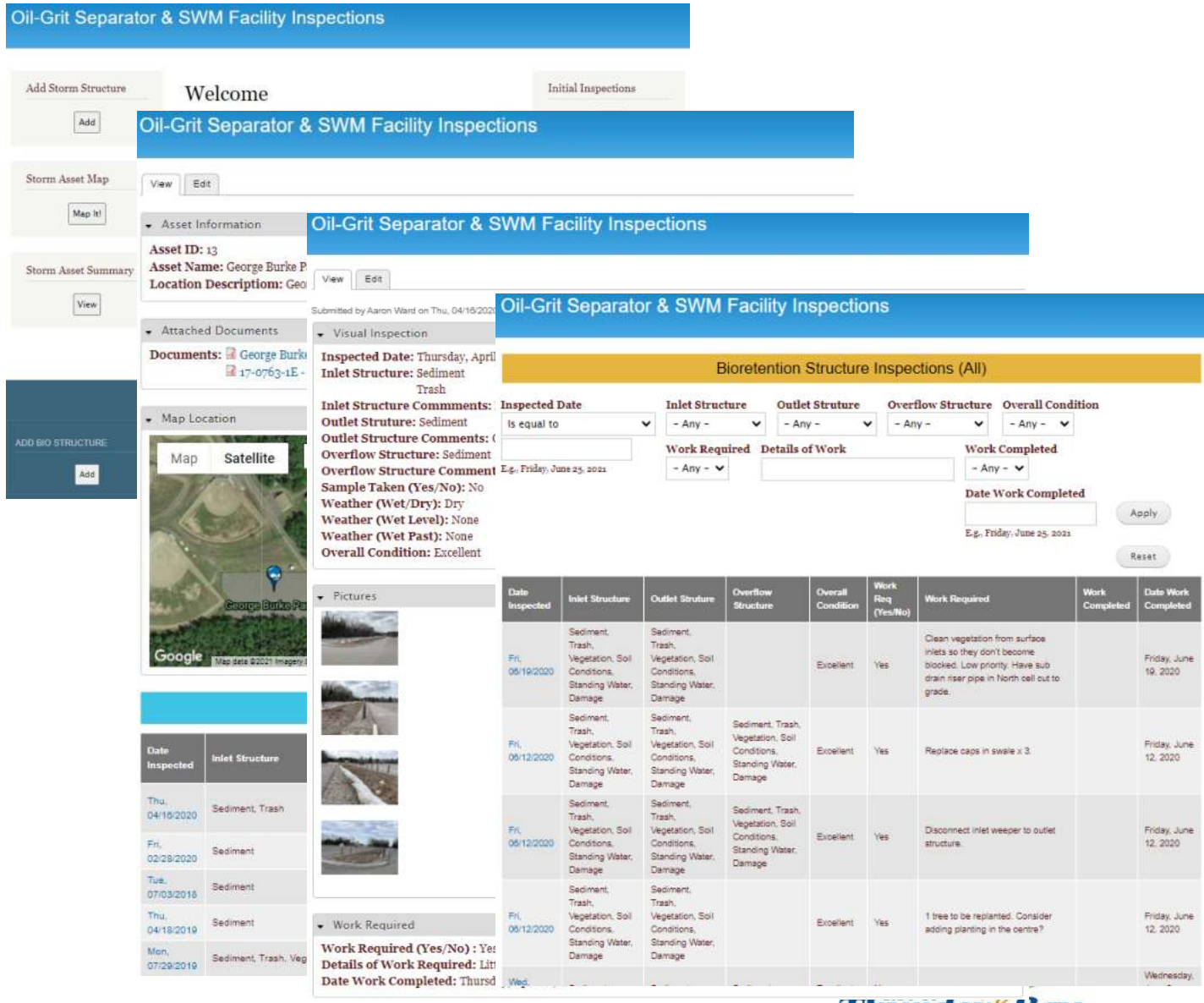
Edward Street – April 20 2021



Green Infrastructure Inspections

Lessons Learned – Inspection

- Create a database for tracking inspections & maintenance
- Seasonal inspections required – including during rainfall (don't be afraid to get wet!)
- Engage O&M staff at earliest stages (Engineering / Parks / Roads, Environment)
  - Joint inspections / tours of facilities after they are built.
- Bring / send the right people
- Preventative maintenance required
- Pre-treatment is critical

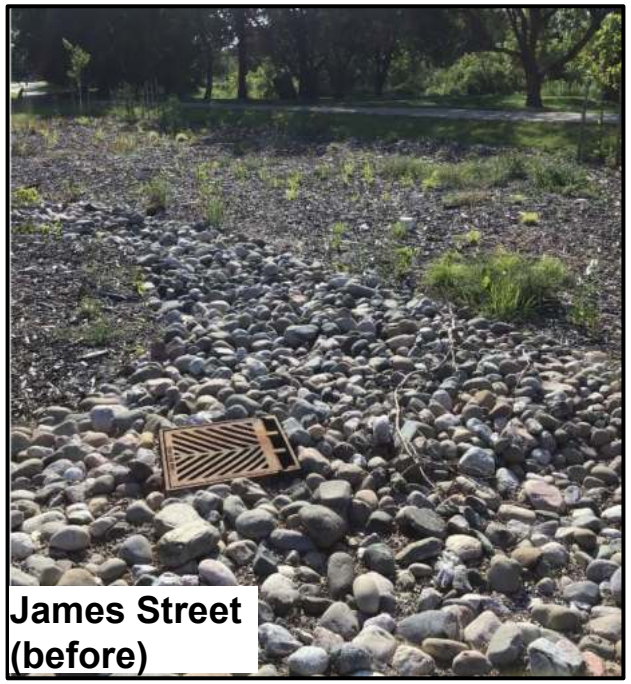


Green Infrastructure Maintenance

- Thunder Bay Conservatory Staff now complete the majority of plant inspections & maintenance
  - Moving ahead, they will also complete all landscape installations at new facilities (excluding trees, mulch & seeding), & all plants are grown from seeds within our greenhouses.

- Benefit of smaller SWM facilities is landscape contractors can assist with maintenance – don't need specialty equipment

- Typical general maintenance
  - Plantings – weeding (where appropriate), removal & replacement of dead vegetation
  - Flush & video sub-drain system
  - Remove sediment from pre-treatment areas
  - Litter removal
  - Snow bank removal



James Street (before)

James Street (after)

Green Infrastructure Inspections & Maintenance

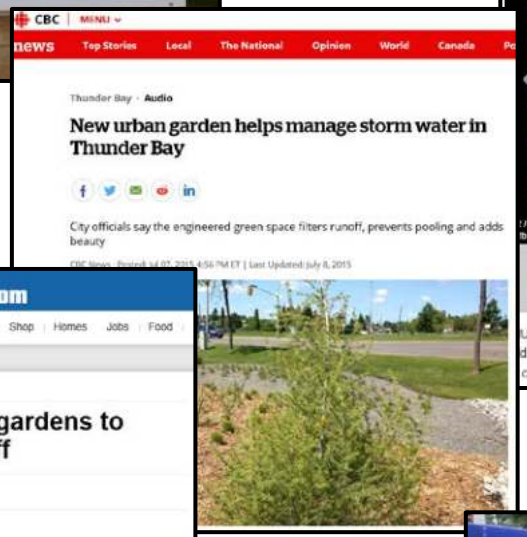
Lessons Learned

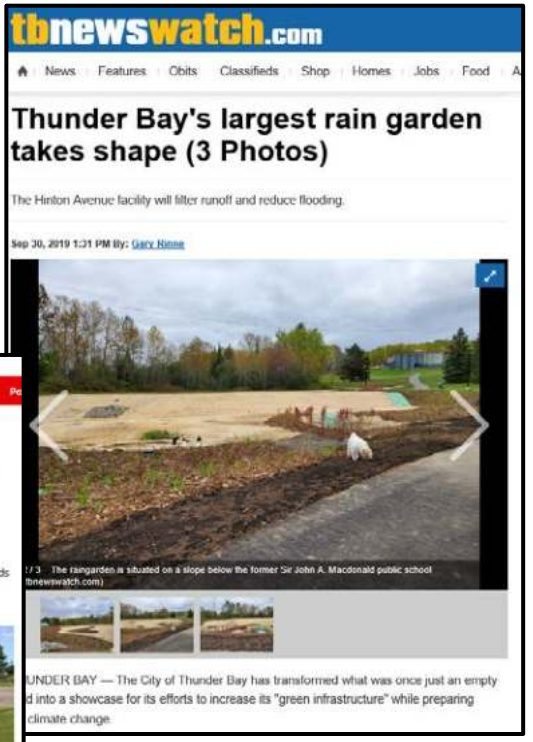
- Dedicated operating budget for maintenance
- Maintenance doesn't have to be complicated!
- May have to change winter maintenance practices (snow plowing) or remove snow accumulation before the melt.
- Different maintenance required at different times of year
- Bring / send the right people to do the work

Public Engagement

- Signage
- Media releases / interviews
- Tours – includes both public and private facilities – invite Council.
- “Neighbourhood” based events
- School tours / presentations
- Engage College / University students & staff
- Videos
- Repetition and consistent messaging

There is no such thing as “too much”!





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Public Engagement

https://www.youtube.com/watch?v=UJpK2OhBTMc

https://www.youtube.com/watch?v=Jtctcf1O2fk

https://www.youtube.com/watch?v=V3vZGtfsclk

https://www.youtube.com/watch?v=fOpnsc-3R4E

https://www.youtube.com/watch?v=j7OuCOSZfPE

https://www.tbnewswatch.com/video/eco-tips/eco-tips-rain-gardens-3765169

https://www.youtube.com/watch?v=8Ow9N9SQKCA

(Residential Rain Garden Design & Installation Workshop)

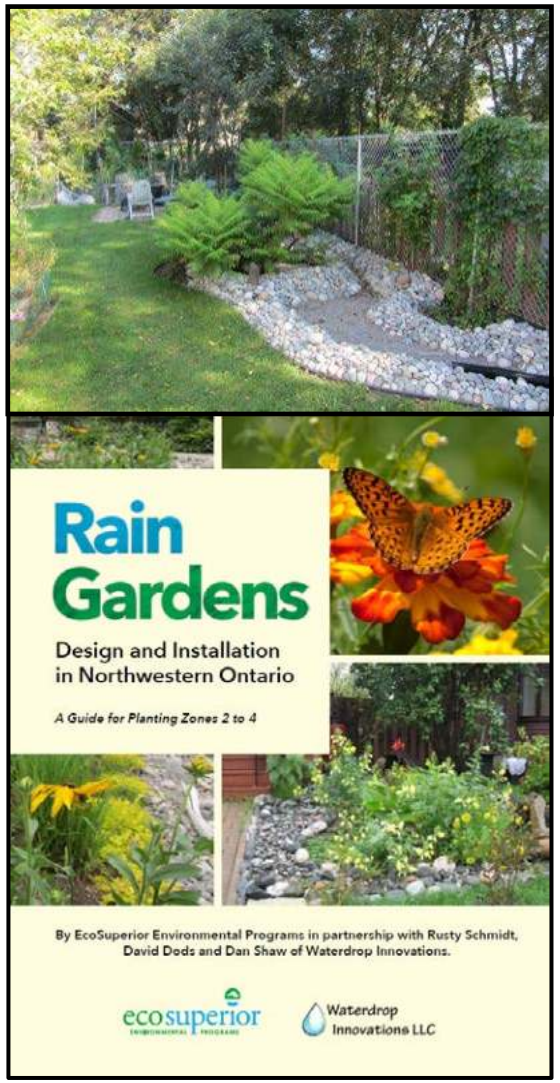
https://www.lakeheadu.ca/about/sustainability/office-of-sustainability/braun-building-rain-garden

https://www.linkedin.com/posts/aaron-ward-3789962b_thunderbay-greeninfrastructure-stormwater-activity-6894049477368639488-XhVV?utm_source=share&utm_medium=member_desktop

Public Engagement

Green Infrastructure on Private Property

Rain Garden Rebate Program



- Rebates up to **$500** *matching funds not required.*
- +/- 120 installed in Thunder Bay under program in 7-years.
- Estimated >3,000m^3 diverted annually

What is a rain garden?

A rain garden is a landscaped depression that will soak up rainwater runoff from the roof of a house or garage, or other hard surface like a parking area. The rainwater is absorbed into the soil instead of flowing into a storm drain that empties into our local streams. Rain gardens are often planted with wildflowers or other plants that provide homes and food for birds and insects.

Rain gardens absorb rainwater, so they can help:

- recharge our groundwater
- protect neighbourhoods from flooding and drainage problems
- keep our streams clean by reducing the amount of polluted stormwater that goes into streams from storm drains
- provide habitat for birds, butterflies and insects.

http://www.ecosuperior.org/raingardenrebate or check-out Eco-Superior's Facebook page for Thunder Bay examples

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Thank you!

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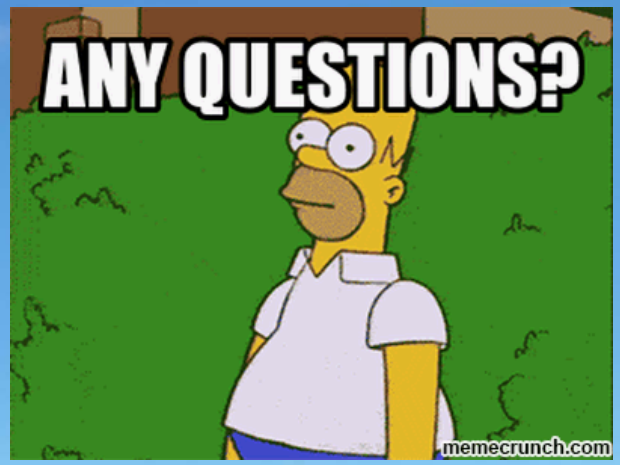

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