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IECA Great Lakes Chapter

Toronto and Region Conservation for The Living City

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WATER CANADA THE COMPLETE WATER MAGAZINE

LID Treatment Train For Thermal Mitigation
– Elm Drive Case Study –

Amanjot Singh and Jordan Wiedrick

TRIECA

March 25, 2015

Credit Valley Conservation

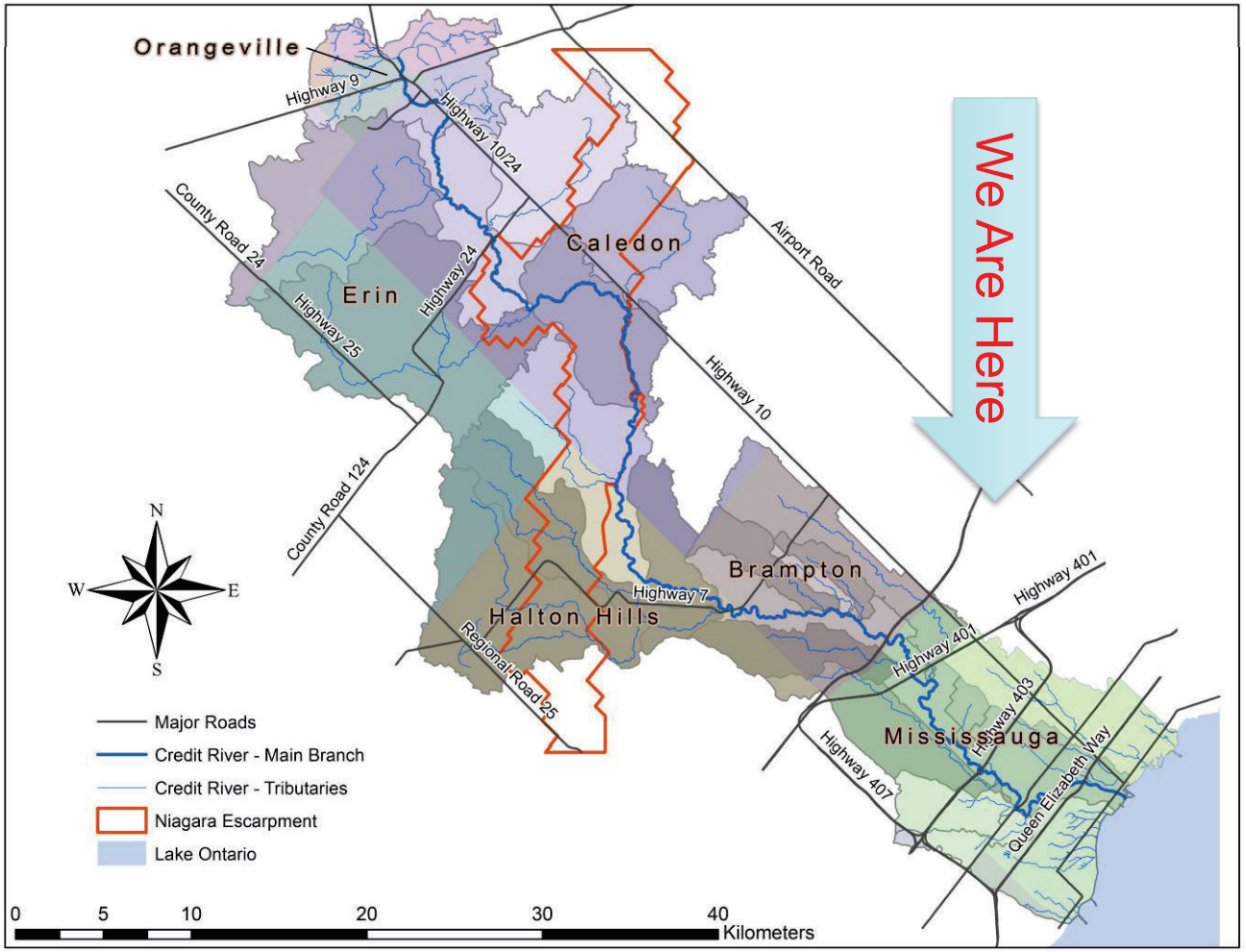
Scope

- Where we are from and why stream temperature is important for us
- Case study 1: Water temperature of an urbanizing stream
- Case study 2: Thermal mitigation observations at Elm Drive, Mississauga, treatment train LID site

Where are we from?

Credit Valley Conservation

Credit River Conservation Jurisdiction



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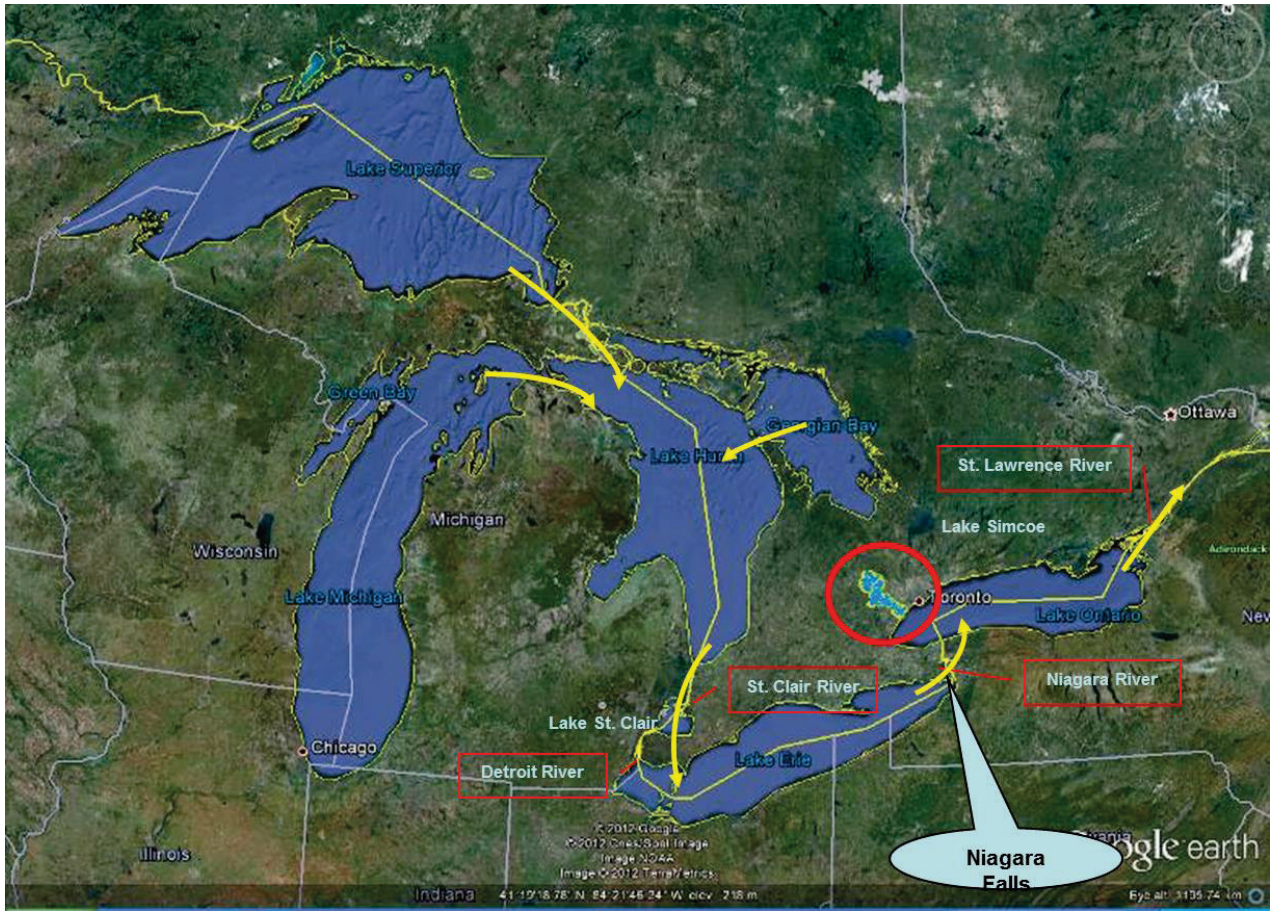
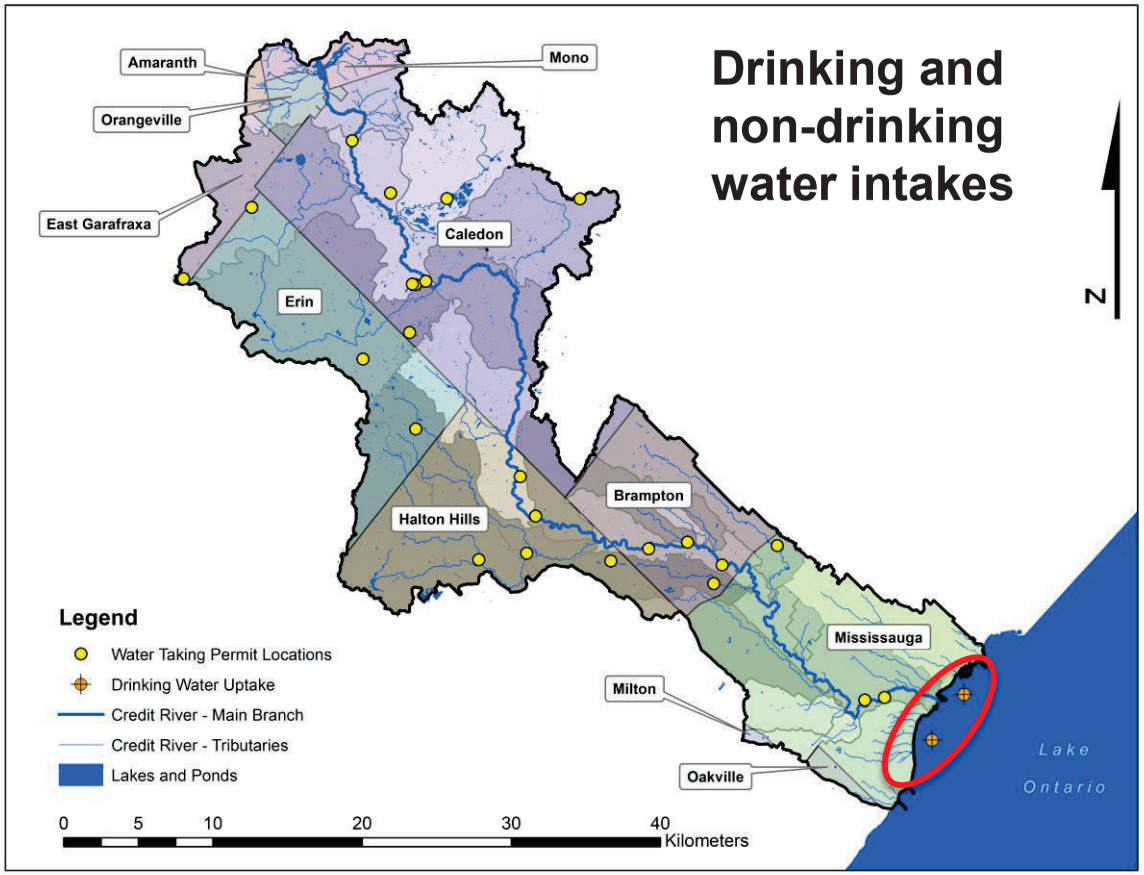
In context of the Great Lakes



Management Challenges

- Water (Drinking)
- Wastewater
- Stormwater
- Preserving native aquatic species
- Recreation
- Climate change

Water: Are Our Sources Protected!



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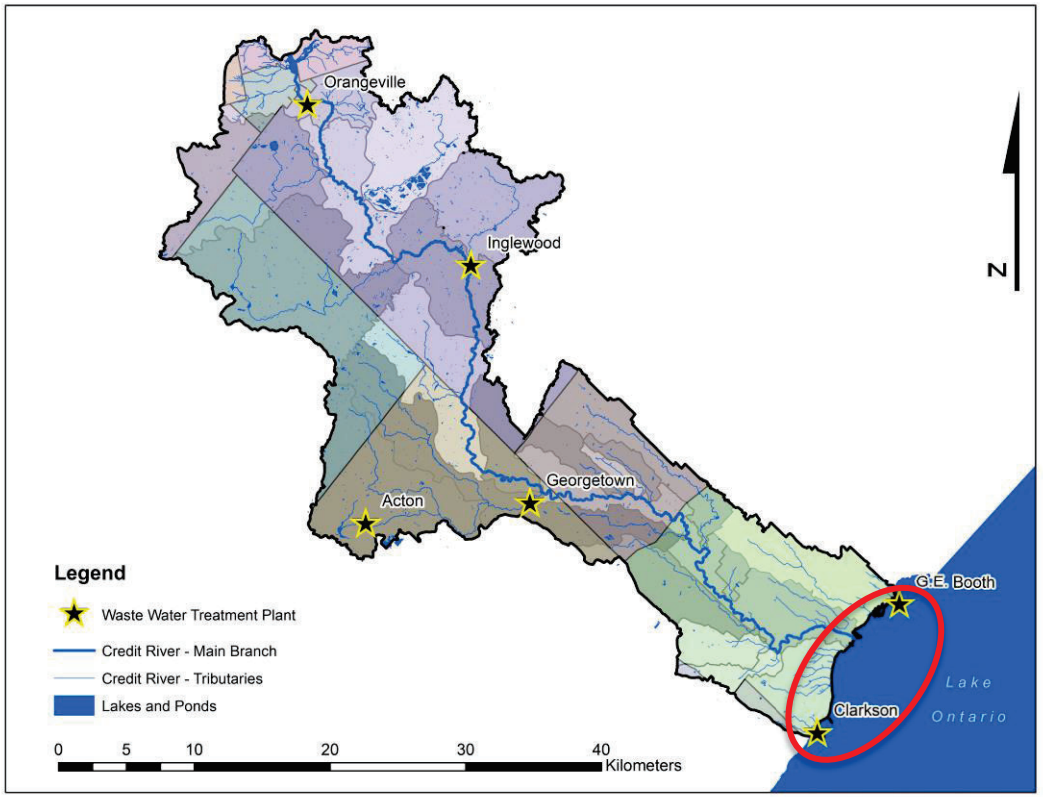
Waste water: Assimilative Capacity of our Watercourses for Effluent Discharges



Stormwater

- Infrastructure stress
- Source to the receiving water bodies

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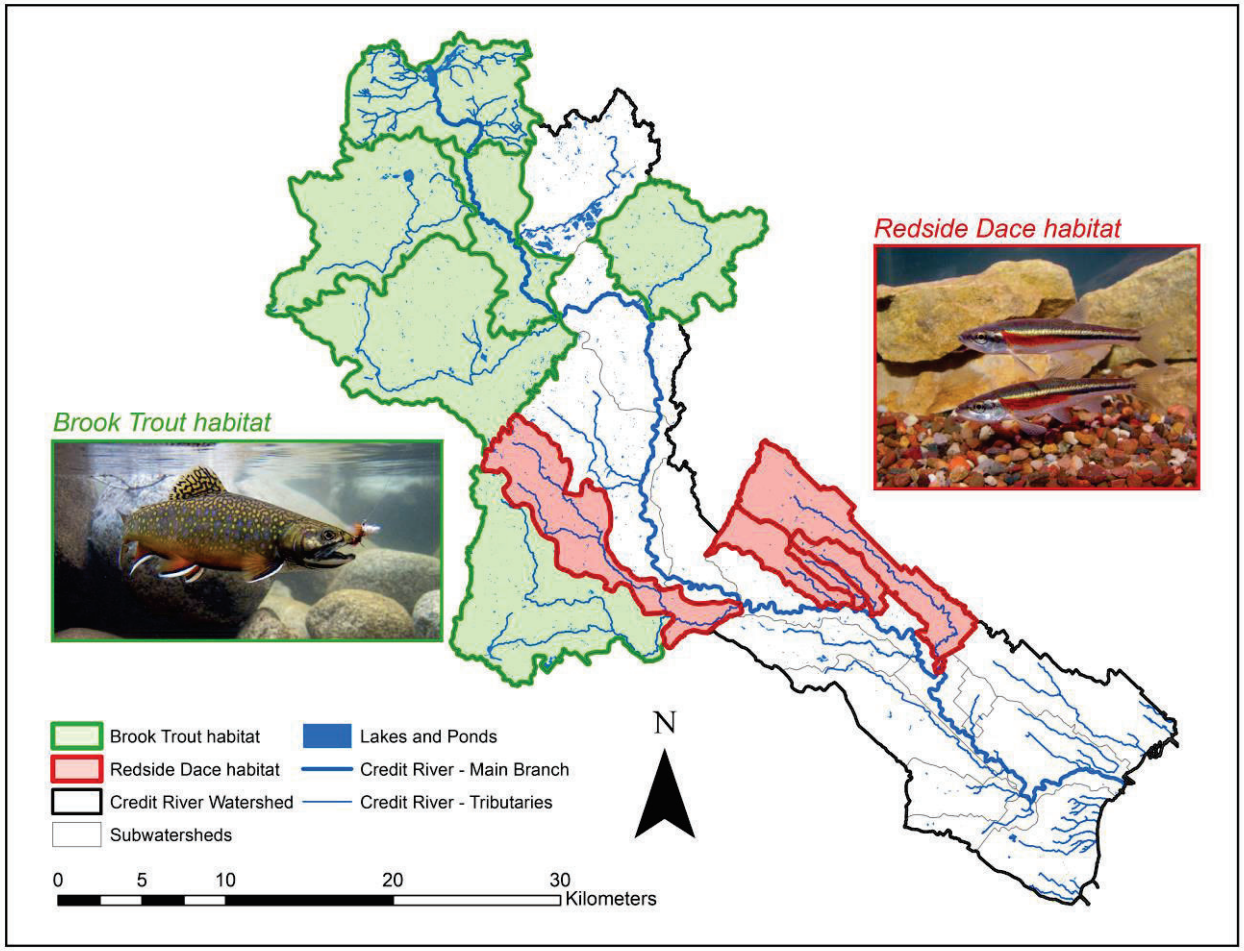
What are Current and Future Stresses to Aquatic Life



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What are Recreational Threats: Economic Loss

Invasive

Climate Change

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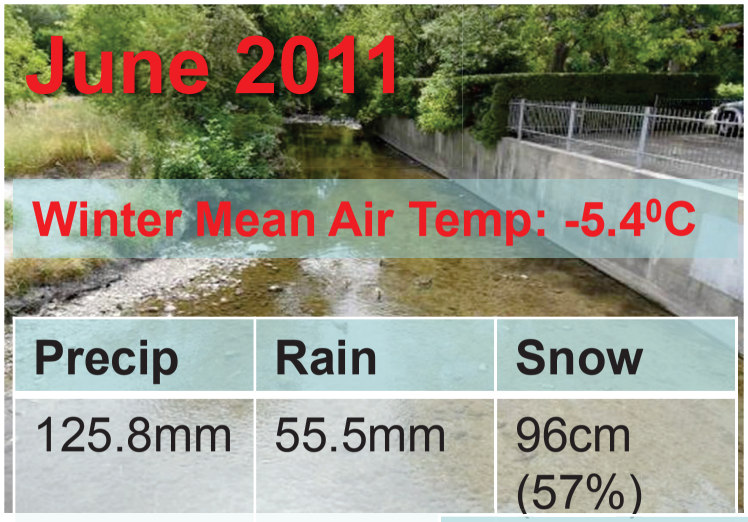
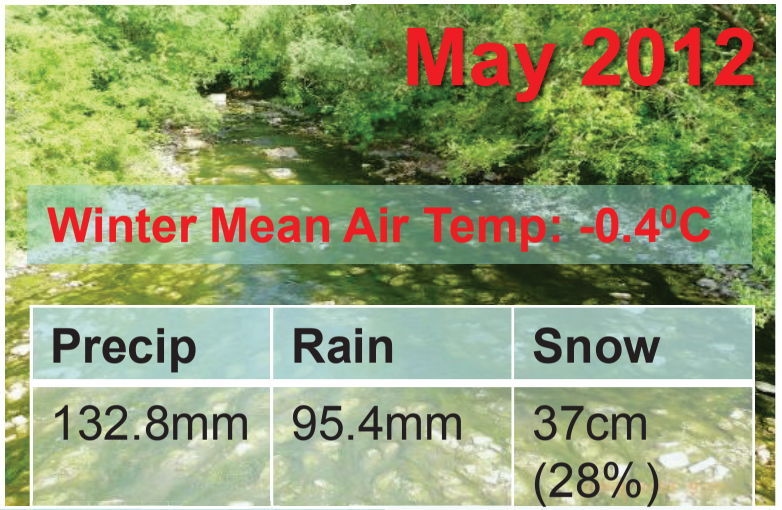


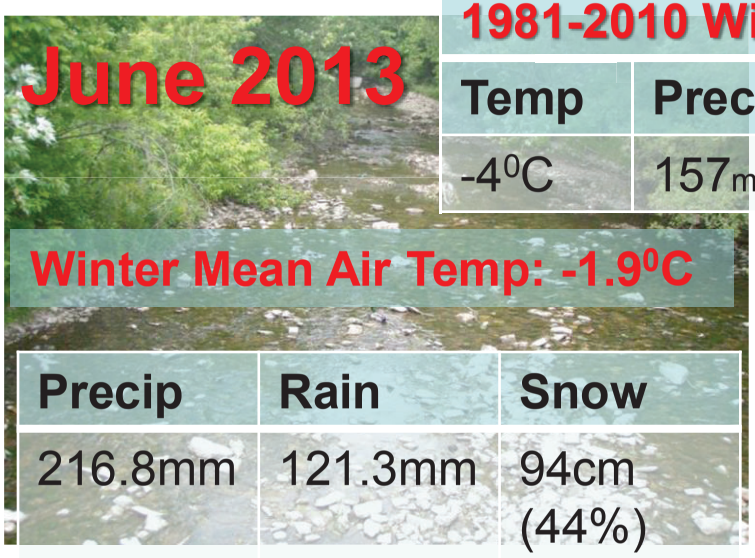
Precip	Rain	Snow
125.8mm	55.5mm	96cm (57%)



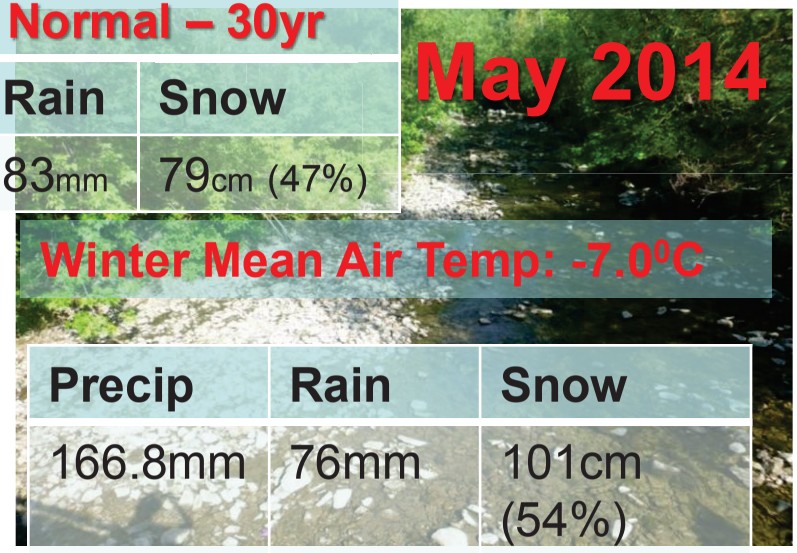
Precip	Rain	Snow
132.8mm	95.4mm	37cm (28%)

1981-2010 Winter Normal – 30yr

Temp	Precip	Rain	Snow
-4^{0}C	157mm	83mm	79cm (47%)



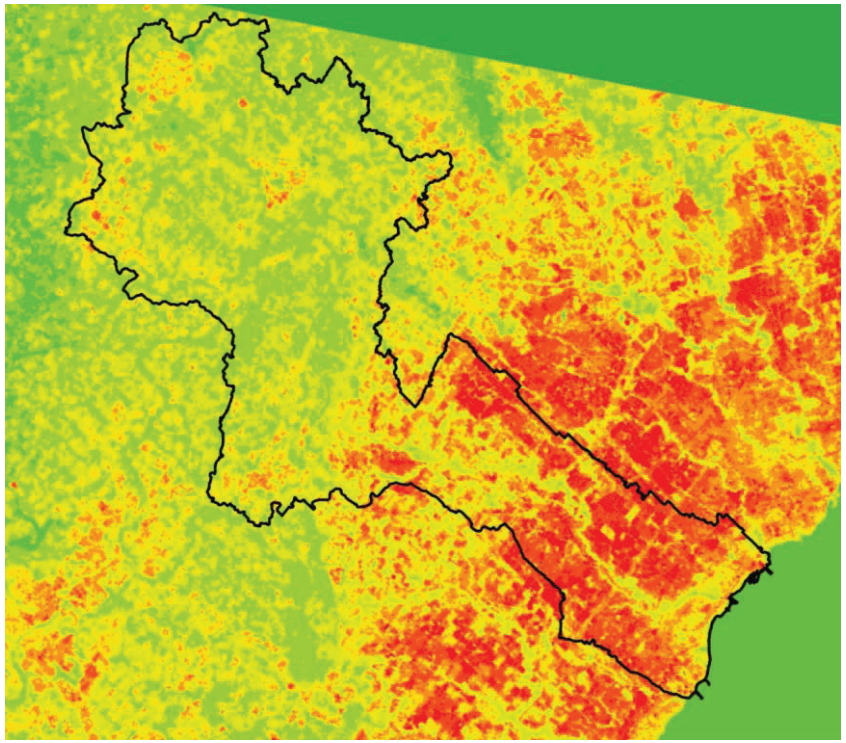
Precip	Rain	Snow
216.8mm	121.3mm	94cm (44%)



Precip	Rain	Snow
166.8mm	76mm	101cm (54%)

Urban thermal impacts on water: Two major concerns

Urban Heat Island



Stormwater Ponds

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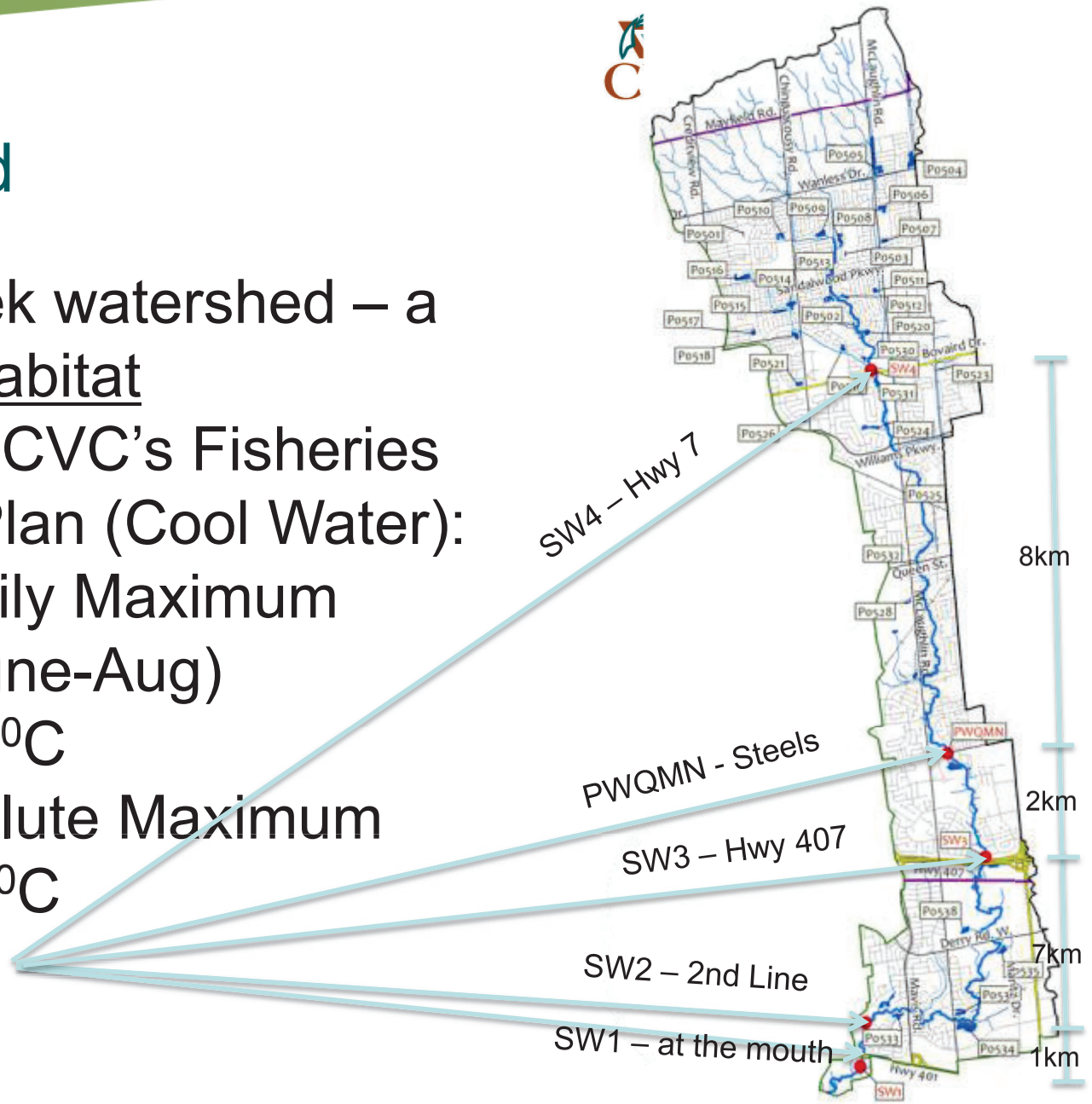
Continuous Temperature Monitoring
- Fletcher's Creek Case Study -

Study Watershed

- Fletcher's Creek watershed – a redside dace habitat
- Guidelines per CVC's Fisheries Management Plan (Cool Water):
  - Chronic- Daily Maximum Summer (June-Aug) Average: 23^0C
  - Acute- Absolute Maximum summer: 28^0C
- Five stations



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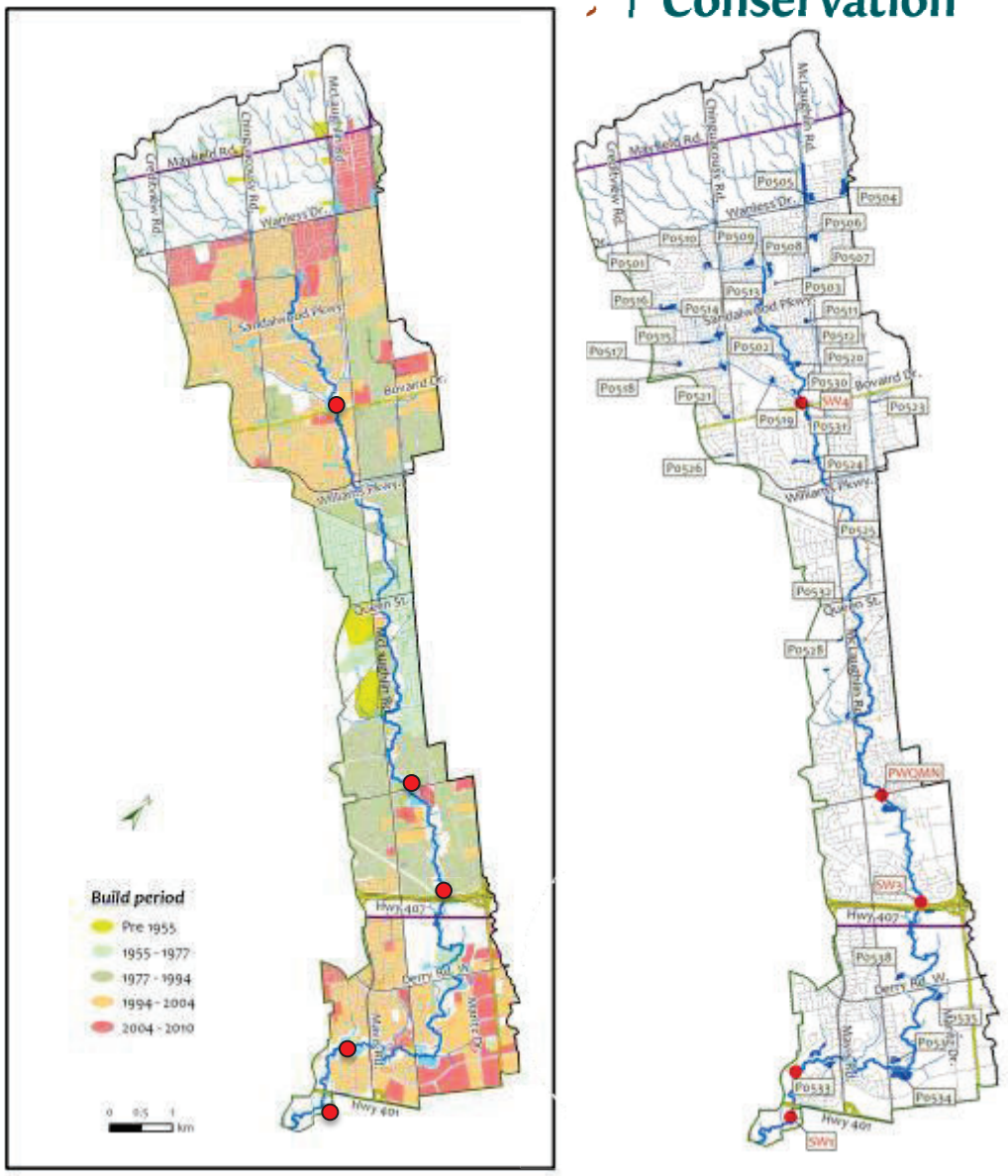
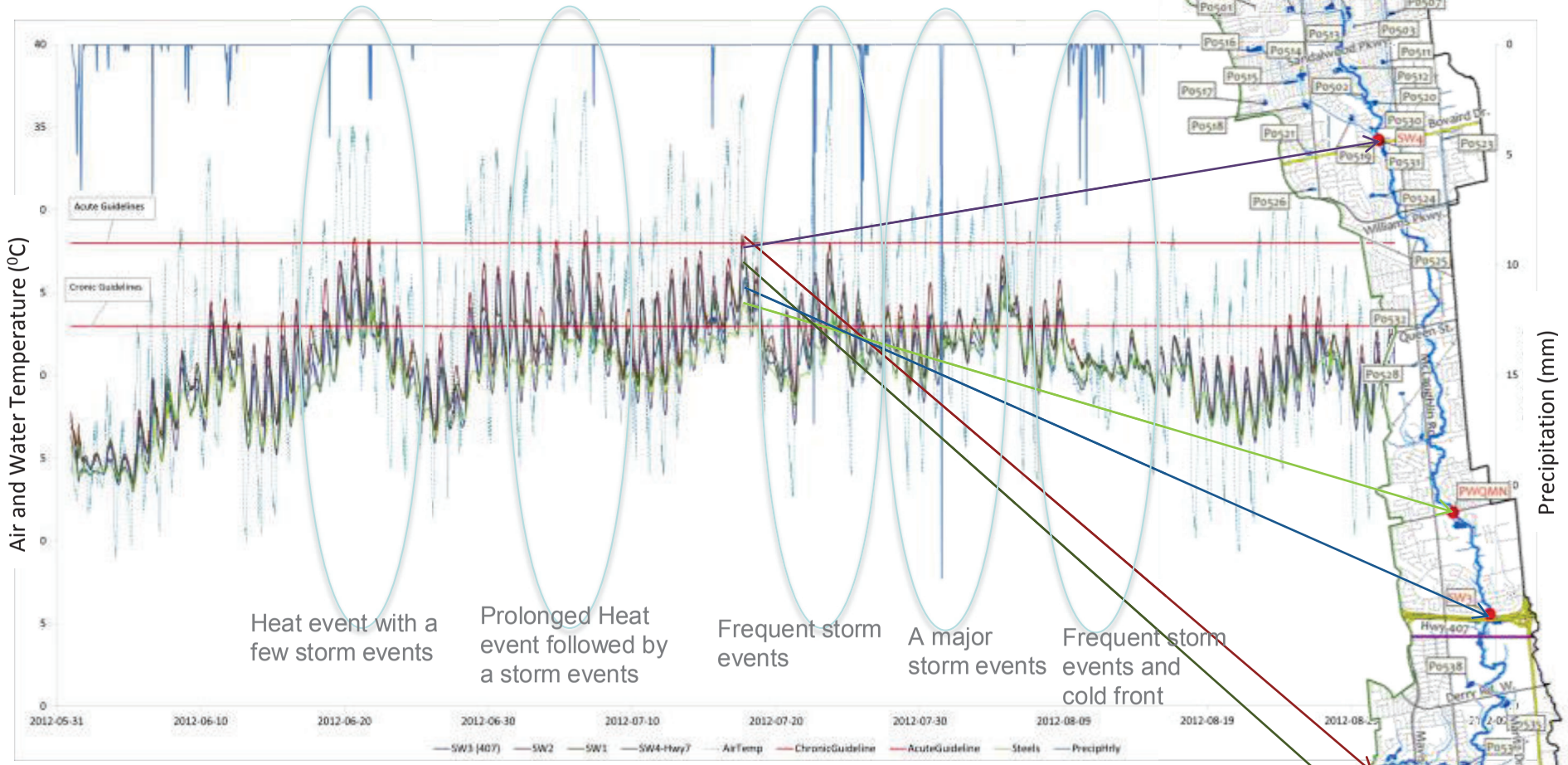
Development History of the Fletcher's Creek Watershed

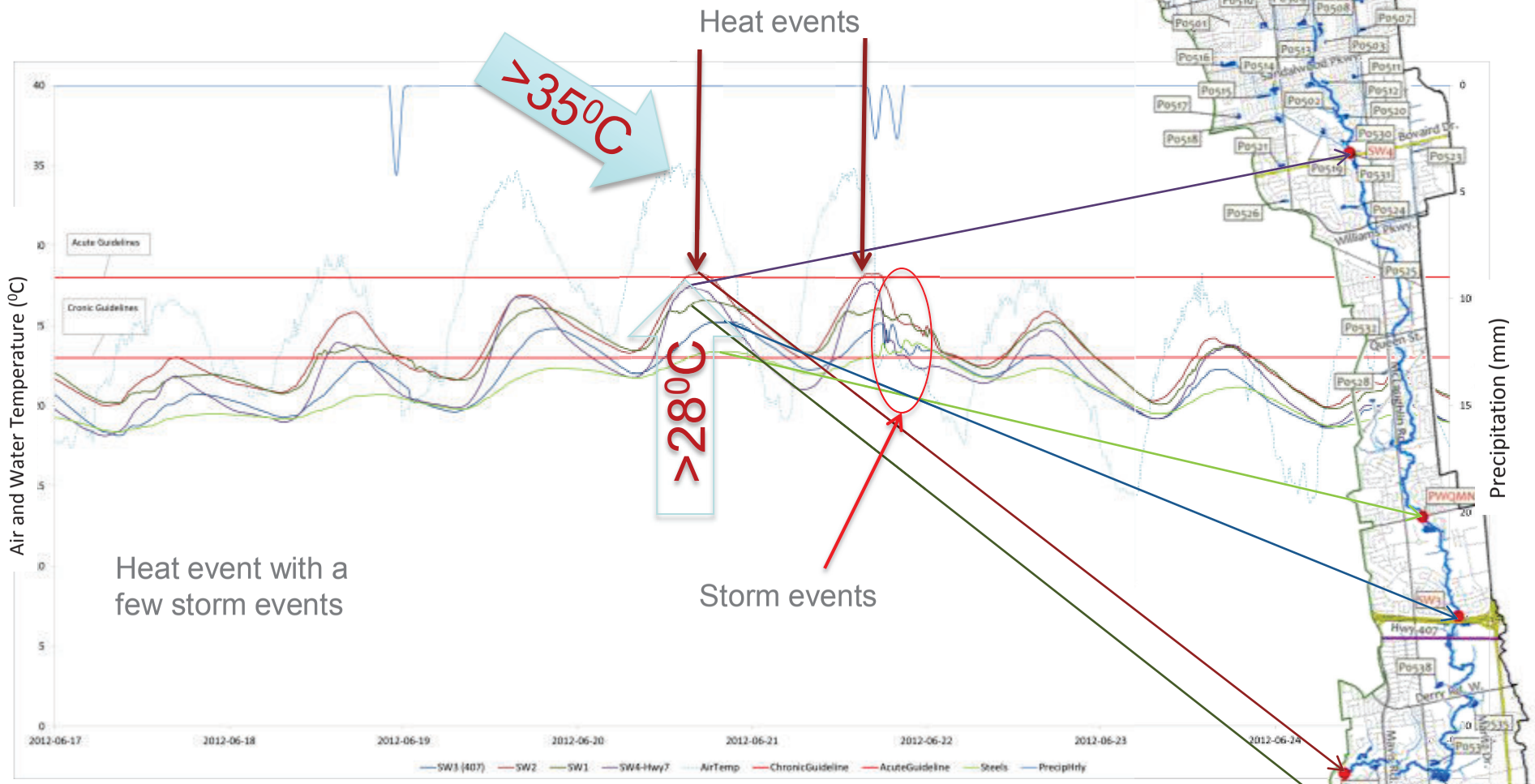


Water Temperature - Summer 2012

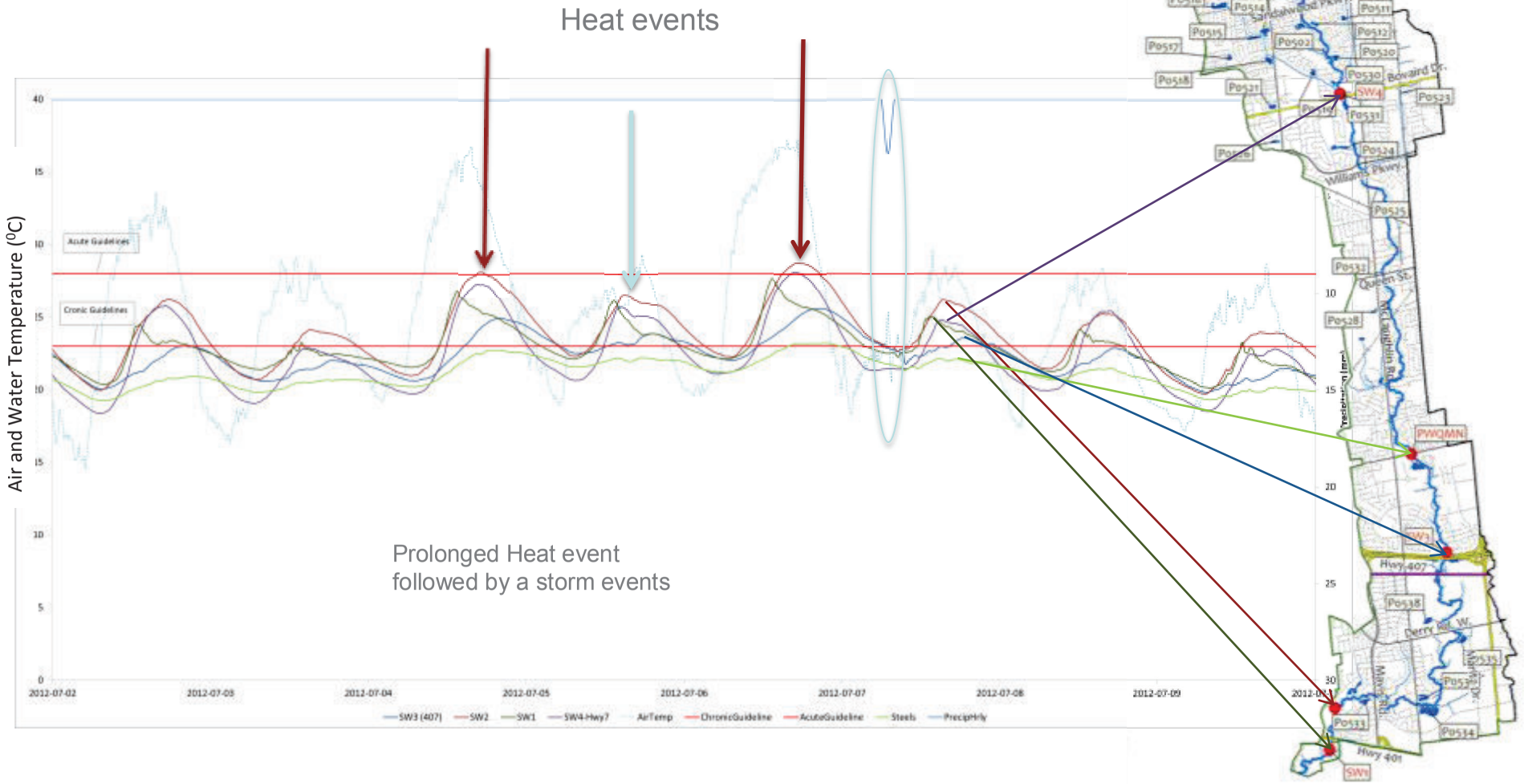


Discussion on 5 events

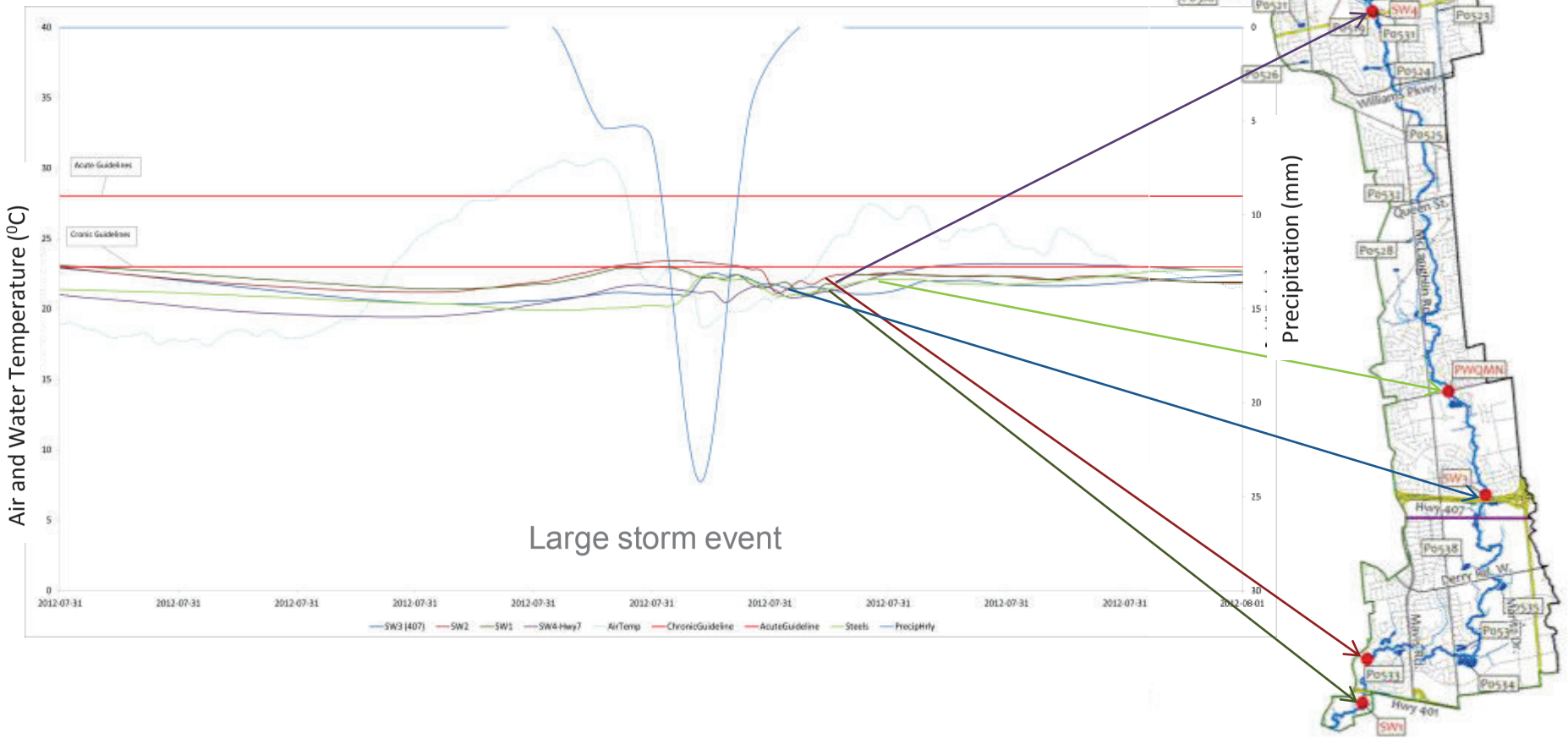
Water Temperature – Heat wave event



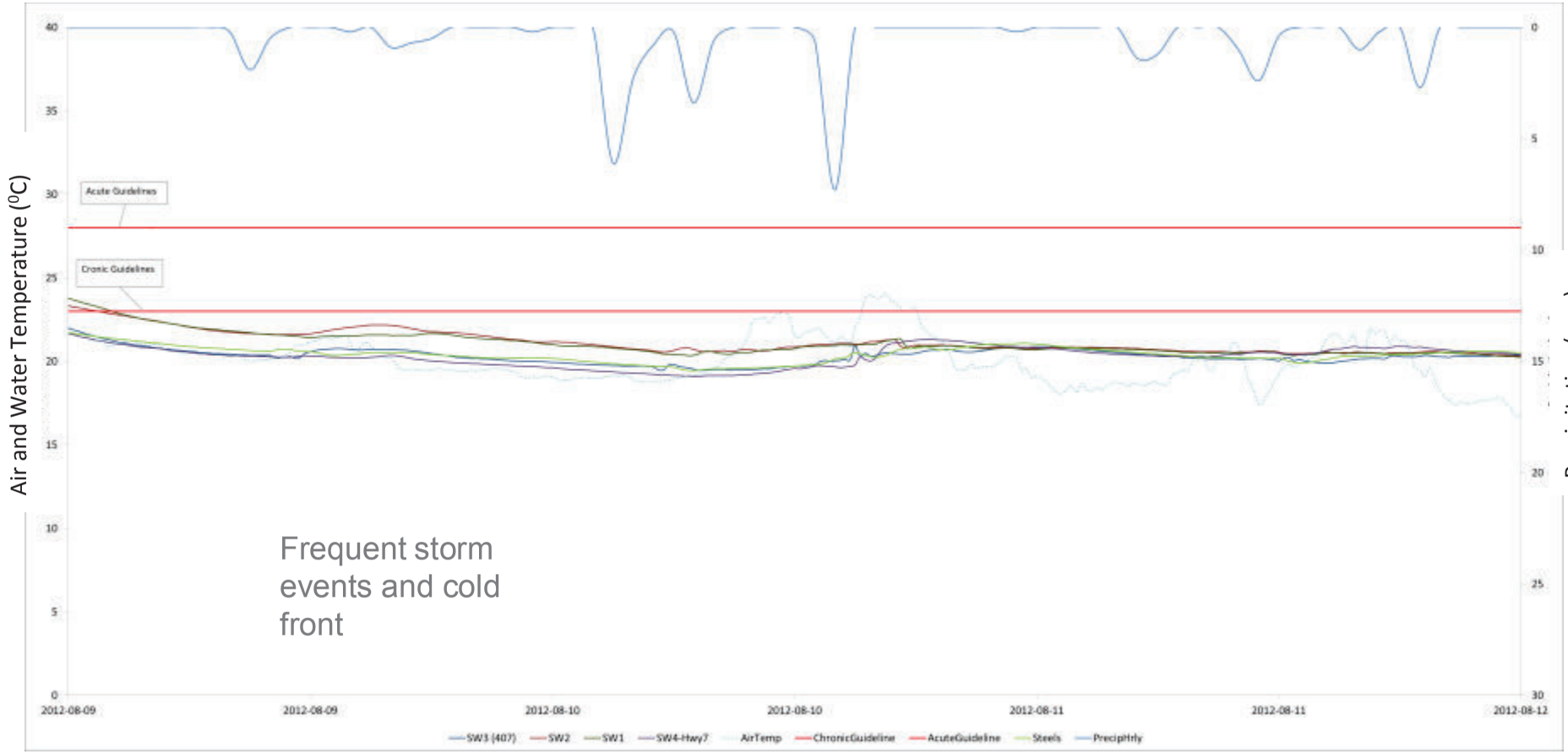
Water Temperature – Heat wave event followed by rainfall and cool air



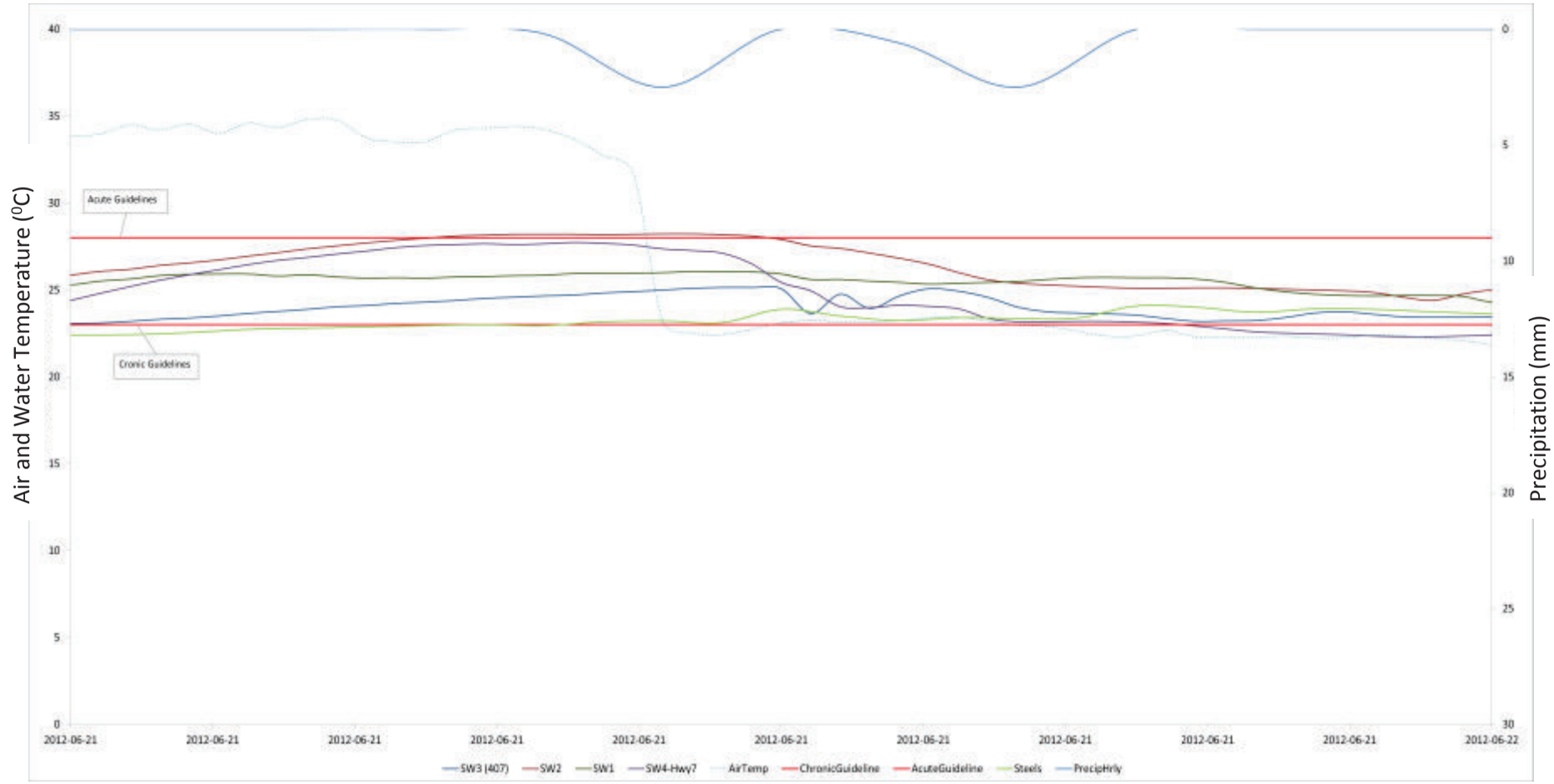
Water Temperature – Following big storm event



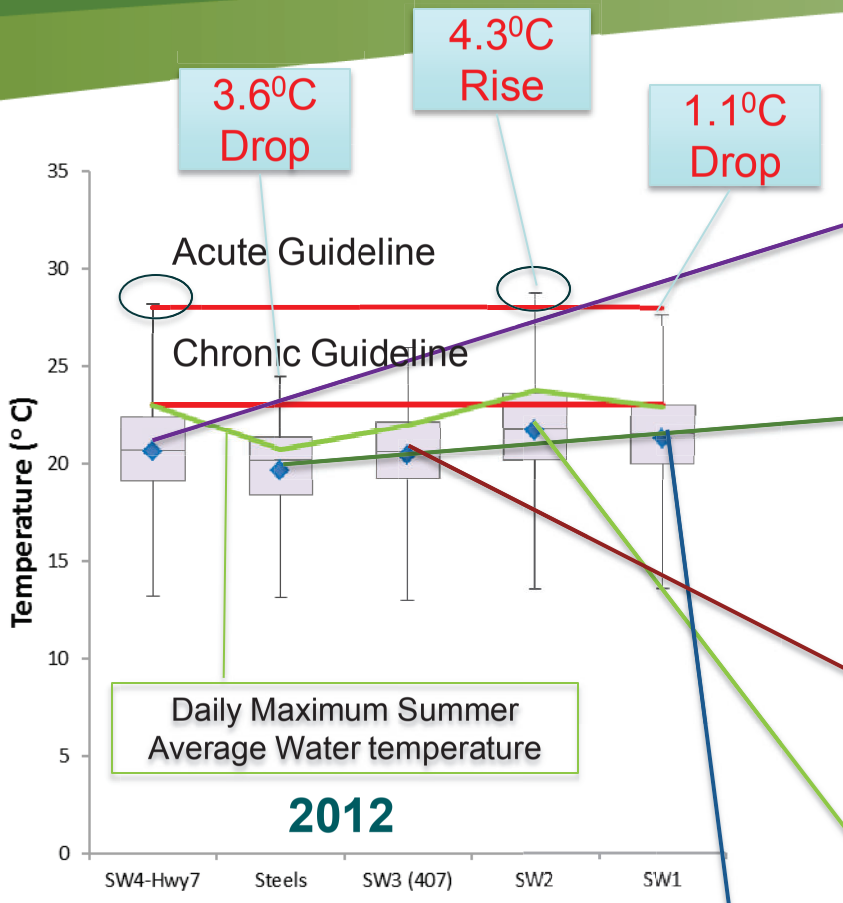
Water Temperature – Response to multiple small rain events and cooler air temperature

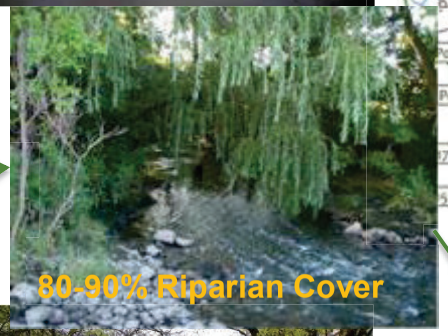


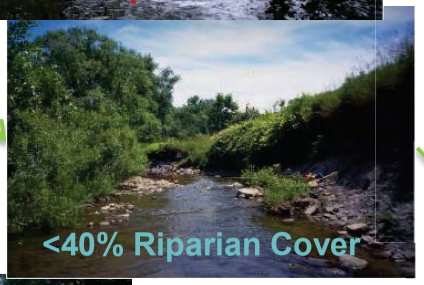
Water Temperature – Rain event at ~4:00pm on a hot day



Water Temperature Vs Riparian Cover







SW4 and SW2, the sites with <40% riparian cover, exceeded both Absolute Maximum Summer and Daily Maximum Summer Average Water temperature guidelines

Conclusion

SWM ponds may transfer thermal loading to the receiving streams when flowing; however, the major threat to temperature sensitive aquatic species is Urban Heat Island

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Options to mitigate thermal impact

Urban Heat Island

- Stream geomorphology
- Riparian buffer
- Green infrastructure
- Urban forestation
- etc.

Stormwater

- Low Impact Development
- Floating Islands
- Cooling trenches
- Bottom draw
- etc.




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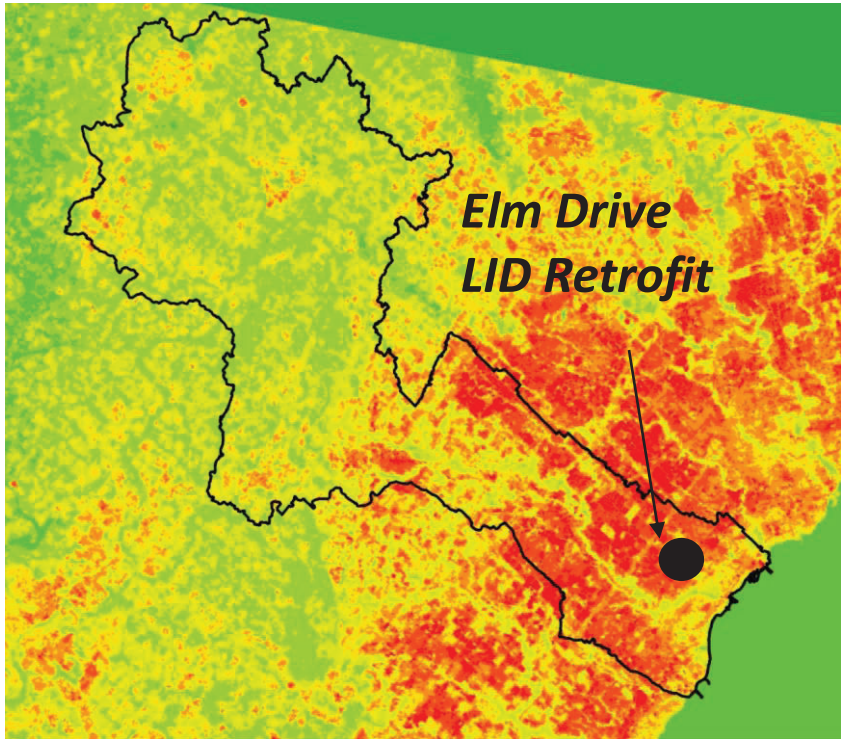
Do LIDs Cool Stormwater?

- Elm Drive retrofit specs
- Methodology
  - Event Mean Temperature (EMT) calculations
  - Thermal Loading calculations
- Results
  - Event Mean Temperature reduction
  - Thermal load reduction
- Summary

Elm Drive Retrofit Specs

- Location

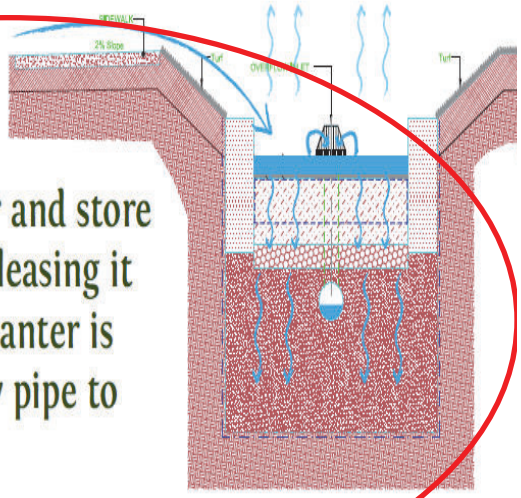


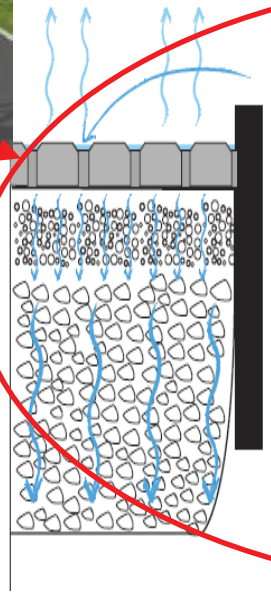
- Drainage area

Treatment Trains - Bioretention Planters & Parking Lay-bys

Bioretention Planter

Bioretention Planters filter and store rainwater before solwly releasing it to Cooksville Creek. The planter is equipped with an overflow pipe to prevent deep ponding.





Permeable Pavement

Permeable pavement allows rainwater to pass through the surface and soak into the ground.

**Bioretention Planters located with PDSB property

**Permeable Paver Lay-by within Municipal Property

Road Right of Ways – Elm Drive

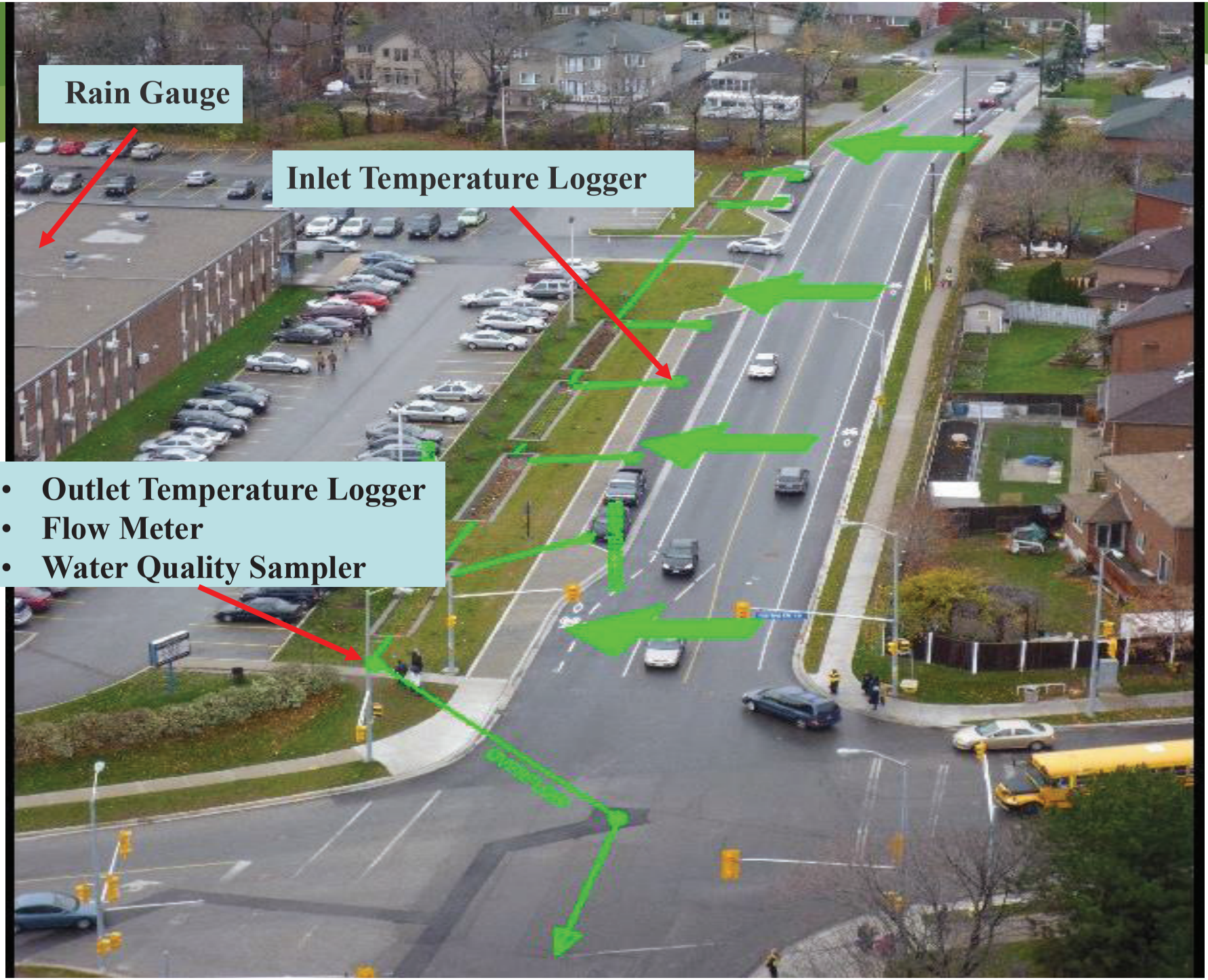
- Construction completed May 2011
- Hydrological monitoring began Aug 2011
- Water quality monitoring began Jun 2012
- Water temperature monitoring began in May 2013

Designed to Provide:

- Enhanced water quality control
- Erosion control to the extent possible

BEFORE

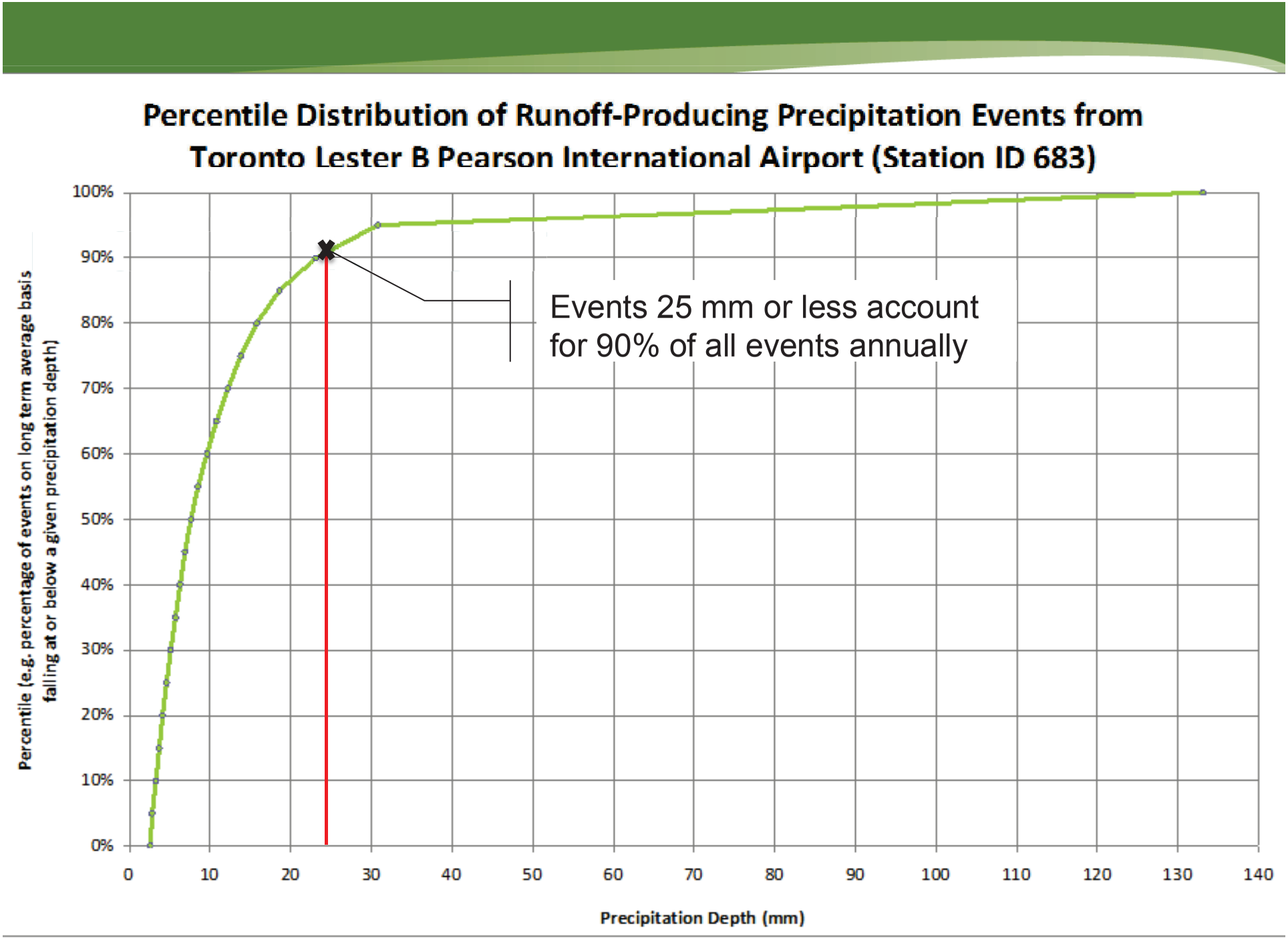
AFTER


Rain Gauge
Inlet Temperature Logger
• Outlet Temperature Logger
• Flow Meter
• Water Quality Sampler

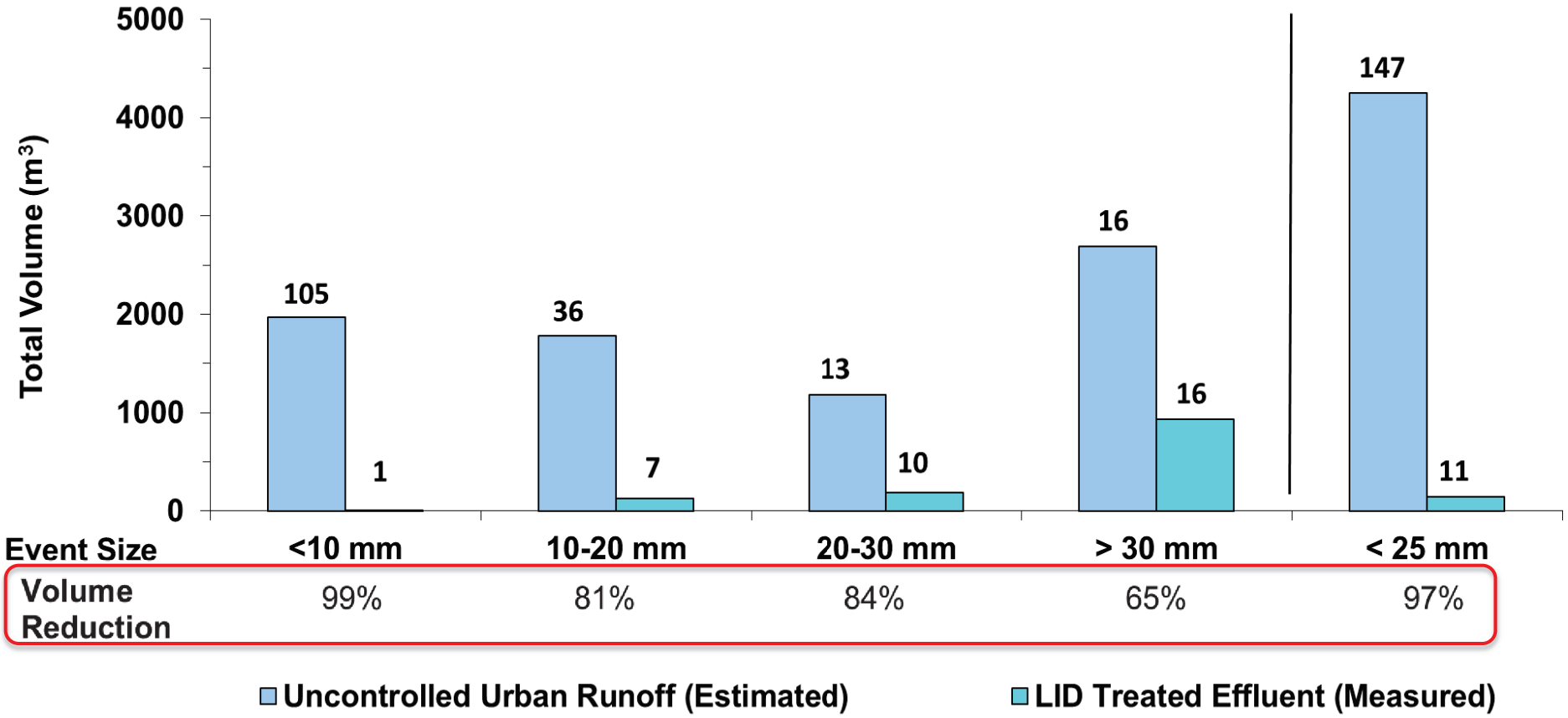
Monitoring Strategy

Data Collected

- Inflow and Outflow Temperatures from May to September 2013 and 2014
- Outlet Flows Measured
- Inlet Flows Estimated with Simple Method (Schueler., 1987)
- 32 Precipitation Events in 2013
- 36 Precipitation Events in 2014
- Events defined as > or = 2mm


Percentile Distribution of Runoff-Producing Precipitation Events from Toronto Lester B Pearson International Airport (Station ID 683)
Events 25 mm or less account for 90% of all events annually
Percentile (e.g. percentage of events on long term average basis falling at or below a given precipitation depth)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Precipitation Depth (mm)

Volume Reduction at Elm Drive



What About Thermal Loads?

Thermal Mitigation: Analysis Methodology

- What was the drop in temperature
  - Event Mean Temperature (EMT) inflow and outflow

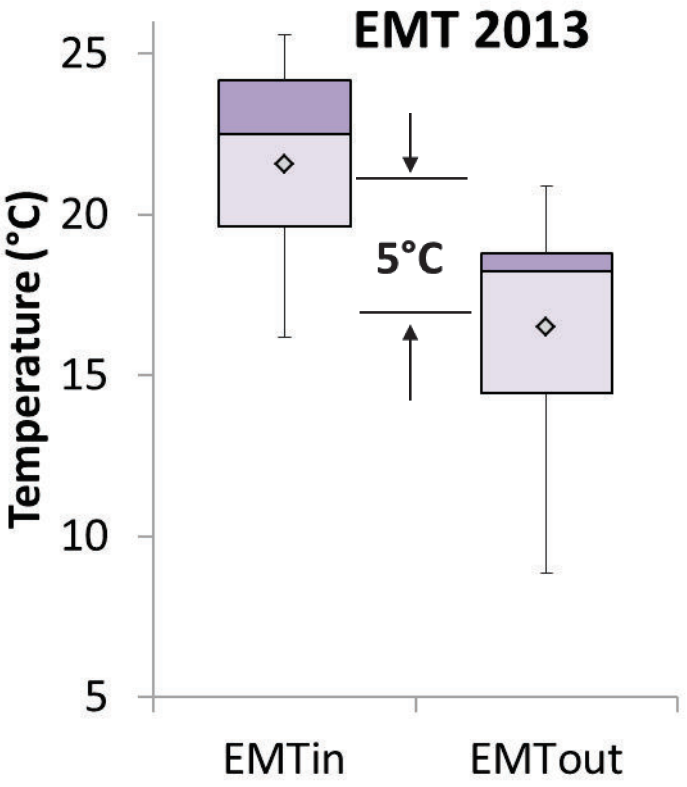
$$EMT_{in} = \frac{\sum T_{in} Q_{in} dt}{\sum Q_{in} dt} \qquad EMT_{out} = \frac{\sum T_{out} Q_{out} dt}{\sum Q_{out} dt}$$

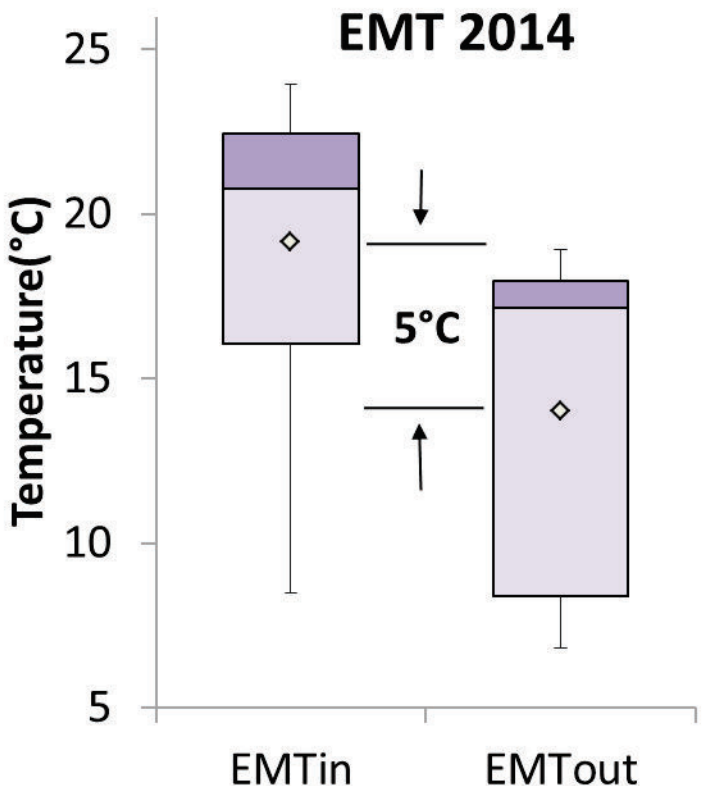
- How much was reduction in Thermal Loading
  - Thermal Load calculations for inflow and outflow

$$TL_{in} = Q_{in} * \rho * T_{in} * C * t$$

$$TL_{out} = Q_{out} * \rho * T_{out} * C * t$$

EMT Flow Results





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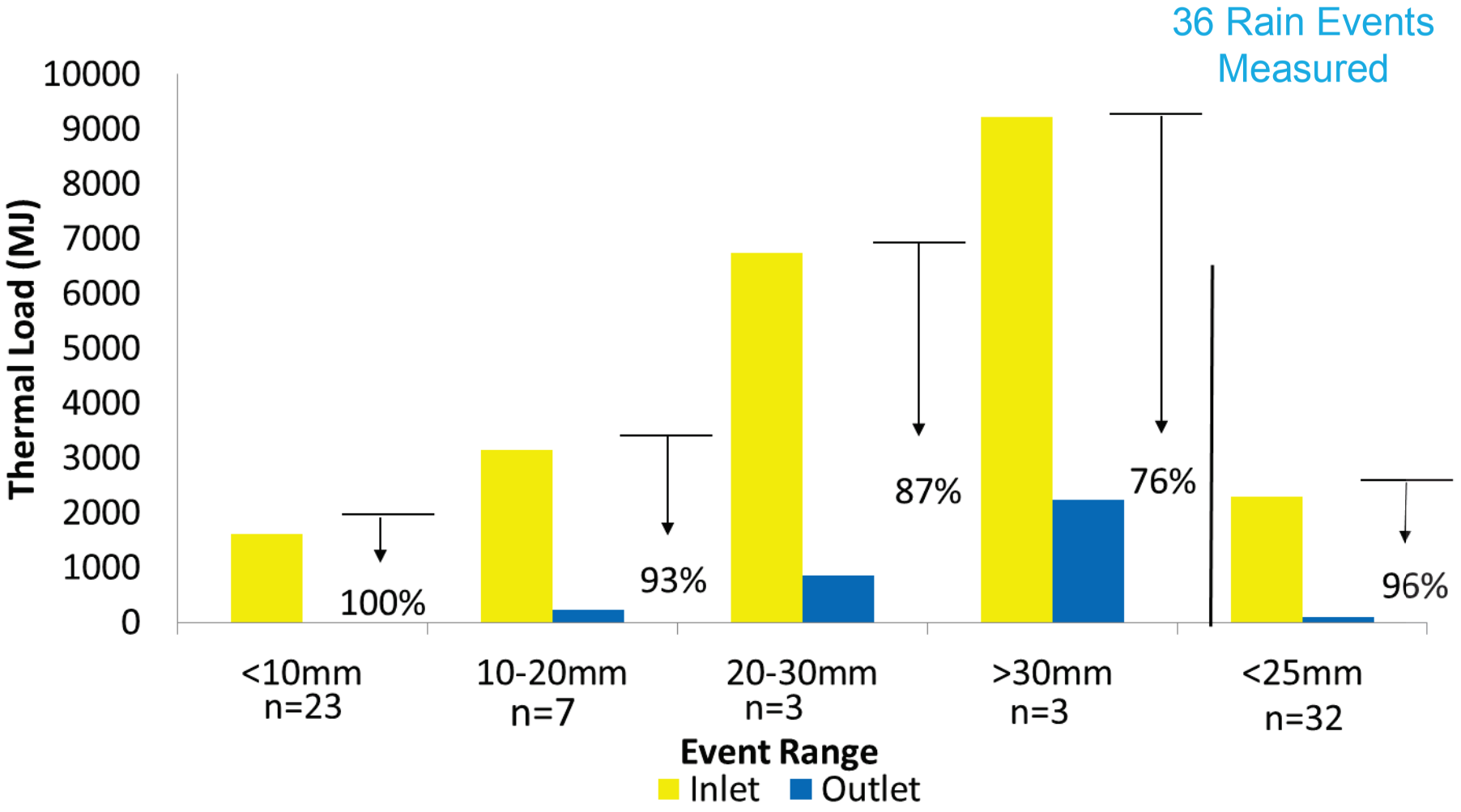
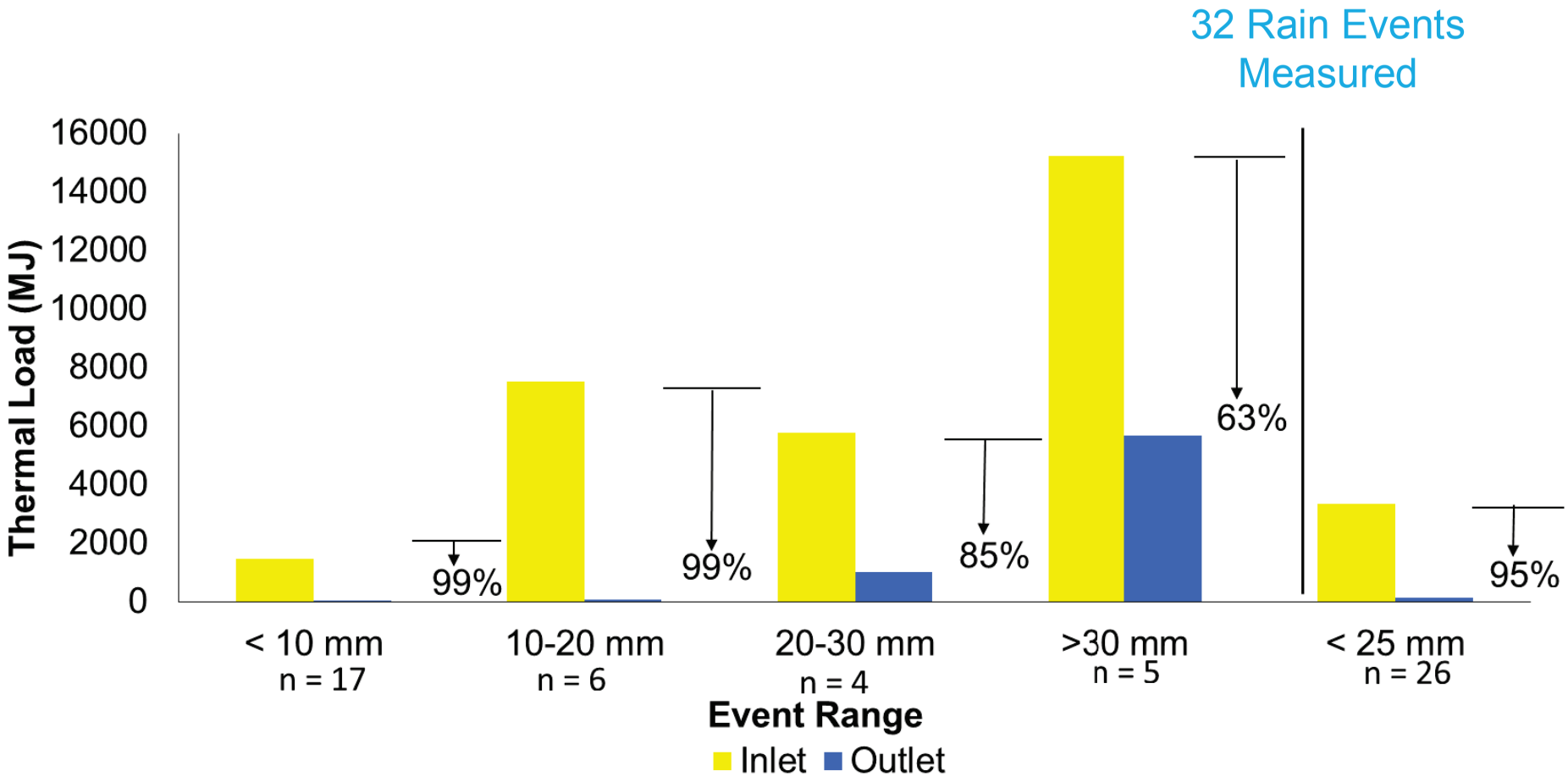
Thermal Load Reduction: 2014 Rain Events



Thermal Load Reduction: 2013 Rain Events



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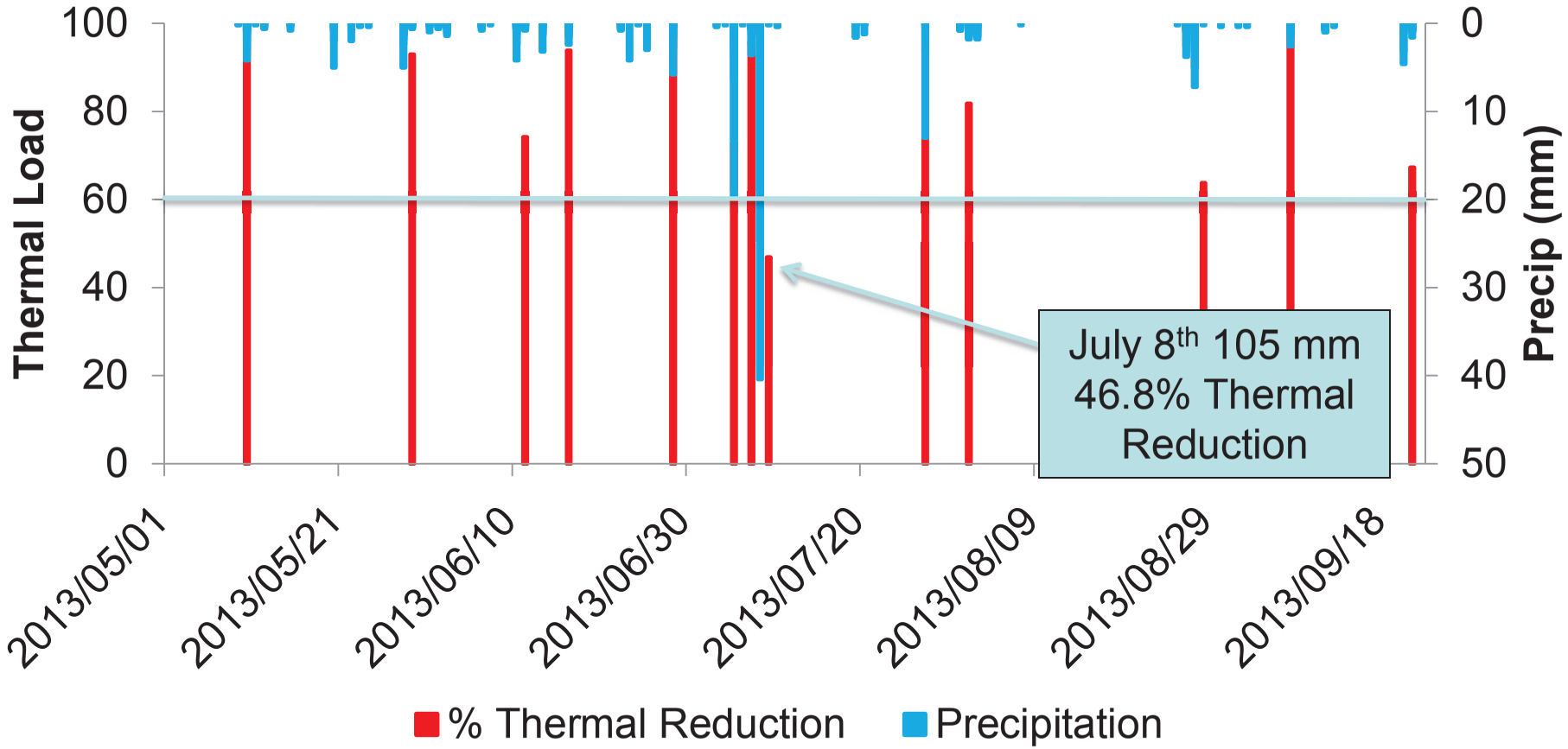
Thermal Load Reductions for all Events with Outflows in 2013



Observing Surface Temperatures Using Thermal Imaging Camera

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FLUKE

FLIR

Measures infrared radiation reflecting off a surface

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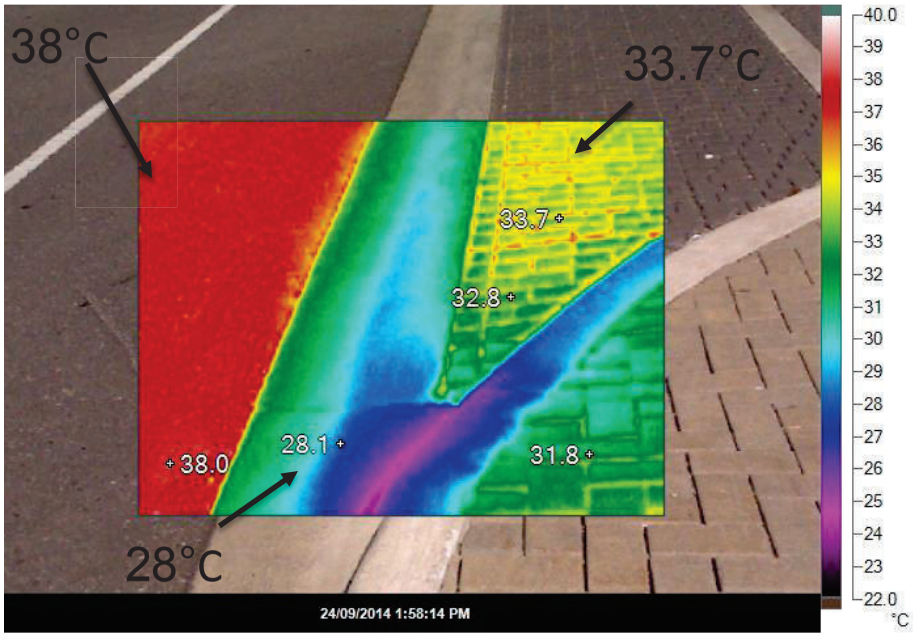
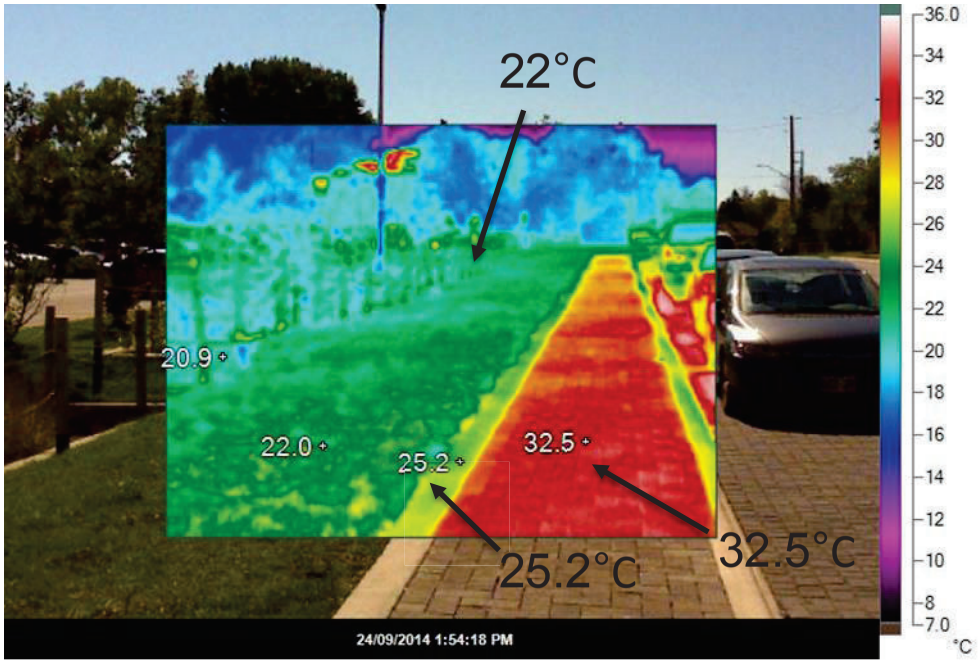
Surface Temperature Difference: Asphalt, Permeable payment, and Grassed area

Air Temp 26.23°C





Urban Tree Cover

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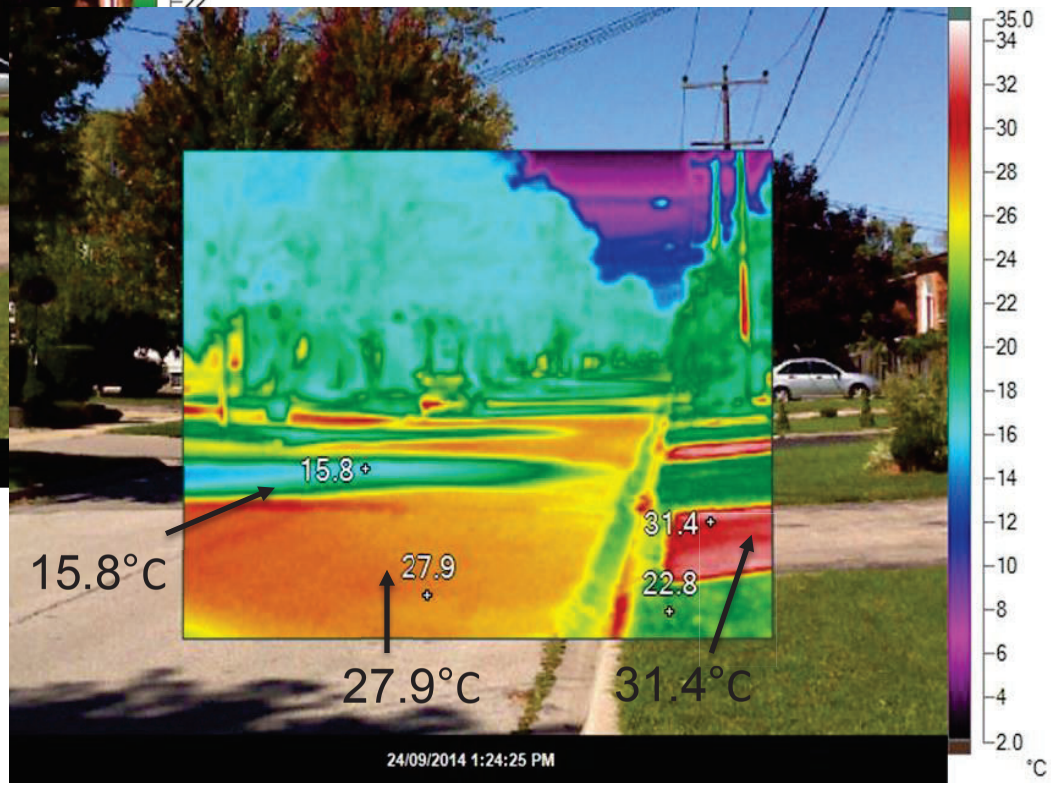
Air Temp 24.12°C



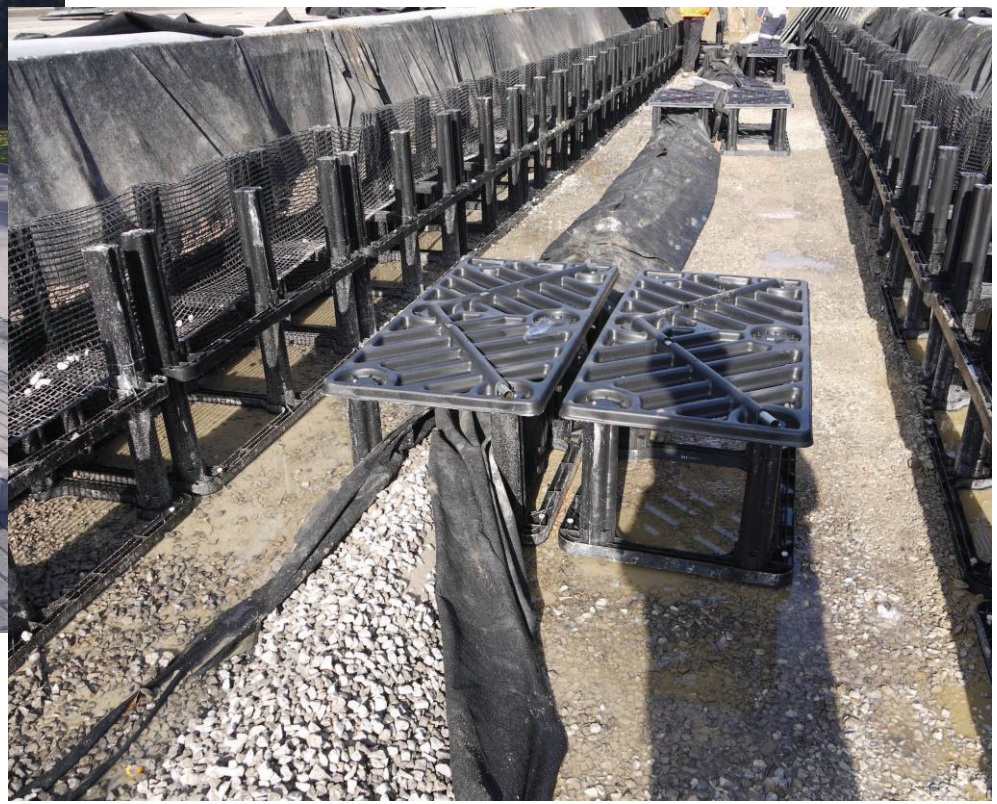
Performance Summary

- Events ≤ 25 mm, negligible outflows, > 95% Reduction
- Events > 30mm, 70% Thermal Load Reduction
- Inflow to Outflow Event Mean Temperature ↓ by 5°C
- Thermal benefits achieved through onsite volume retention and cool bioretention soil

Recreating nature in the heart of the City

Coming in 2015

Central Parkway Median Retrofit



Coming in 2015

Mississauga Road Median Retrofit


THANK YOU!

Project Partners

Ontario Ministry of the Environment through a grant entitled *Showcasing Water Innovation*

Region of Peel

Maxxam Analytics

Environment Canada

University of Guelph

Town of Orangeville

Polis Project on Ecological Governance

Imbrium

Aquafor Beech Limited

Sequoia Grove Homes

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Building Industry and Land Development Association

Peel District School Board

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SIXTY YEARS

Our Heritage to Conserve