Assessing the Sources and Management Options for Detroit River Nutrient Loads to Lake Erie

Project Advisory Group Conference Call
2 - 4 p.m., Thursday, October 5, 2017

Audio: 1-888-240-2560; Code: 734.763.0056

WATER CENTER
UNIVERSITY OF MICHIGAN

Fred A. and Barbara M.
Erb Family Foundation

Project Advisory Group

Diverse expertise

Diverse sector and geographic representation

Participating in Call

- All audio is through phone.
  - Please mute yourself during team presentations.
- Through GoToWebinar console you can:
  - View participants
  - Submit comments through chat box, if you prefer.
- During and after each section, we will take questions and comments verbally. Don’t hesitate to interrupt us!
- At end, we will call on each participant to voice any additional ideas.

Agenda

- Introduction - *Jen Read*
- Lake St. Clair Modeling - *Serghei Bocaniov*
- Watershed Modelling Update - *Awoke Teshager*
- Scenario Approach
  - Regional Watershed Model - *Awoke Teshager*
  - Detroit Urban Model - *Branko Kerkez*
  - Polling and Discussion about Initial Runs - *Lynn Vaccaro*
- Wrap-Up - *Jen Read*
  - What's most important for us to keep in mind as we finalize models and begin scenario development and testing?

Meeting Objectives

- Provide updates on Lake St. Clair and SWAT modeling
- Review our approach for developing scenarios in urban and rural settings
- Get your input on:
  - Which single practice scenarios would you like to see evaluated before our next meeting?
  - Other advice as refine models and begin exploring scenarios
  - Dates and locations for our annual in person meeting

Project Re-Cap

Timeline: 2016 – 2018

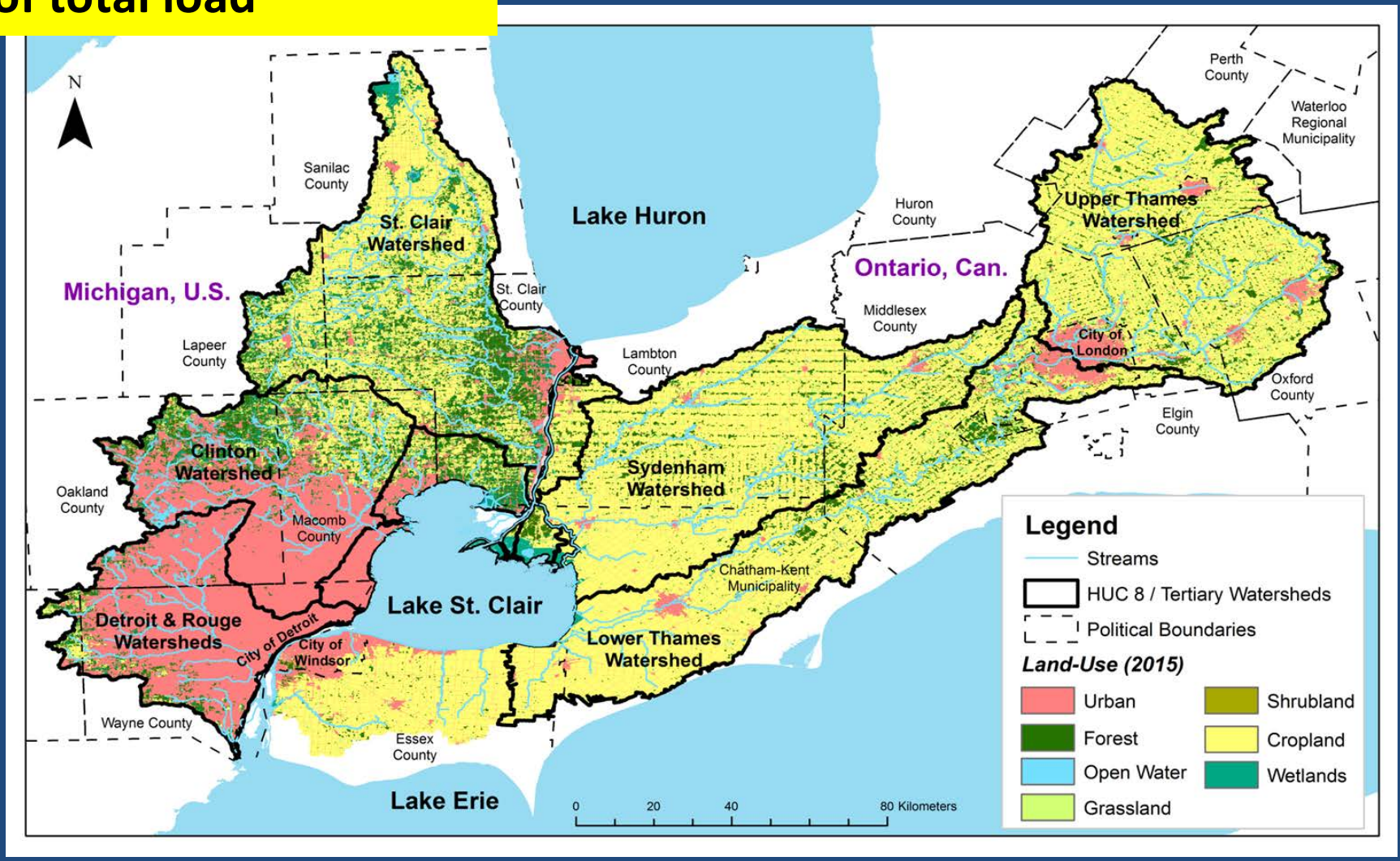
Funding: Erb Family Foundation

Objectives:

- Engage policy and management community
- Develop watershed models to assess nutrient loads from different sources.
- Explore options for reducing P loads from the most important sources

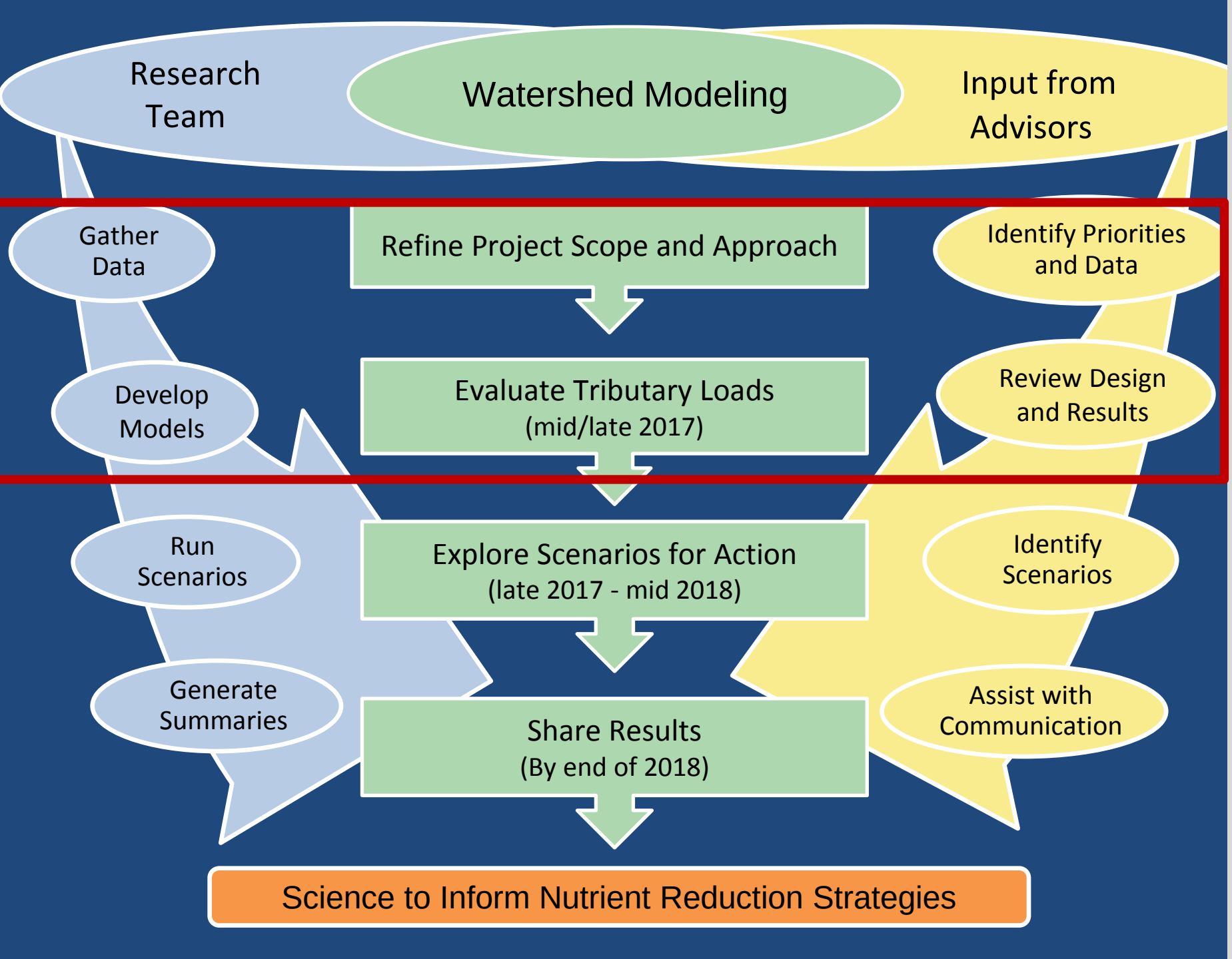
Study Area: Watershed of St. Clair- Detroit River System

35% of Western Basin load
21% of total load



Modeling Approach

- Urban modeling: Urban source analysis, detailed modeling for metro Detroit
- Regional model: Soil & Water Assessment Tool Model (SWAT) for entire study area
- Lake St. Clair model: to estimate retention and delivery properties (ELCOM-CAEDYM)


Research Team
Watershed Modeling
Input from Advisors
Gather Data
Refine Project Scope and Approach
Identify Priorities and Data
Develop Models
Evaluate Tributary Loads (mid/late 2017)
Review Design and Results
Run Scenarios
Explore Scenarios for Action (late 2017 - mid 2018)
Identify Scenarios
Generate Summaries
Share Results (By end of 2018)
Assist with Communication
Science to Inform Nutrient Reduction Strategies
2016
2017
2018

Upcoming Advisory Group Meetings

- Annual Meeting: February 2018, in Windsor
  - Calibration results for water quality parameters
  - Initial scenario runs
- Conference Call: Summer 2018
  - Draft results, communication plans
- Final Meeting: November/ December 2018, in Ann Arbor
  - Draft report, communication products

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Lake St. Clair Modeling Update

How processes in Lake St. Clair affect the delivery of phosphorus from the watershed to Lake Erie.

NOTE:
Serghei Bocaniov's slides will be available by January 2018. The results are under review for publication.

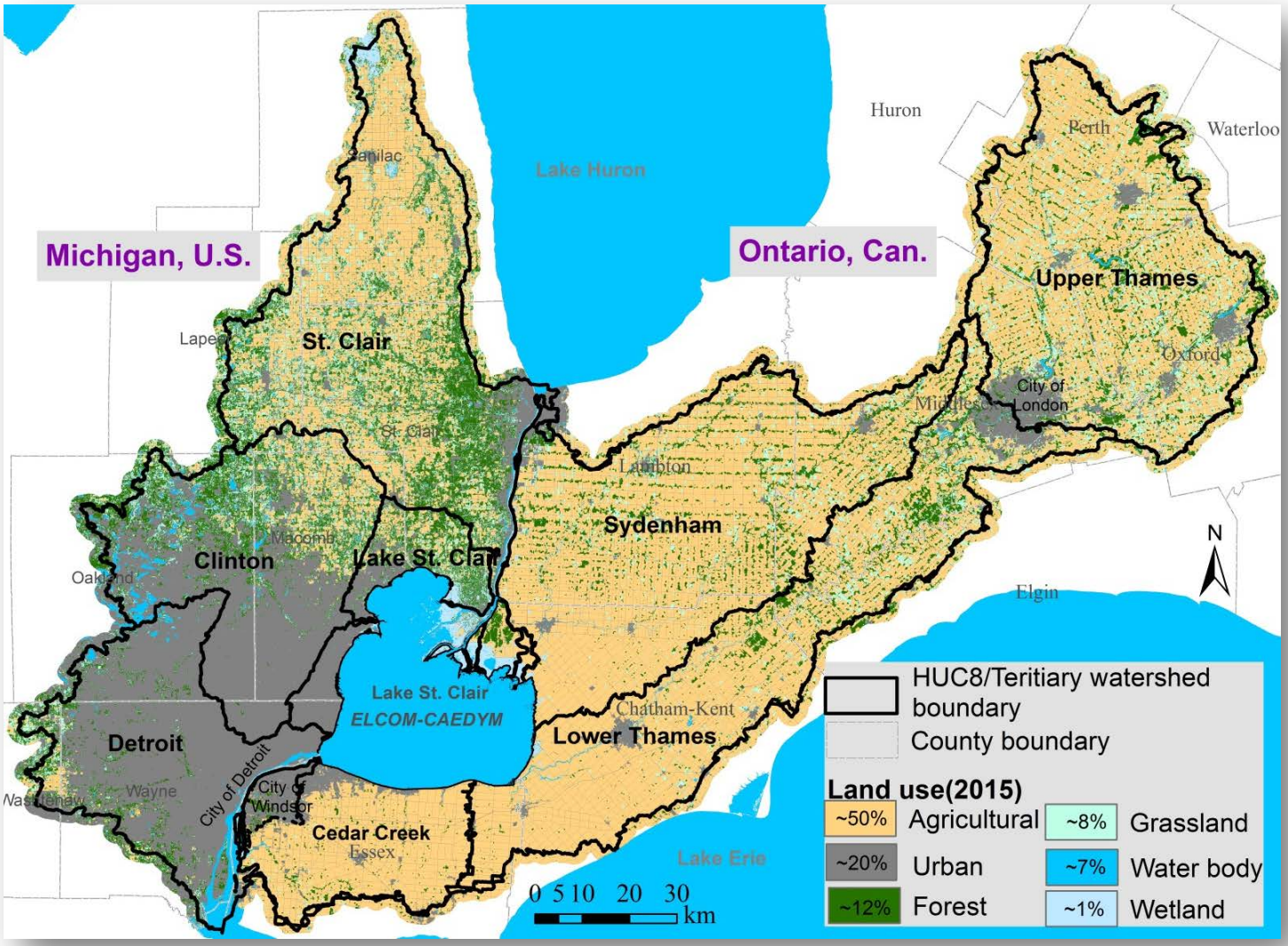
Watershed Assessment of Nutrient Loads to the Detroit River

SWAT Preliminary Calibration Simulations

Oct 5, 2017

Call Meeting

Study Area: St. Clair-Detroit River System Watershed



Area: ~**19040** km^2

- 40% in MI, US
- 60% in Ont., CAN

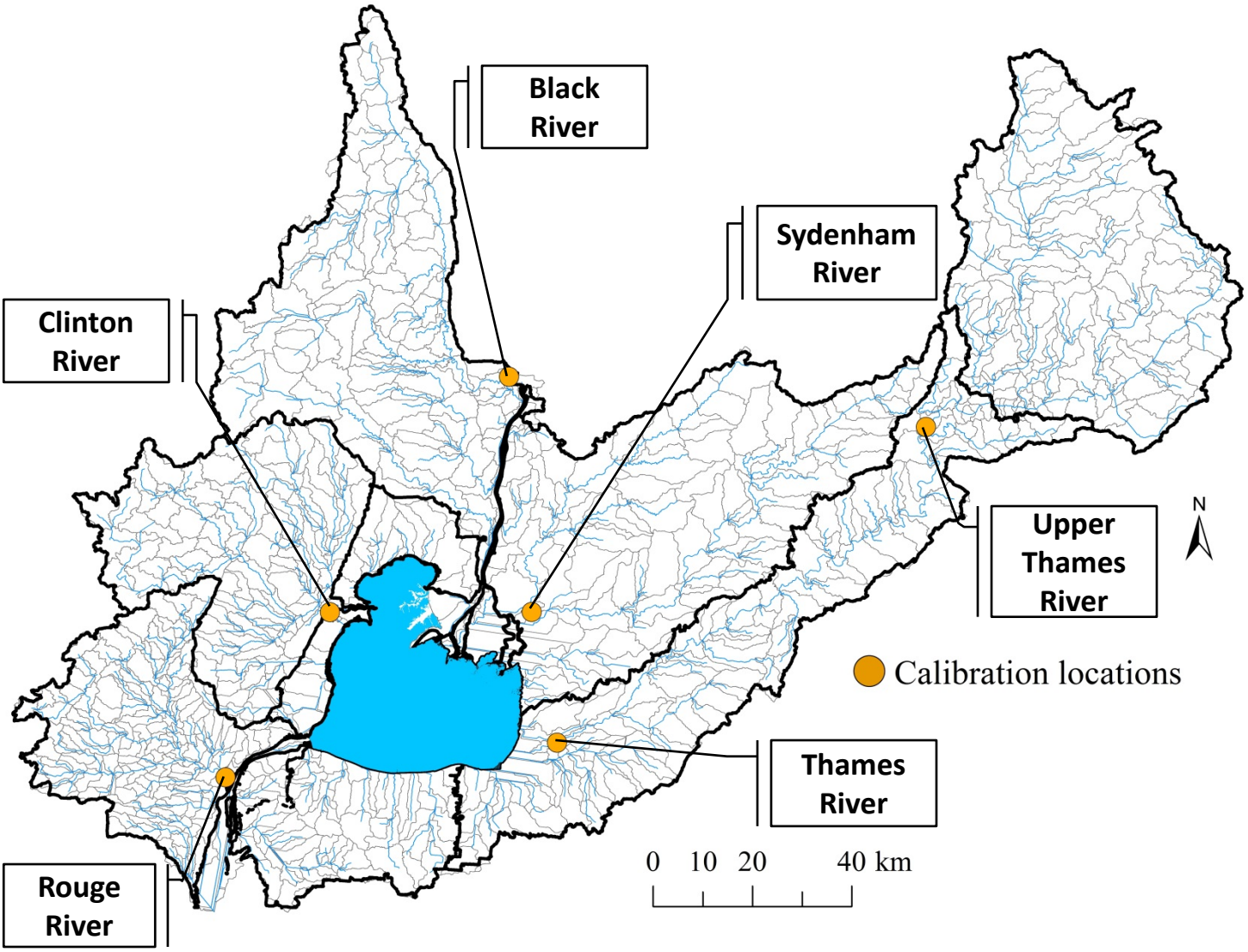
Subbasins:

- 800
- ~24 km^2

HRUs:

- 27751
- ~69 ha

Calibration/Validation



Simulations

Warm-up:

- 2 years

Calibrate:

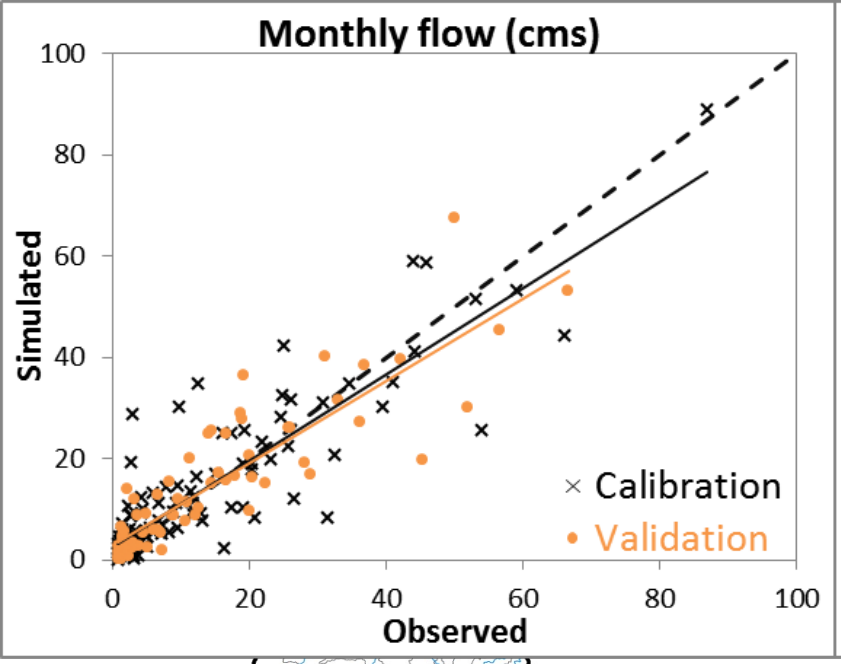
- 2007-2015

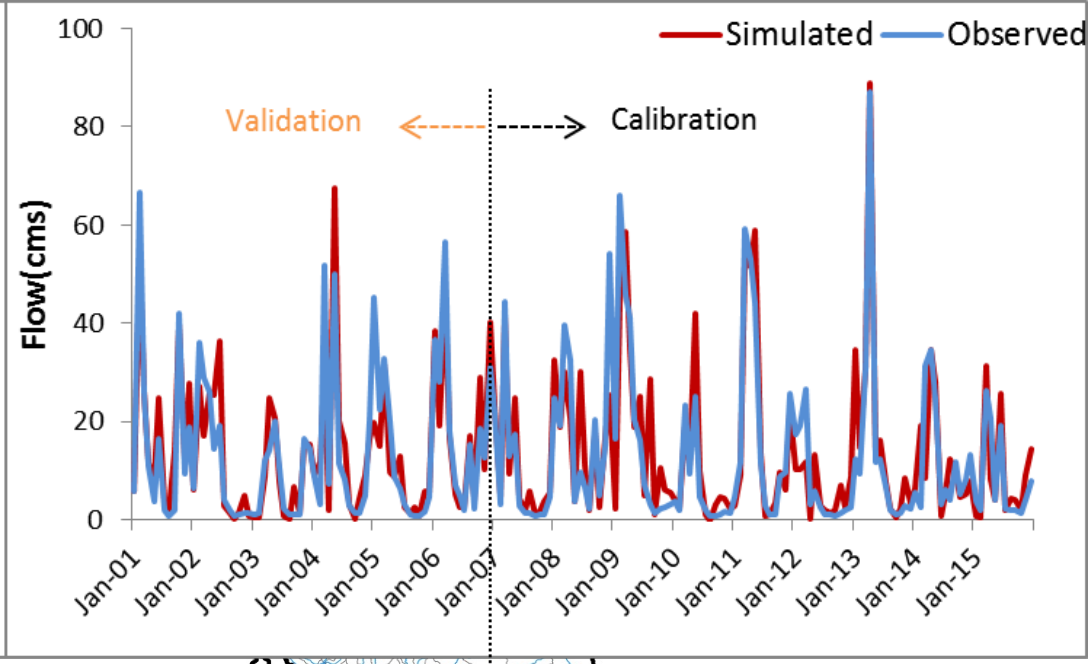
Validate:

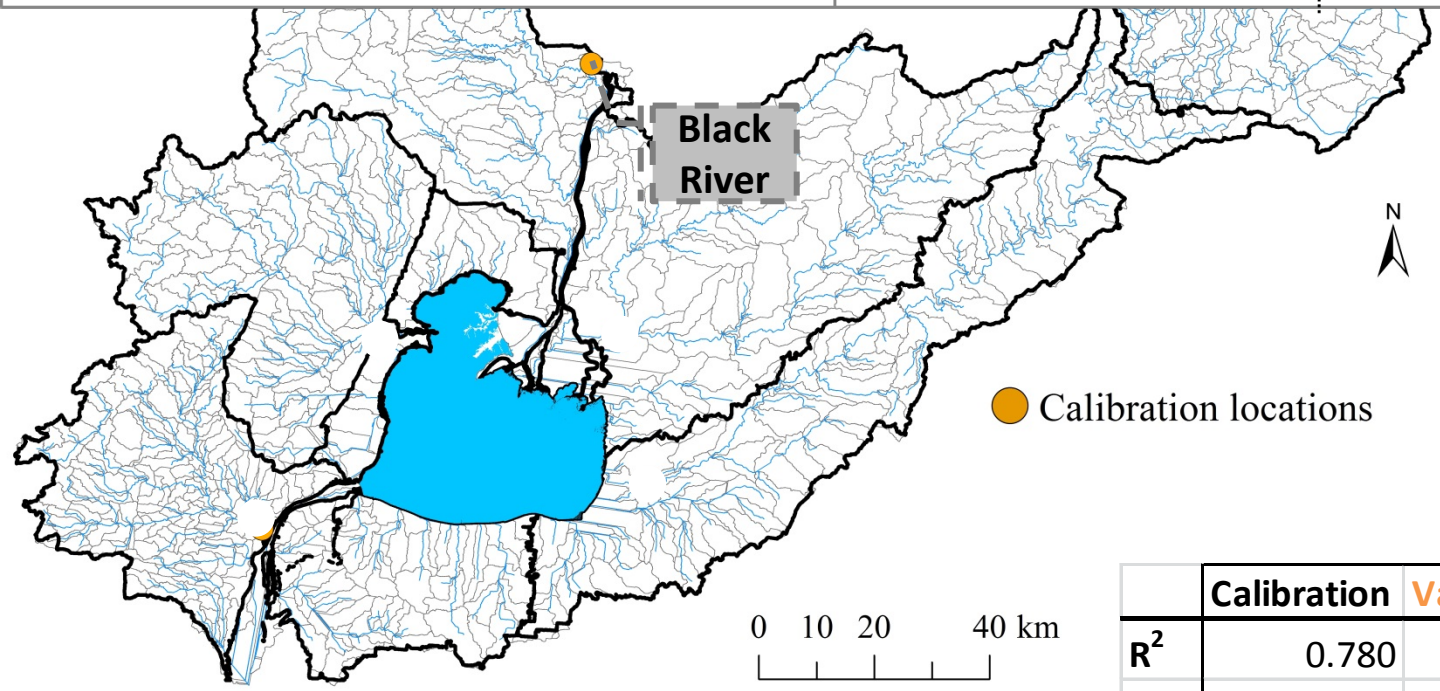
- 2001-2006

Model evaluation statistics

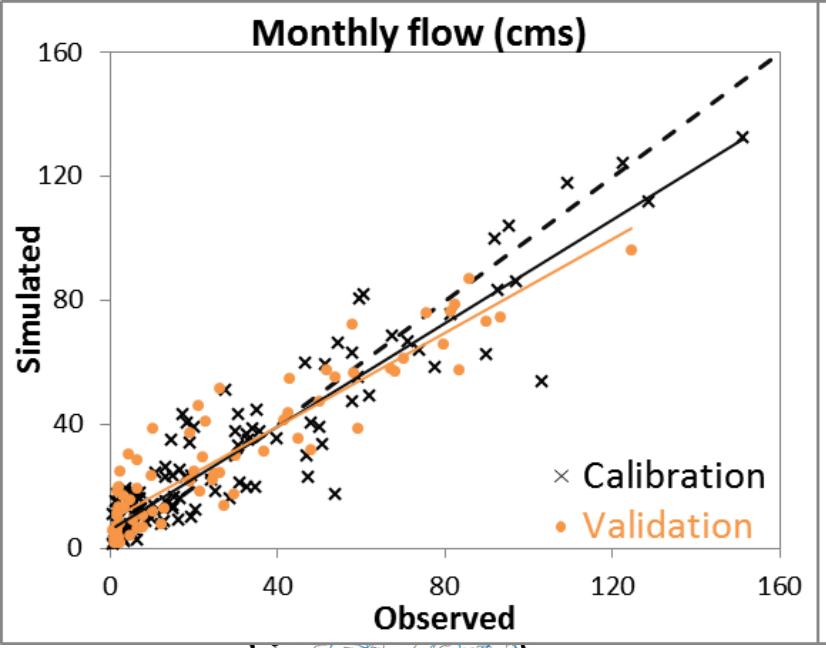
- **R^2 – Coefficient of determination**
  - Describes the proportion of the variance in measured data explained by the model
  - **0 to 1**: generally > 0.5 is acceptable
- **NSe – Nash-Sutcliffe efficiency**
  - Indicates how well the plot of observed versus simulated data fits the 1:1 line
  - **-∞ to 1**: generally > 0.0 is acceptable
- **PBs – Percent bias**
  - Measures the average tendency of data to be larger or smaller than their observed counterparts
  - **0.0** being optimum: +ve = overestimation
    –ve = underestimation

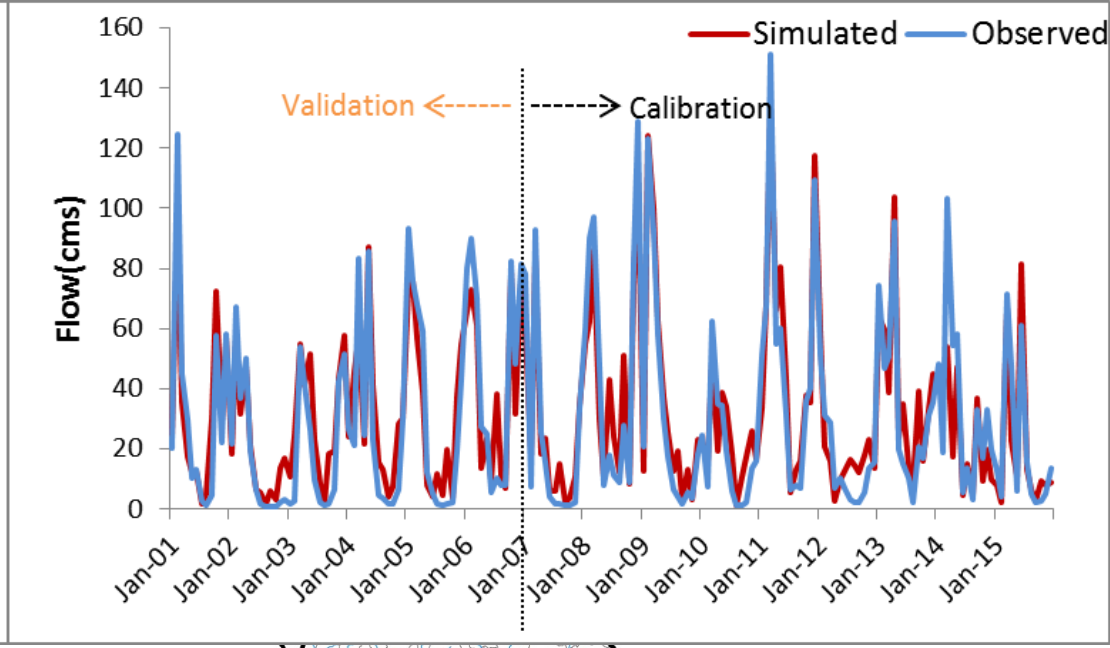


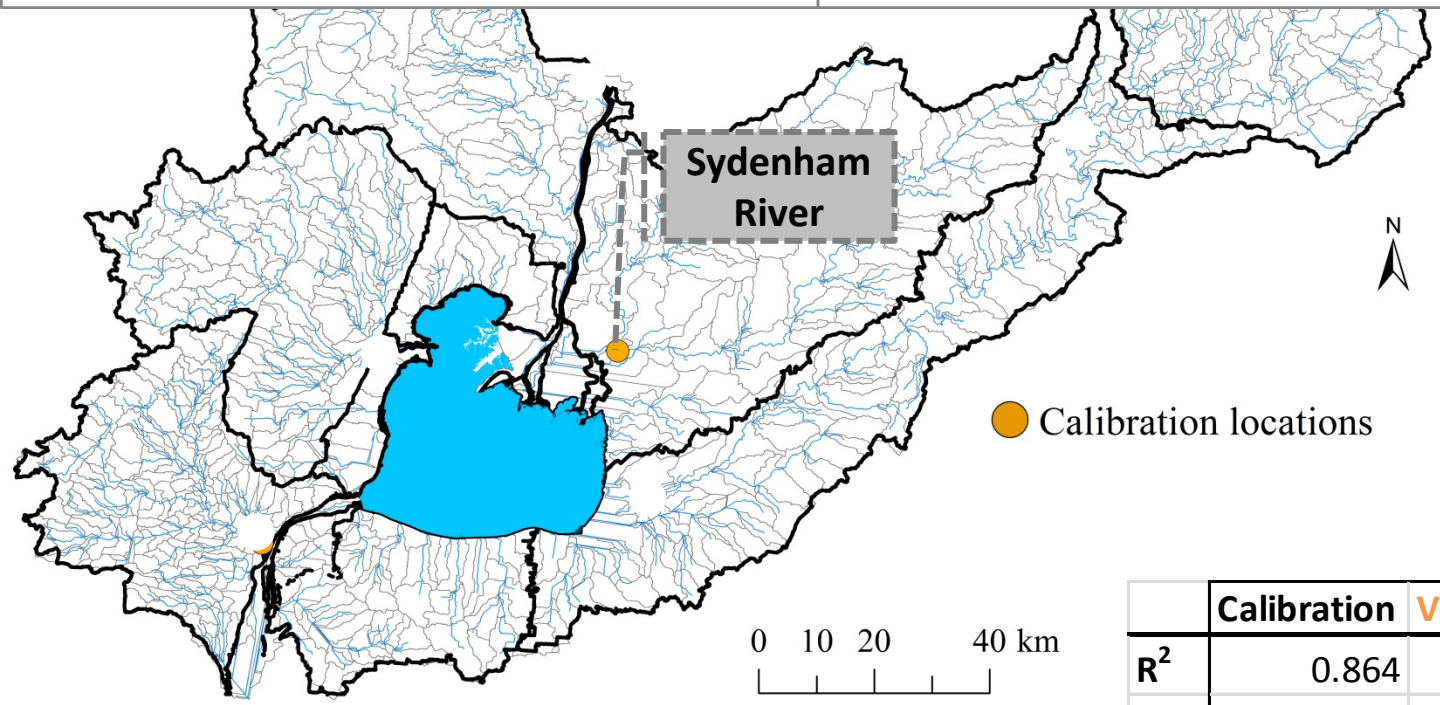




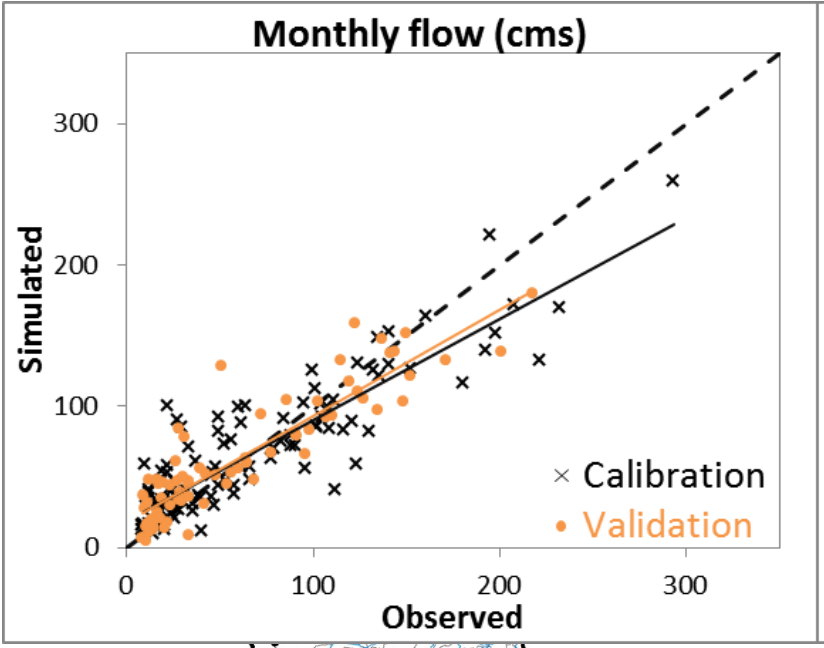
	Calibration	Validation	Satisfactory range
R^2	0.780	0.776	
NSe	0.772	0.774	> 0.50
PBs	5.0	2.0	-25% to 25%

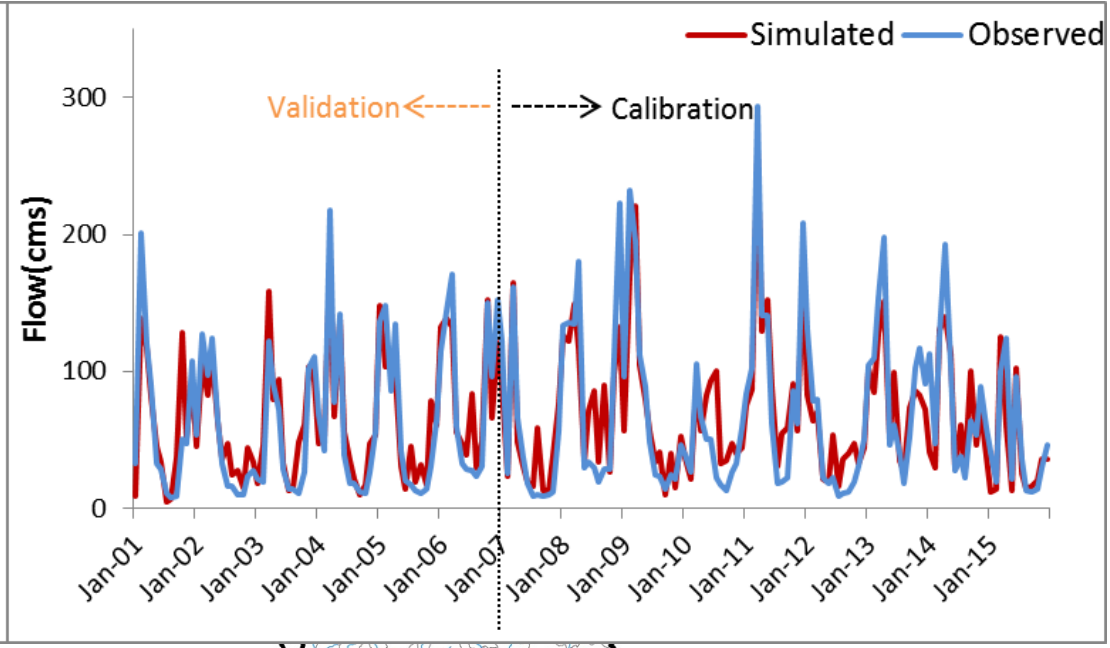


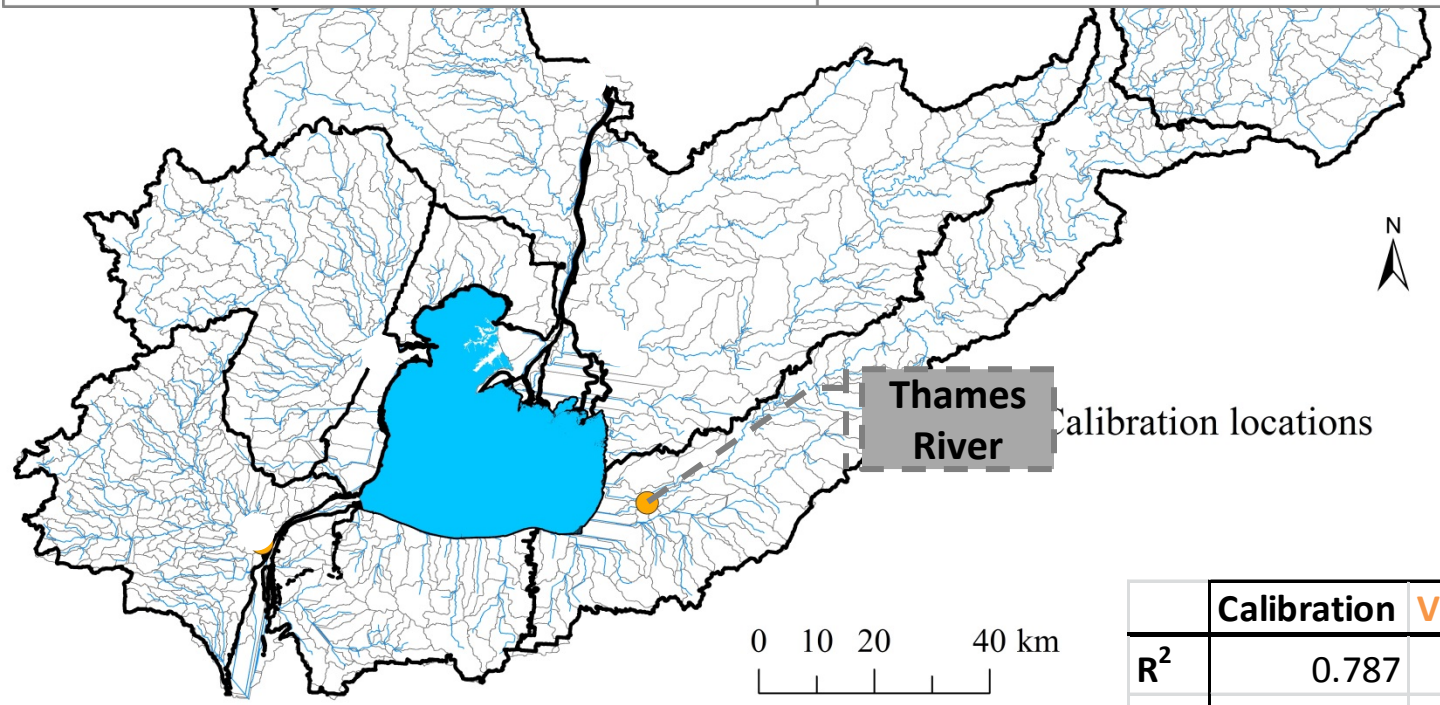




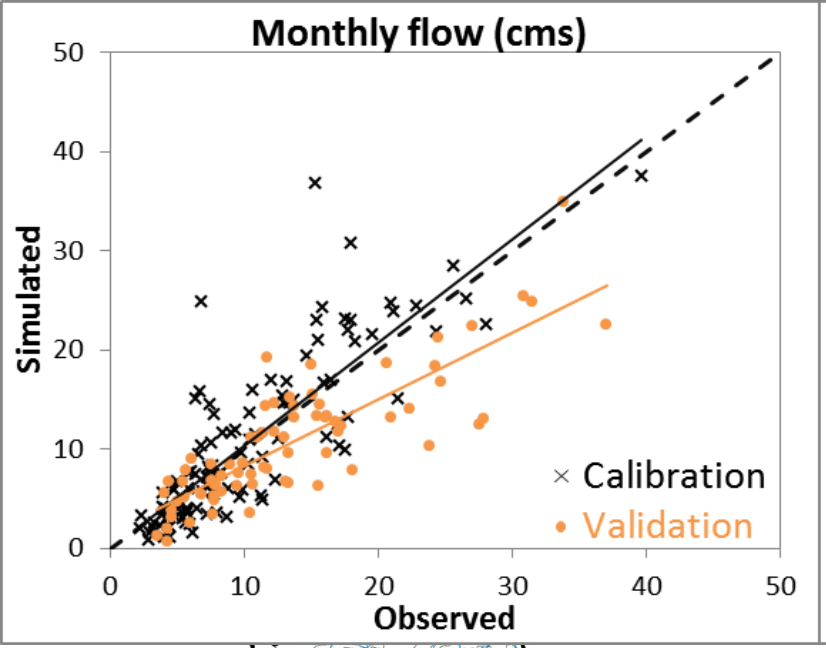
	Calibration	Validation	Satisfactory range
R^2	0.864	0.858	
NSe	0.862	0.839	> 0.50
PBs	3.2	7.8	-25% to 25%

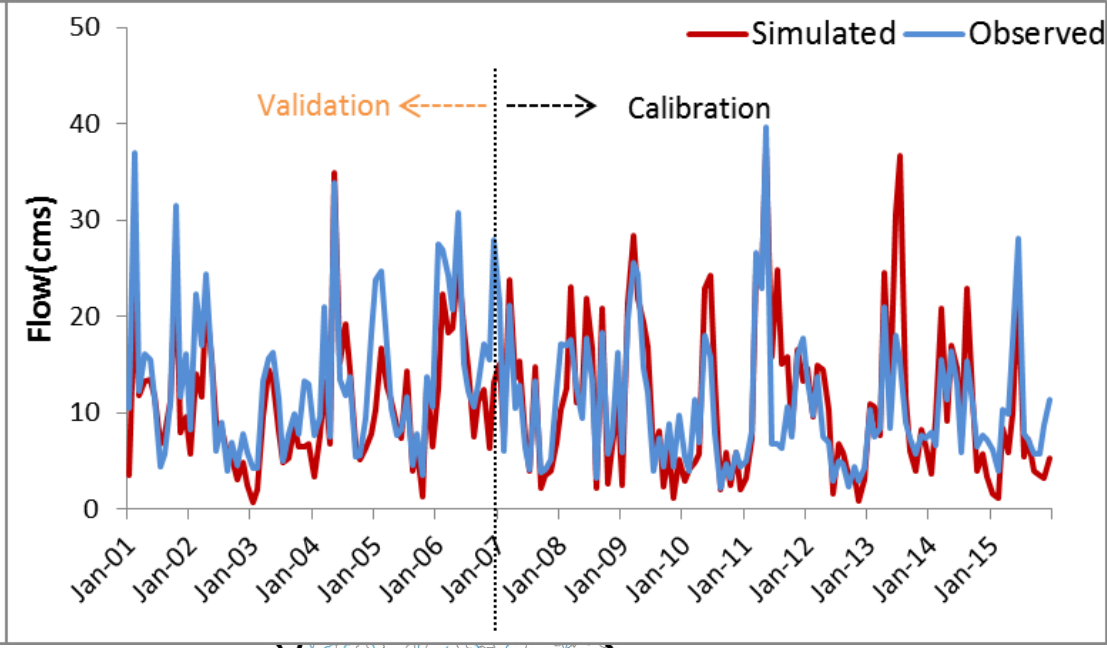


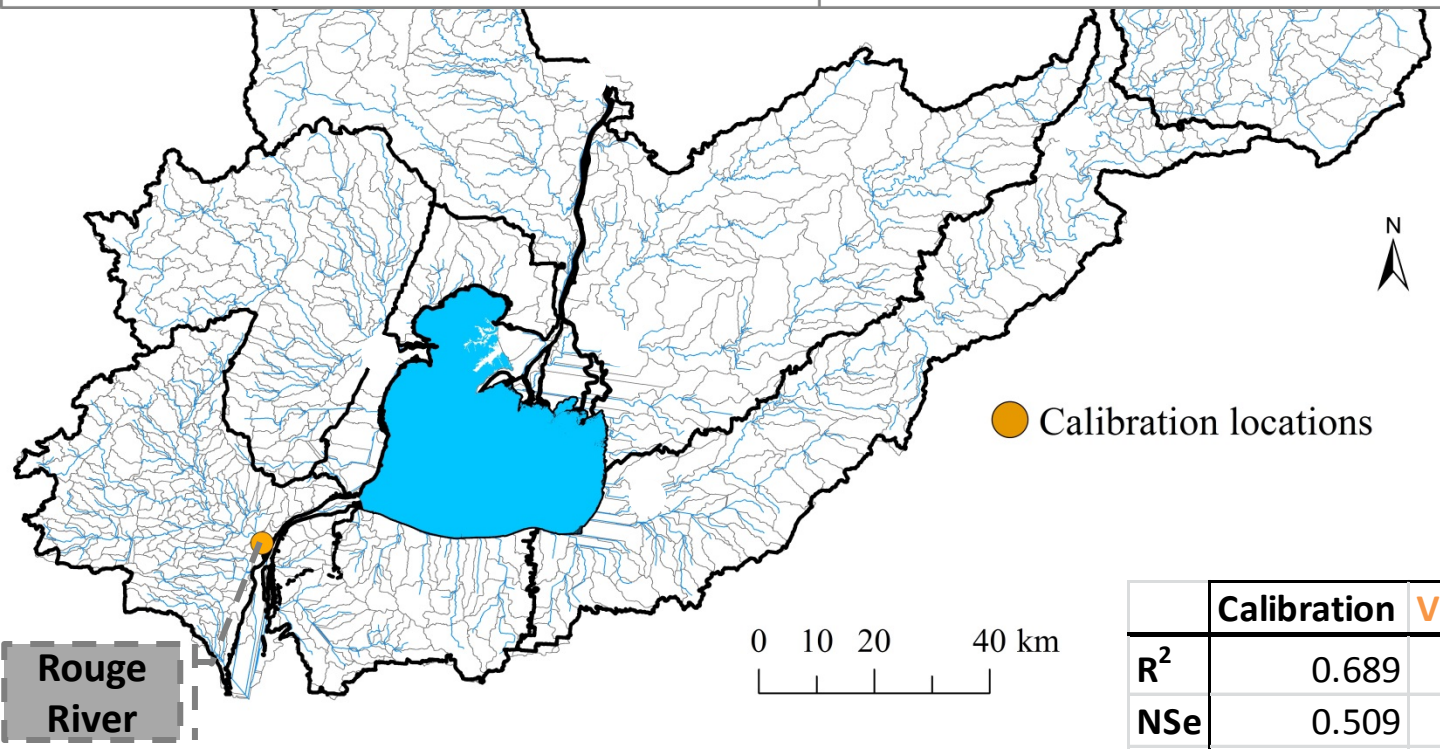




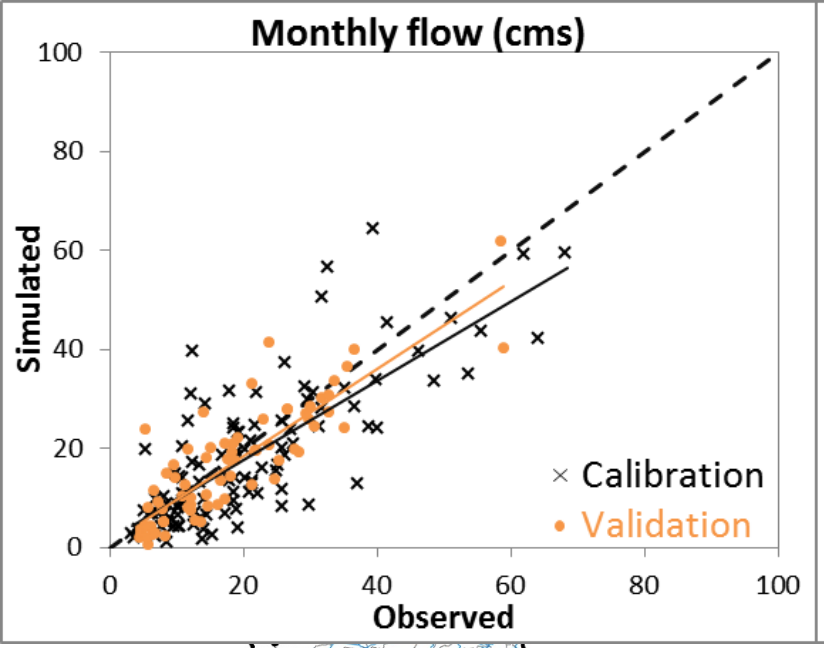
	Calibration	Validation	Satisfactory range
R^2	0.787	0.815	
NSe	0.780	0.806	> 0.50
PBs	-0.5	4.9	-25% to 25%

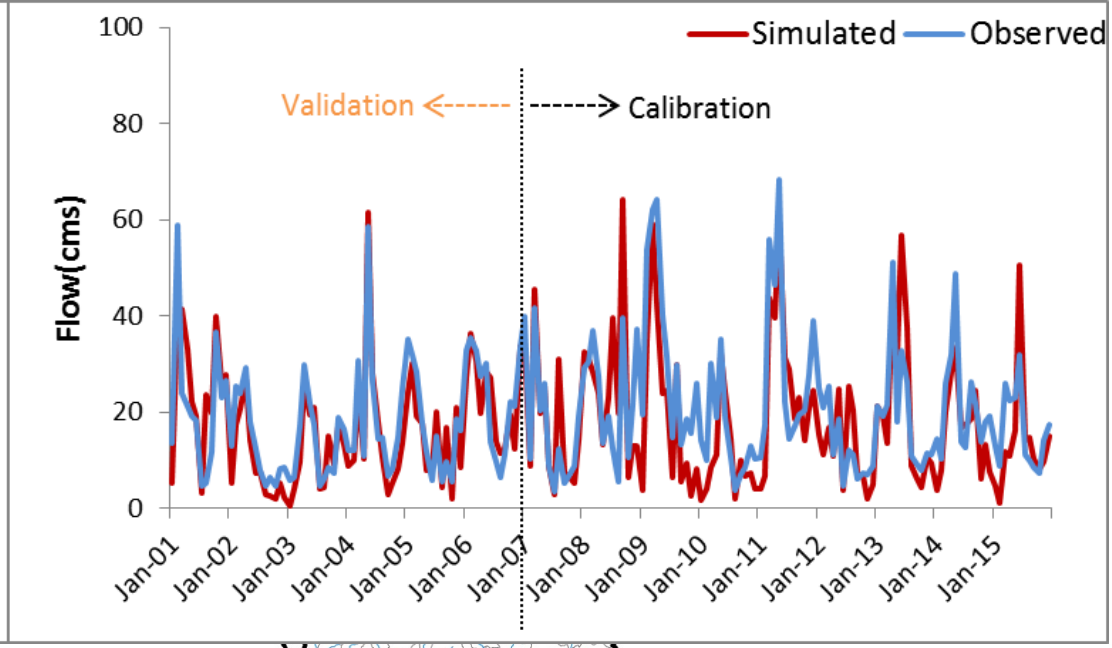


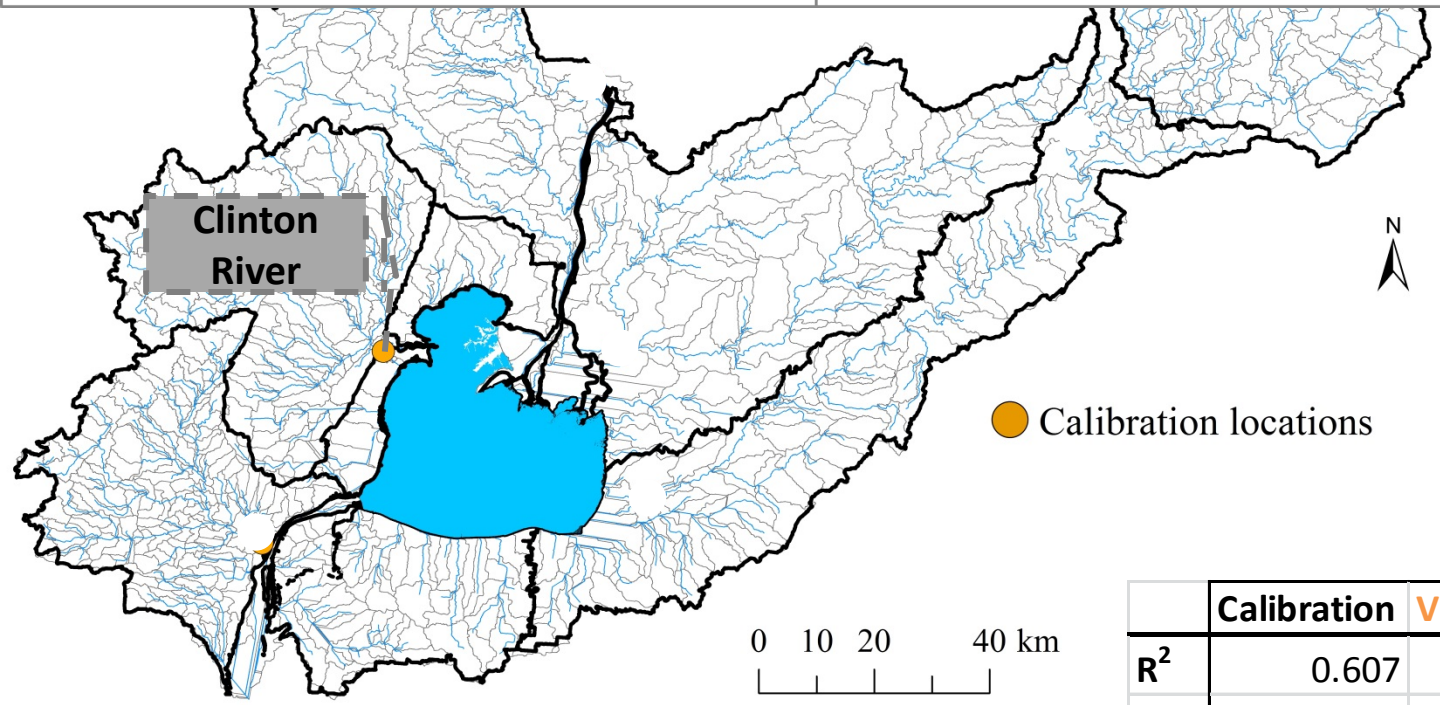




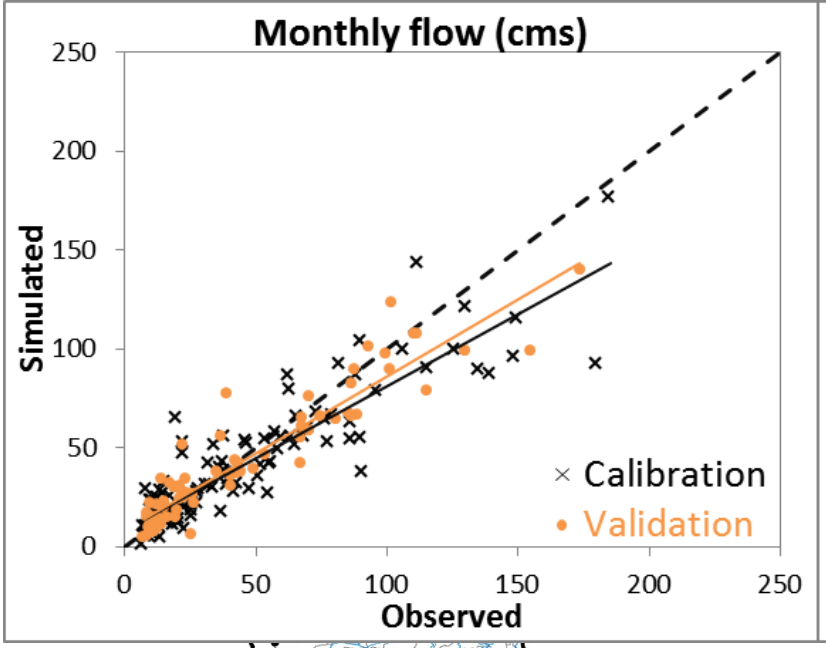
	Calibration	Validation	Satisfactory range
R^2	0.689	0.698	
NSe	0.509	0.562	> 0.50
PBs	3.9	-21.1	-25% to 25%

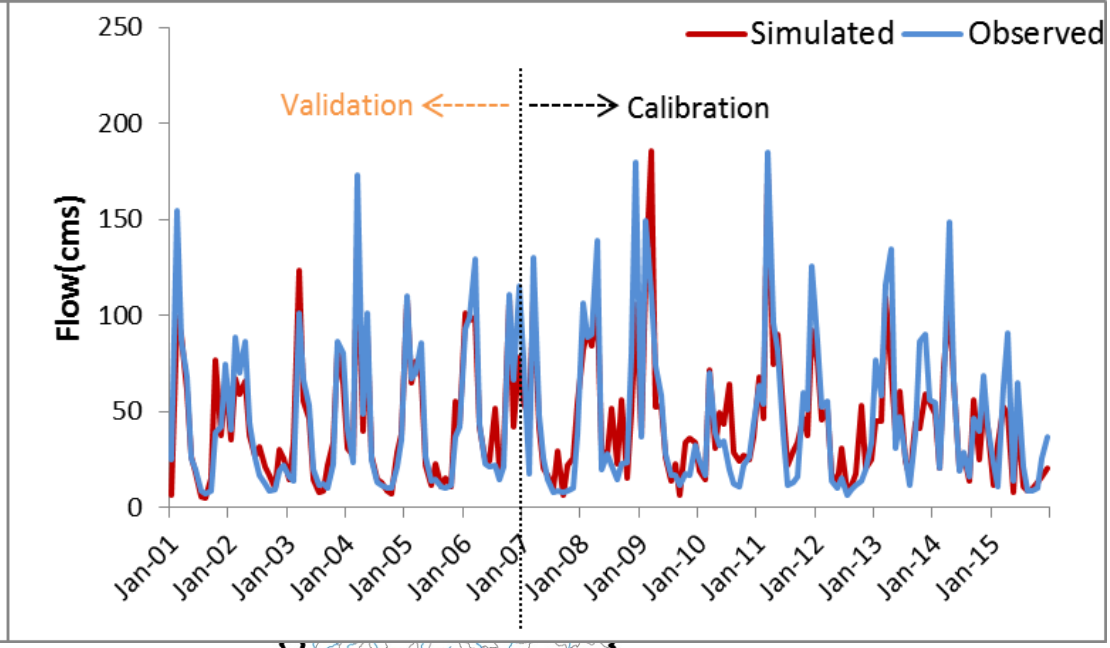


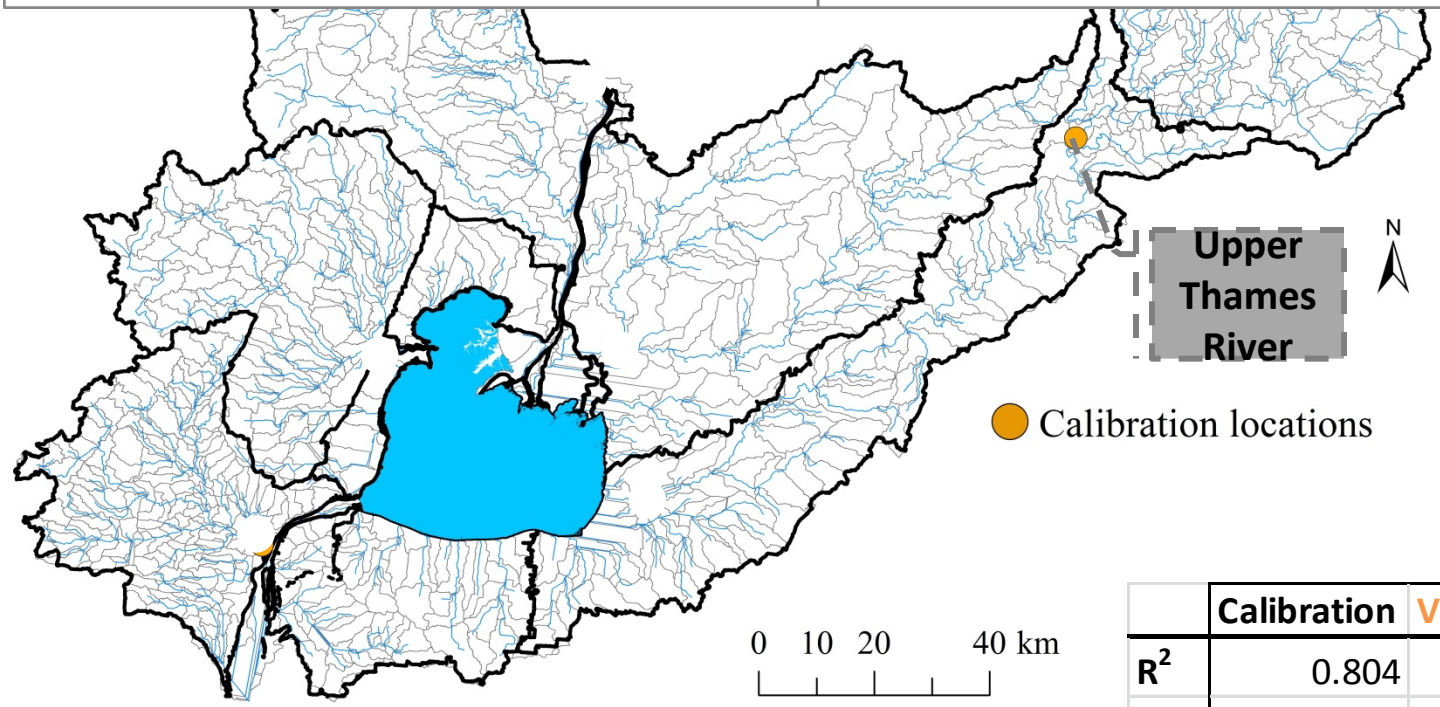




	Calibration	Validation	Satisfactory range
R^2	0.607	0.741	
NSe	0.508	0.706	> 0.50
PBs	-12.2	-6.5	-25% to 25%







	Calibration	Validation	Satisfactory range
R^2	0.804	0.876	
NSe	0.784	0.864	> 0.50
PBs	-9.7	-4.1	-25% to 25%

In progress

What crop was planted on this field in each year?

	2016	2015	2014
Corn	○	○	○
Soybeans	○	○	○
Wheat	○	○	○
Soybeans/Wheat double crop	○	○	○
Other	○	○	○

When was this field tilled during each year?

	2016	2015	2014
Winter (Dec. of prior year - February)	☐	☐	☐
Spring (March - May)	☐	☐	☐
Summer (June - August)	☐	☐	☐
Fall (September - November)	☐	☐	☐

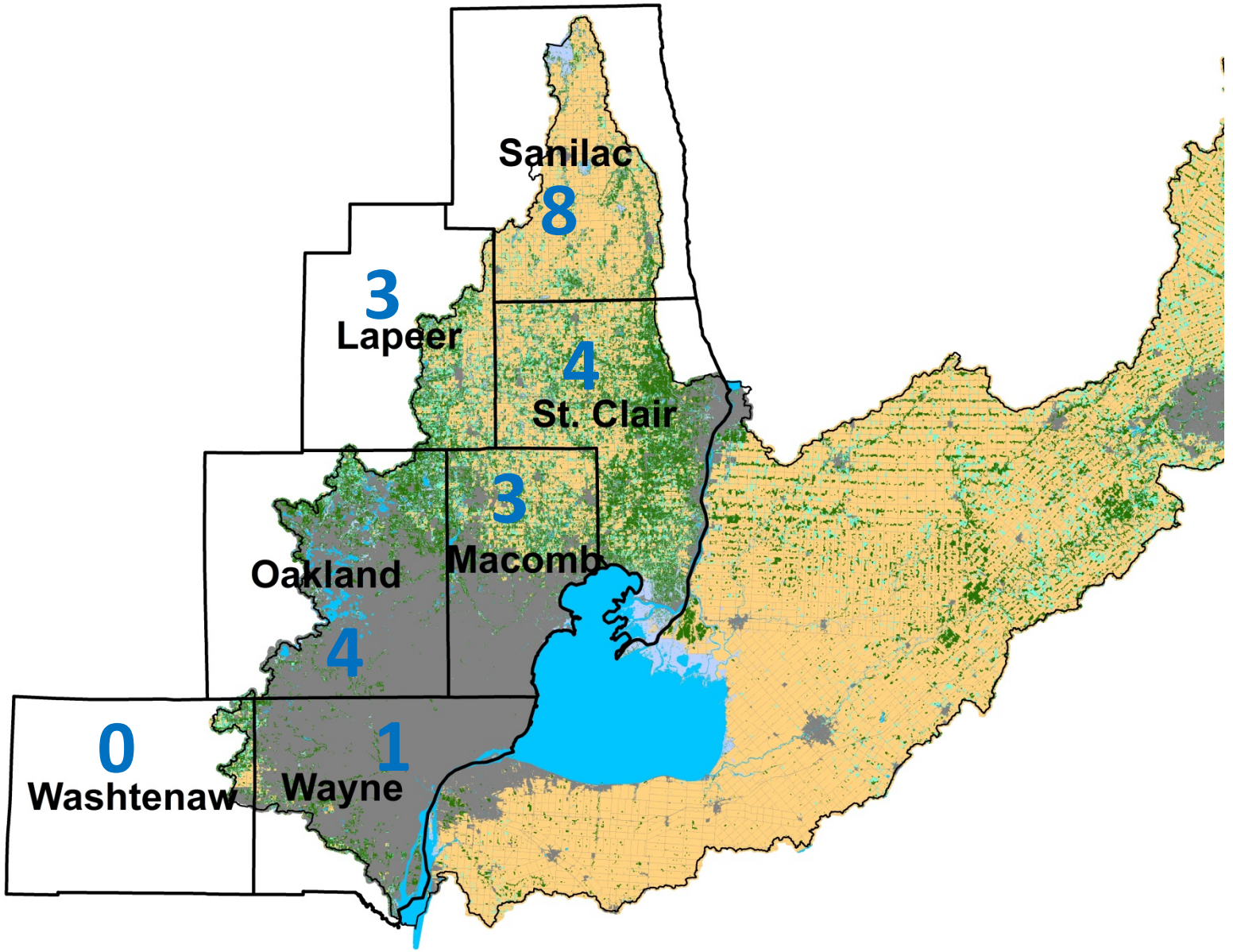
What kinds of implements were used on the field? (Select all that were used in each year.)

	2016	2015	2014
Chisel plow 	☐	☐	☐
Disk ripper 	☐	☐	☐

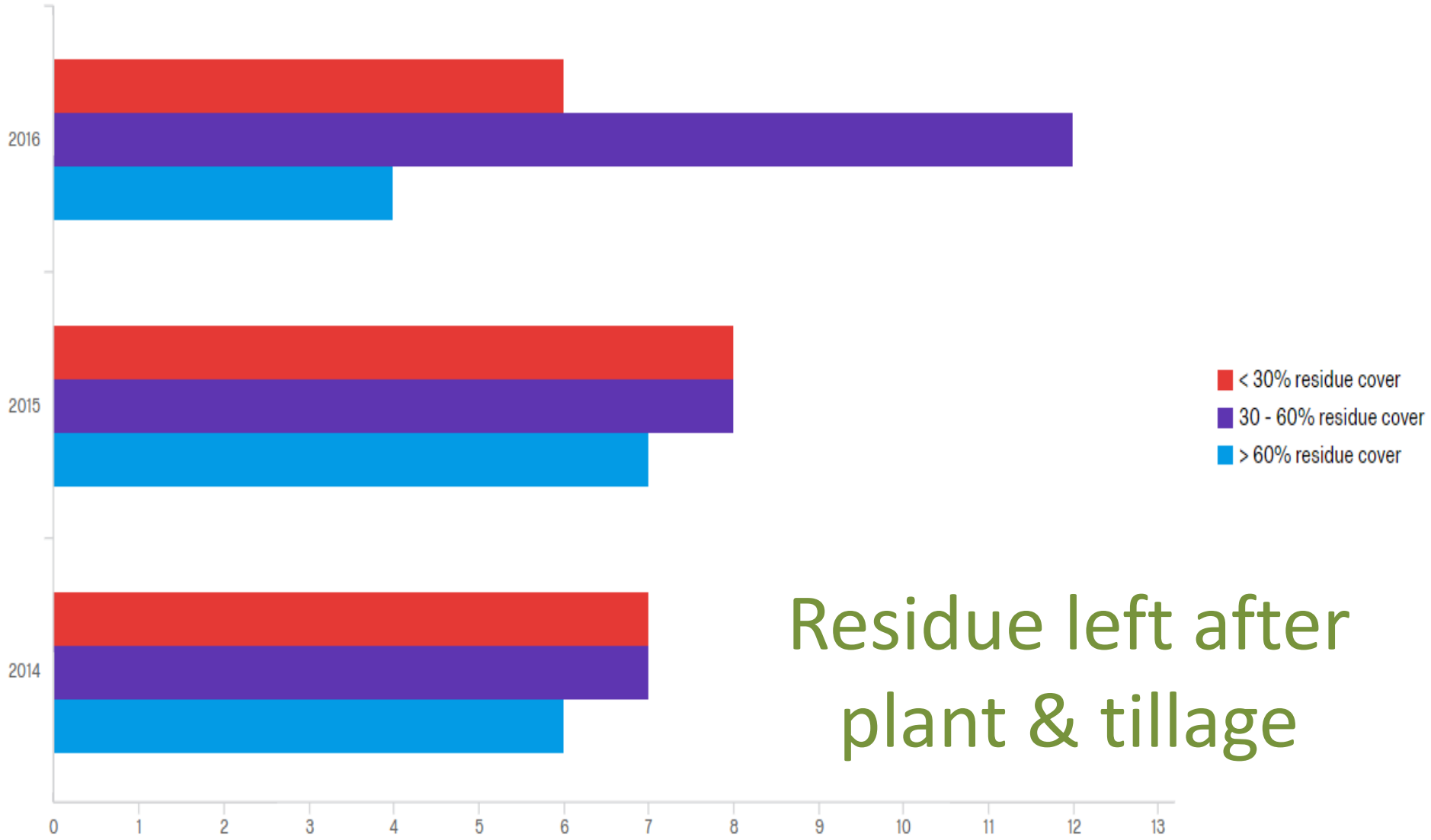
How much plant residue was left after any tillage and planting? Use the images here for reference.

	2016	2015	2014
< 30% residue cover 	☐	☐	☐
30 - 60% residue cover 	☐	☐	☐

Preliminary Survey Results *(26 respondents)*



Preliminary Survey Results *(26 respondents)*



Residue left after plant & tillage

Next Steps

- Nutrient and sediment calibration/validation
  - In progress
- Scenario development
  - Today's main discussion
- Scenario runs

Scenario Discussion

Outline

- General approach - *Lynn Vaccaro*
- Watershed model scenario development - *Awoke Teshager*
- Urban scenario development - *Branko Kerkez and Yao Hu*

As we select single practice scenarios to run before our next meeting, which practices are of most interest to you?

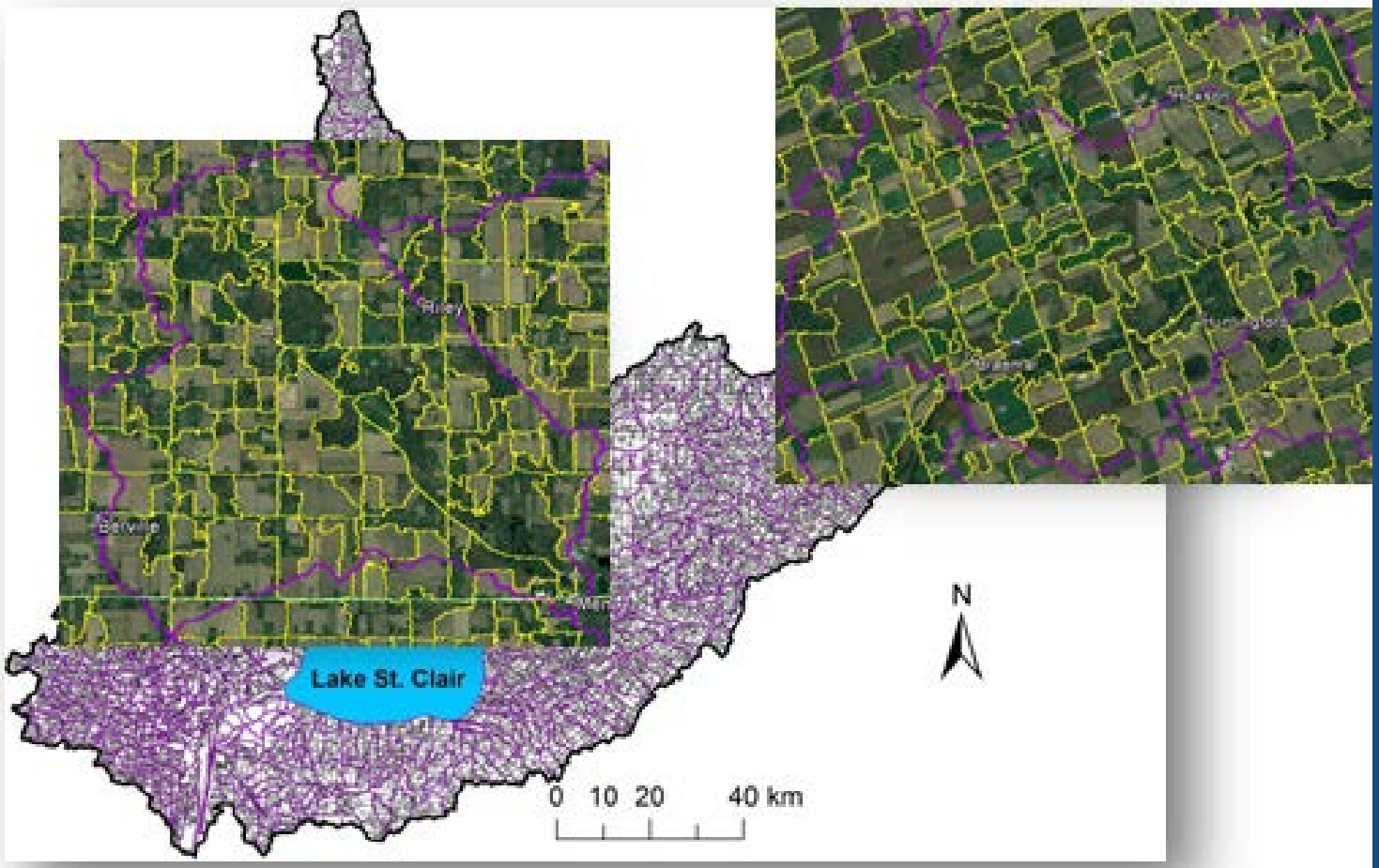
General Approach to Developing Scenarios

- Review list of ideas generated at prior meetings
- Develop a way to modify model parameters to represent the action
- Solicit input through smaller consultations as needed to revise details of placement or specifications.
- Run a select number of single practice / basic scenarios before our next meeting
- Discuss with group how to combine practices, actions, climate or other variables for more complex scenarios.

Approach to Developing Agricultural Scenarios

- Change input values
  - e.g., fertilizer/manure rates, point sources
- Change input methods
  - e.g., fertilizer/manure placement/timing/source, tillage
- Change cropping system
  - e.g., winter cover crop, crop rotation
- Implement management operations
  - e.g., filter strips, grassed waterways, wetlands, controlled drainage

Spatial Resolution for Scenarios Implementation - HRUs/Subbasins



Subbasins:
- 800
- ~24 km²

HRUs:
- 27751
- ~69 ha

Potential Agricultural Practices to Test

As we select scenarios to run before our next meeting, which single practice agricultural scenarios are of most interest to you?

(Choose up to 2 from each list)

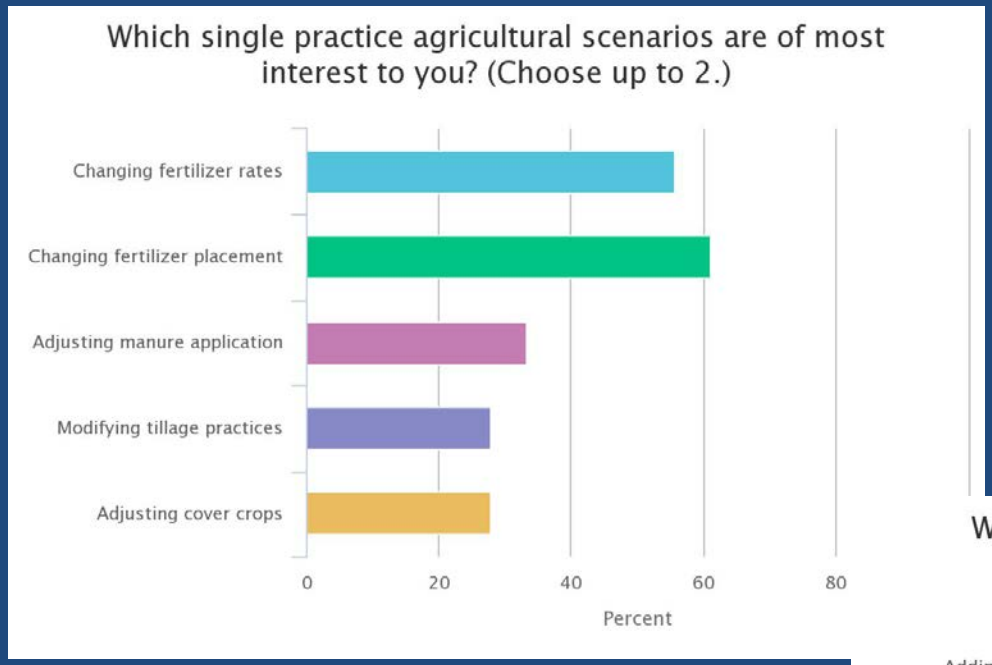
Poll # 1 Options:

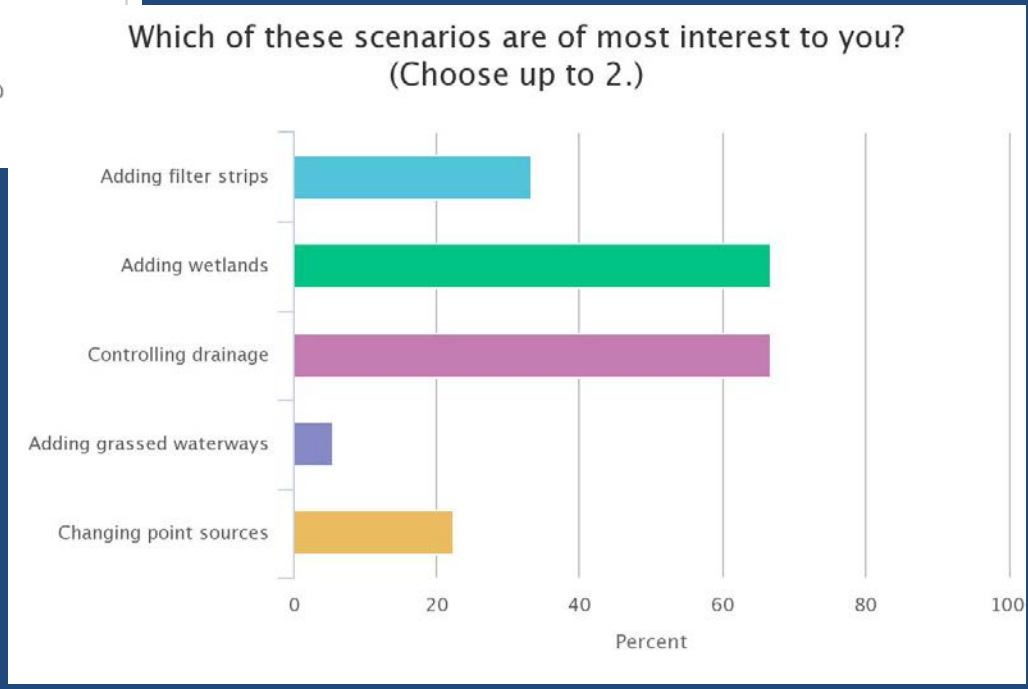
1. Changing fertilizer rates
2. Changing fertilizer placement
3. Adjusting manure application
4. Modifying tillage practices
5. Adjusting cover crops

Poll # 2 Options:

1. Adding filter strips
2. Adding wetlands
3. Controlling drainage
4. Adding grassed waterways
5. Changing point sources

Polling results





Developing more Complex Agricultural Scenarios

Potential approaches:

A. Work backwards from targets, what is required?
B. Focus on elements in Domestic Action Plans and evaluate potential impacts.

Other ideas we continue to think about:

- Land ownership
- Customized farm conservation plans
- Greenhouses
- Implementation costs

Urban Model: Status Update

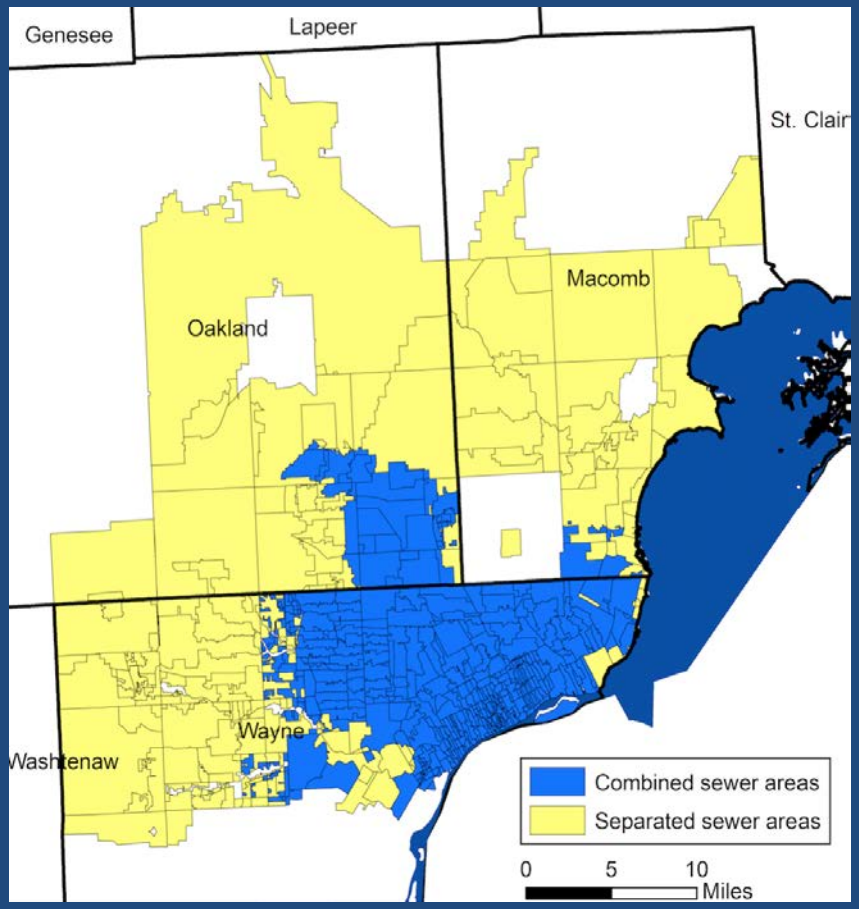
First Phase: Analysis of nutrient sources in urban areas

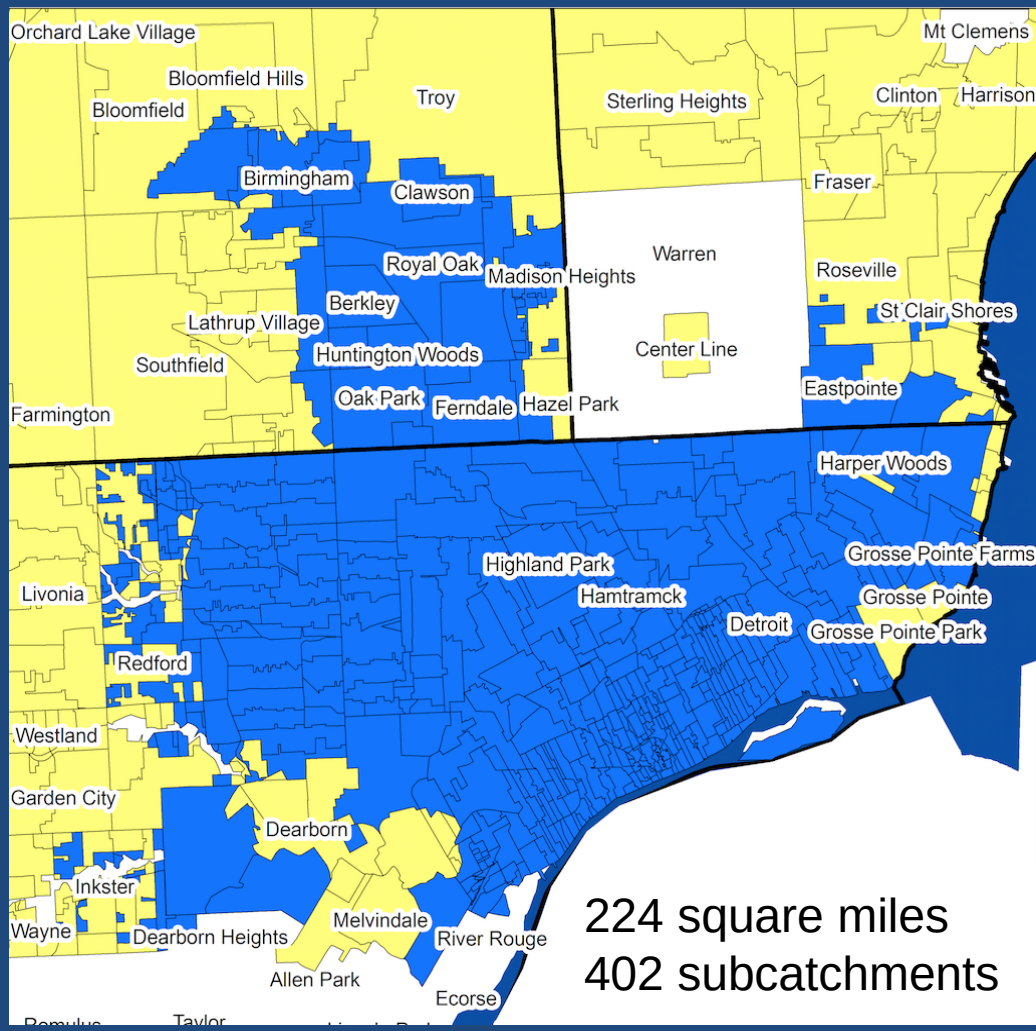
- Point sources
- Treated and untreated CSOs
- Run-off

Urban Model: Status Update

Phase Two:

Development and calibration of pipe-scale Detroit model



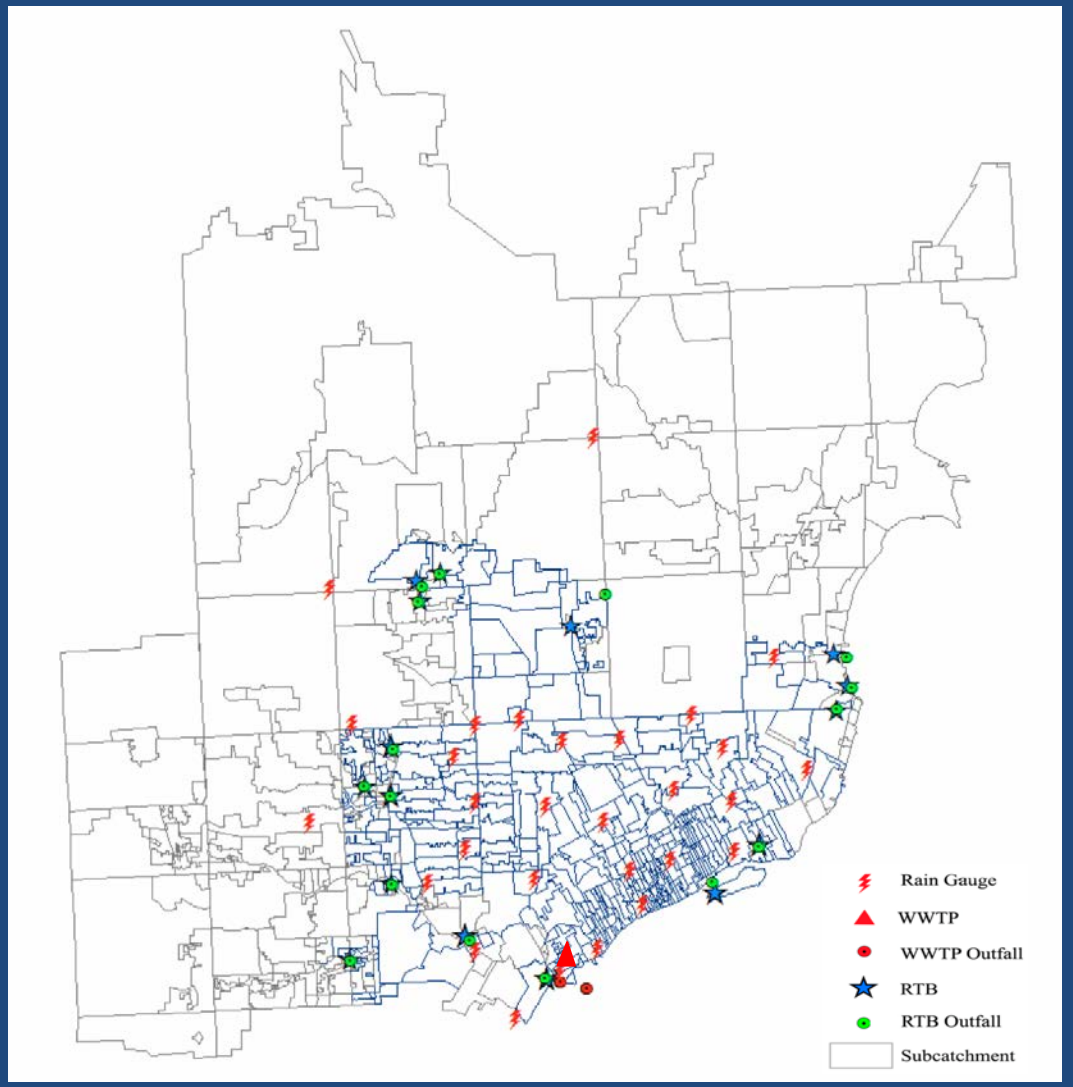


Development and Calibration

Two-tiered approach

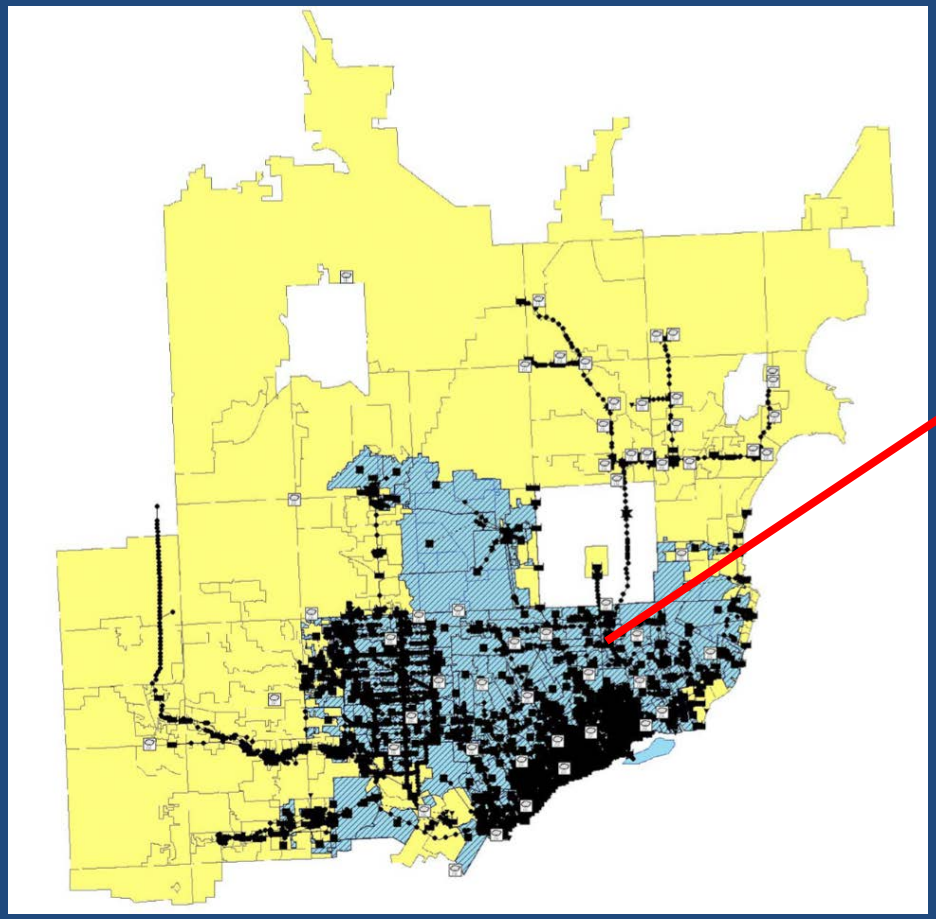
1. Physical Model (SWMM) that represents rainfall response and flow through pipe
2. Data-driven layer that corrects physical model based on actual sensor measurements

Calibrated using flow sensors from 3 interceptors and 29 rain gauges.



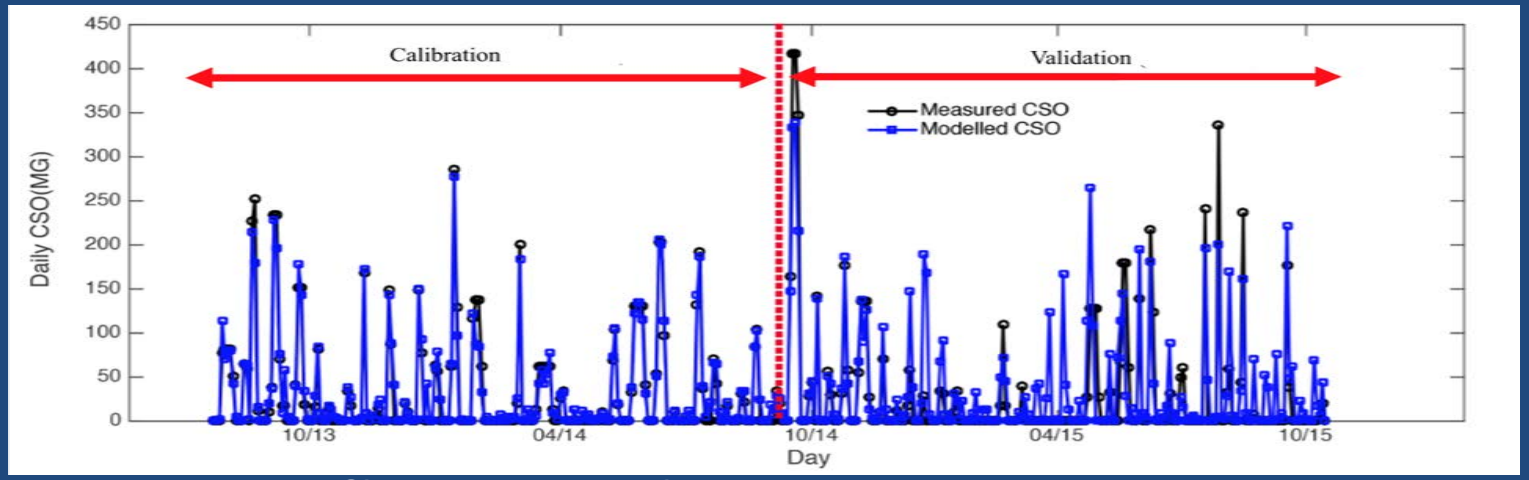
Capabilities

Model at the level of major pipes and interceptors

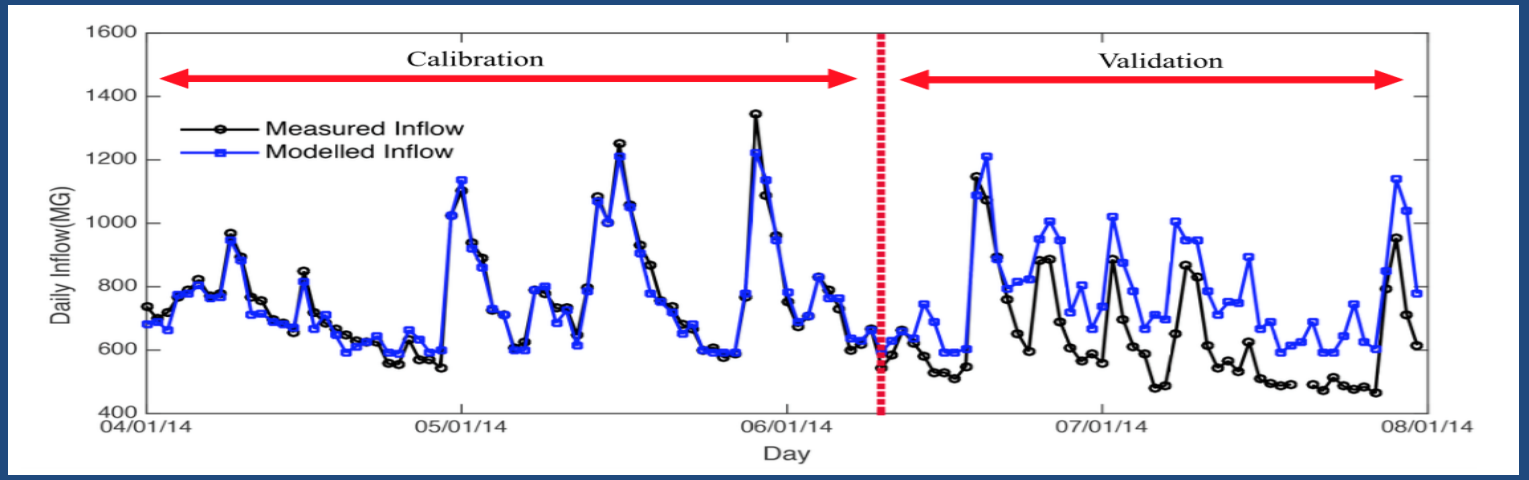


Preliminary performance

Predict flows at individual CSO outfall



Predict inflows to the wastewater treatment plant

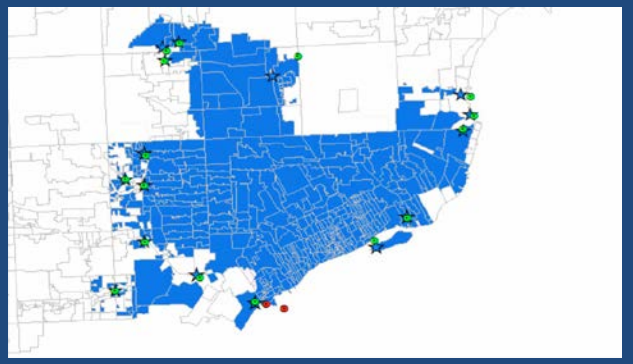


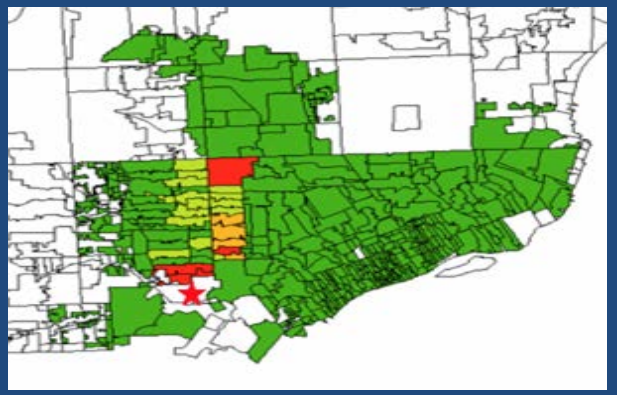
Calibration/validation using 3 flow sensors from 04/14-07/14 and 29 rain gauges from 05/13-12/15.

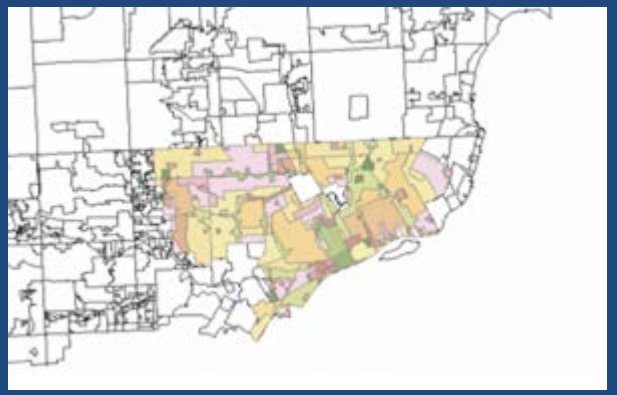
Approach to Developing Urban Scenarios

- Now that we are close to having a reliable model, we can test a variety of scenarios by
  1. Determining where the current system is most stressed and critical
  2. Adding new elements to the system, or
  3. Redesigning the system

- We can then measure outcomes across
  1. Inflow to WWTP
  2. CSO discharges
  3. Runoff volume
  4. TP loads







Feedback on Green Infrastructure Scenarios

- Green infrastructure (GI) Scenario
  - Select the places to implement GI (% of each subcatchment).
  - Test different GI practices by changing infiltration parameters in each subcatchment
  - Evaluate the impact of GI on inflow and CSOs.

As we select single practice scenarios to run before our next meeting, which GI practices are of most interest to you?

Polling Options:

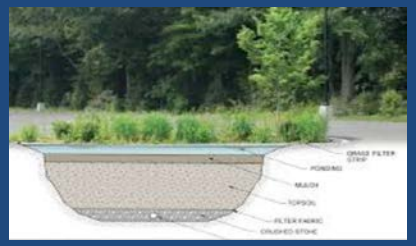
1. Rainwater harvesting
2. Permeable pavement
3. Bioretention
4. Green roofs

Rain Barrel

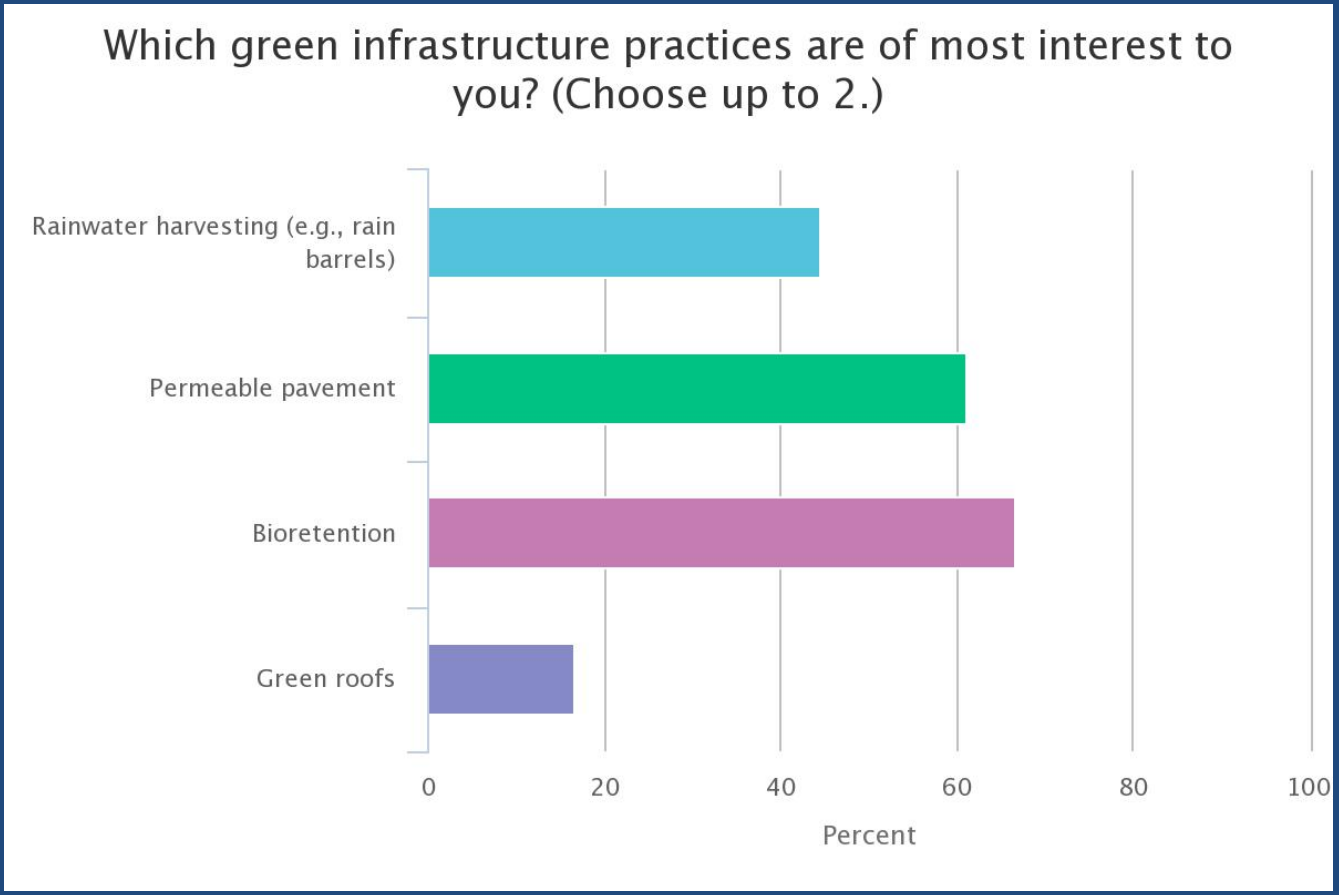
Permeable Pavement

Green Roof

Bioretention Cell



Polling results



Potential Urban Solutions to Test

Potential Approaches:

1. Evaluate the impact of existing green infrastructure plans for Detroit treatment plant inflows and CSO discharges.
2. Are there ways to optimize the placement of green infrastructure to stabilize inflow and reduce CSOs?
3. Evaluate the influence of different subcatchments on inflows and CSOs and test the impact of removing their stormwater from the system.
4. Identify underutilized portions of the system and evaluate the potential of retrofit. Are there any opportunities to optimize storage within the sewer collection system?

Upcoming Advisory Group Meetings

- Annual Meeting: February 2018, in Windsor
  - Calibration results for water quality parameters
  - Initial scenario runs
- Conference Call: Summer 2018
  - Draft results, communication plans
- Final Meeting: December 2018, in Ann Arbor
  - Draft report, communication products

Which days work best for our annual in person advisory group meeting?

- Noon, Wed Feb. 7 — noon, Thurs, Feb 8
- Noon, Thurs Feb. 8 — noon, Fri, Feb 9
- Noon, Tues, Feb 13 —noon, Wed, Feb 14
- Noon, Wed, Feb 21 — noon, Thurs, Feb. 22

Final Comments

What's most important for us to keep in mind as we finalize models and begin scenario development and testing?

Thank You!