Avonhead Creek Daylighting Project: characterizing flow for natural channel design

Natural Channel Design Conference

September 27, 2016

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Outline

- Project location
- Overview of the project
- Problem statement
- Approaches to solve the problem
- Findings and Next Steps
- Lessons Learned

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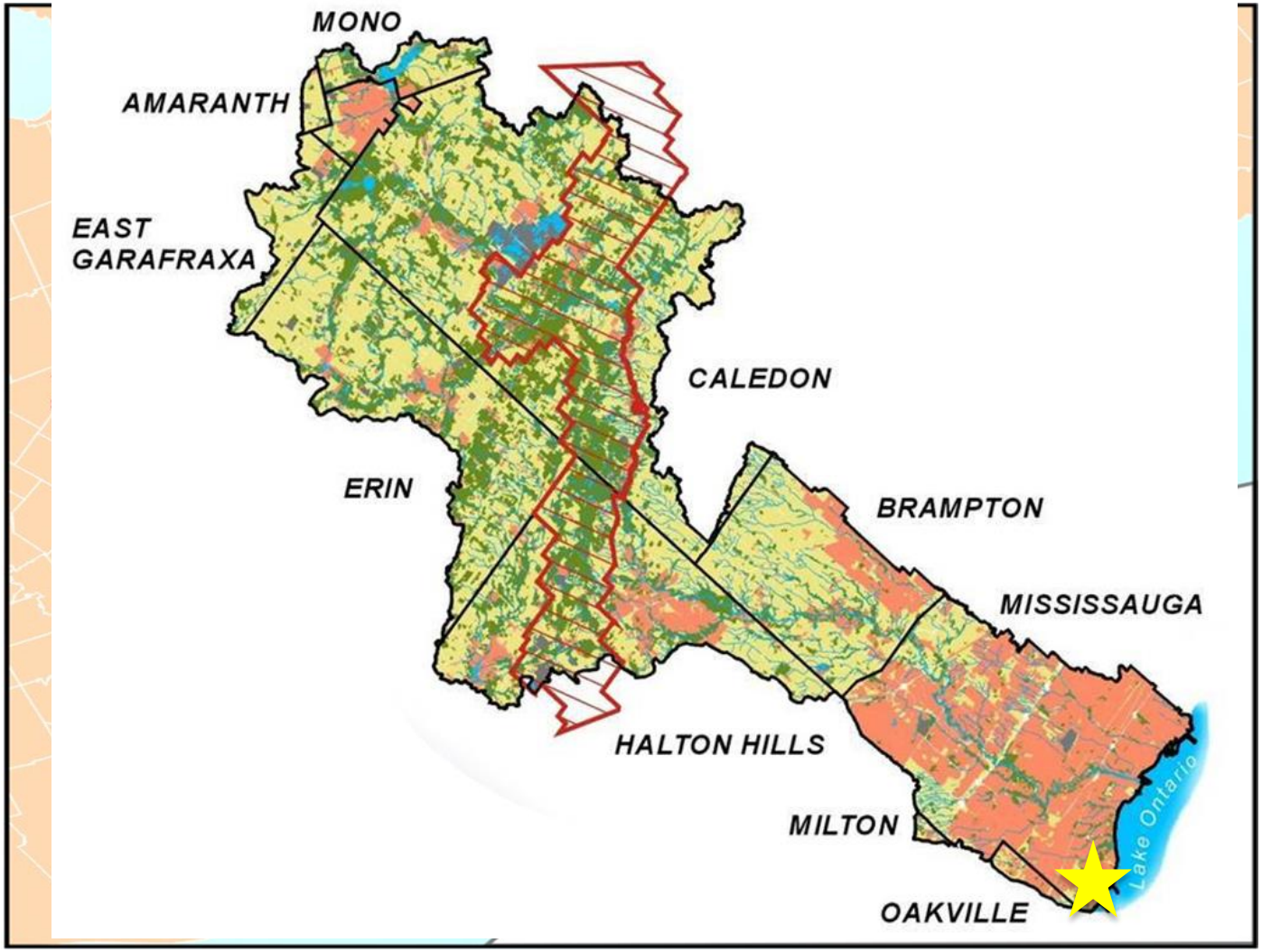
Project Location



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Historical Assessment

1950s – Creek is surrounded by agricultural fields

1970s- Avonhead Creek piped through storm sewer south of Lakeshore Road

1980s – Realignment of reaches

2000s – Diversion of major flows at Orr Road to adjacent creek

Current- Proposed Daylighting

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Watershed characterization

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Avonhead Creek Daylighting Project

Objectives:

- restore geomorphic and hydrologic stream functions
- create habitat for migratory and resident birds, wetlands for amphibians, birds and fish
- restore fish access to Avonhead Creek from Lake Ontario

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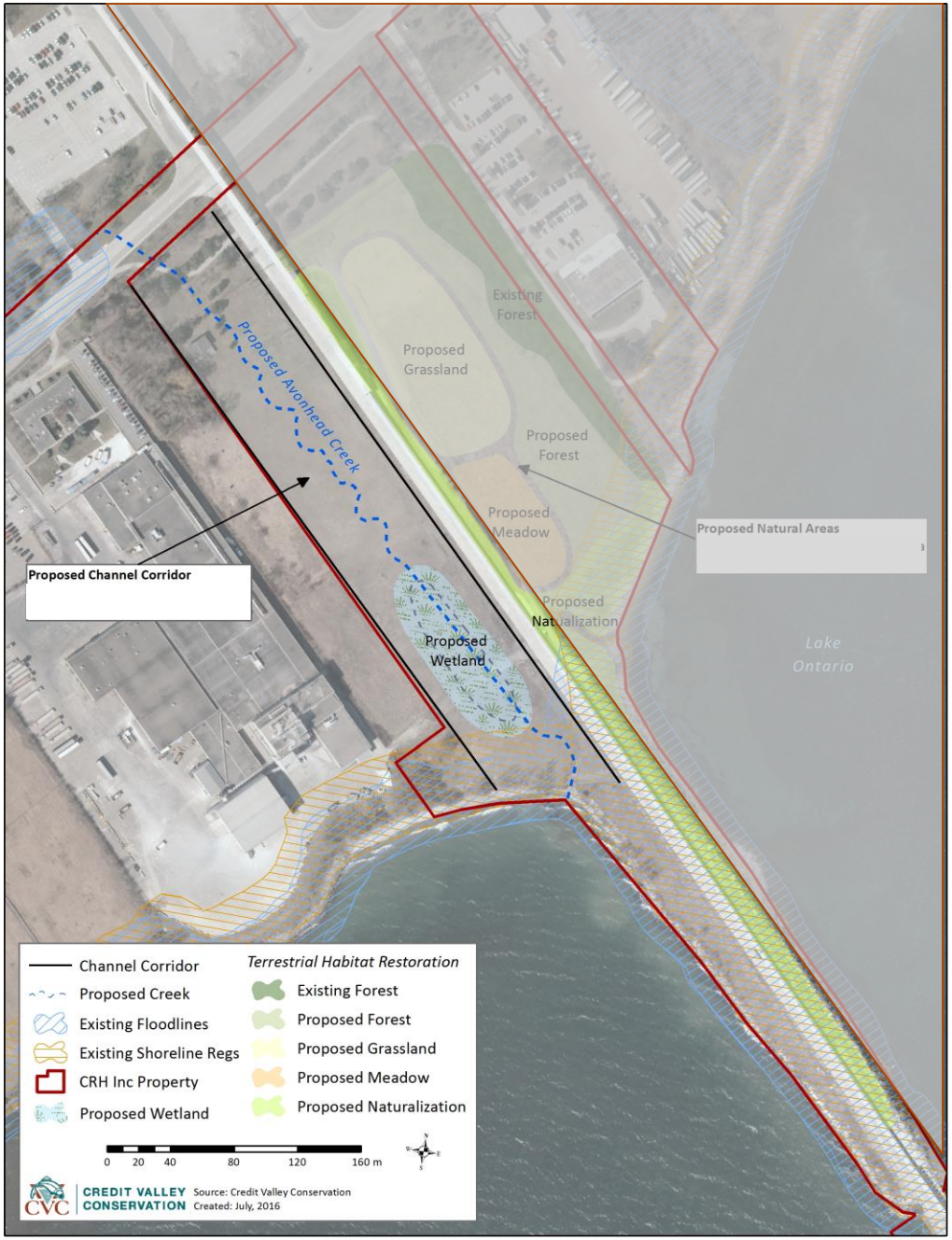
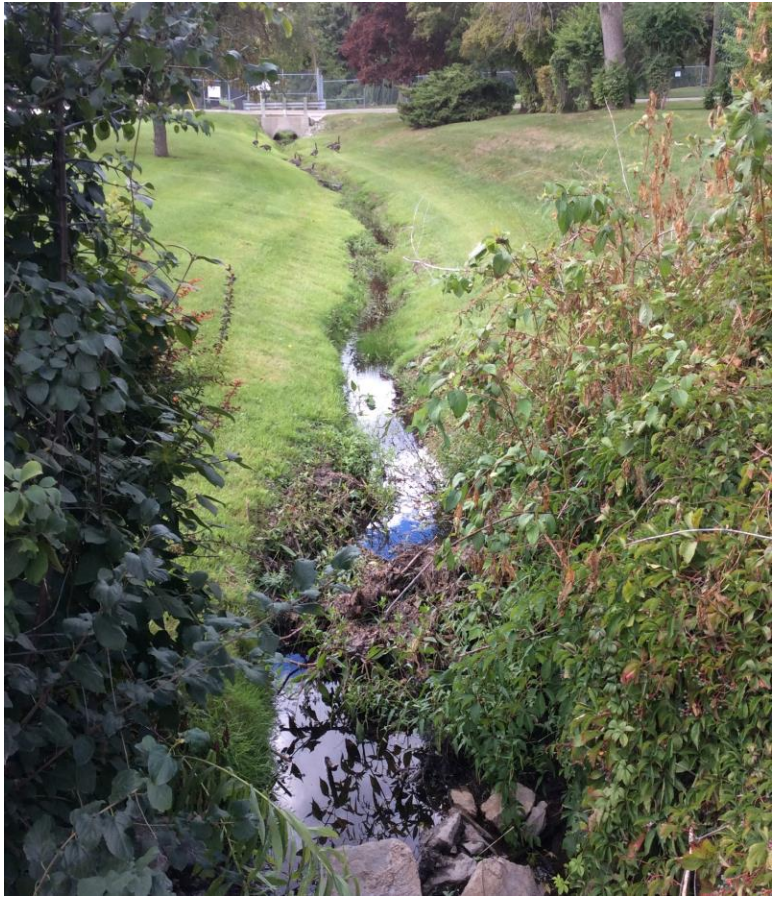
Avonhead Creek Feasibility Study

ecosystem recovery inc.
PROFESSIONAL ENGINEERS

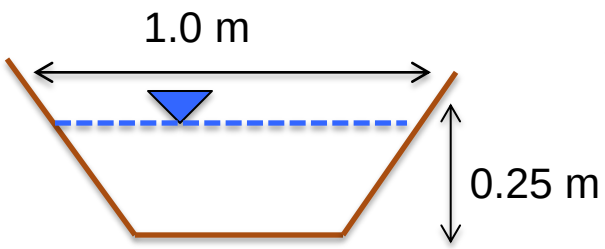


Estimating design flow…

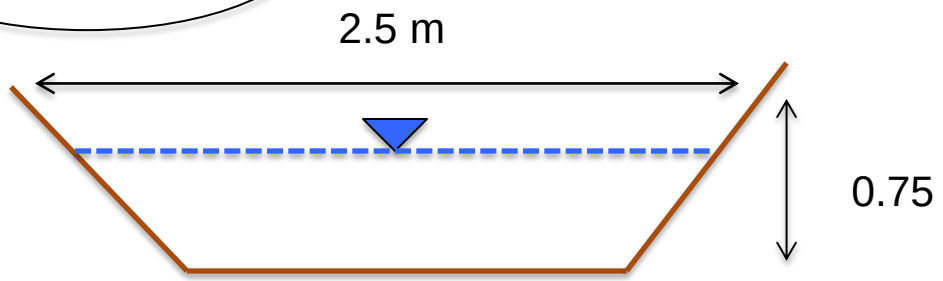
Discharge (m^3/s)	
Existing Hydrology Model (2 yr. return period)	4.0
Design flow estimate (60% of 2 yr. return period)	**2. 4**



6 x bigger !



Cross section upstream



Estimated cross section of proposed channel

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Problem Statement

What is an appropriate design flow to allow for geomorphic processes (and desired habitats), floodplain connectivity and maintenance of wetland features?

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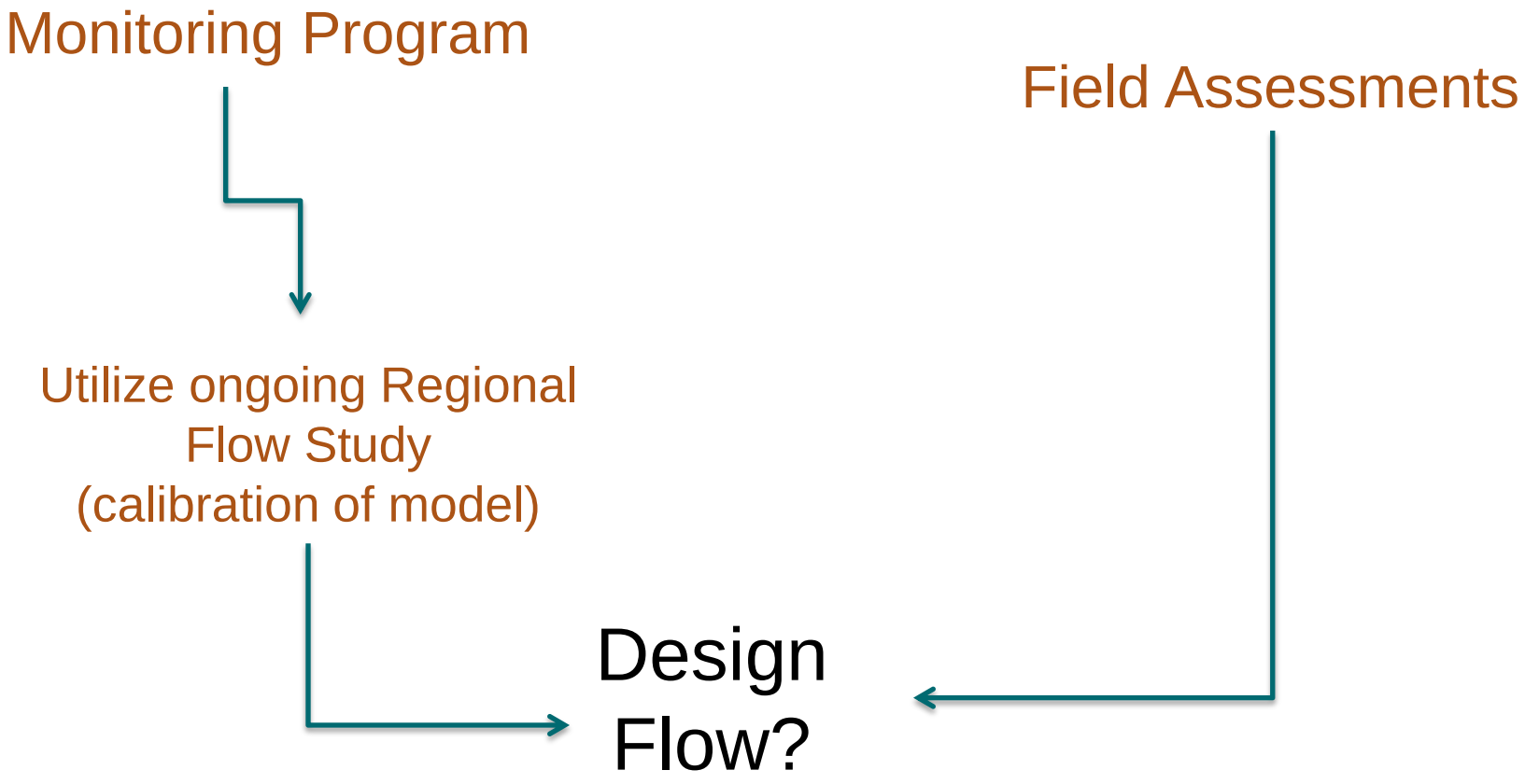
Approach



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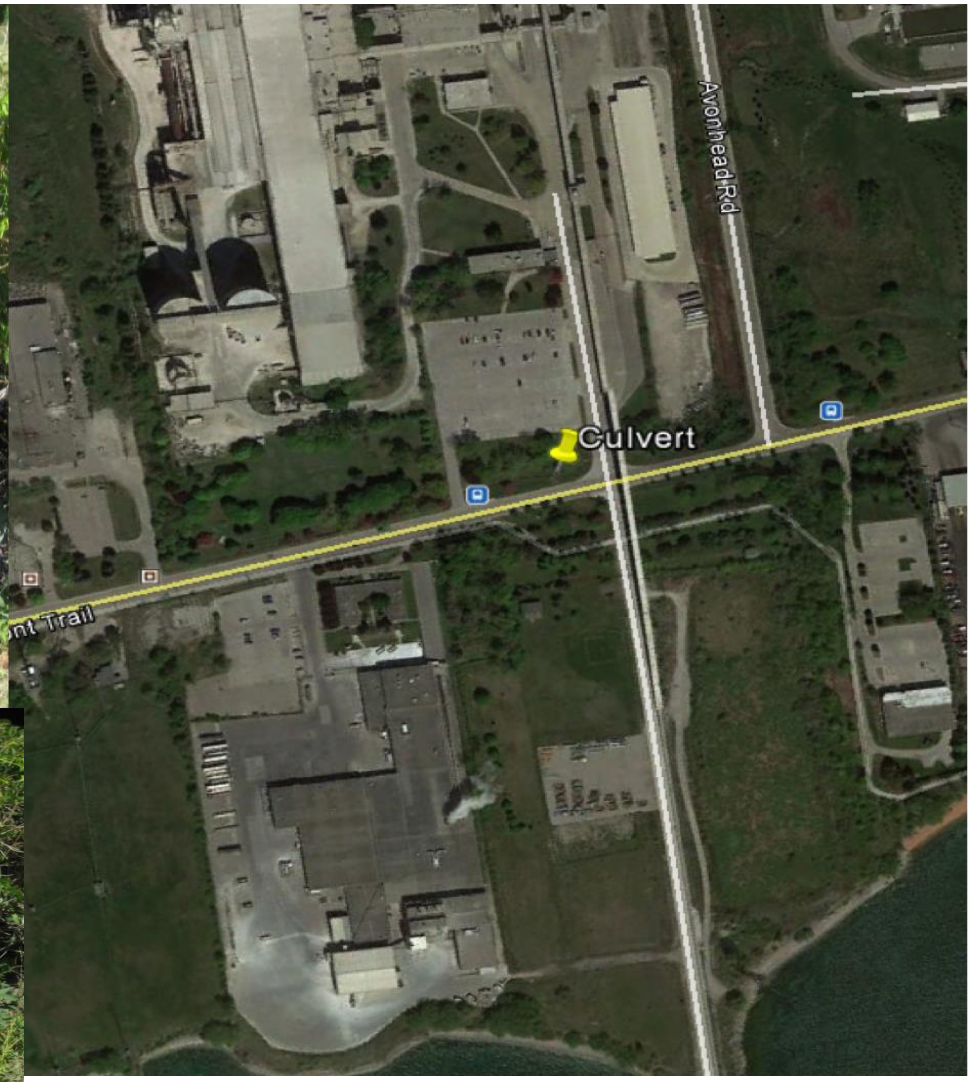
Monitoring Program (Sept 2015 – ongoing)



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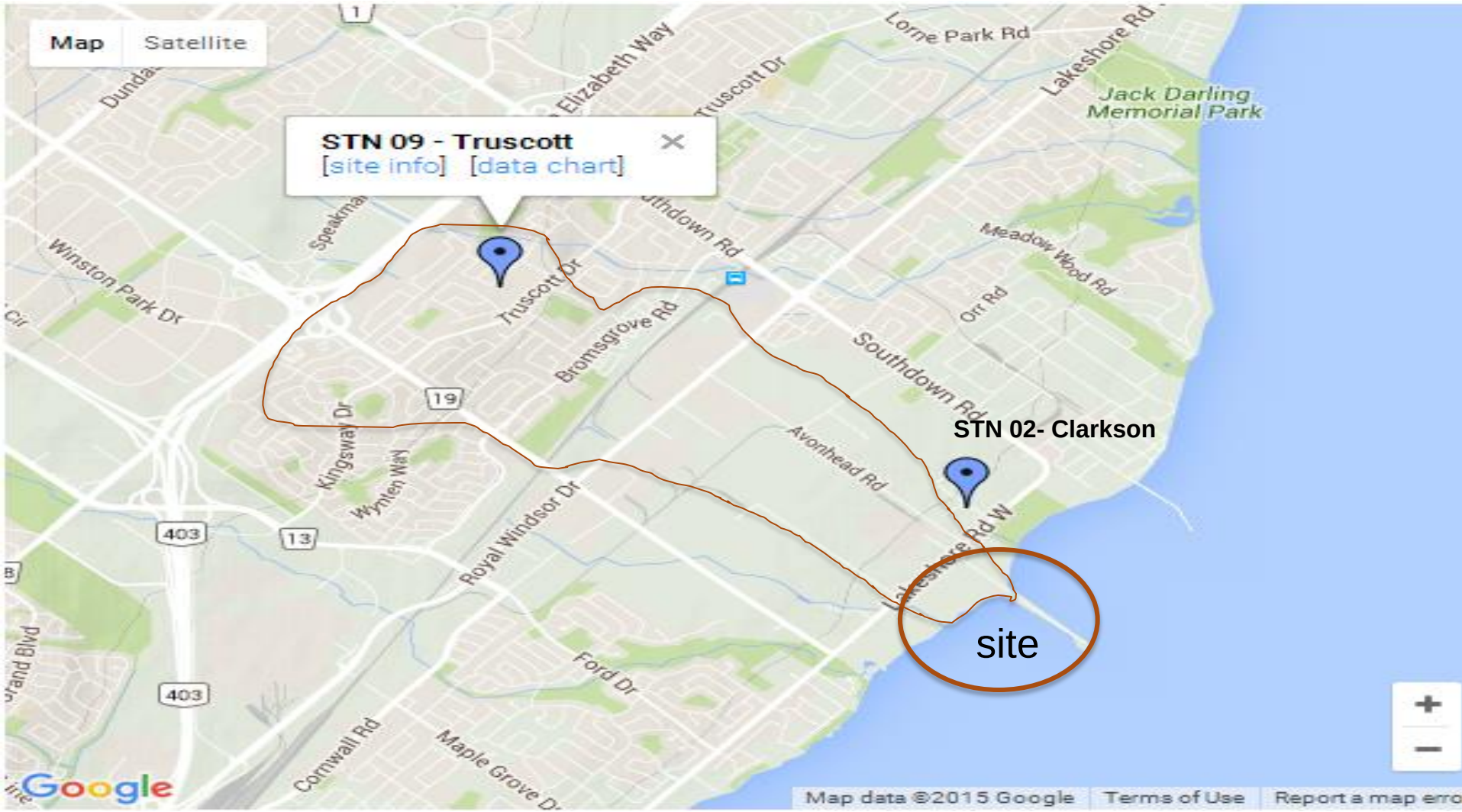
Precipitation Data from nearby rain gauge



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Summary Table of Monitoring Data

Storm Events	Total Storm Depth (mm)	Storm Duration (hr)	Peak Flow Observed (m^3/s)
Sept 11th 2015	27	46	0.09
Sept 29th 2015	36	5.6	0.36
Oct 24th 2015	15	5.0	0.09
Oct 28th 2015	**34**	21	0.31
Nov 10th 2015	14	17	0.11
Dec 29th 2015	10	14	0.16
Jan 10th 2016	11	10	0.20
Feb 24th 2016	17	15	0.32
Mar 31st 2016	26	18	0.49
July 1st 2016	13	2.0	0.014
July 14th 2016	17	2.0	0.05
July 25th 2016	15	1.0	0.06
Aug 13th 2016	13	7.8	0.04
Aug 25th, 2016	24	18	**0.66**
Sept. 7, 2016	14	6.3	0.10

vs. 2.4 m^3/s

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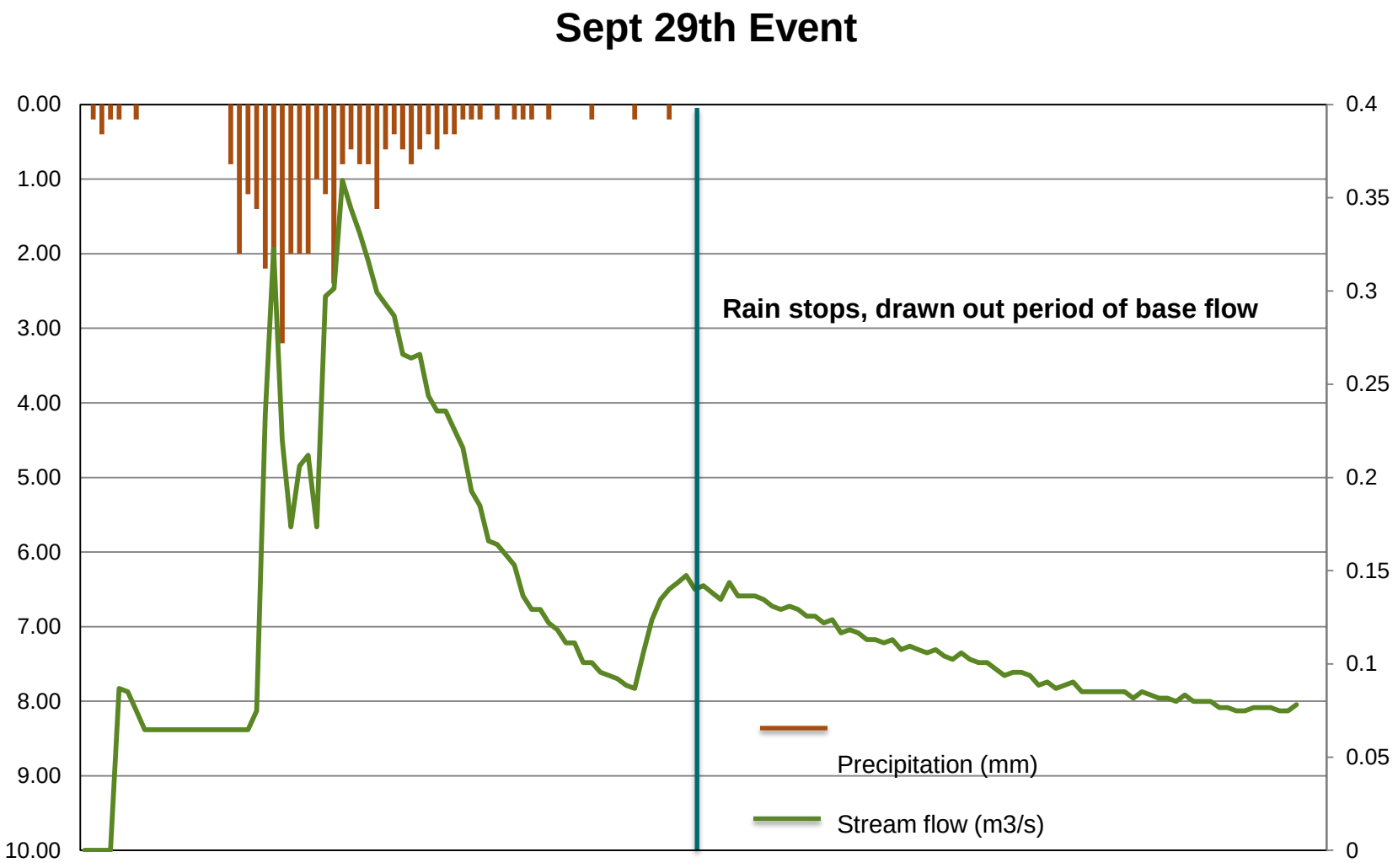
Flow Observation



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Monitoring: Time lapse

- Camera installed captures images every 5 minutes
- Ground-truth monitoring data and utilized for QA/QC

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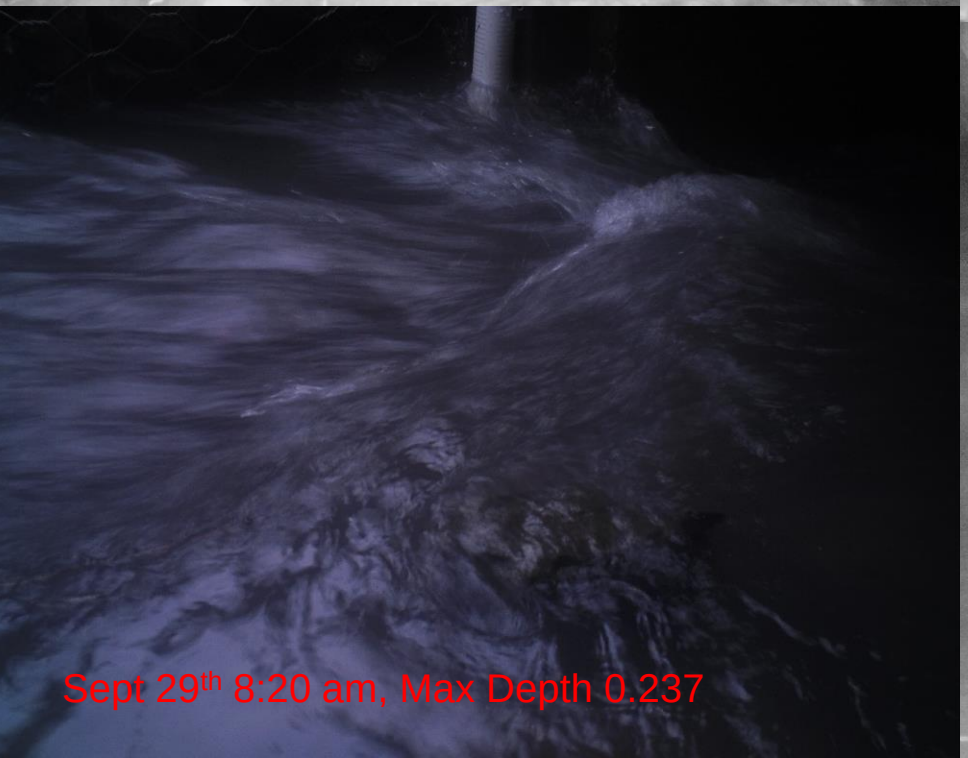
Sept 29th 7:00 am,


Sept 29th 7:40 am,


Sept 29th 8:20 am, Max Depth 0.237


Sept 29th 17:25 pm

Challenge

Short period of monitoring data

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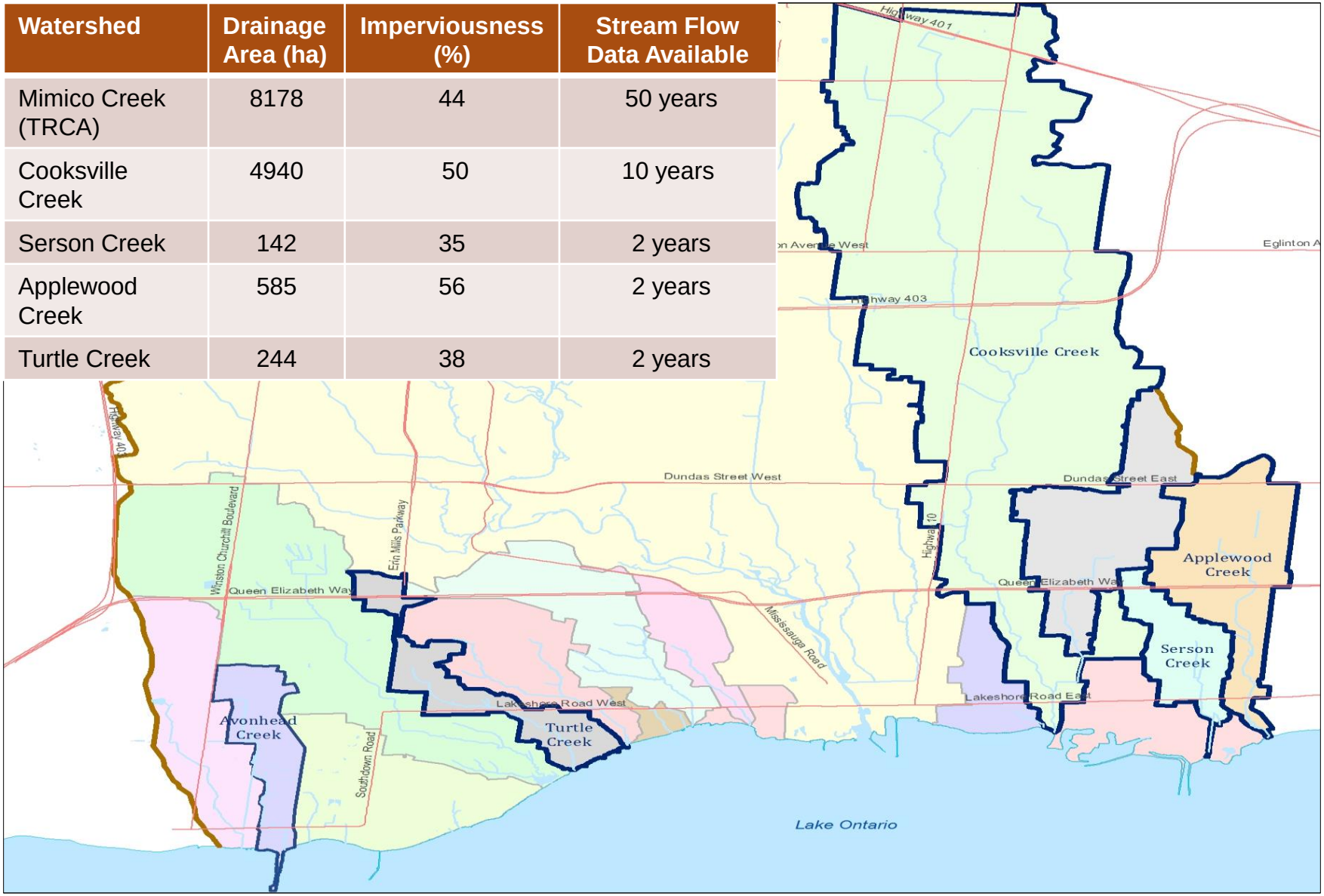
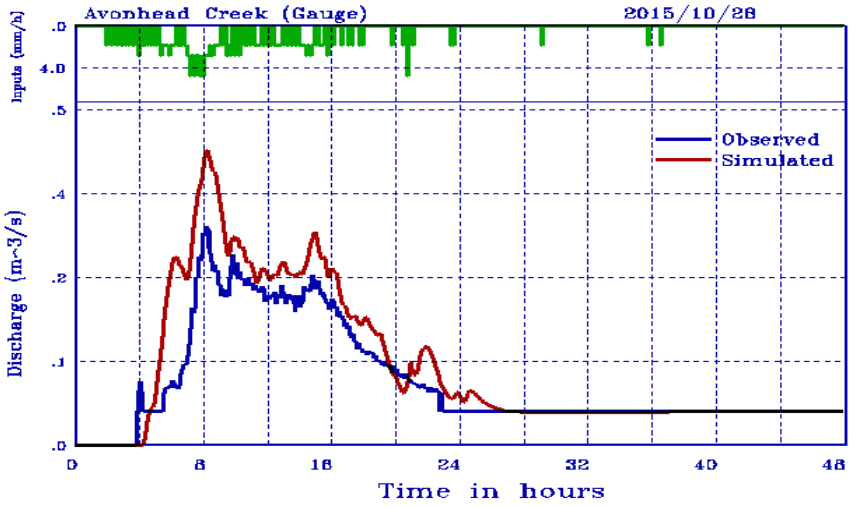
Solution: Regional Flow Frequency Analysis

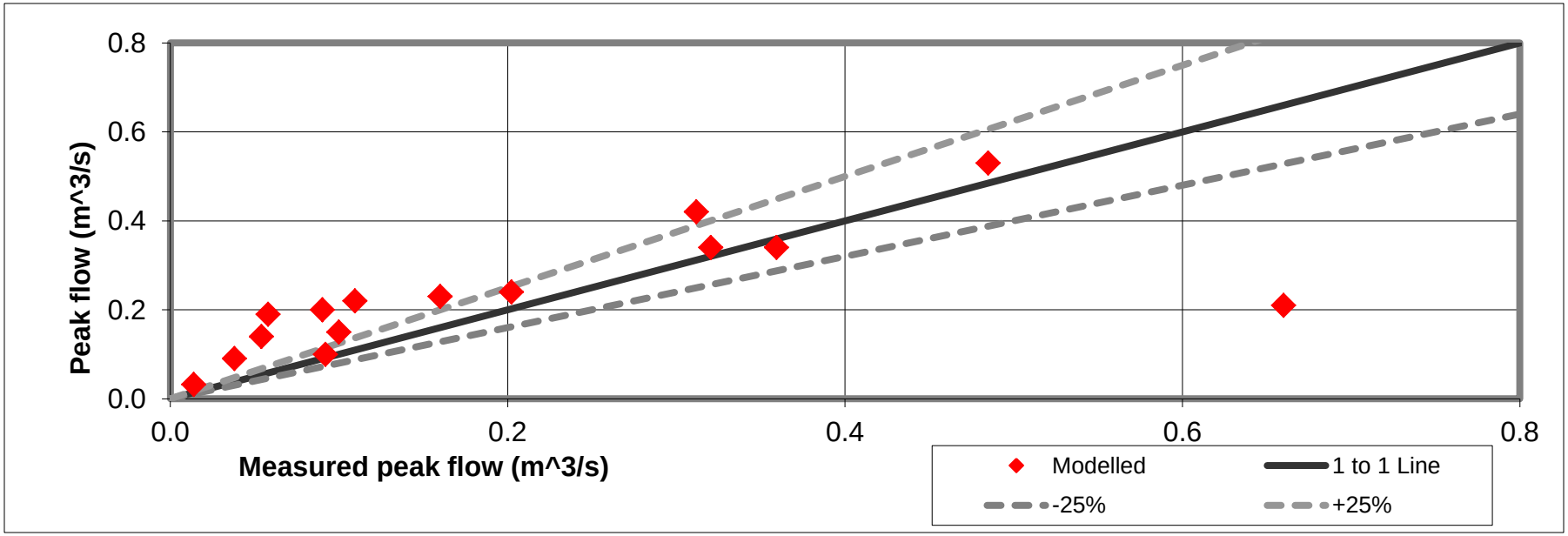
Watershed	Drainage Area (ha)	Imperviousness (%)	Stream Flow Data Available
Mimico Creek (TRCA)	8178	44	50 years
Cooksville Creek	4940	50	10 years
Serson Creek	142	35	2 years
Applewood Creek	585	56	2 years
Turtle Creek	244	38	2 years



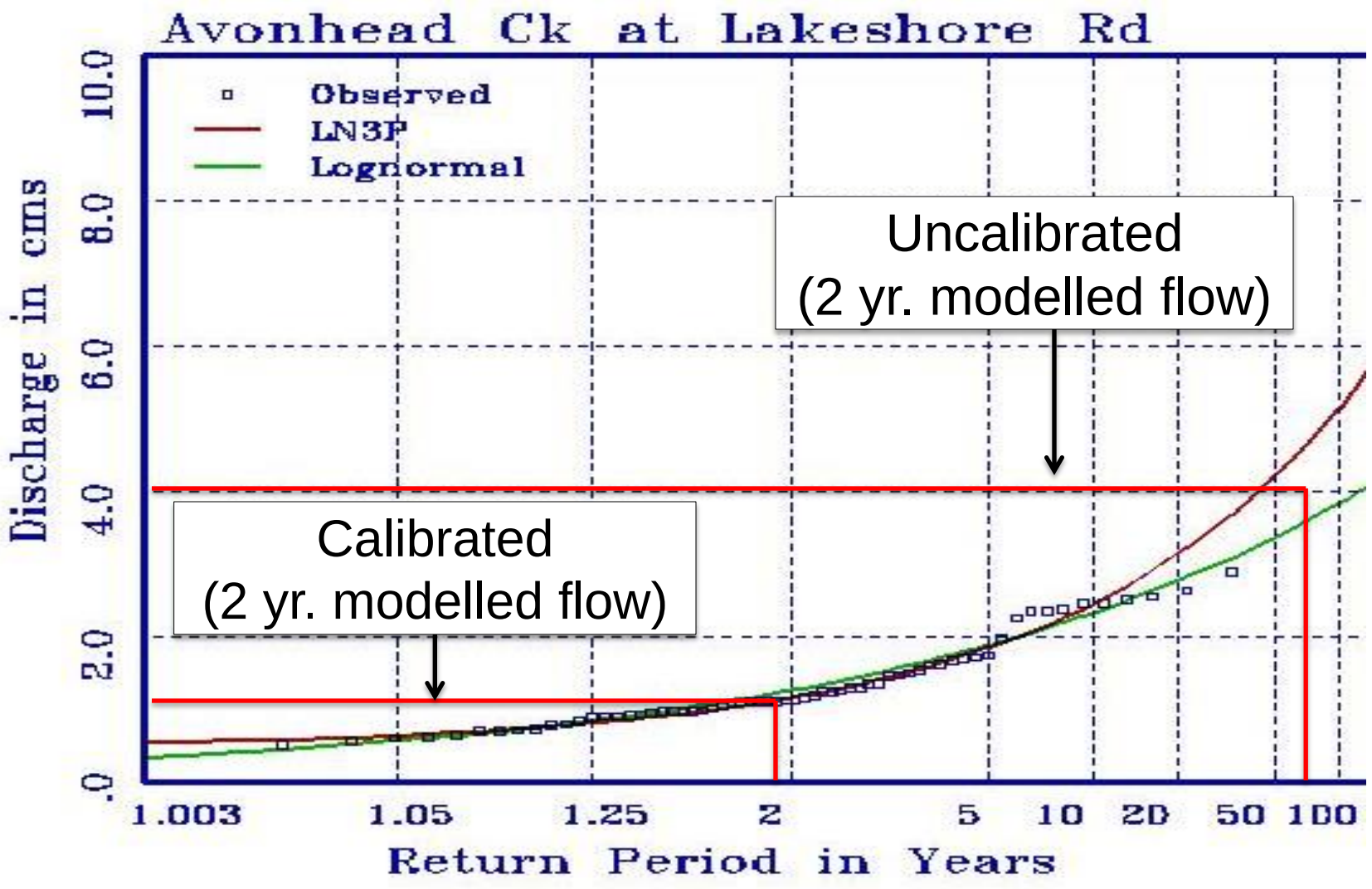
Avonhead Model Calibration

- Utilize the stream flow data available to calibrate a watershed model for Avonhead Creek in GAWSER
- Run simulations with long term data (60 years of rainfall data)





Flow Frequency Analysis



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Comparison of discharges with flow frequencies

Return period	Existing Uncalibrated Model (m^3/s)	Calibrated Model with monitoring data (m^3/s)
1.005 yr.	-	0.36
1.05 yr.	-	0.55
1.25 yr.	-	0.82
60 % of 2 yr. (design flow)	*2.4*	*0.75*
2 yr.	4.0	1.2
5 yr.	6.7	1.8
10 yr.	9.5	2.3
50 – 100 yr.	12- 15	~ 4.0

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Not a reference reach – field assessment

- Survey data for upstream reach
- Visual observations of erosion indicative of flows experienced (measured)
- Manning's equation and Flowmaster used to estimate discharge
  - Q = 0.50 m^3/s

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Findings and Next Steps

Approaches	Design Flow (m^3/s)
Existing hydrology model (60% of 2 yr. return period)	**2. 4**
Flow frequency analysis with monitoring data (Between 1.05 – 1.25 return period)	**0.55 - 0.83**
Field Assessment	**0.50**

- Continue monitoring program to refine the results
- Agreements from regulators on the design flow
- Other outputs through the calibration exercise will inform the monthly water budget for wetland and aquatic habitat
- Review groundwater data available on site to inform wetland design

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Lessons Learned

- Traditional flood models can over estimate discharge for lower return period flows (in this case 3 times higher)
- Robust monitoring programs can shed insight into the complex hydrology/hydraulics of urban creeks
- Time lapse photography can be helpful in verifying the monitored data
- Continuous stream flow records can be utilized to perform flow frequency analysis to estimate design flow

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Acknowledgement

Project Team:

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Phil James- CVC

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Jayeeta Barua – CVC

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Questions

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Together, it's our nature to conserve and our future to shape.