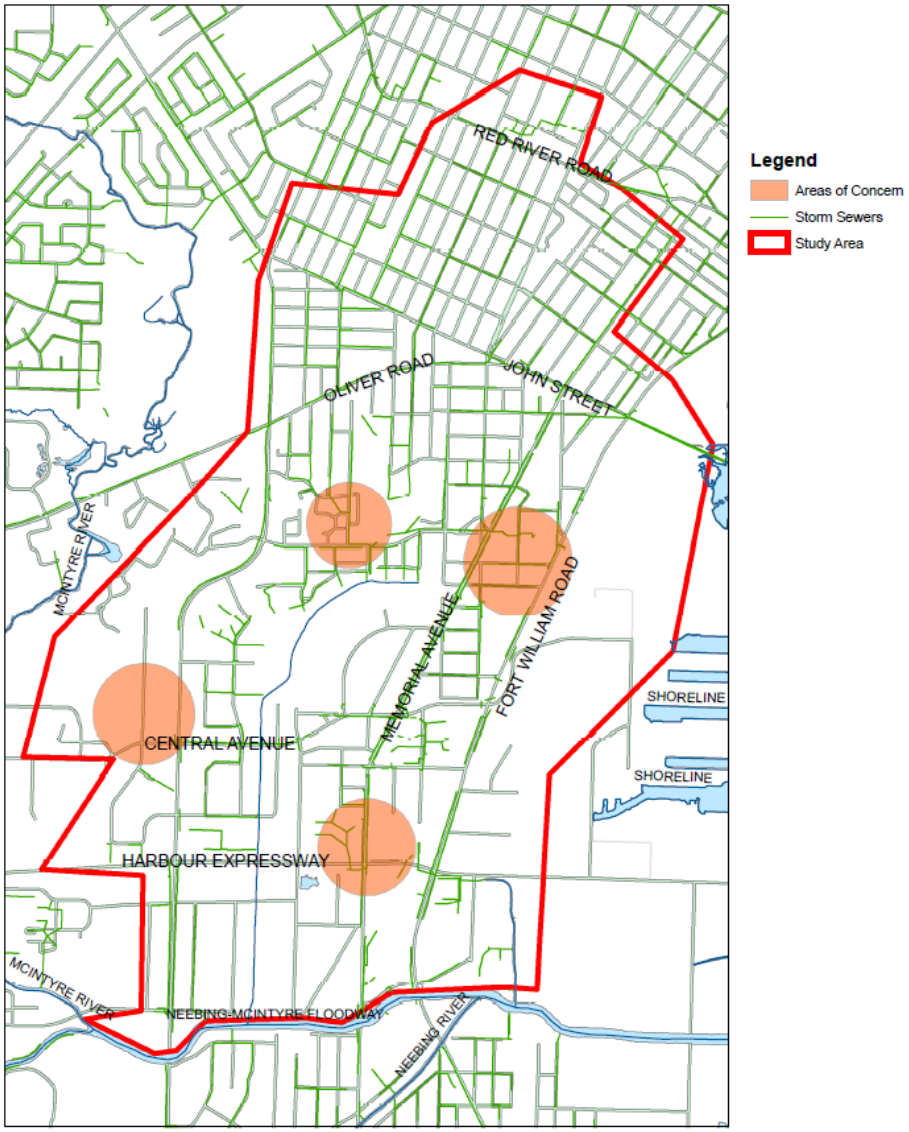
2D Stormwater Modelling for Flood Management
Intercity Drainage Study

Intercity Drainage Study

- Study Area extends from Hill area south of Red River Road to Neebing-McIntyre Floodway, west to Balmoral Avenue and east to Lake Superior.
- Characterized by flat low lying land – 0.1% grade from Memorial Avenue to the lake
- Original land had 4-6 feet of muskeg

Figure 1 - Study Area and Areas of Flooding Concern



Flooding History

- Flooding in Thunder Bay has been seen since the beginning of the two communities.
- Serious problem with riverine flooding in the 1890s and early 1900s
- Major flooding events in 1941, 1950, 1968, 1971 and 1977
- After Floodway was built in 1984, major rainstorm flooding events in 1997, 2008, 2012 and 2016

Flooding 1912

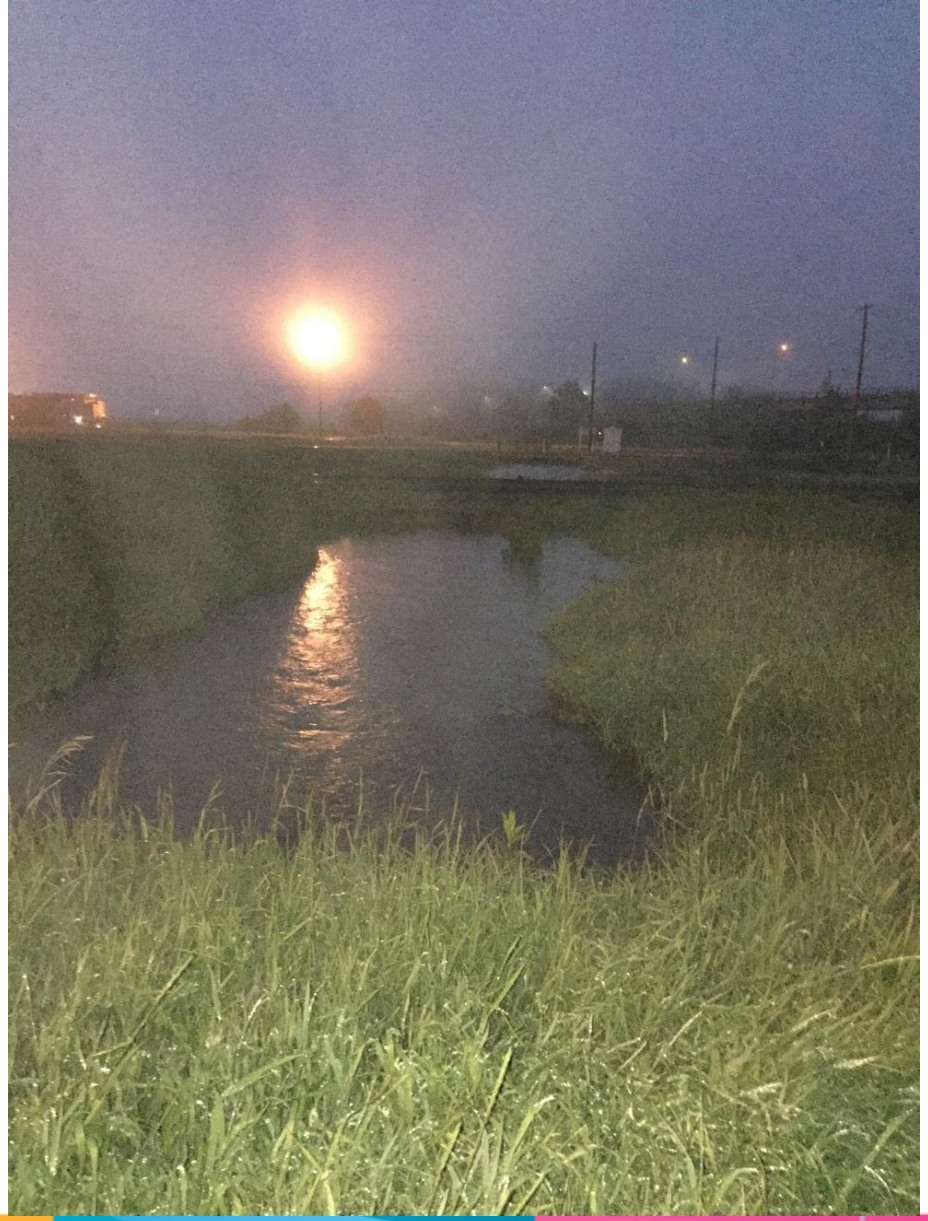
Neebing River 1941

Flooding June 8th and 9th, 1968. Spofford Street looking West toward Ontario Street

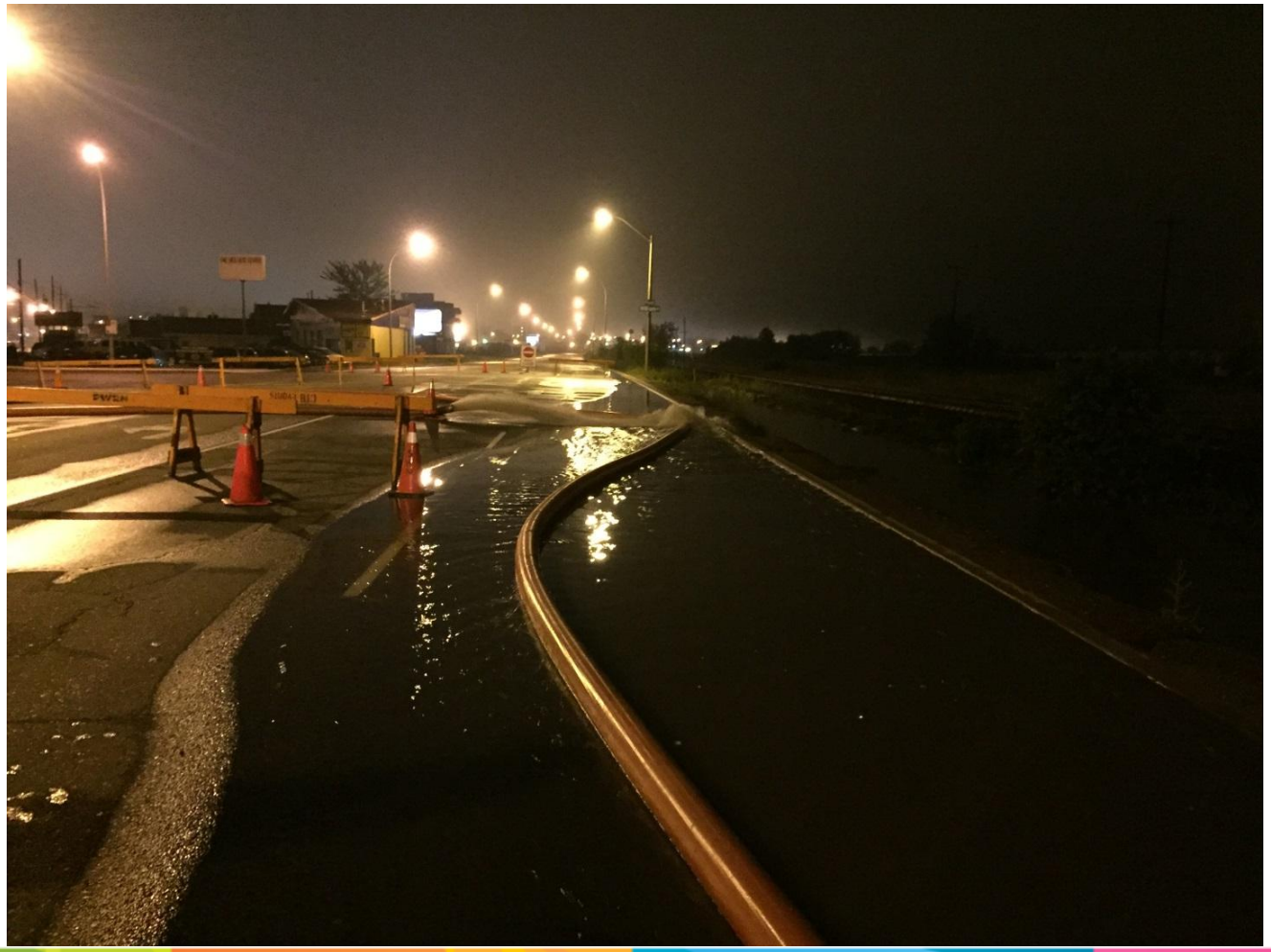
Flooding June 8th and 9th, 1968. High Street looking South from just North of 2nd Avenue.

Flooding June 8th and 9th, 1968. 1st Avenue looking East from Ontario Street.

Fort William Road Looking East across Rail Yard



Fort William Road – Discharge from Pump at Moose Hall



Fort William Road – East Side Ditch

Pump at Moose Hall

Second Avenue near Fort William Road

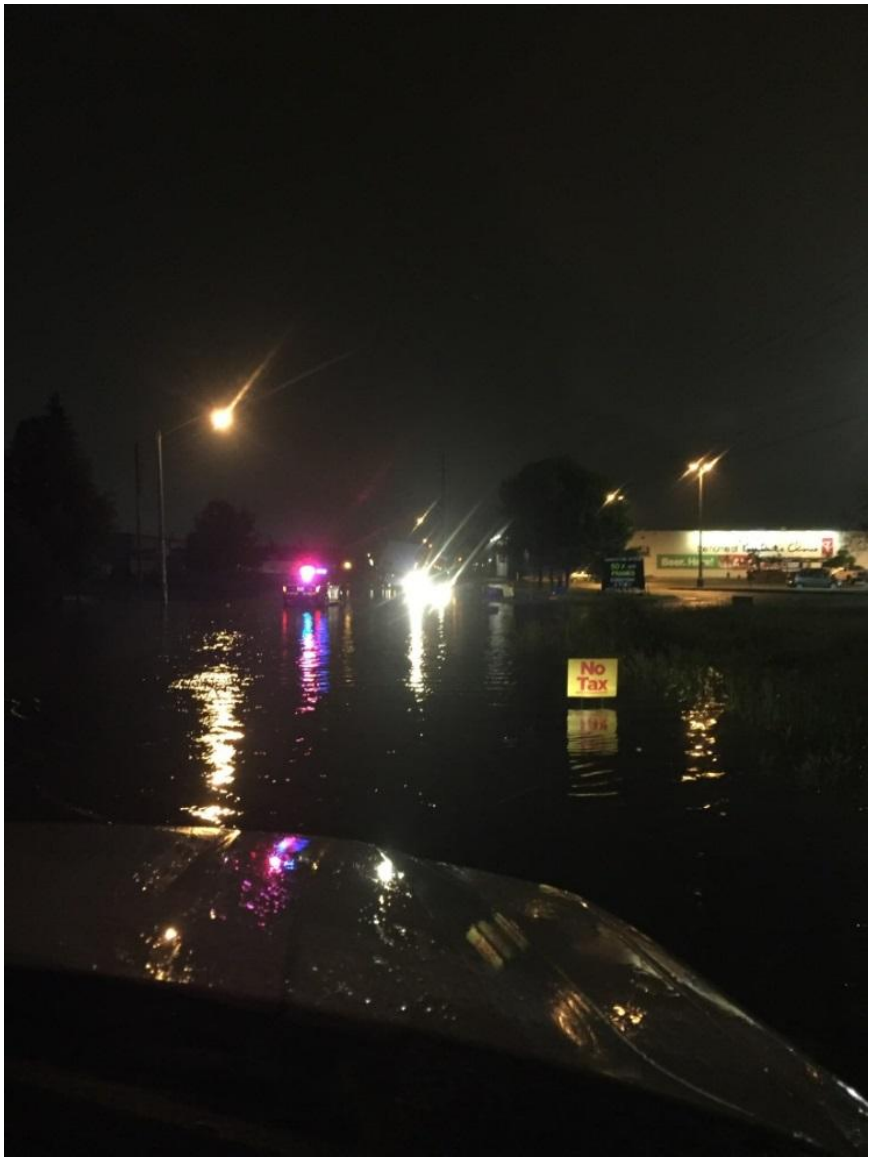
Harbour Expressway at Memorial Avenue

Central Avenue at Balmoral – Police Station

Lyon’s Ditch at Central Avenue

Near Holiday Inn Carrick Street

Superstore – Carrick & Harbour Expressway



Footbridge at Ford
& Neebing River

Neebing River at Floodway

Neebing River at Edward Street

Northwood Mall Parking Lot

History of Flood Mitigation

- Neebing-McIntyre Floodway – Designed to handle the Regional Storm – 193 mm in 12 hours.
- Works as designed – no riverine flooding seen since it was completed in 1984
- Total cost of $15 million.


Neebing - McIntyre Floodway
Operational Since Fall of 1984
Harbour Expresssway
Confederation College
McIntyre River
Dredge approximately every 10 years
Balmoral Street sediment trap area
Memorial Ave
Fort William Road
Intercity Shopping Centre
Thunder Centre
Home Depot
Periodic sediment removal approximately every 15 to 20 years
Island Drive
Neebing-McIntyre Floodway
C.P.R. sediment trap
Sewage Treatment Plant
Periodic close-cut clearing of vegetation
Periodic sediment removal
Diversion Channel
Balmoral Ave
Periodic sediment removal after significant event
Ford Street
May Street
Simpson Street
Neebing River
Diversion structure
Victoria Ave
Kaministiquia River
LAKEHEAD REGION CONSERVATION AUTHORITY
N
0 50 100 200 300 400 m
Non-motorized Boat Sign
LRCA property boundary
This publication was produced by:
Lakehead Region Conservation Authority
130 Conservation Rd.
Thunder Bay, ON
P7B 6T8
Base data used under license through the members of the Ontario Geospatial Data Exchange.
This map is illustrative only. Do not rely on it as being a precise indicator of routes or features, nor as a guide to navigation.
Datum: NAD 83
Projection: UTM Zone 16N
Date: January 2016
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History of Flood Mitigation

- Storm sewer and ditches
- Trunk Ditches: Lyon's Ditch to the West, Railway/Fort William Road ditches on the East side
- Lyon's Ditch – Built starting in the 1960s. Works well, upgrades to road access in 2017 for maintenance.
- Railway ditching – Main constriction is CN and CP crossings to the lake.

History of Flood Mitigation

- Storm Pumping Stations
- Six in total – 4 built in the 1970s, 2 in the 2000s.
- Assists in conveying drainage but downstream capacity limits effectiveness

Reasons for a New Study

- Flooding events in 2012 & 2016
- Perception of larger and more frequent storms
- Plan required to access funding
- New stormwater computer modelling available.

Goal of the Study

- Use the Model to Identify:
  - Maximum flooding depths
  - Runoff Peak Flows
  - Runoff volumes
  - What happens during a 100+ year storm?
- Run scenarios for various mitigation options
- Determine Cost-Benefit for options
- Develop a Capital Plan for future works

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Stormwater Model Development

Intro to Stormwater Modelling

- Can be an effective tool to:
  - Determine what happened and why
  - Estimate what may happen in the future under different conditions
  - Evaluate feasibility and effectiveness of improvements
- A model is an “representation” of what exists
  - Does not always replicate exact conditions, some interpretation of results is necessary
- Size & complexity can vary widely
  - Coarse – main infrastructure only – large / very large areas
  - Fine – majority of infrastructure – small / medium size areas
  - Very fine – all infrastructure – small / very small areas
  - Each model is tailored to project’s needs & scope - sanitary, land drainage, planning, final design

Stormwater Model Development

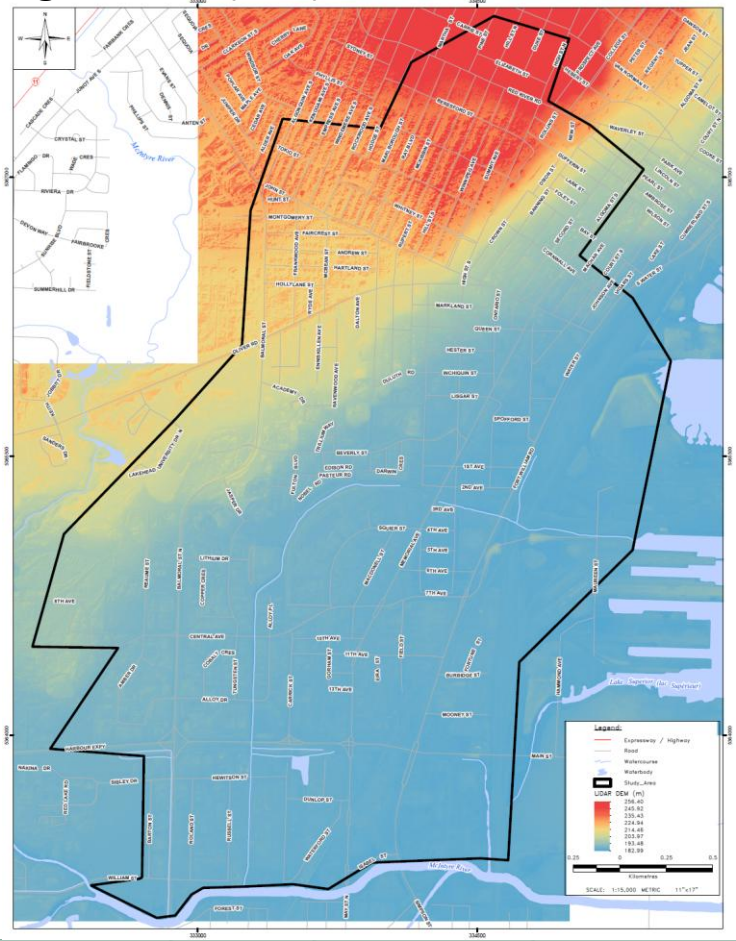
Intercity Drainage Study

- PCSWMM
  - Based on EPA SWMM Engine
    - In development since 1971
    - Tried / Tested / True
  - Easy interface
  - Affordable
  - Capable of Hydrologic & Hydraulic simulations (rainfall/runoff -> hydraulics & overland flow)
  - Quasi-2D functionality
  - Used by many municipalities throughout Ontario

Stormwater Model Development

Background Info

- City of Thunder Bay – GIS Database of Land Drainage Sewer (LDS) infrastructure
  - Sewers, ditches, channels, manholes, catchbasins
- KGS Group Survey
  - Capture critical missing information
    - pipe sizes, invert elevations, etc.
- LiDAR Data
- Pump Data
  - City of Thunder Bay
  - Pump operations staff
  - Pump manufacturers
- Aerial Imagery



Stormwater Model Development

Model Set-Up

- 1D Model
  - Add pipes & manholes, ditches, pumps. No catchbasins
  - Nodes & Links (~875 Nodes, ~865 Conduits)
  - Subcatchment delineation -> Based on LiDAR & street/sewer network configuration (560 subcatchments)

Stormwater Model Development

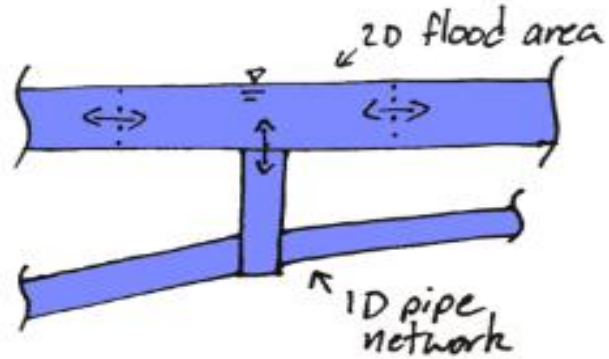
Model Set-Up

- 2D Overland Model
  - Recent computational advancements & Information Availability (LiDAR surveys)
  - Predict/Esitmate Flow Paths
  - Computes water depth, surface storage, velocity
- LiDAR -> Digital Elevation Models
- Other layers (building GIS layers)

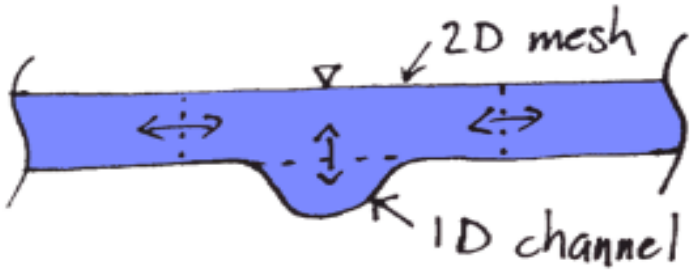
→ 2D Nodes -> 2D "Mesh"

- Mesh is "draped" on the 1D model – 1D/2D interface

Pipe Network



Open Channels



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Stormwater Model Development

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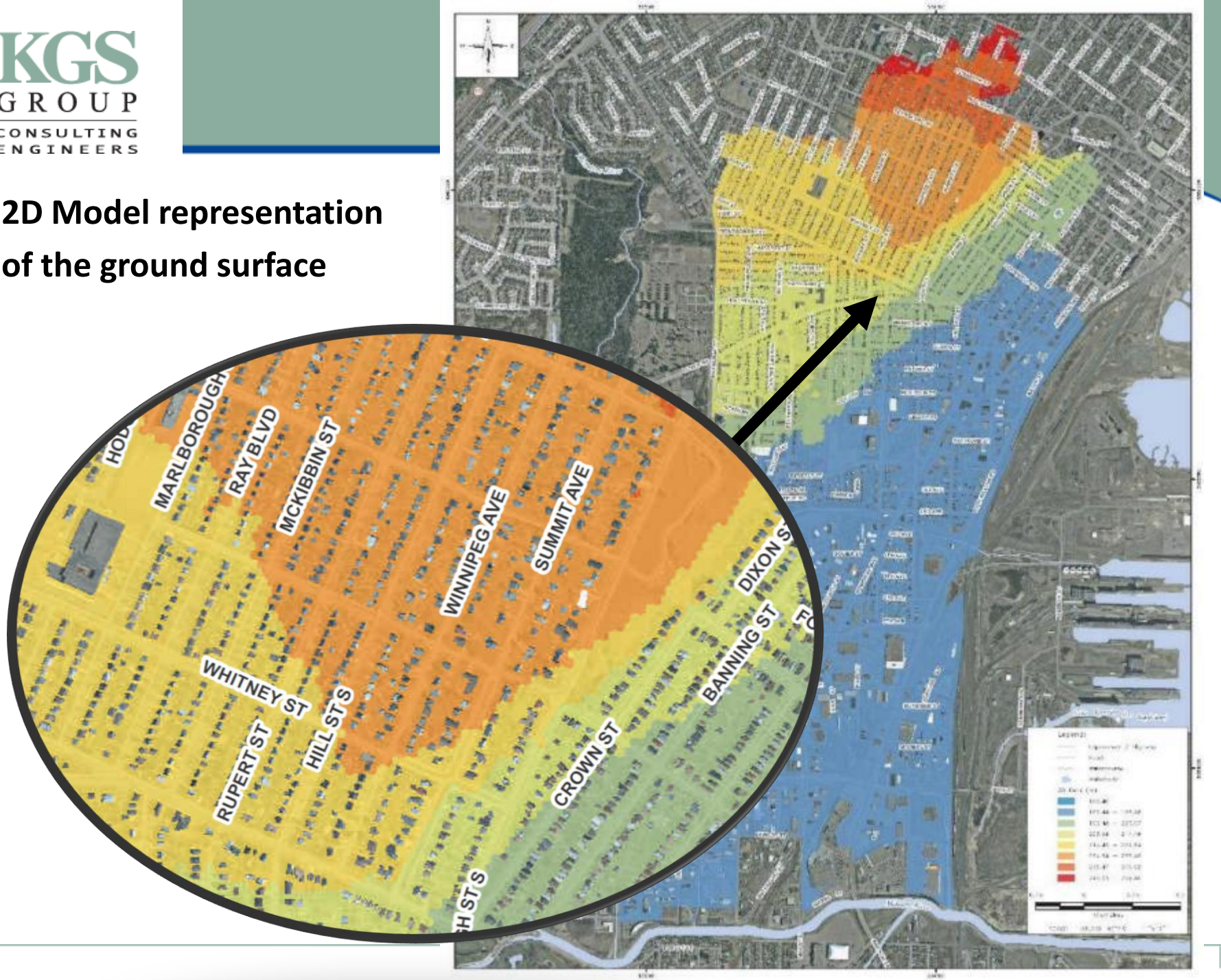
2D Model representation of the ground surface



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Stormwater Model Development

Model Calibration

- Simulate “Real World” known event
  - Make adjustments for accuracy
  - Build confidence in model
- June 25, 2016 -> Approx. 25 Year rainfall event (volume)
  - Typical municipal design is for 5 year storm
  - Flooding is expected in certain areas
- Calibrate to Water Level Monitors & City’s experience with areas flooded

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Stormwater Model Development

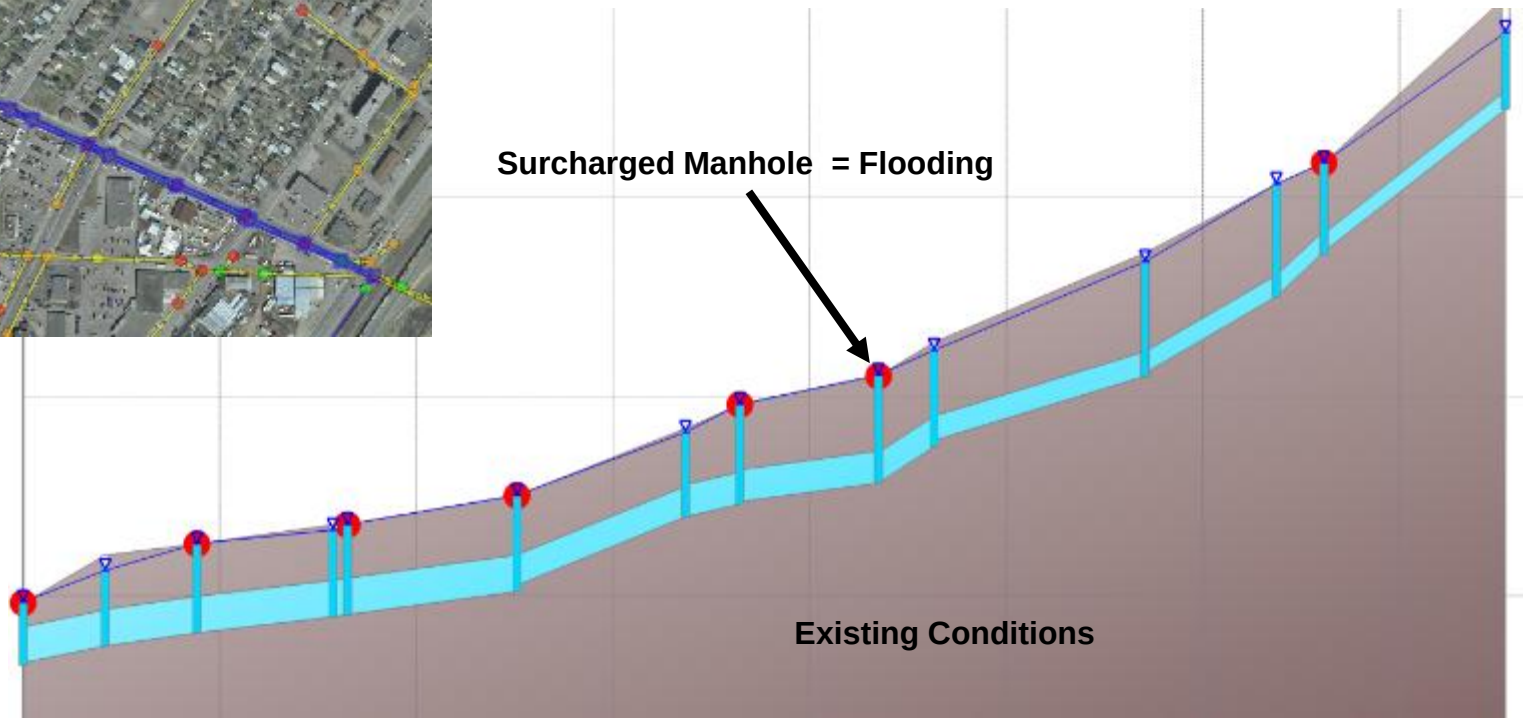
Areas For Improvement Options

- 6 Locations were chosen based on
  - Flooding severity & property damage potential
  - Disruption to emergency vehicles
  - Disruption to residents & nuisance flooding
- Multiple potential mitigation options explored for each

Mitigation Option Example

John St. @ Water St.

- Known flooding location
- Issues with outfall
- Model results reflect flooding experience



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Mitigation Option Example Model Results

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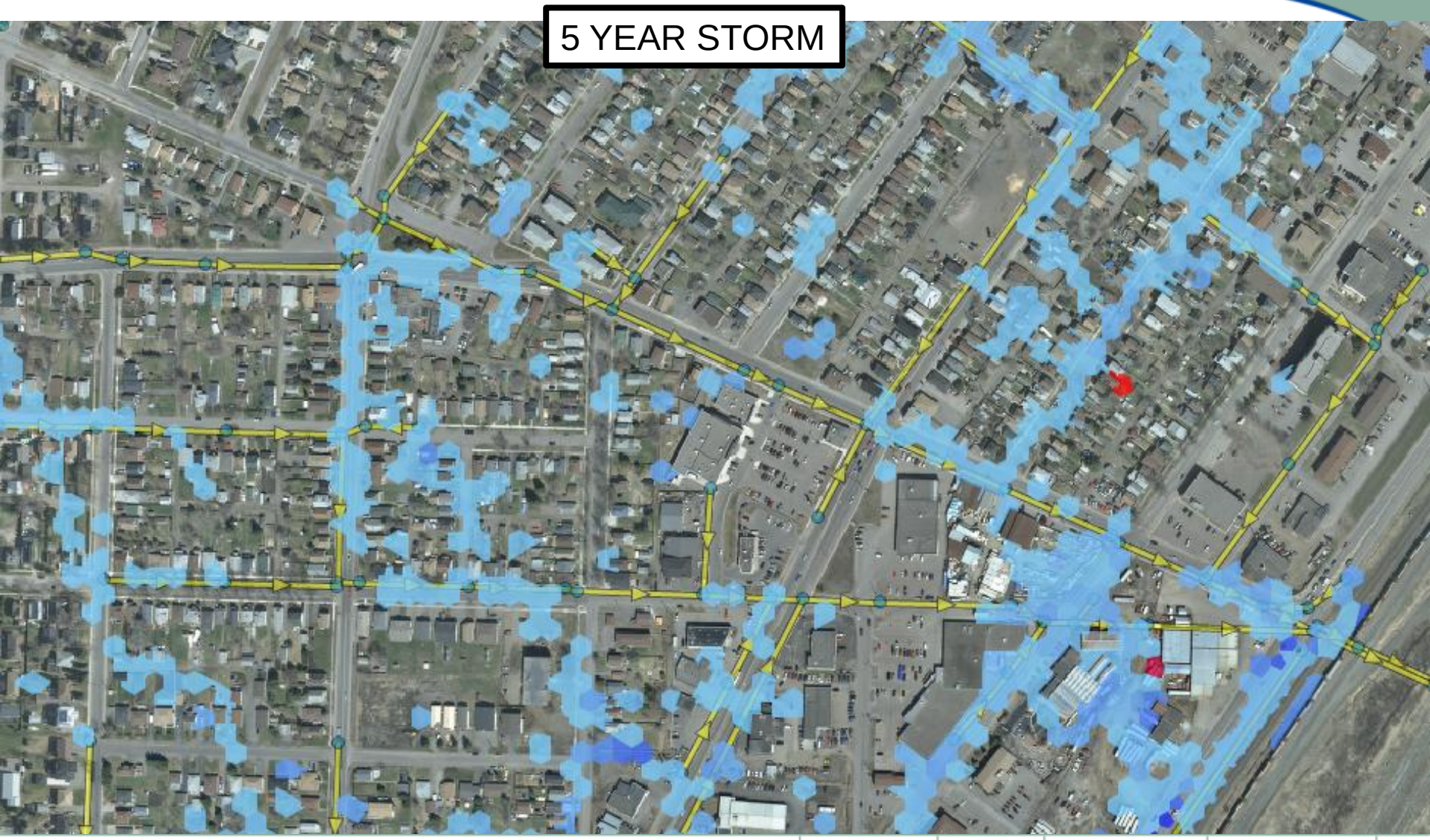
Mitigation Option Example Model Results



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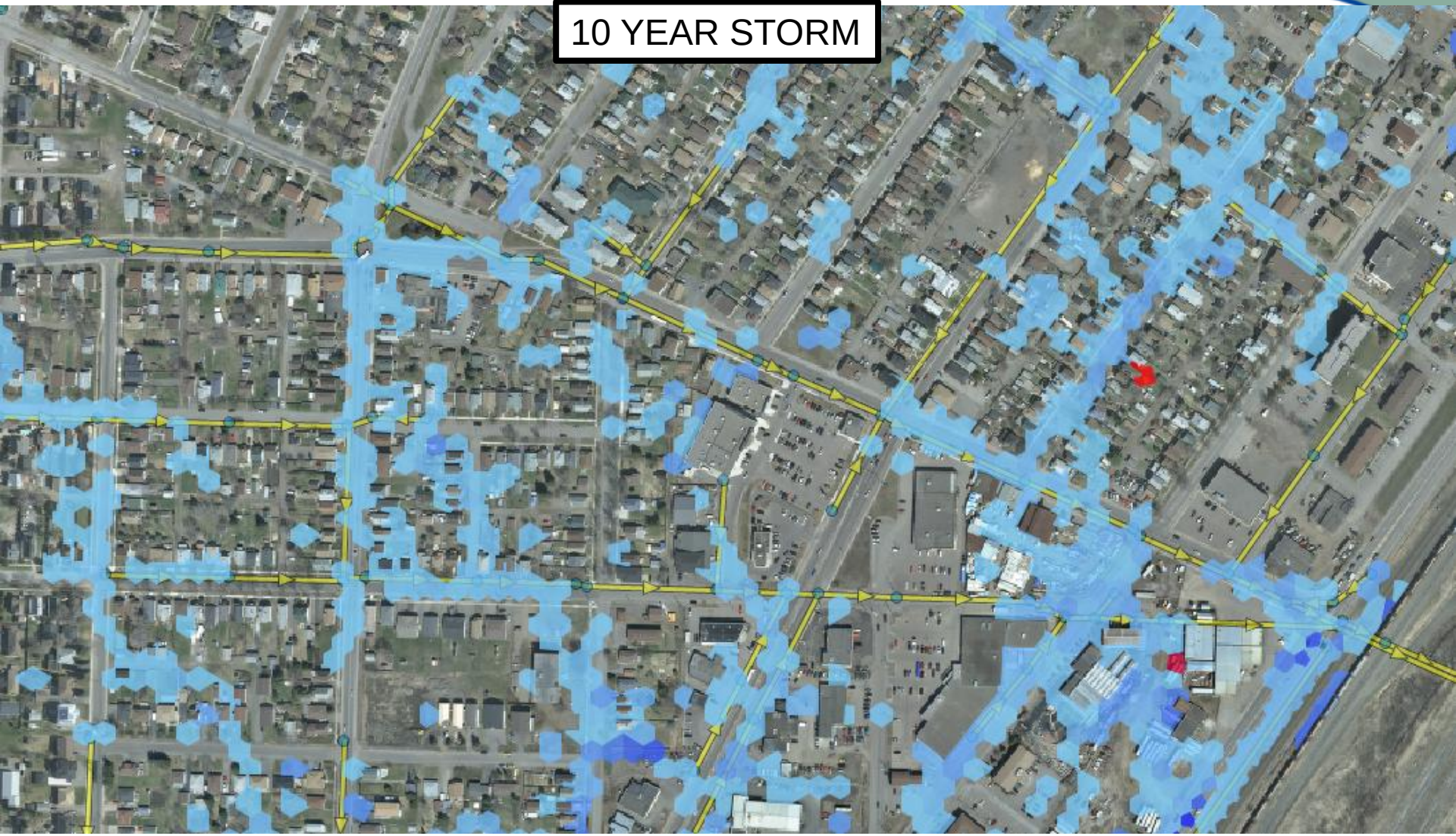
Mitigation Option Example Model Results



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Mitigation Option Example Model Results

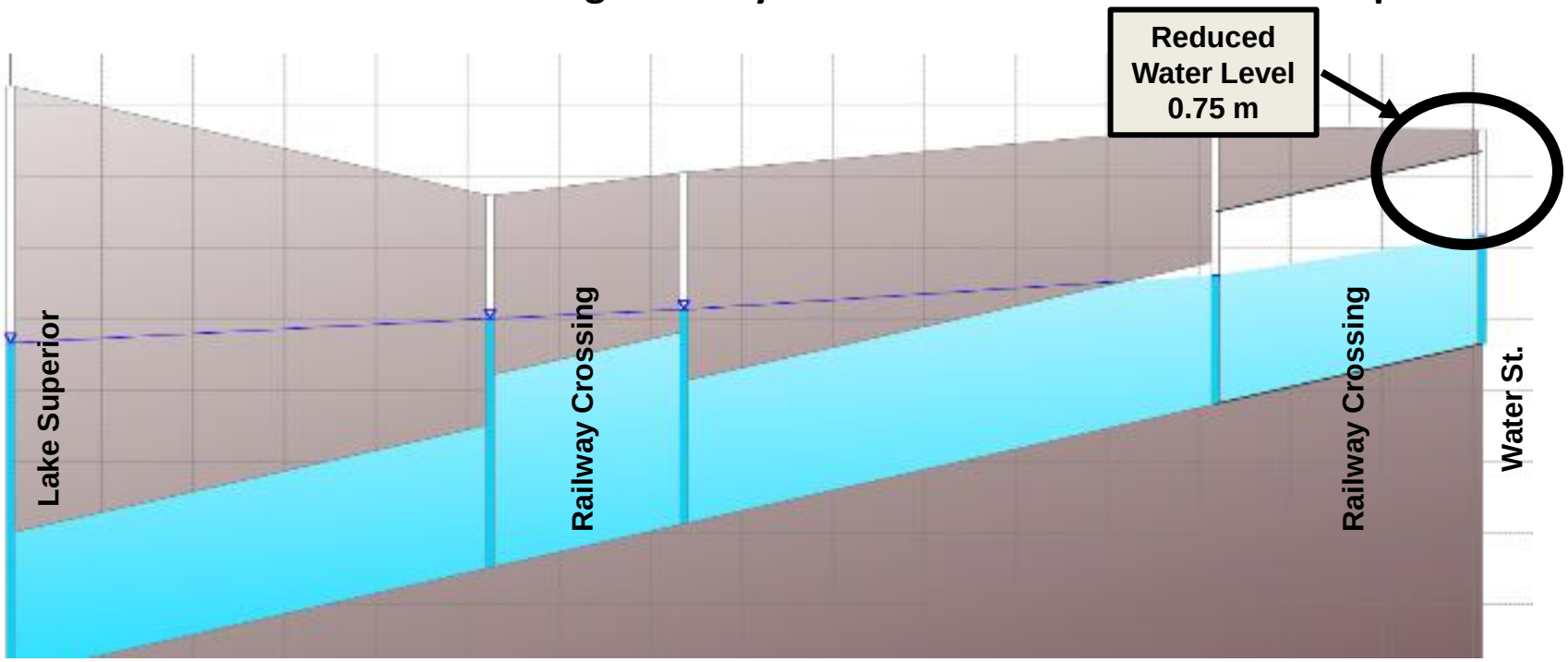
EXISTING CONDITIONS

Mitigation Option Example

John St. @ Water St.

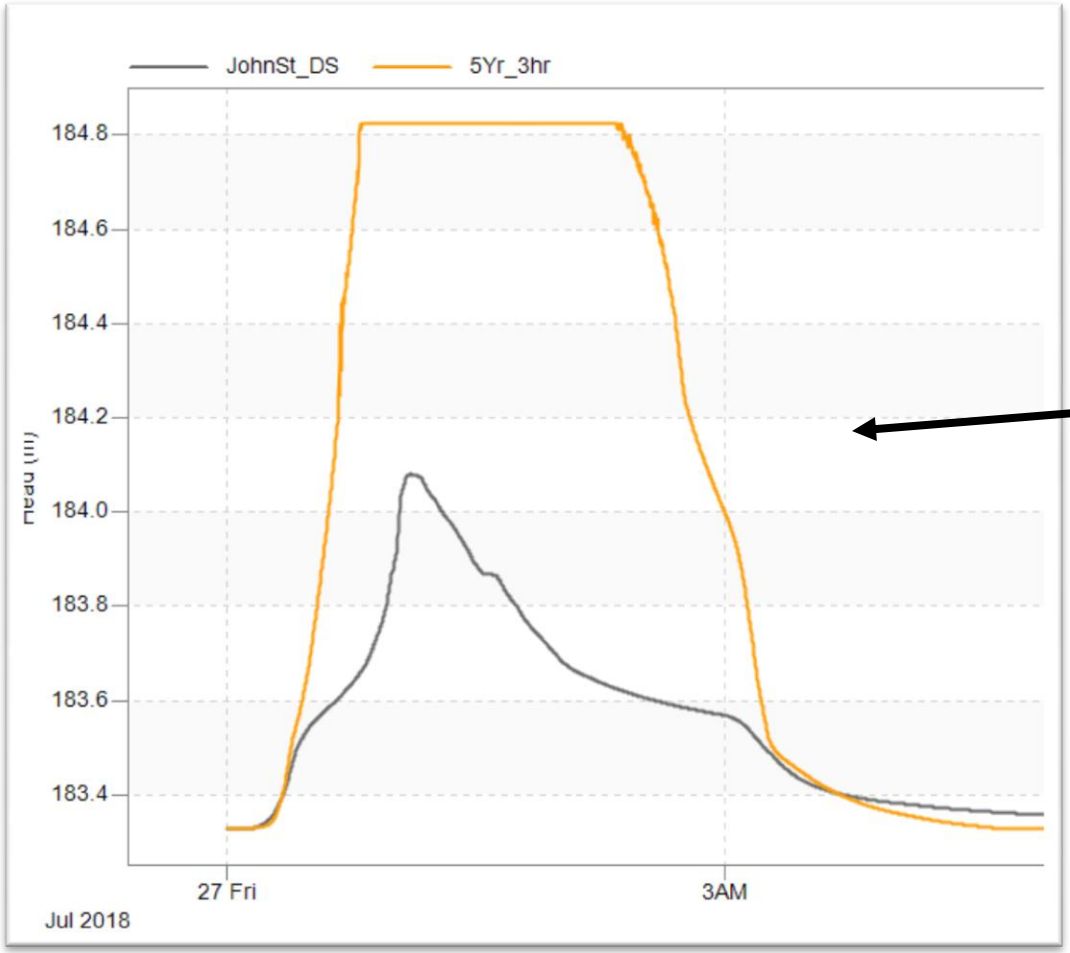
Mitigation **-** Replace conduits east of Water St. with open ditch and culverts

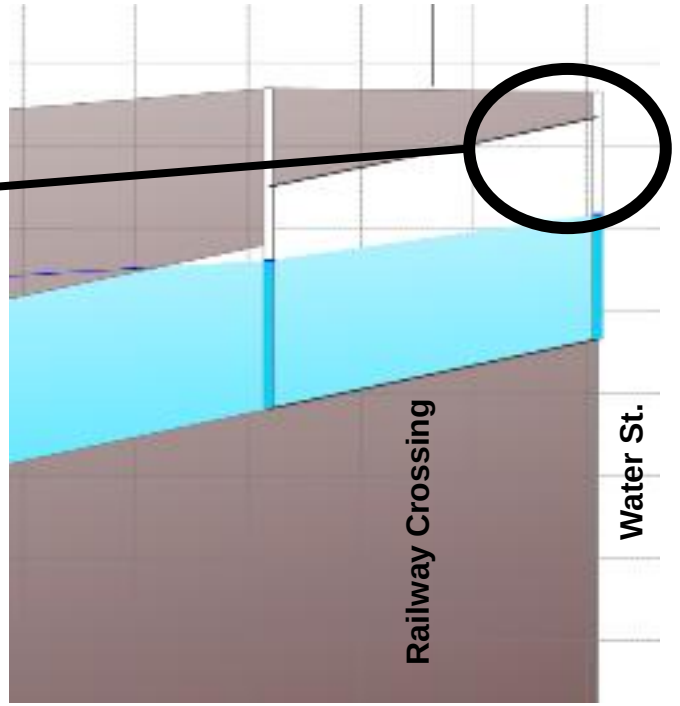
- **Ditch size of 1m base width, 4H:1V side slopes**
- **Culverts through railway sized 1.3m x 2.1m Horizontal Ellipse CSP**



Mitigation Option Example

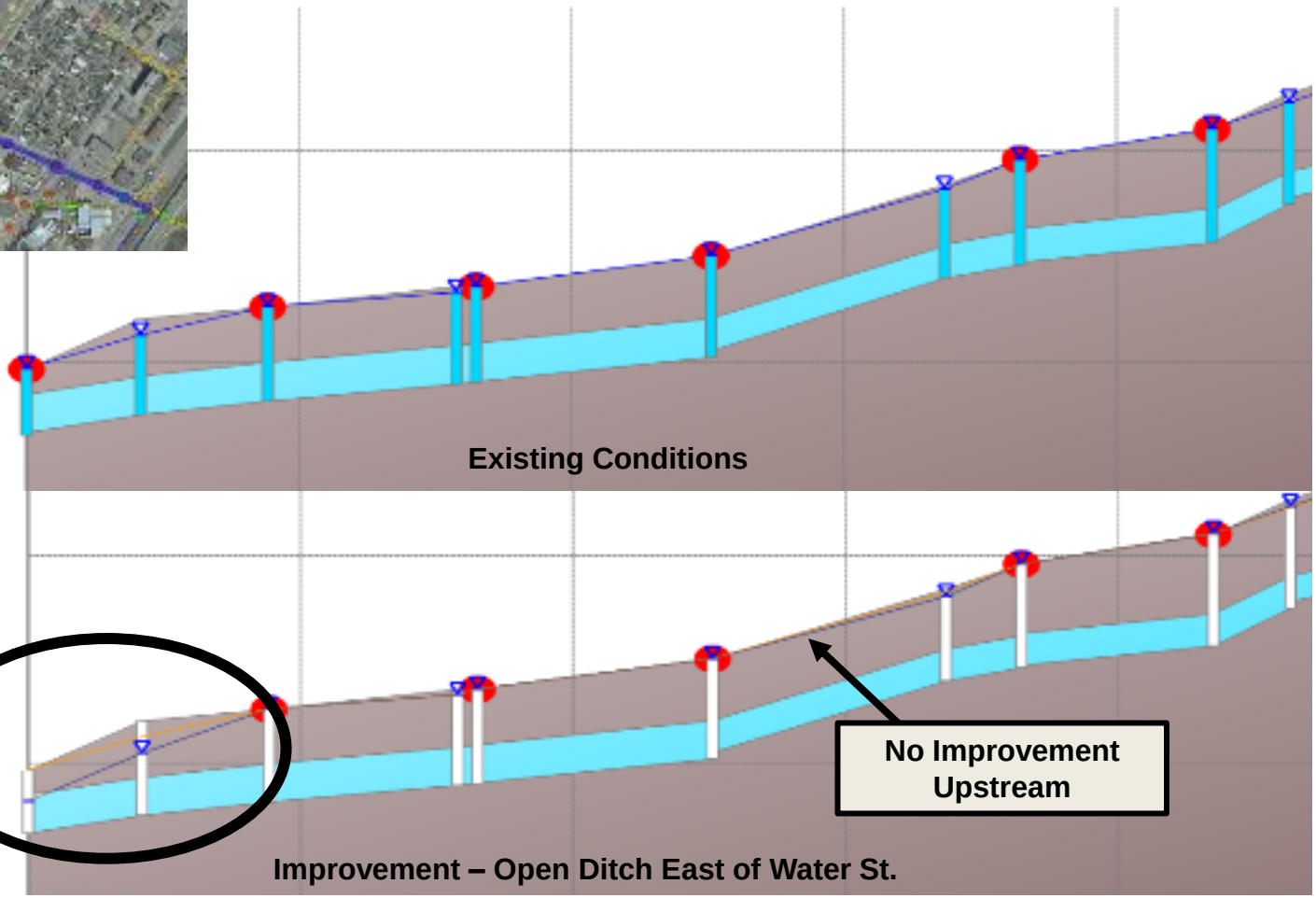
John St. @ Water St.





Mitigation Option Example

John St. @ Water St. – Upstream effects



Mitigation Option Example Model Results

AFTER MITIGATION

Area of Mitigation Measure

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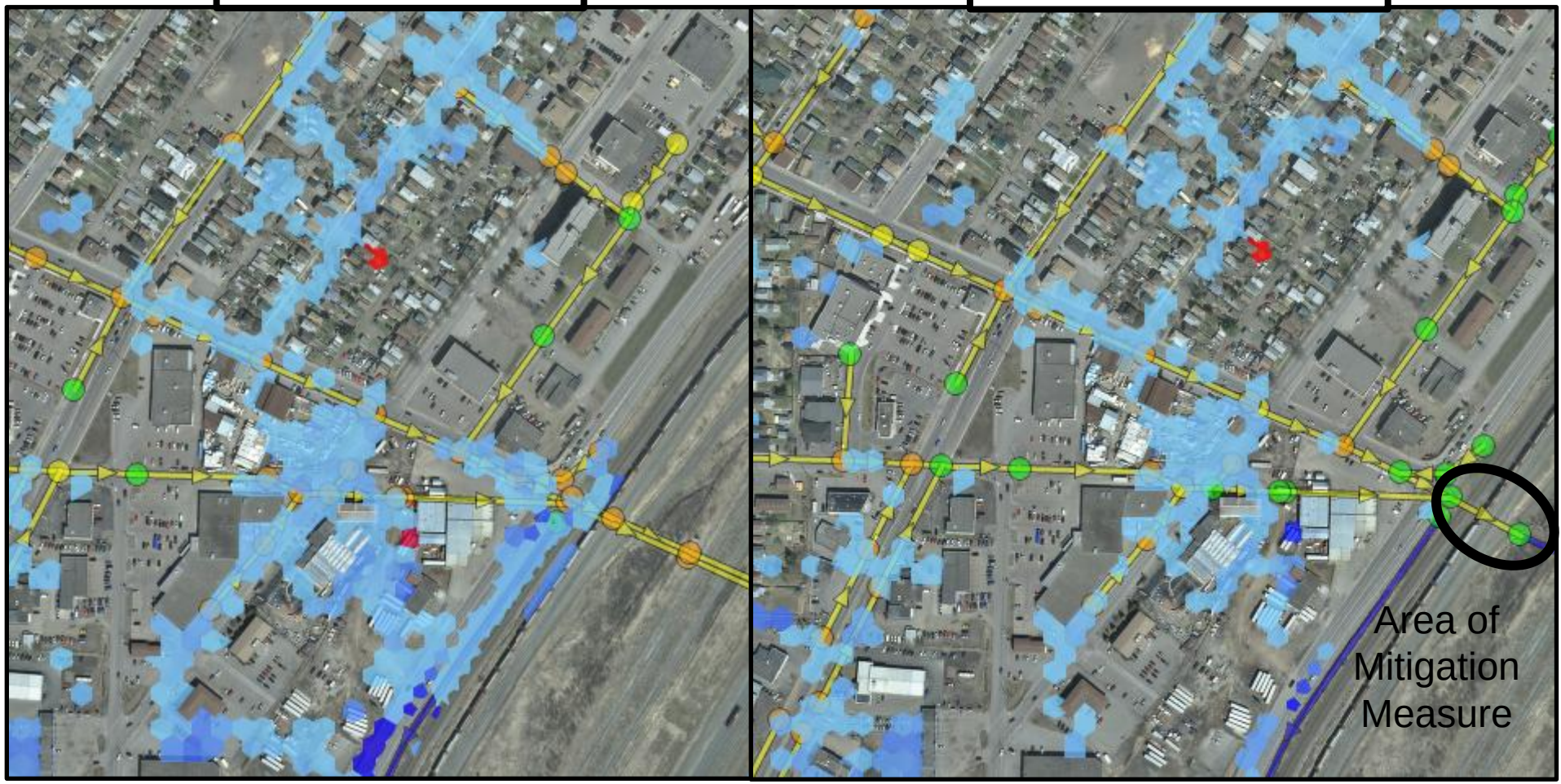
Mitigation Option Example

5 YEAR STORM

Existing Conditions

With Mitigation Option



Mitigation Option Example

John St. @ Water St.

- Additional mitigation options explored at this location:
  - Replacing additional lengths of pipe along John St.
  - Replacing additional lengths of pipe along Queen St.
- Found additional options to be only locally effective, little benefit to surrounding areas

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Next Stages of the Study

- Public Consultations / Open House / Public Feedback
- Further/Refined Analysis of Preferred Options & Effectiveness
- Implementation methods
- Cost Analysis

Questions

- Thanks for listening!

For additional questions, please feel free to contact:

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