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Making the Connection between Ecosystems and Water: Advancing Analysis of Water Balance for Natural Features

Scott Sampson, Manager, Natural Heritage, CVC
Laura Del Giudice, Senior Ecologist, TRCA





Outline

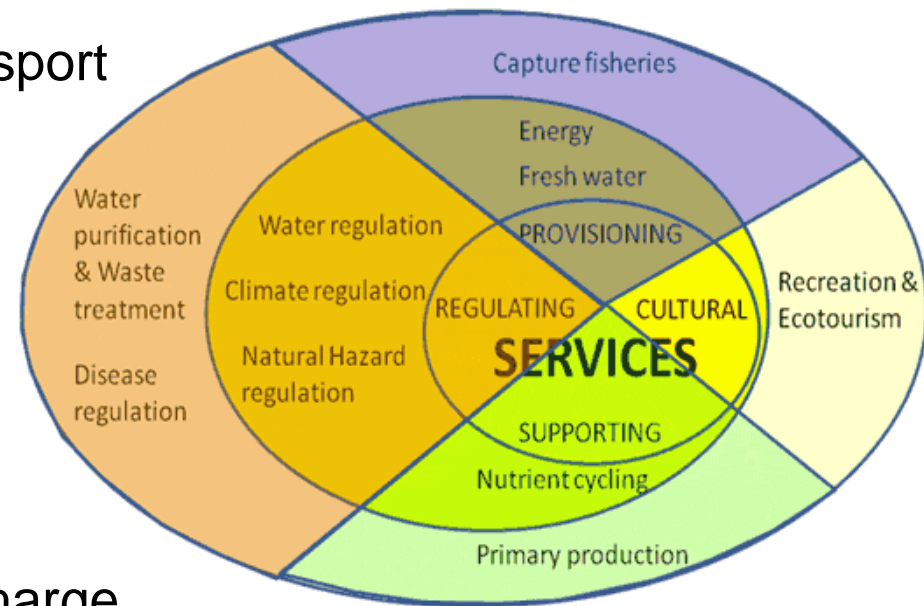
- Importance of natural feature hydrology to the watershed and to ecosystems
- Land use changes and impacts on natural features
- Water balance for natural features guidelines
- Overview of the wetland water balance study
- Development of tools, protocols and additional guidance
- Formation of the External Stakeholder Committee





The “Bigger Picture”

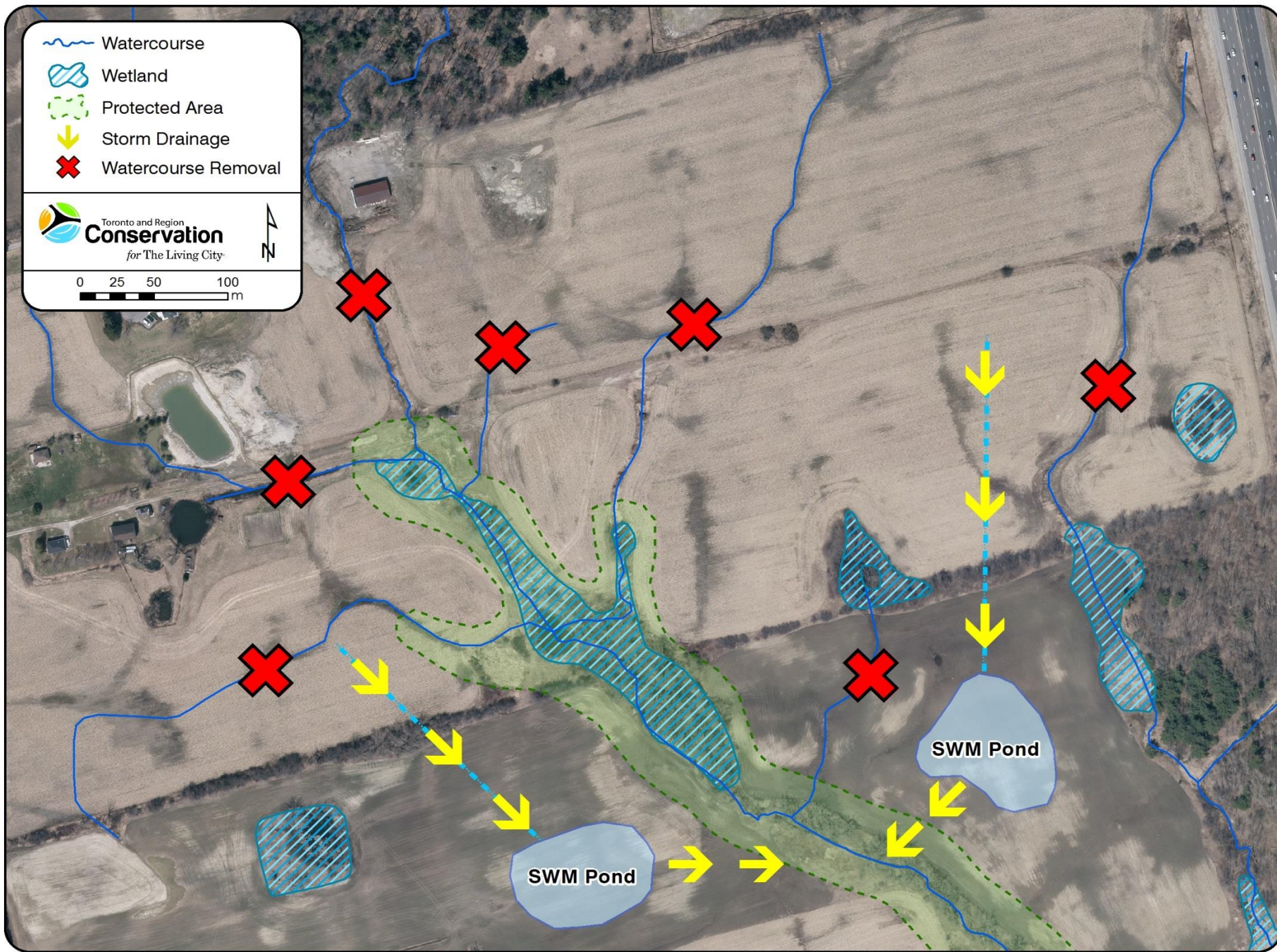
- Flood attenuation
- Water storage and release
- Nutrient and energy cycling/transport
- Water quality improvement
- Carbon sequestration
- Primary production
- Habitat provision
- Connectivity
- Evapotranspiration
- Groundwater recharge and discharge
- Sediment regulation
- Social and economic benefits



- Watercourse
- Wetland
- Protected Area
- Storm Drainage
- Watercourse Removal



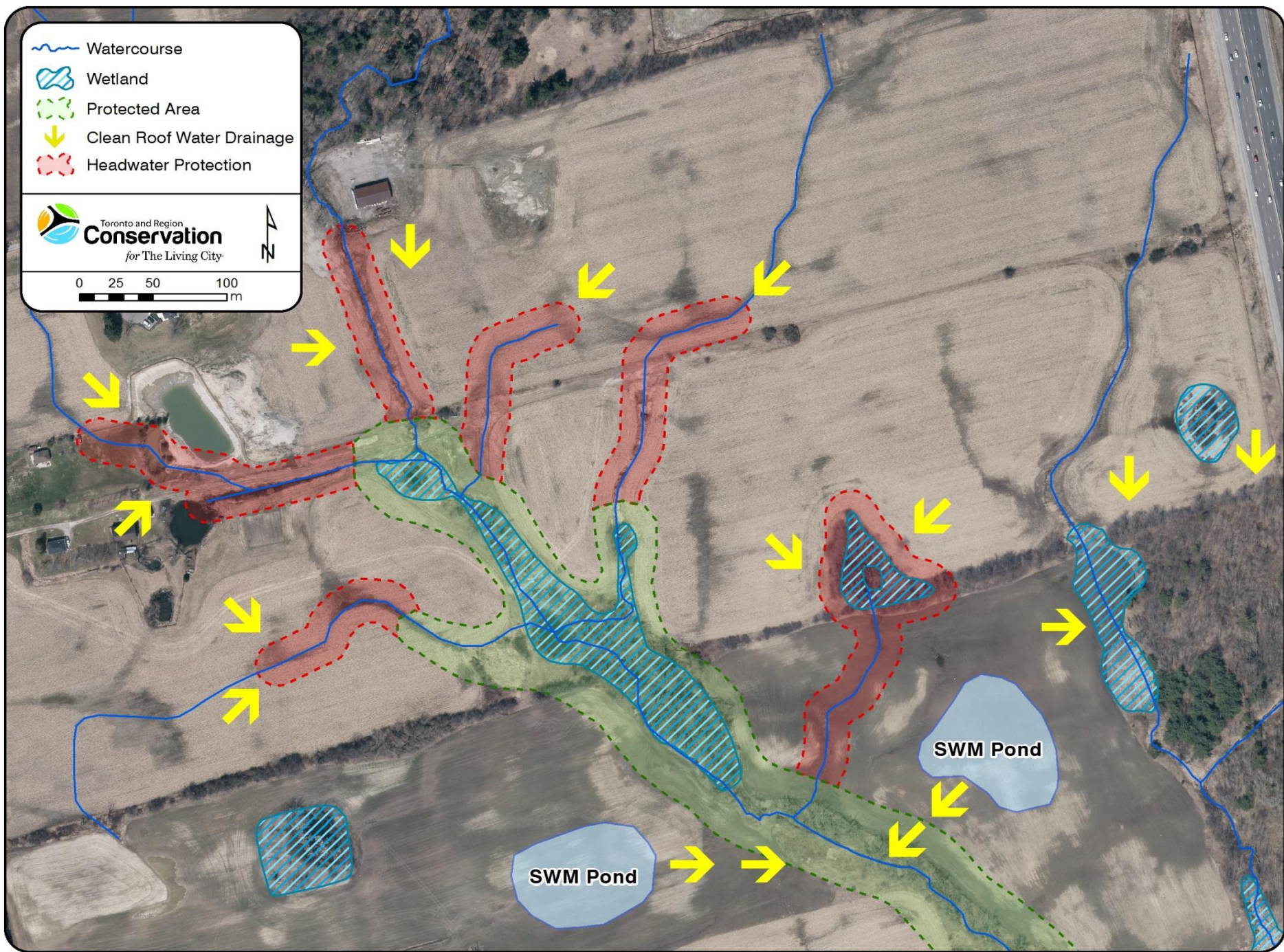
0 25 50 100
m



- Watercourse
- Wetland
- Protected Area
- Clean Roof Water Drainage
- Headwater Protection

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0 25 50 100
m





The Right Water in the Right Place



6 HOURS

KW -1

JUL.08,13 11:00 AM



The Right Water in the Right Place





The Right Water in the Right Place



6 HOURS

KW -1

JUL.15,13 05:00 PM



The Right Water in the Right Place





Water in the Wrong Place





Hydrology & Ecology

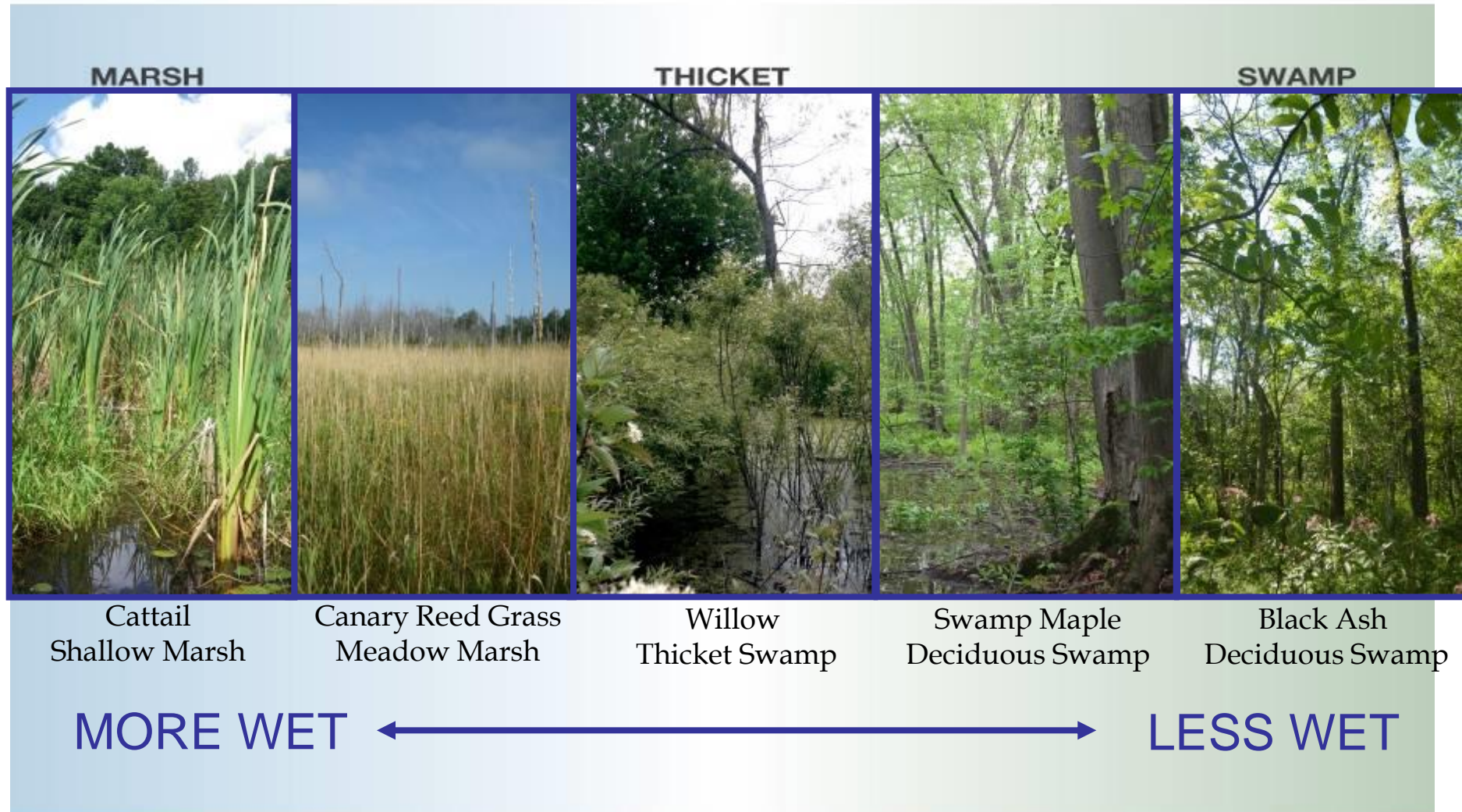


Hydrology is one of the most important factors affecting ecological structure, composition & function of natural areas

- **HYDROPERIOD:** Seasonal pattern of water fluctuation
- Hydrologic signature of each wetland
- Four important attributes:
 - Duration;
 - Extent;
 - Depth; and
 - Timing

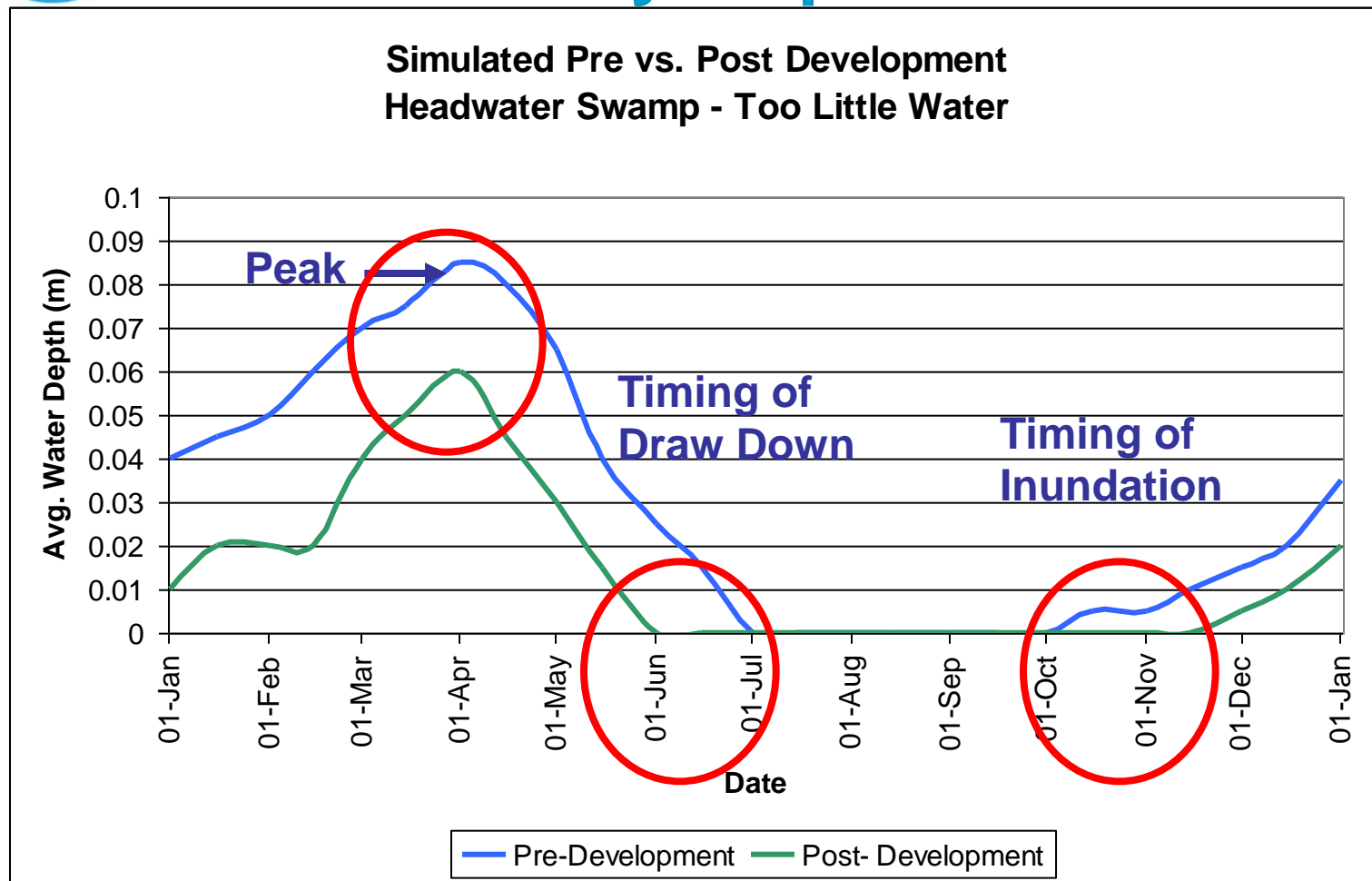


Wetland Hydrological & Ecological Gradients





Post – Pre Hydroperiod



WATERCOURSES



WOODLANDS



WETLANDS



Photo Credit: The Sernas Group

THE PROBLEM

An aerial photograph of a suburban neighborhood with a red boundary line. The neighborhood features a central green space with a pond, surrounded by residential streets and houses. A red line outlines the perimeter of the neighborhood. At the bottom left, there are three red arrows pointing towards the equation $P = ET + I + RO$.
$$P = ET + I + RO$$



Consequences & Risk



- Decomposition of organic soil
- Stress & death of wetland plants & trees
- Loss of brook trout population
- Loss of cedar swamp



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TORONTO AND REGION CONSERVATION AUTHORITY



Guideline Recommendations

Step 1

Determining Need for Water Balance



Step 2

Establish Baseline Conditions



Step 3

Developing Existing Water Budget Model



Step 4

Comparing Post-to-Pre Development



Step 5

Apply Mitigation



Step 6

Reporting and Monitoring

Drainage area to pond

Clean drainage to features





Outside Guideline Scope

Wetland Protection Process

Determine Wetland Protection through Planning Process

Guideline Step 1

Determine Need for Water Balance

Risk Evaluation

Guideline Step 2

Establish Baseline Conditions

Monitoring Protocol

Guideline Steps 3 and 4

Developing Existing Water Budget Model and Compare pre-to-post

Modelling & Mitigation Direction

Guideline Step 5

Apply Mitigation

Modelling & Mitigation Direction / Ecological Assessment Tool

Guideline Step 6

Reporting and Post-Dev't Monitoring

Monitoring Protocol



External Stakeholder Committee

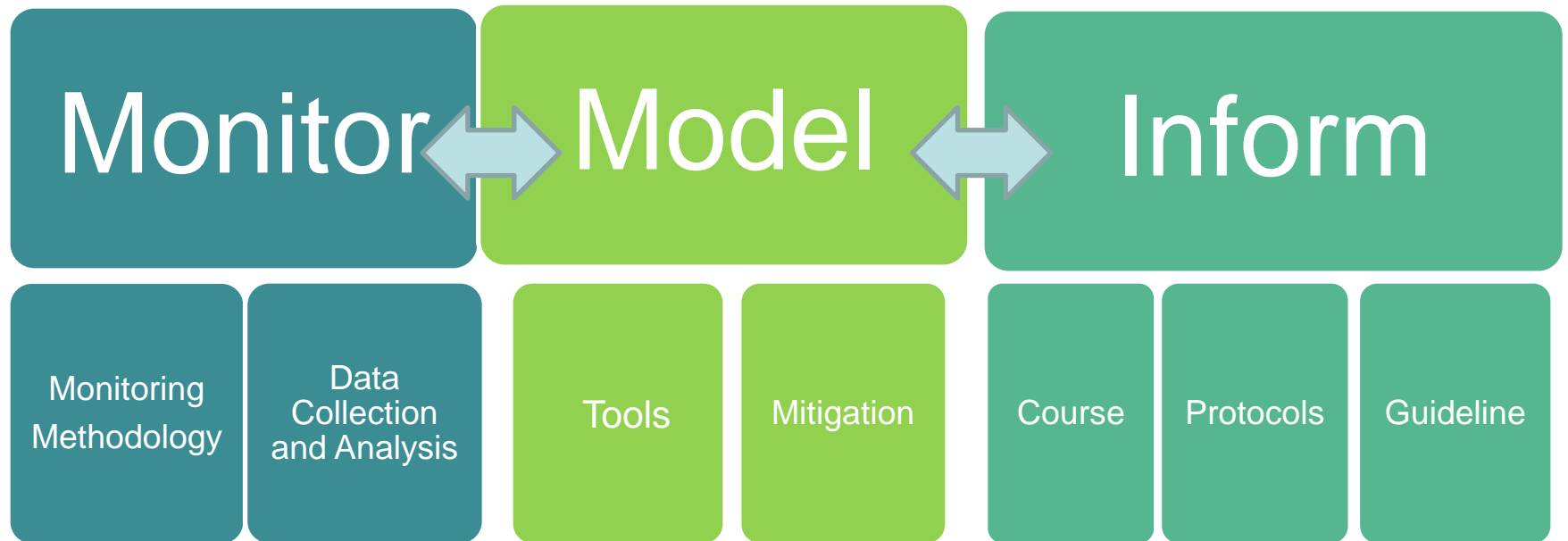
- BILD
- Partner municipalities
- Consulting industry
 - Engineers
 - Ecologists
 - Hydrogeologists
 - Planners

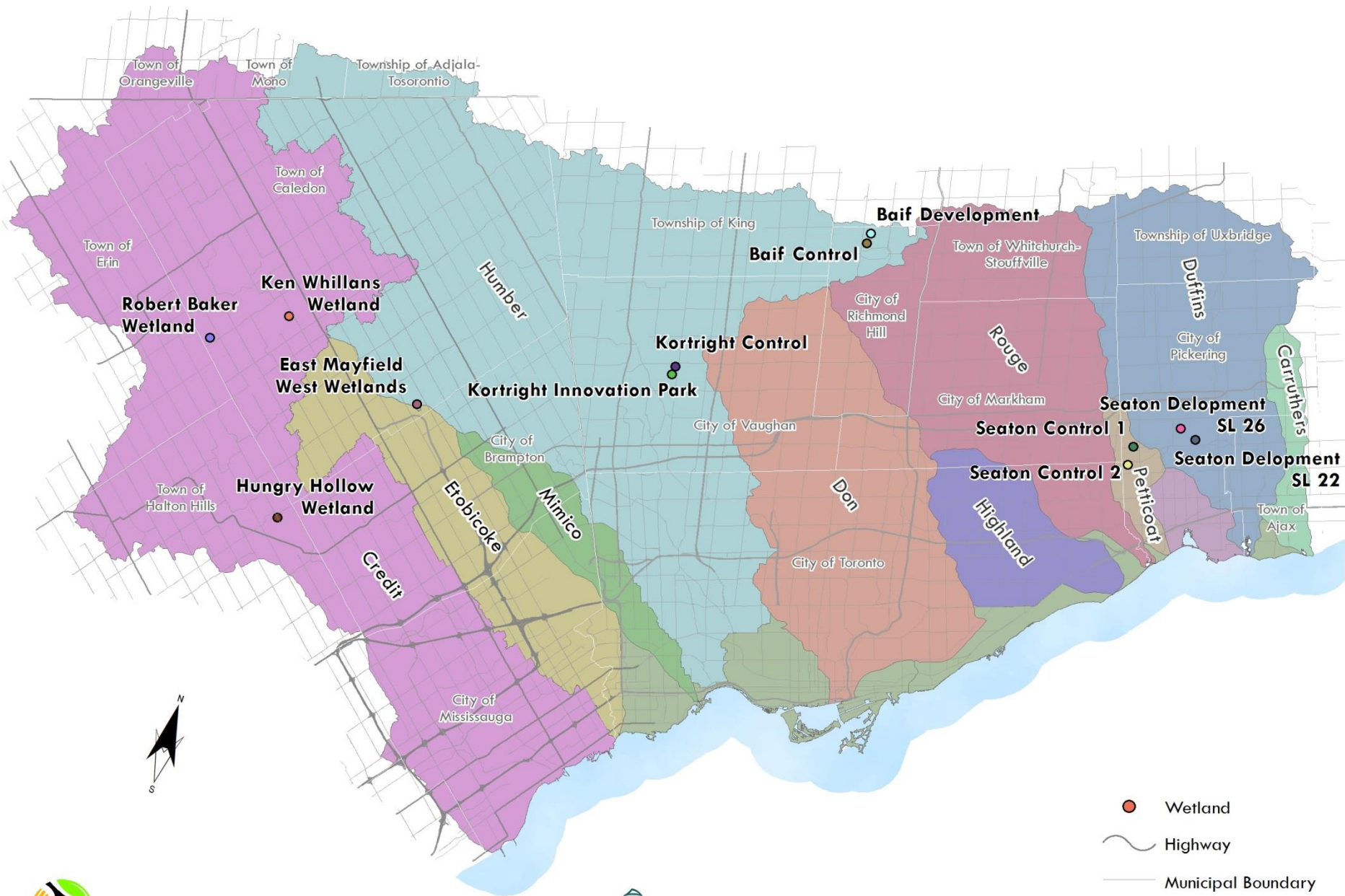




Water Balance Project Structure

Water Balance Project





Pre-development catchment

Soil Moisture Probes

Vegetation Transect

Amphibian Stn.

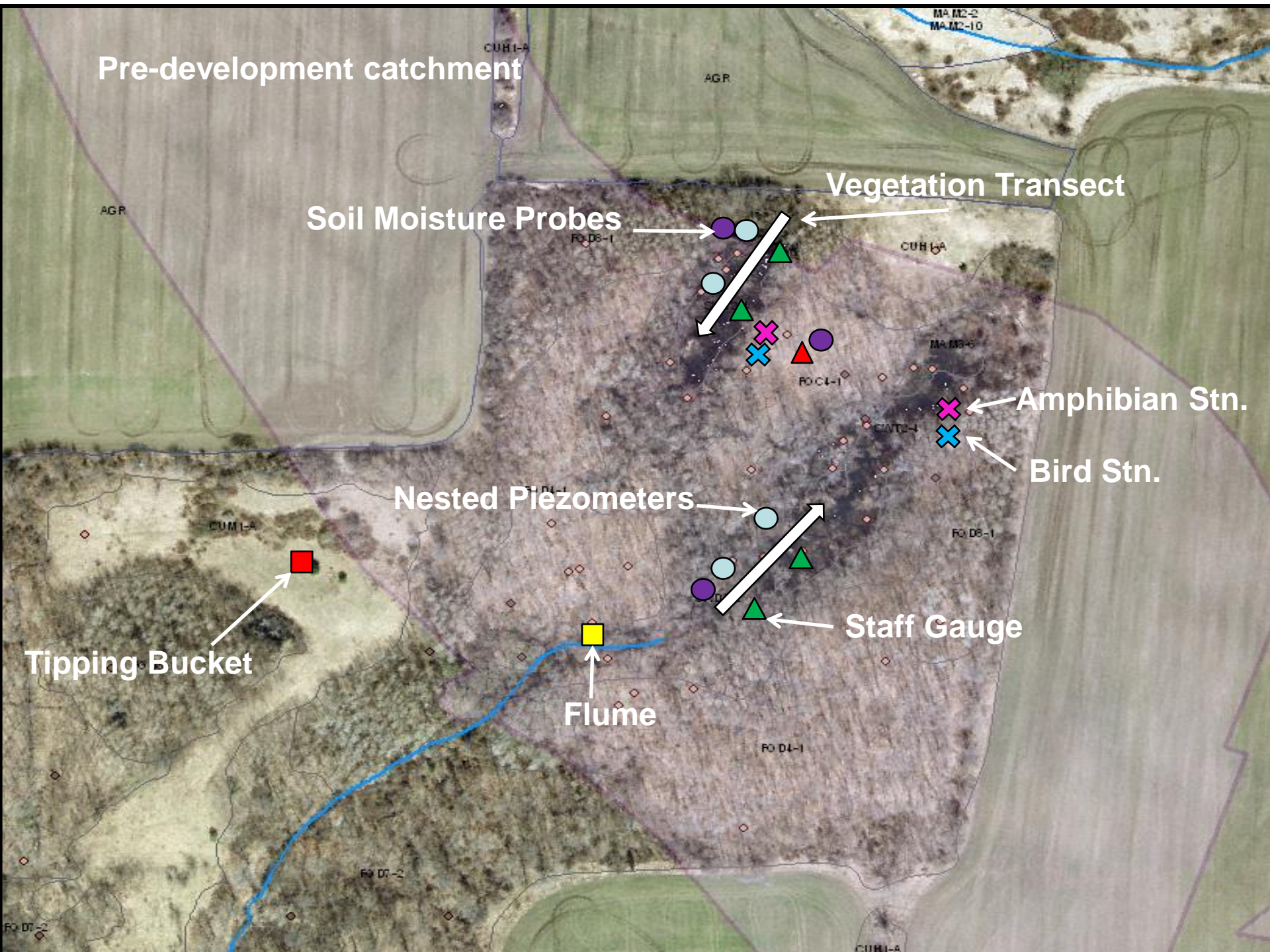
Bird Stn.


Nested Piezometers

Tipping Bucket

Flume

Staff Gauge



Risk Evaluation Criteria for Water Balance Need Determination	Risk of Hydrologic Impacts to Ecological Wetland Function		
	HIGH RISK	MEDIUM RISK	LOW RISK
Wetland Site Type	Low Assimilative Capacity	Intermediate Assimilative Capacity	High Assimilative Capacity
Sensitivity (refer to species and vegetation lists appended)	High Sensitivity	Medium Sensitivity	Low Sensitivity
Scope and Scale of Changes in Water Inputs/Outputs and Water Quality	High Probability of Hydrologic Change	Intermediate Probability of Hydrologic Change	Low Probability of Hydrologic Change
Risk Evaluation for Project (Refer to Decision-trees) 	HIGH RISK PROJECT: <ul style="list-style-type: none">Comprehensive monitoring required in keeping with Wetland Water Balance Monitoring Protocol.Modeling analysis required using continuous hydrologic model (e.g. PC SWMM, MIKE SHE, etc.) calibrated with monitoring data based on full wetland water budget.	MEDIUM RISK PROJECT: <ul style="list-style-type: none">Monitoring may be scoped.Scoped modeling analysis required using spreadsheet or extended simulation model (e.g. PC SWMM) using only runoff from development area.	LOW RISK PROJECT: <ul style="list-style-type: none">No monitoring or modeling analysis required, however maintain or enhance watershed functions of wetland (refer to Table X) and overall recharge/water balance of site.



Wetland WB Monitoring Protocol

- Outlines the steps for designing a monitoring program for high and medium risk projects
- Comments received by ESC, to be finalized this spring
- To be revised following findings of study



WETLAND WATER BALANCE MONITORING PROTOCOL

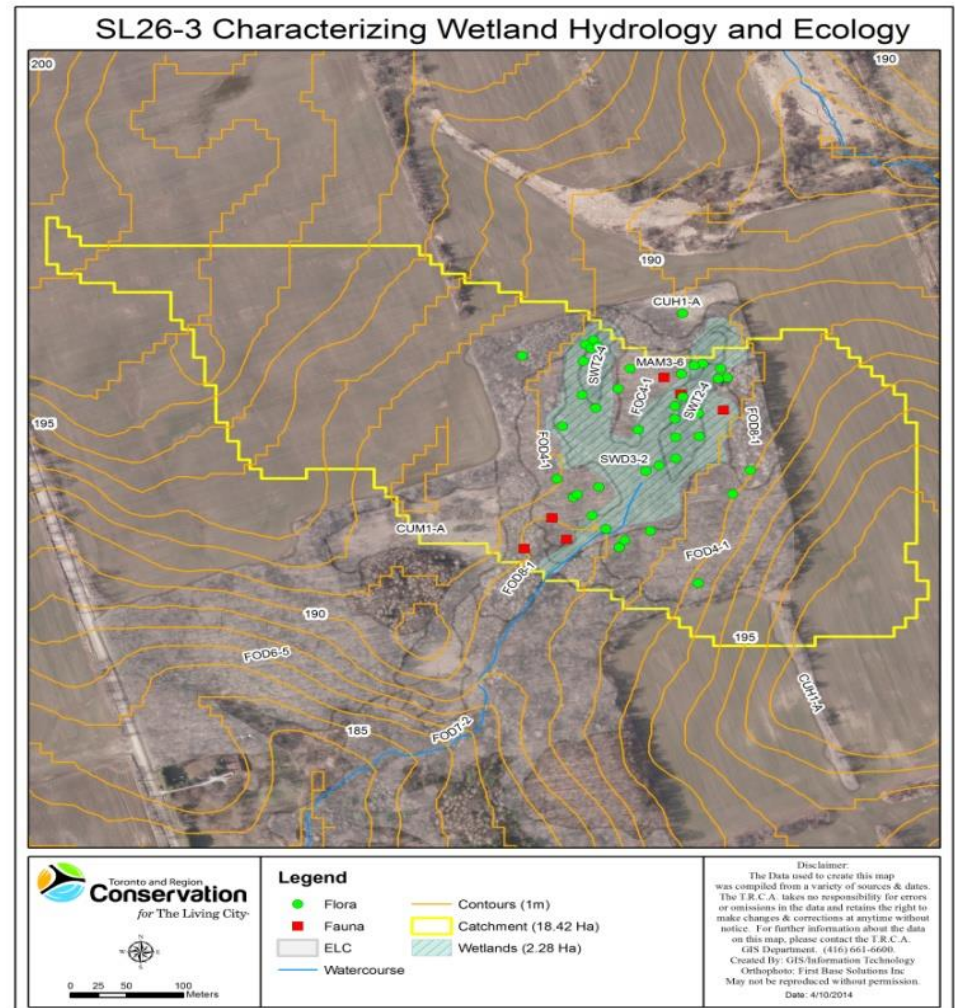
Research and Development Section
Planning Ecology Section
Toronto and Region Conservation Authority
April 2014





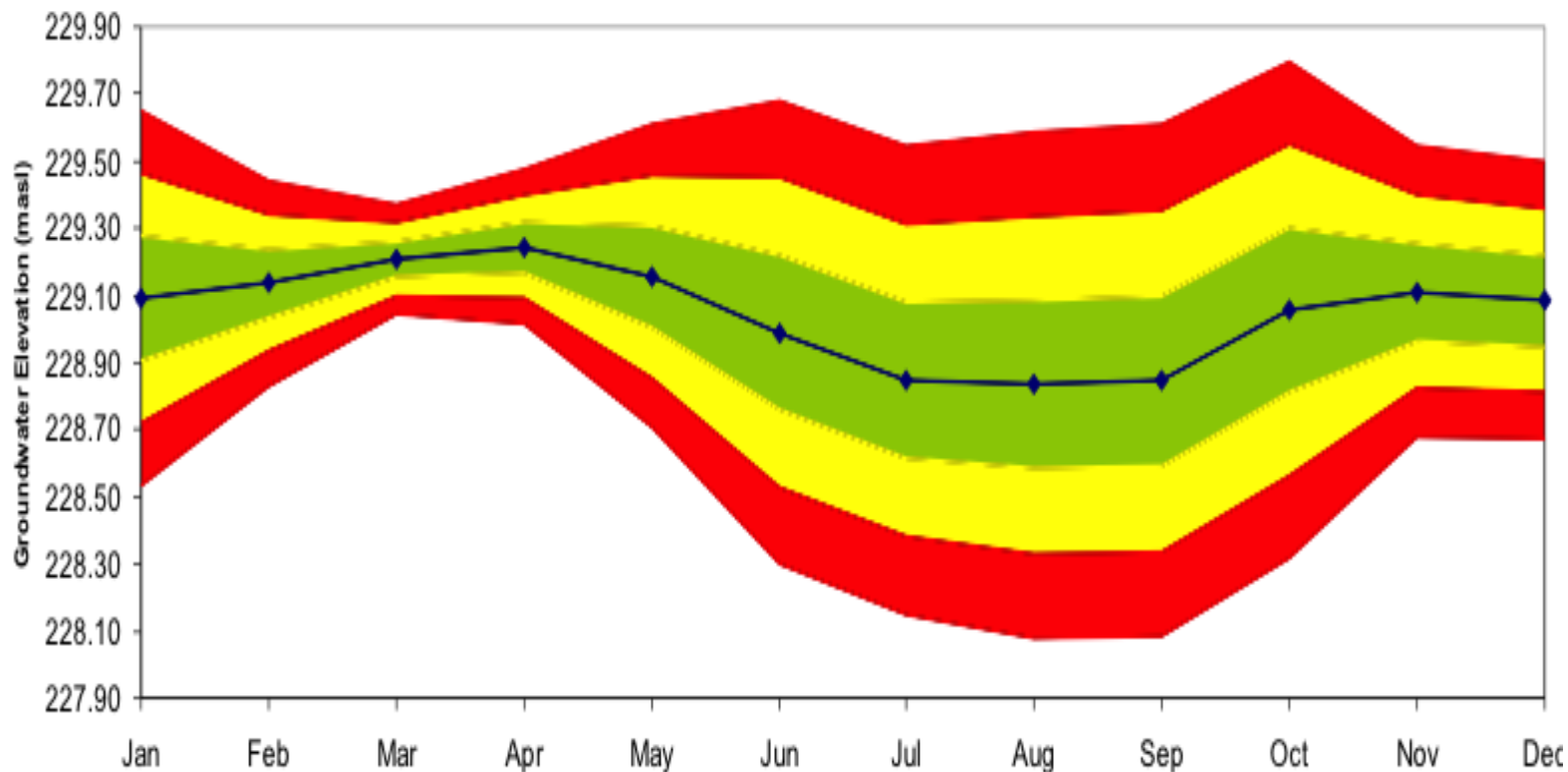
Data Analysis, Modeling, and Direction

- Some data analysis by M.Sc. Student at University of Guelph
- Feeding into modeling exercise
- Directions on modeling and mitigation measures





Ecological Tolerances Tool





QUESTIONS?