



# **Water and its Economic Advantage for Michigan's Food and Agriculture System**

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**Michigan Commission of Agriculture and Rural Development  
September 17<sup>th</sup>, 2014**

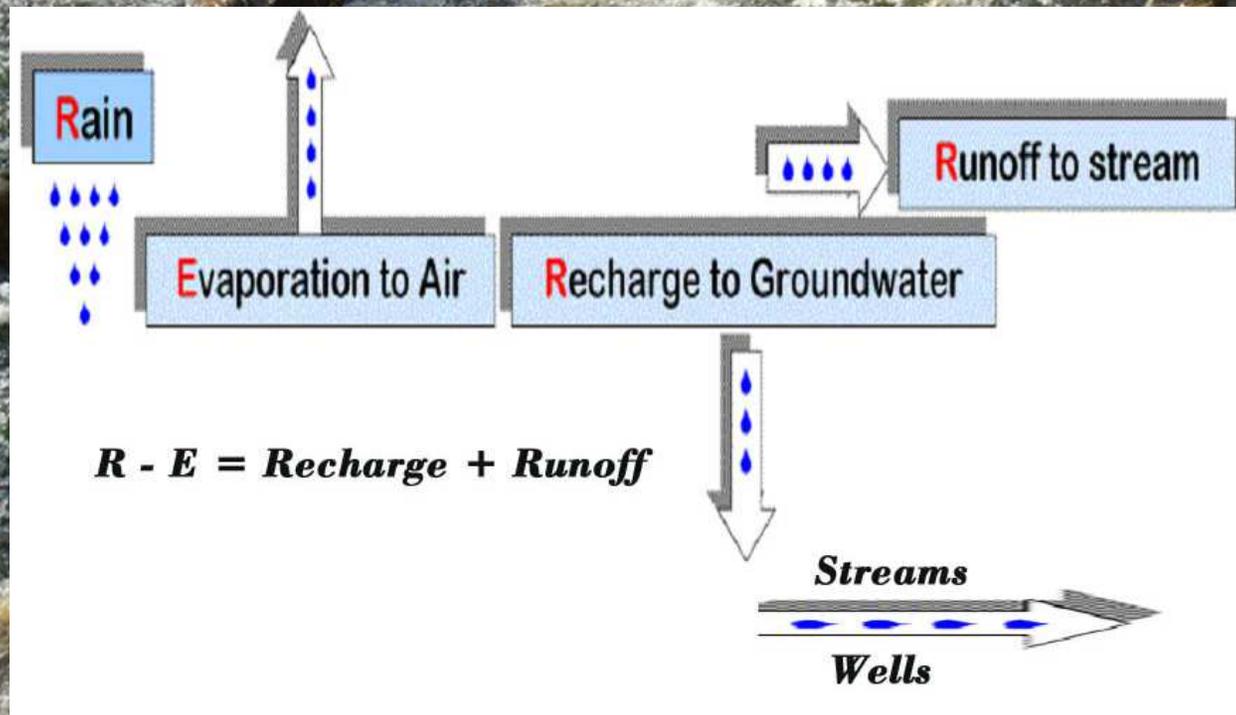


## Drawing from Recent White Paper

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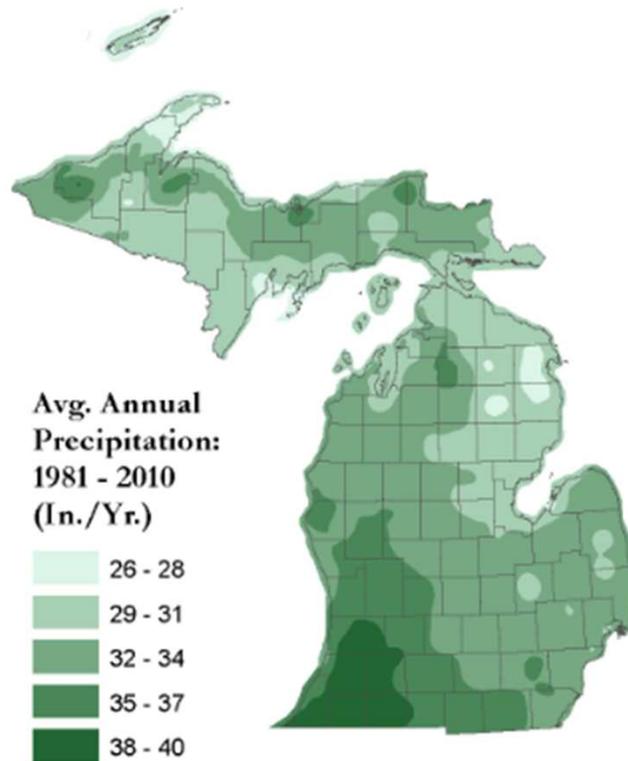
- The Water Cycle
- Water Strategy in Michigan
  - Water Quantity
  - Water Quality
- Water Resource Study – Ottawa County

# Water Cycle

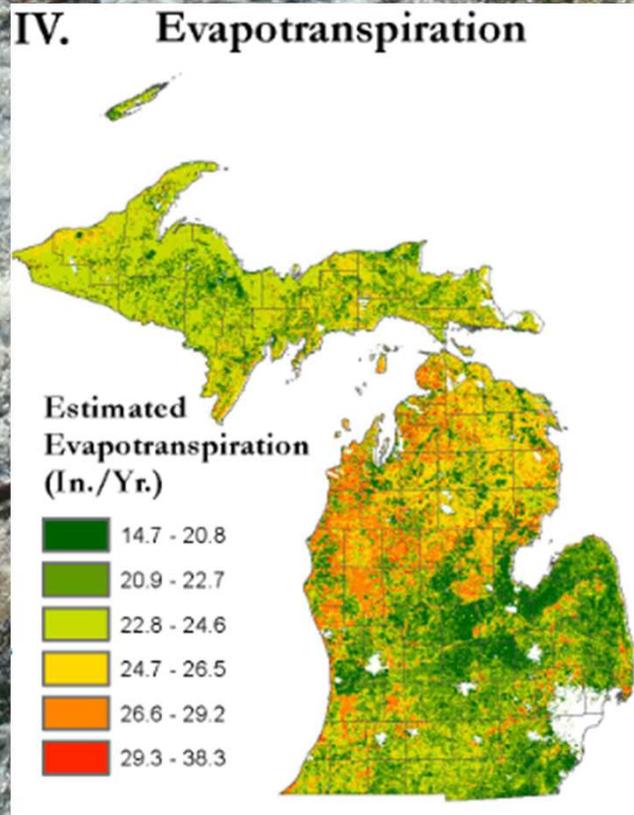


# Annual Precipitation

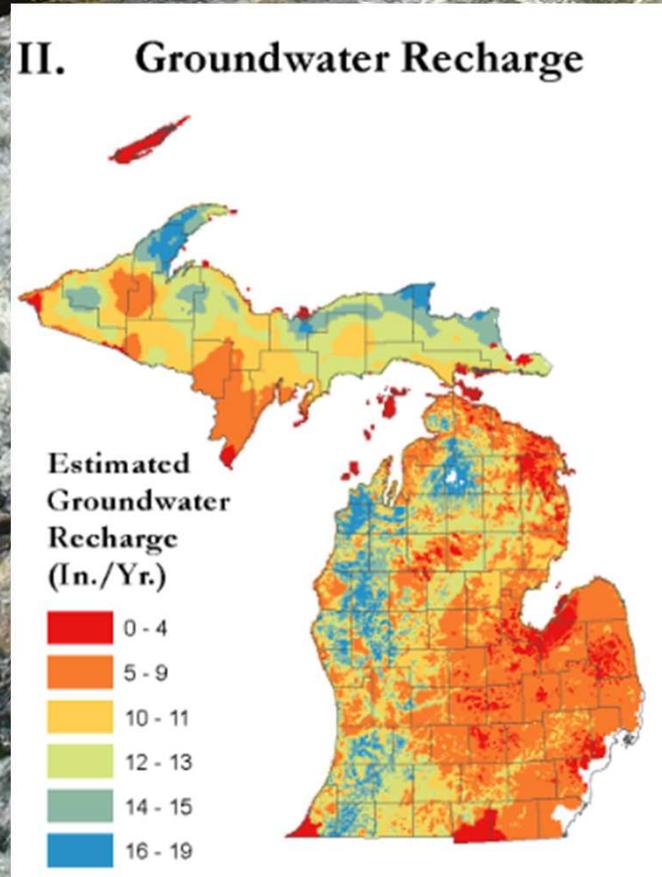
## I. Annual Precipitation



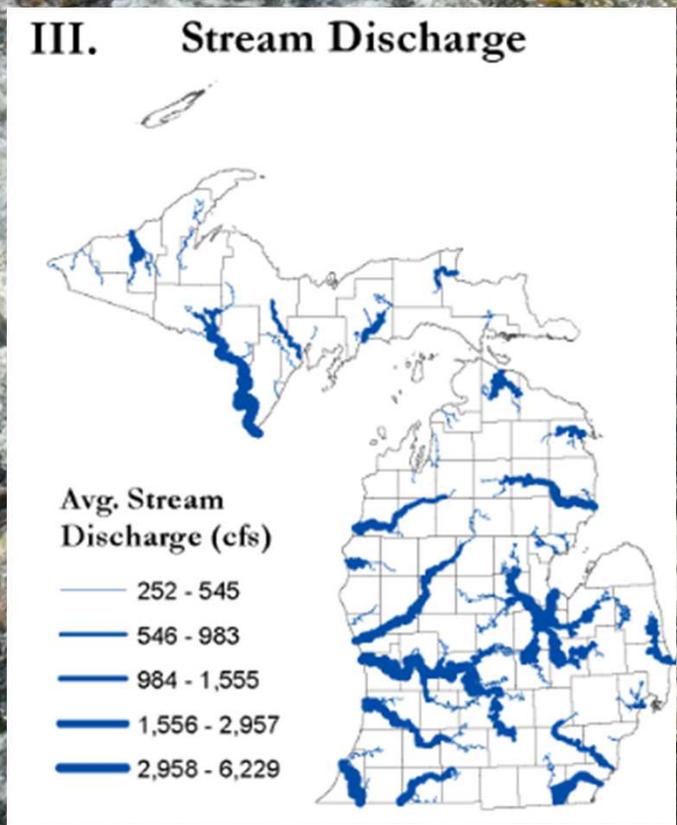
# Evapotranspiration



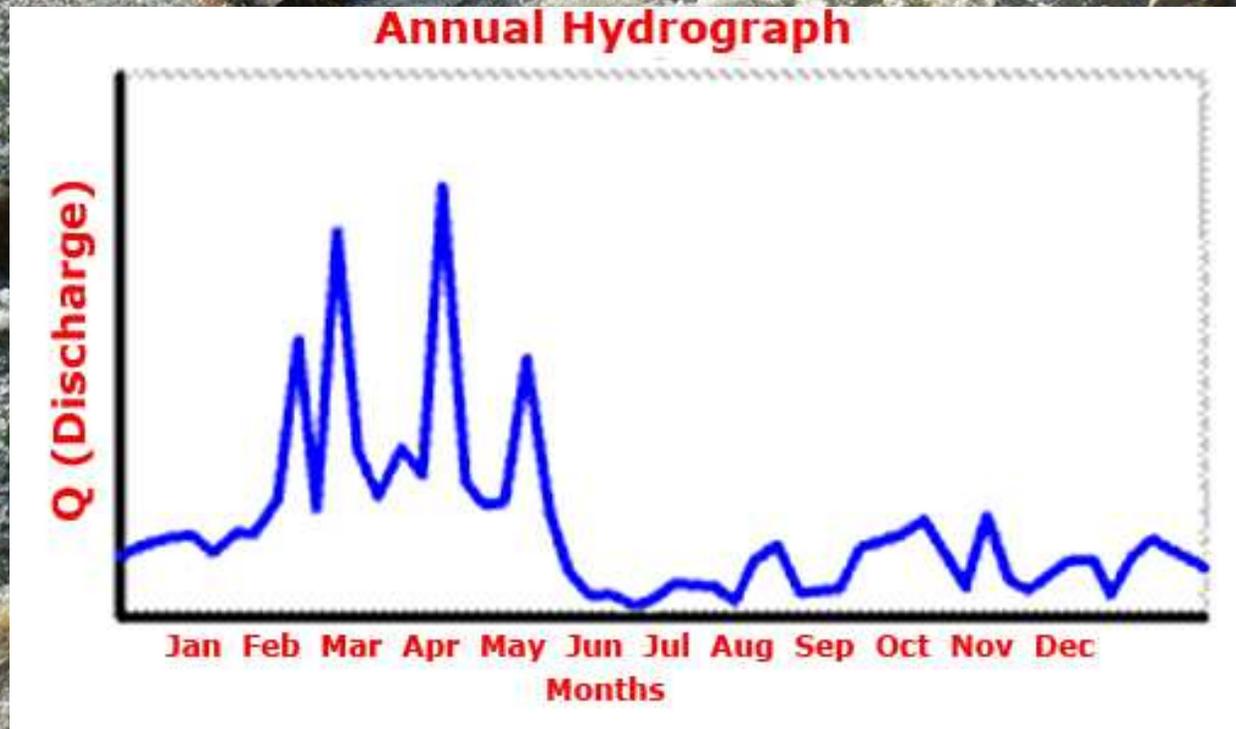
# Groundwater Recharge



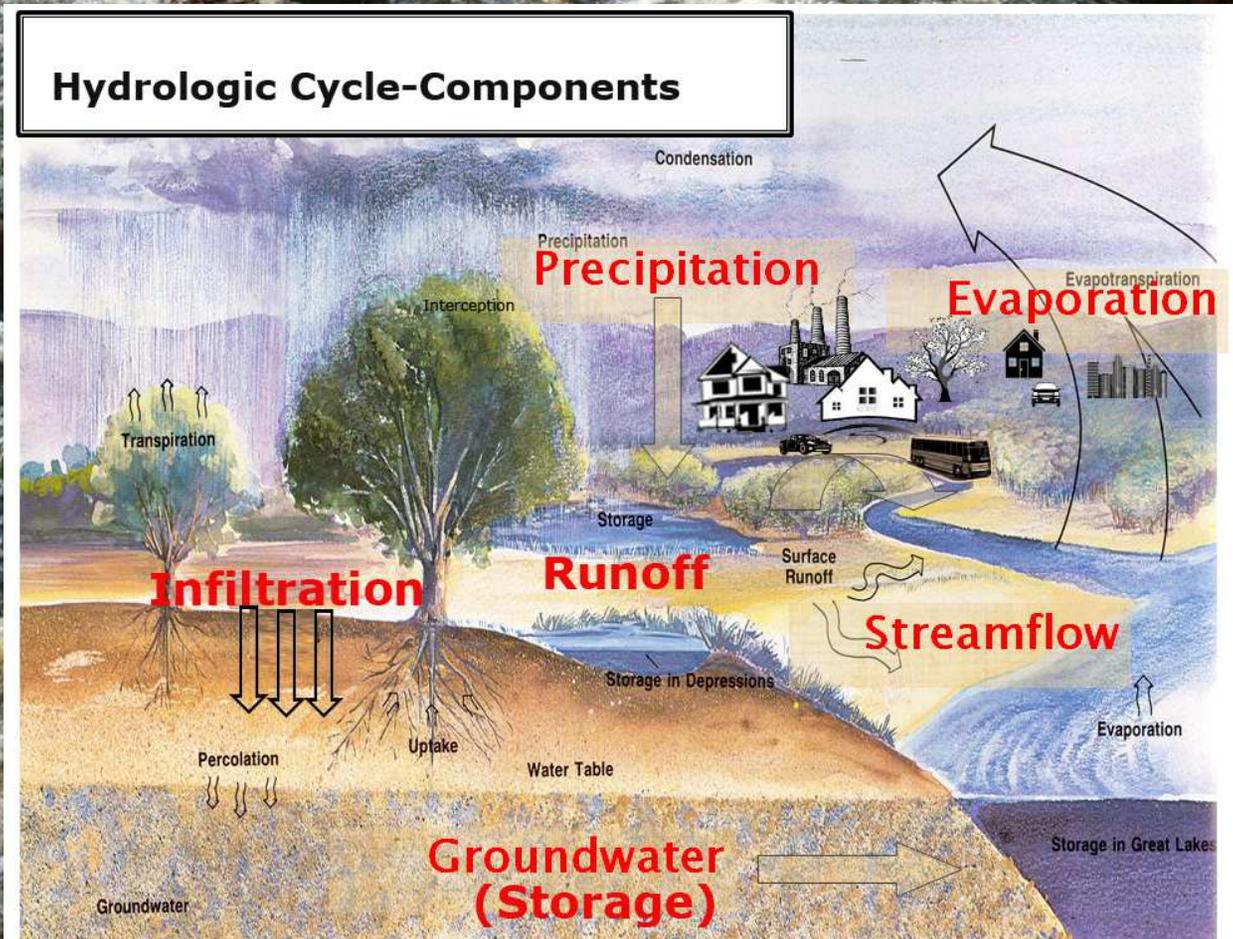
# Stream Discharge



# Annual Hydrograph



# Water Cycle



A photograph of a stream with white water rapids, rocks, and fallen leaves. The water is turbulent and white with foam as it flows over dark, wet rocks. Numerous yellow and brown leaves are scattered throughout the water and along the banks. The scene is captured from a slightly elevated angle, showing the flow of the water from the top left towards the bottom right.

# Water Quantity

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# Water Strategy for Michigan: Agricultural Expansion and Water Resource Protection

Dr. Jon Bartholic  
Michigan State University  
Institute of Water Research



# Topic Overview

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- As Michiganders, we can work together to provide a system that is fair, equitable and ***assures sustainable water resources***
- Sustainable water management is within the best interests of both **water users** (e.g., irrigators, industry, municipalities) and the **public**

# Growing Agricultural Demand for Water

- World's population is expected to expand from 7 to 9 billion by 2050
- Agricultural industry is growing annually and has significant implications for future water demand considerations
- Water quality impacts in Ottawa County



# Policy Basis of Regulatory Framework

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- Passage of Great Lakes Compact and package of bills in 2008 established a new water management process and **Water Withdrawal Assessment Tool (WWAT)**
- **WWAT** is a screening tool created and used by the state to evaluate the potential impact of large quantity withdrawals on nearby rivers and streams.
- Watersheds that are fully subscribed in the WWAT's accounting database may convene a local **Water Users Committee** to determine how resources will be shared among users. They are *encouraged* but not mandated.

# Effective Governance Structure: Michigan's Systems

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- Water Users Committees can:
  - Evaluate the status of current water resources, water use and trends in water use within a watershed
  - Structure a voluntary agreement among water users to prevent an ARI, but not mandated
- Serious consideration needs to be given to overall effectiveness of committees, including their strength, roles, and limitations

# Water Strategy

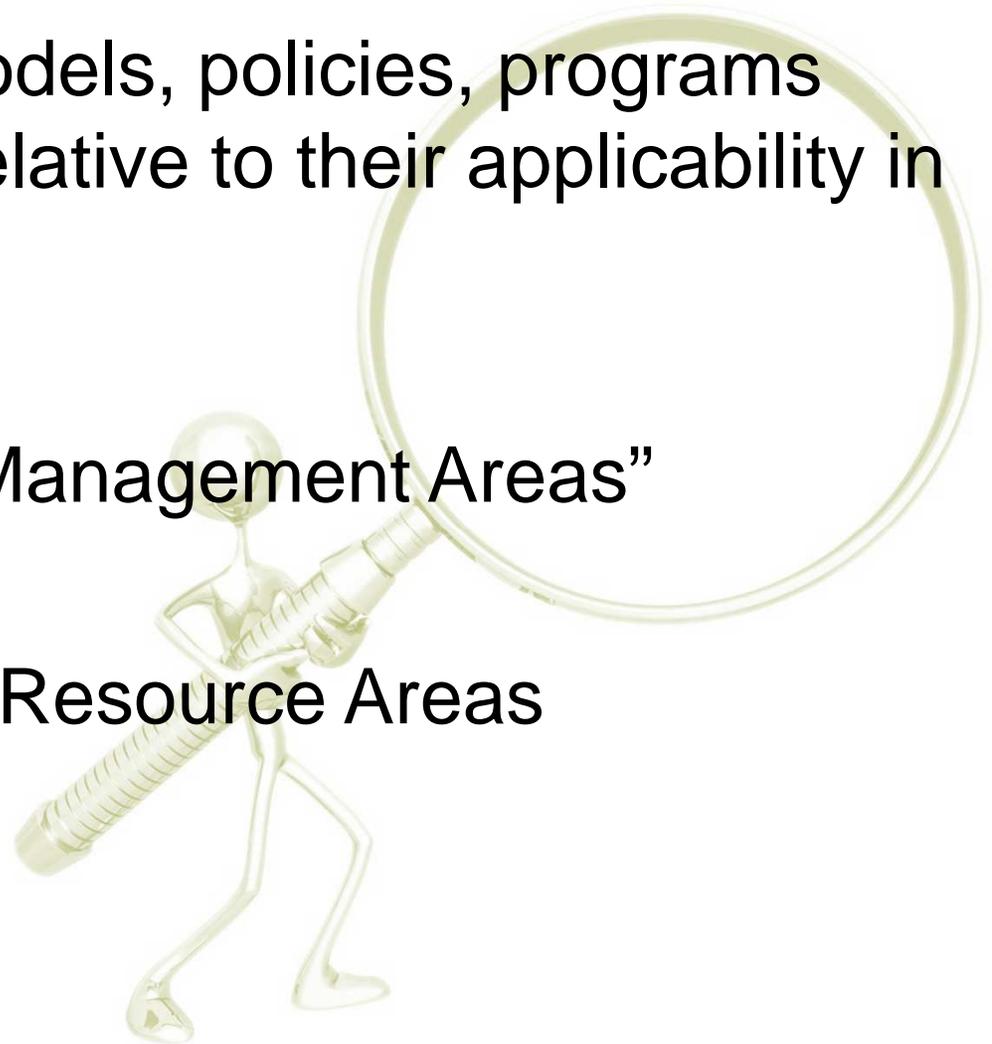
Water Quantity:  
Expanding Use of Agricultural Tile Drainage



# Effective Governance Structure: Learning from Other States

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- Exploring other models, policies, programs and approaches relative to their applicability in Michigan
- Arizona's "Active Management Areas"
- Nebraska's Water Resource Areas



# Crowd Hydrology



A photograph of a stream with white water rapids, rocks, and fallen leaves. The text "Water Quality" is overlaid in blue.

# Water Quality

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# Presentation Outline

- ❖ The BIG Picture
  - ❖ Food
  - ❖ Environmental Sustainability
- ❖ Example Situations
  - ❖ Large Scale
  - ❖ Local
- ❖ Information Technology (GIS) assistance
  - ❖ ELUCID
  - ❖ GLWMS
- ❖ Working Together
  - ❖ Integrated System for Sustainable Ecosystems

# Demand

## WORLD POPULATION

**1950    2.5 Billion**

**2011    7.0 Billion**

**2050    9.2 Billion**

Source:  
United Nations

# Water Quality: Saginaw Bay



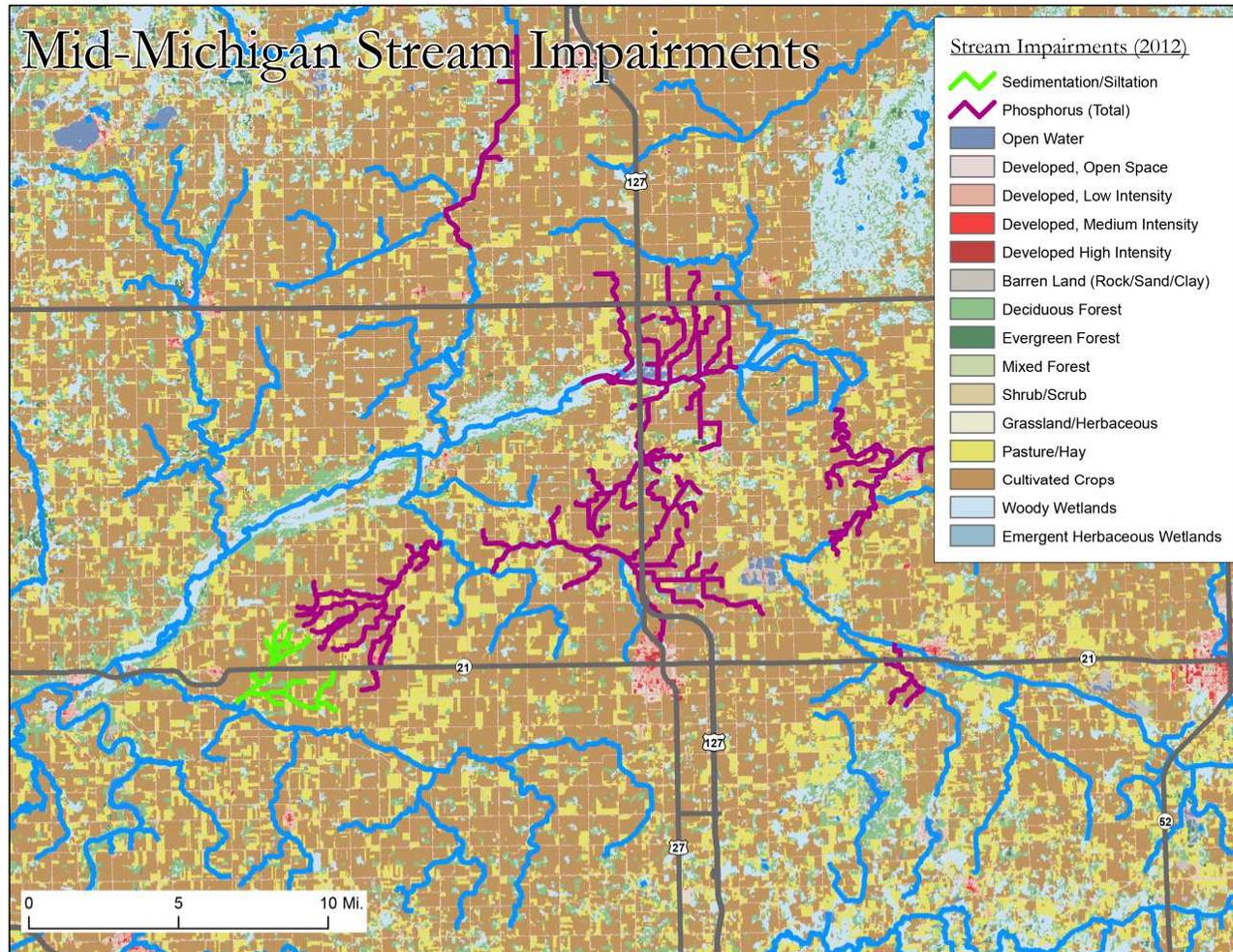
# Water Quality: Lake Erie



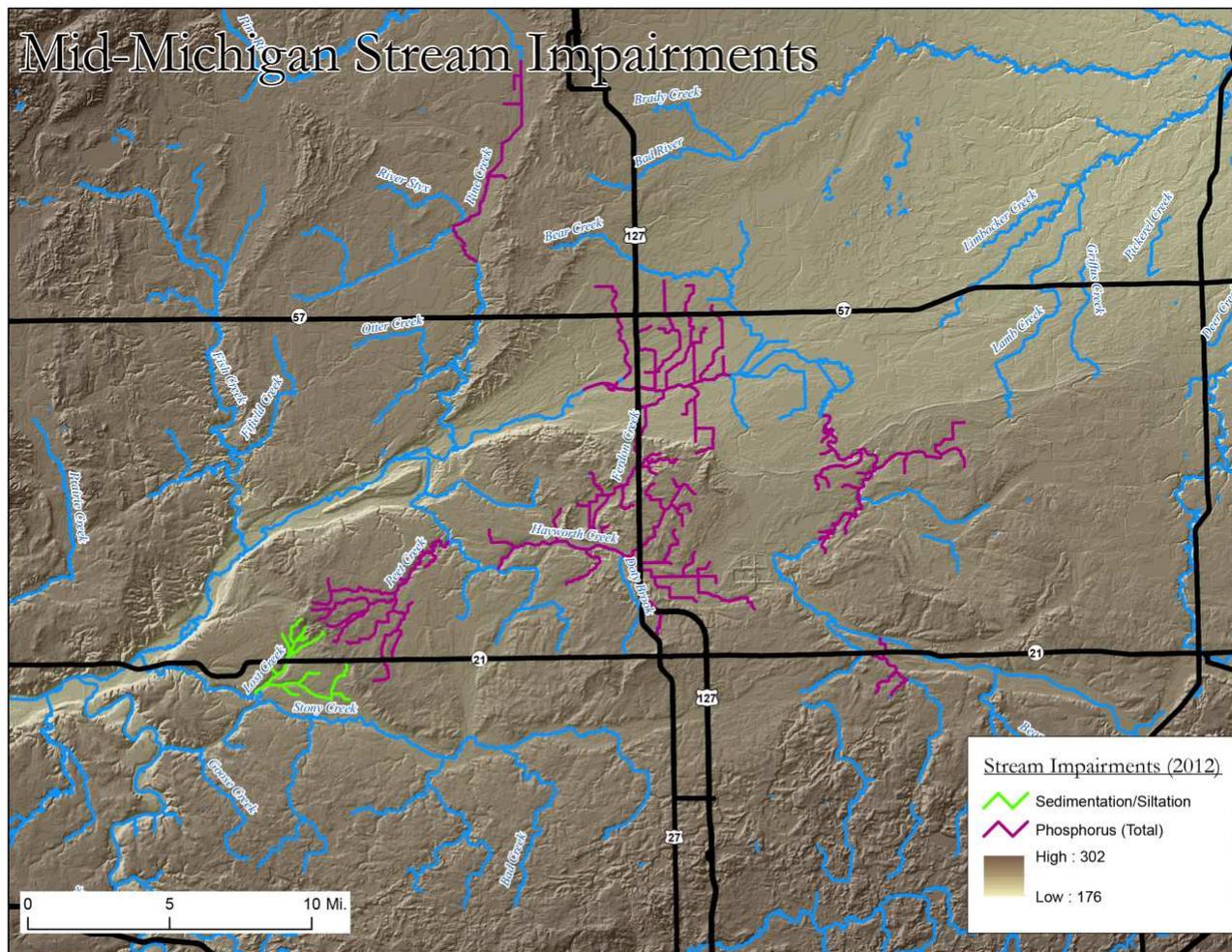
# Water Quality: Lake Erie



# Mid-Michigan Water Quality



# Mid-Michigan Water Quality



# Solutions

ELUCID

[elucid.iwr.msu.edu](http://elucid.iwr.msu.edu)

The Great Lakes Watershed Management System

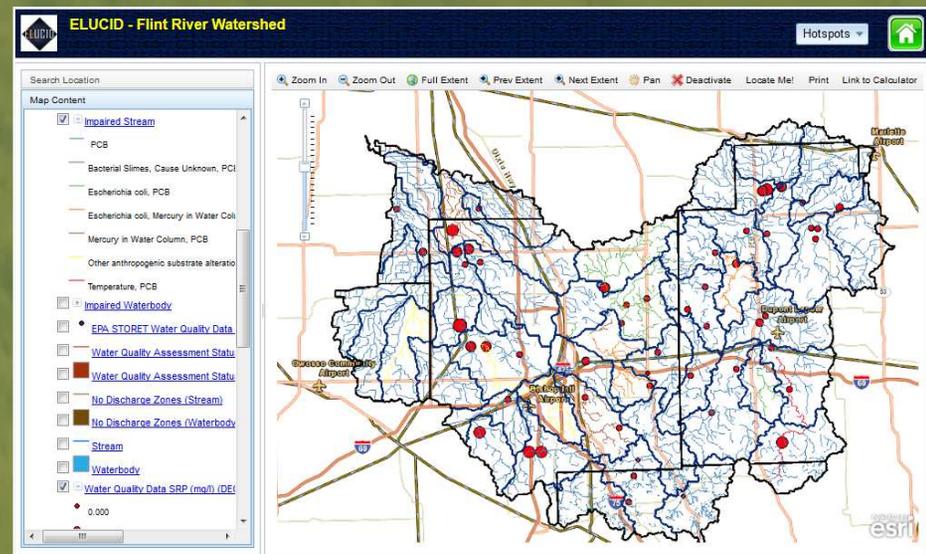
[www.iwr.msu.edu/glwms](http://www.iwr.msu.edu/glwms)

# ELUCID

❖ *Environmental Learning Using Computer Interactive Decisions*

❖ Developed through a GLRI project

❖ Flint River Watershed



# Great Lakes Watershed Management System

- ❖ Provides baseline non-point source pollution model estimates at field-scales



# ELUCID

## ELUCID - Flint River Watershed

The ELUCID (Environmental Learning Using Computer Interactive Decisions) tool uses data and modeling results from multiple sources to support natural resource conservation. The common scenarios addressed here include Water Quality, Land Protection, Urban Planning, Stormwater Management and Project Mapping. The manual of the system can be accessed [here](#). The answers to frequently asked questions (FAQ) can be found [here](#). For more information about the system and the upcoming updates, you can visit the [project website](#). You may also email [IWR staff](#) with questions and comments.

### - Generic Entry



#### Go to Generic Entry Map

The Generic Entry Map allows users to select their own data layers to show on the map. It's intended for conservation technicians in the field. T...



### + Water Quality

### + Land Protection

### + Urban Planning

### + Stormwater Management

### + Project Mapping

### + School District

### + Flint River Watershed Tour

# ELUCID

**ELUCID - Flint River Watershed** Hotspots

Search Location: \_\_\_\_\_

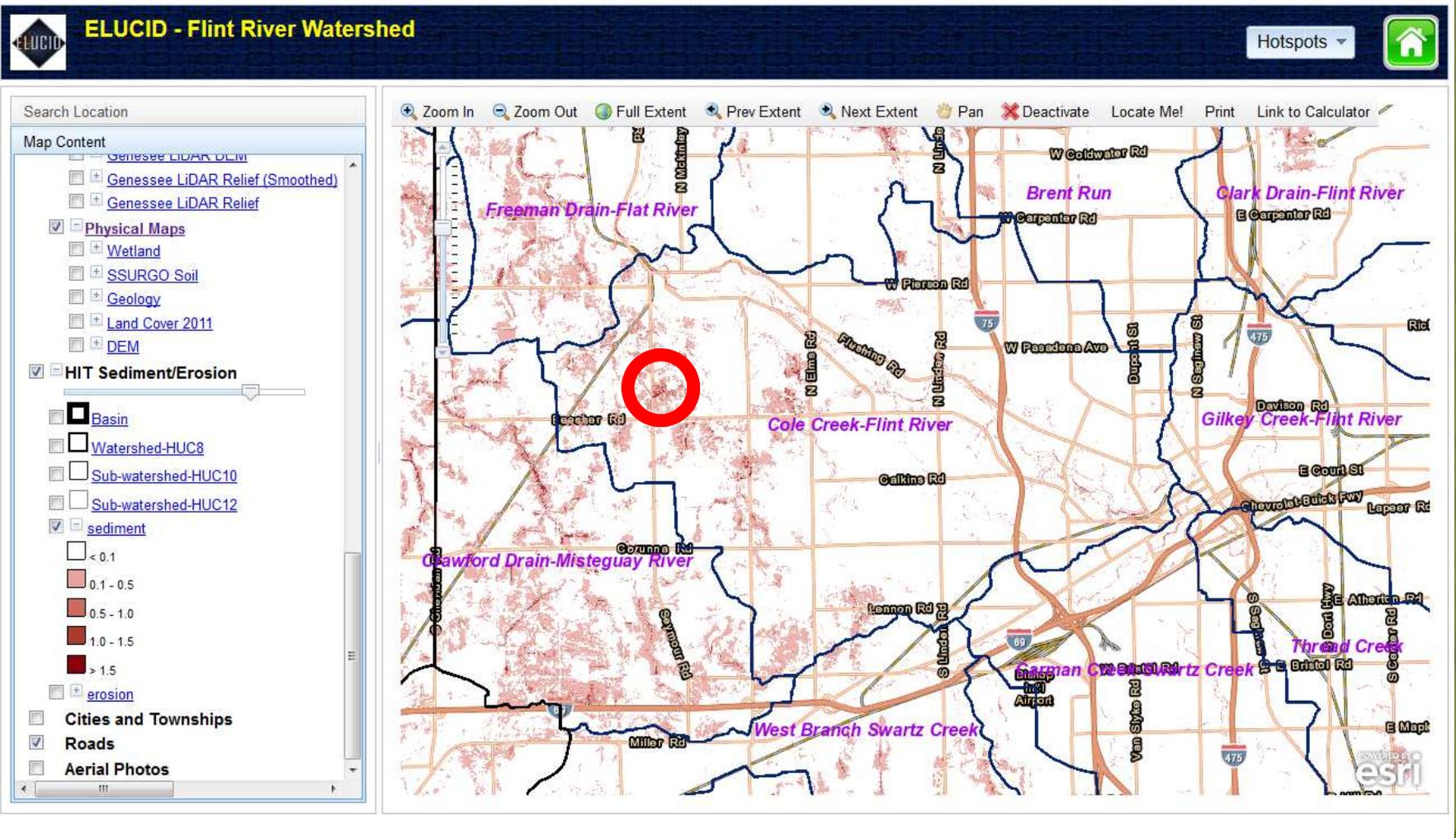
Map Content

- Flint River Watershed
  - Base Maps
  - Water Quality Maps
    - Subwatershed
    - Flint Watershed
    - Stream TMDL
    - Waterbody TMDL
    - Impaired Stream
    - Impaired Waterbody
    - EPA STORET Water Quality Data
    - Water Quality Assessment Status
    - Water Quality Assessment Status
    - No Discharge Zones (Stream)
    - No Discharge Zones (Waterbody)
    - Stream
    - Waterbody
    - Water Quality Data SRP (mg/l) (DEQ 1)
    - Water Quality Total P (mg/l) (DEQ 1)
    - Water Quality Total P (mg/l) (DEQ 2)
    - Total P Load (lbs/acre/year) by Subw

Zoom In Zoom Out Full Extent Prev Extent Next Extent Pan Deactivate Locate Me! Print Link to Calculator

esri

# ELUCID



# ELUCID



## ELUCID - Flint River Watershed

Hotspots ▾

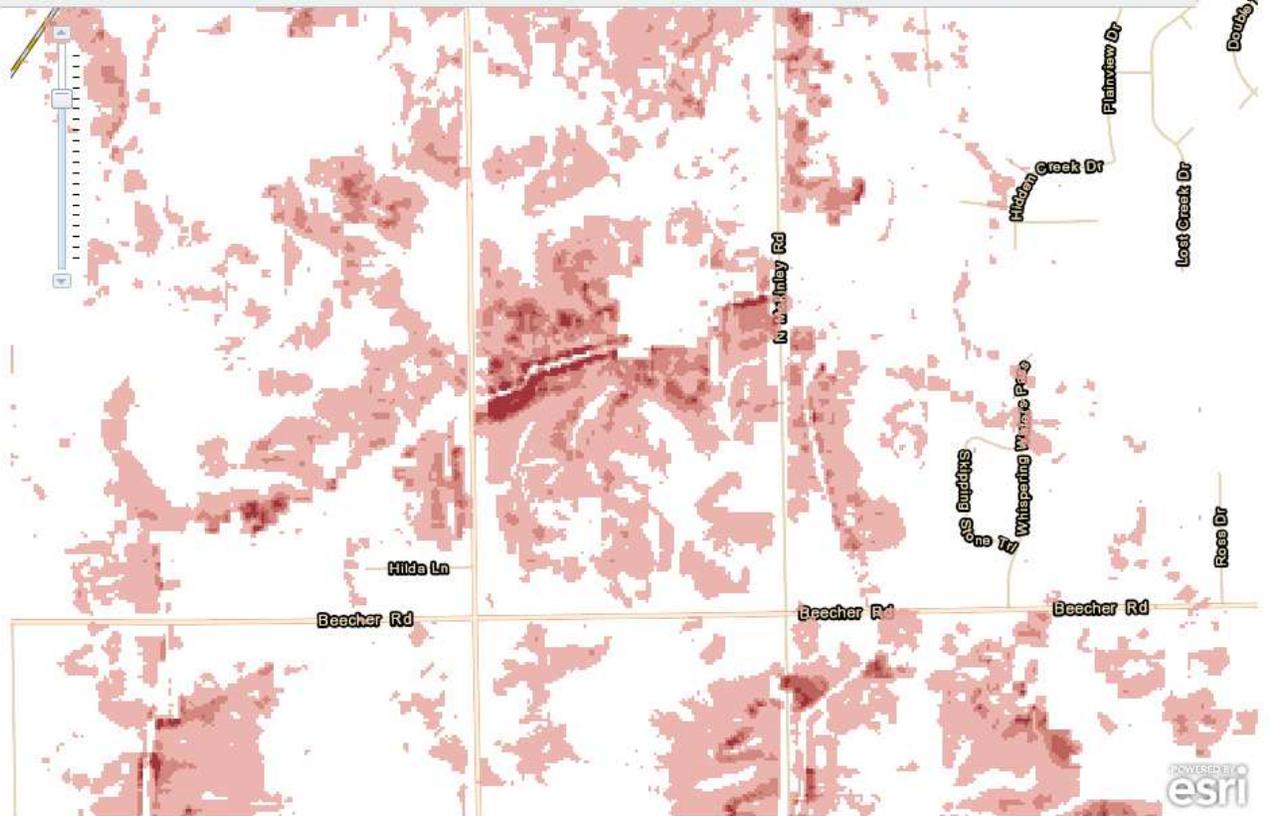


Search Location

Map Content

- Genessee LiDAR DEM
- Genessee LiDAR Relief (Smoothed)
- Genessee LiDAR Relief
- Physical Maps
  - Wetland
  - SSURGO Soil
  - Geology
  - Land Cover 2011
  - DEM
- HIT Sediment/Erosion
  - Basin
  - Watershed-HUC8
  - Sub-watershed-HUC10
  - Sub-watershed-HUC12
  - sediment
    - < 0.1
    - 0.1 - 0.5
    - 0.5 - 1.0
    - 1.0 - 1.5
    - > 1.5
  - erosion
- Cities and Townships
- Roads
- Aerial Photos

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# ELUCID



## ELUCID - Flint River Watershed

Hotspots ▾

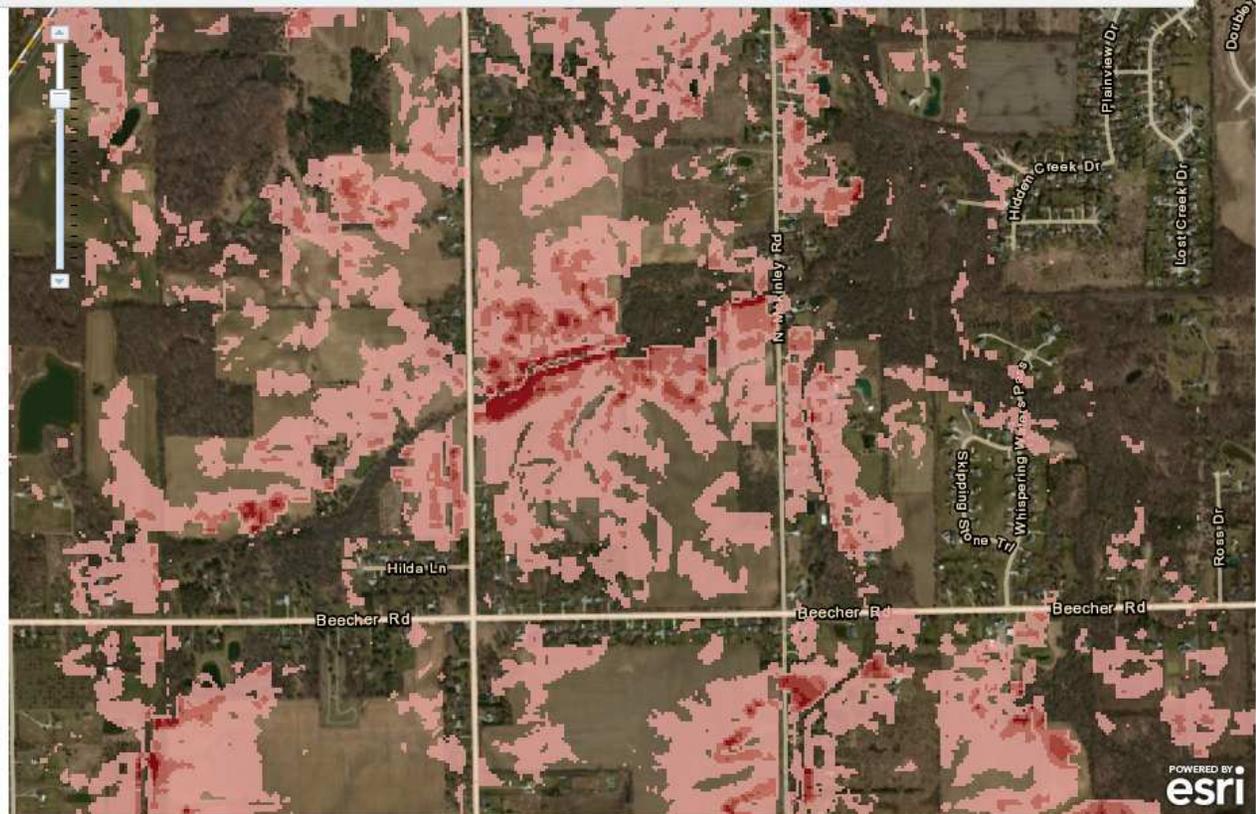


Search Location

### Map Content

- Genessee LiDAR DEM
- Genessee LiDAR Relief (Smoothed)
- Genessee LiDAR Relief
- Physical Maps
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  - Geology
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- Cities and Townships
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# ELUCID

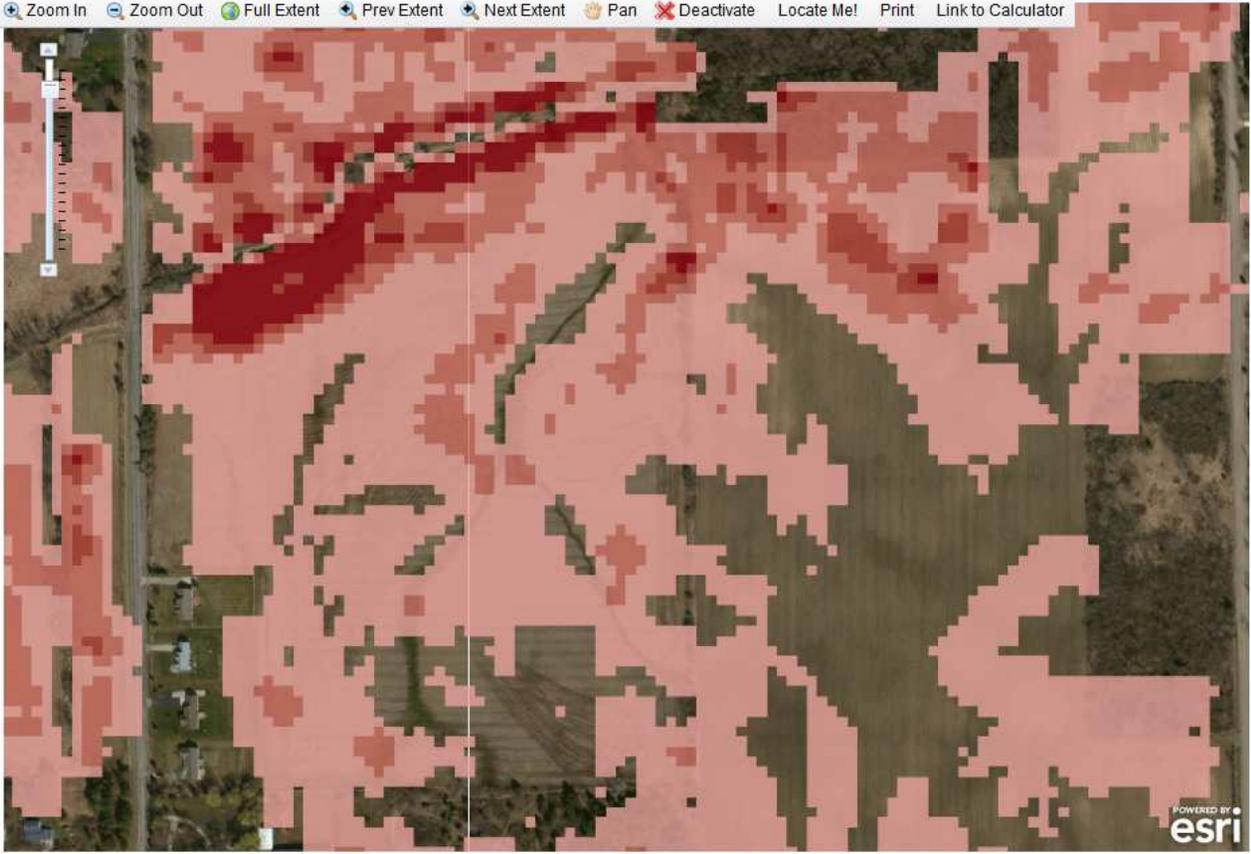
**ELUCID - Flint River Watershed** Hotspots 

Search Location

Map Content

- Waterbody
- Water Quality Data SRP (mg/l) (DEQ 2003)
- Water Quality Total P (mg/l) (DEQ 1998)
- Water Quality Total P (mg/l) (DEQ 2003)
- Total P Load (lbs/year) by Subwatershed
- Cattle Counts by Subwatershed
- Septic Systems Counts by Subwatershed
- Total Crop Acreage by Subwatershed
- Sediment by NHDPlus Catchment (tons/yr)
- Land Protection Maps
- Physical Maps
- HIT Sediment/Erosion
  - Basin
  - Watershed-HUC8
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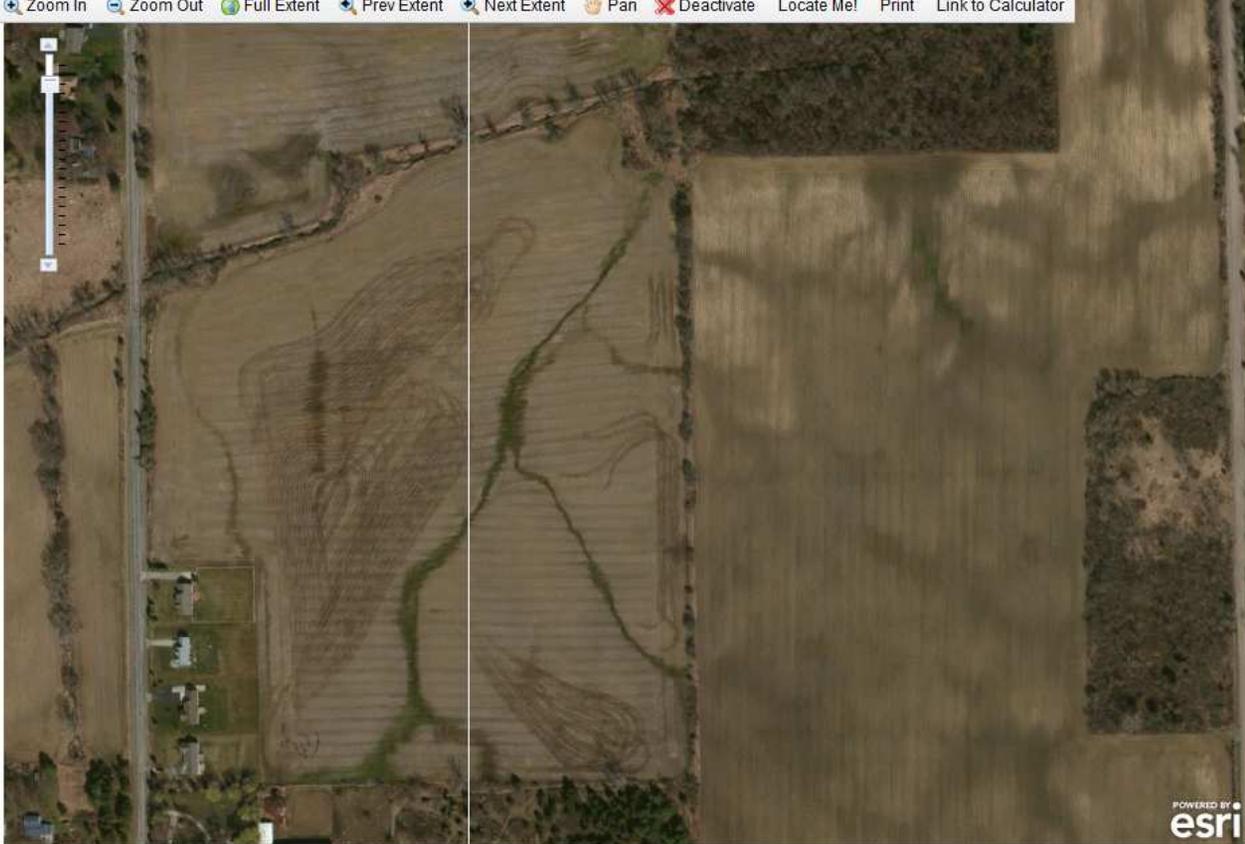
# ELUCID

**ELUCID - Flint River Watershed** Hotspots 

Search Location Zoom In Zoom Out Full Extent Prev Extent Next Extent Pan Deactivate Locate Me! Print Link to Calculator

**Map Content**

- Water Quality Assessment Status (Wate
- No Discharge Zones (Stream)
- No Discharge Zones (Waterbody)
- Stream
- Waterbody
- Water Quality Data SRP (mg/l) (DEQ 200
- Water Quality Total P (mg/l) (DEQ 1998)
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  - Sub-watershed-HUC12
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# ELUCID

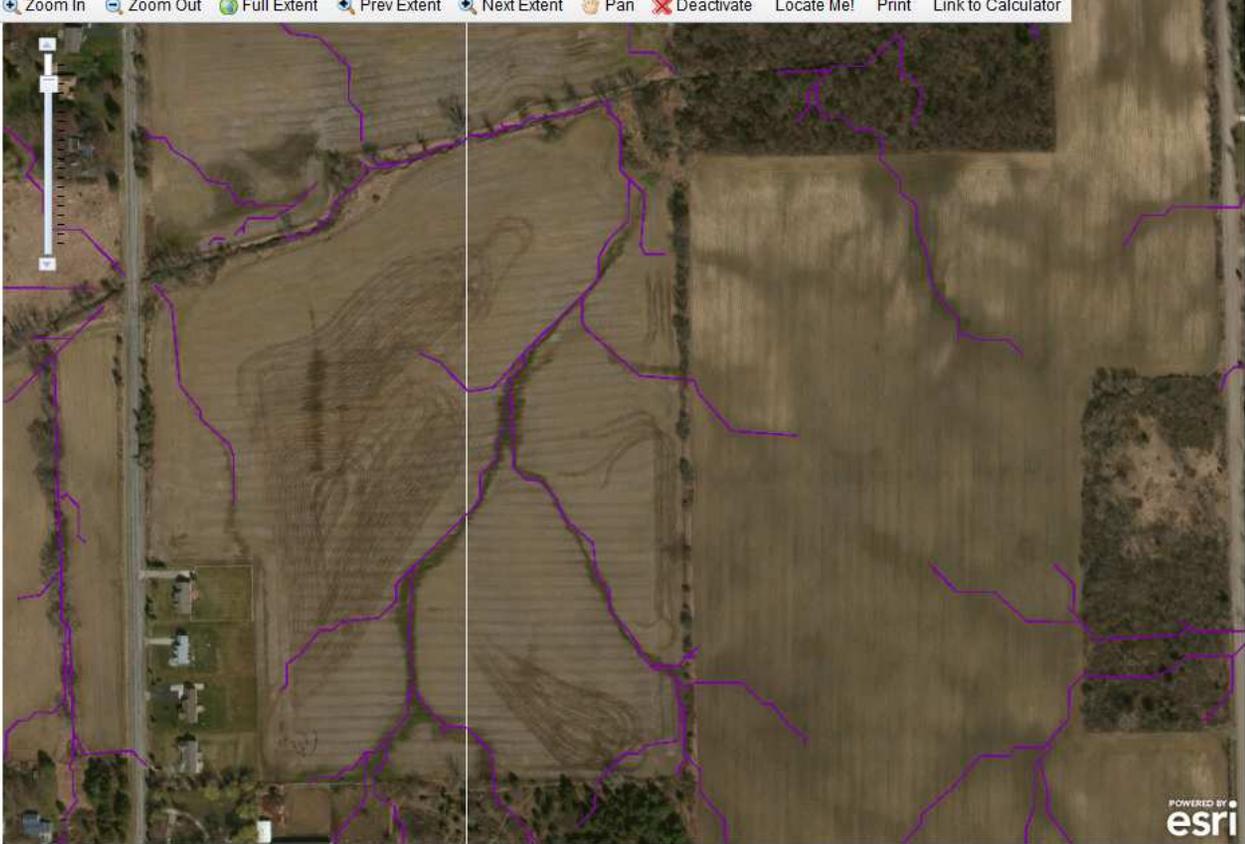
**ELUCID - Flint River Watershed** Hotspots 

Search Location

Map Content

- Segment of Watershed Catchment (cont.)
- Land Protection Maps**
  - USGS Edge of Fields Sites
  - Concentrated Flow
  - Gully Erosion Potential
  - Genesee County Parcel Boundaries
  - Potential Wetland Restoration
  - NRCS Easement
  - Preserved Area
  - Conservation and Recreation Lands
  - Soil Wind Erodibility Group
  - Genesee LiDAR DEM
  - Genesee LiDAR Relief (Smoothed)
  - Genesee LiDAR Relief
- Physical Maps**
- HIT Sediment/Erosion**
  - Basin
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# ELUCID

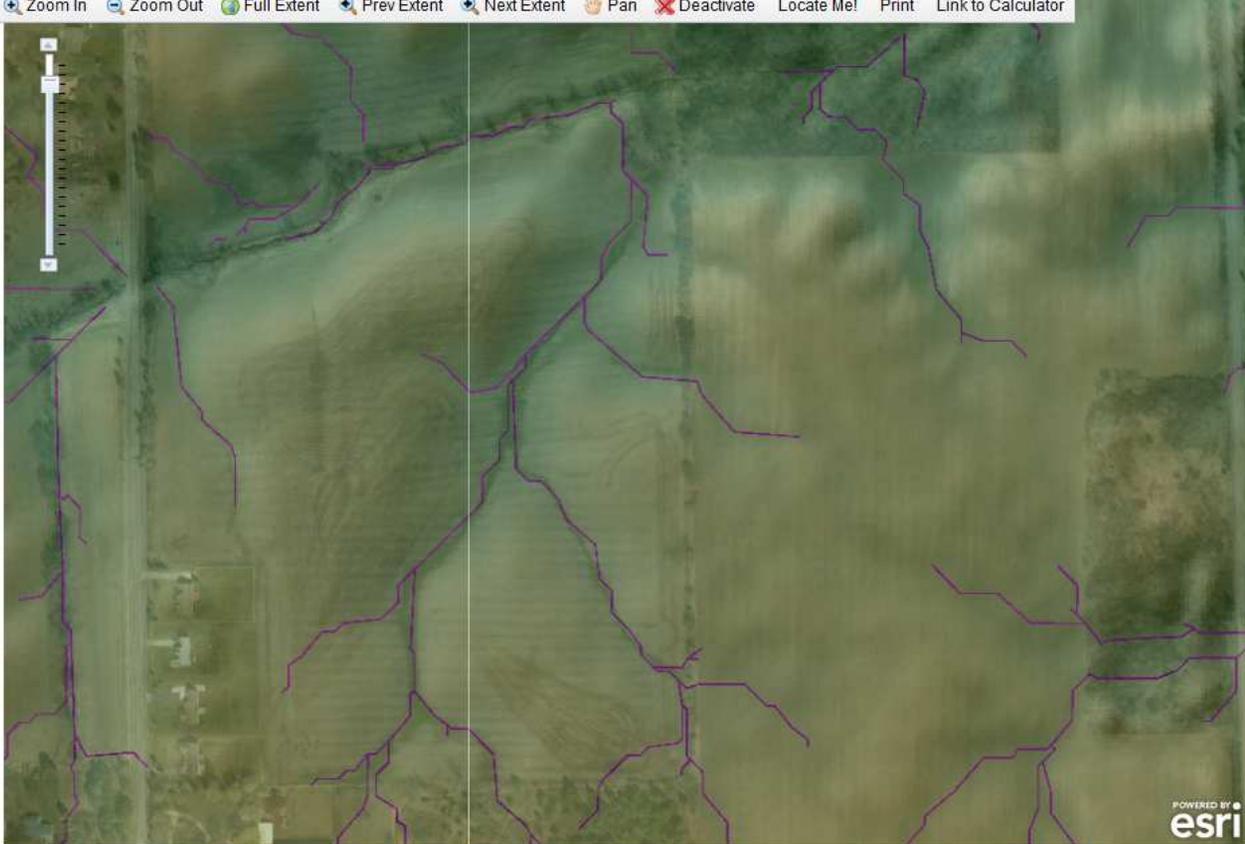
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  - Potential Wetland Restoration
  - NRCS Easement
  - Preserved Area
  - Conservation and Recreation Lands
  - Soil Wind Erodibility Group
  - Genesee LiDAR DEM
    - High : 1033
    - Low : 0
  - Genesee LiDAR Relief (Smoothed)
    - High : 245.633
    - Low : 53.551
  - Genesee LiDAR Relief
    - High : 445
    - Low : 0

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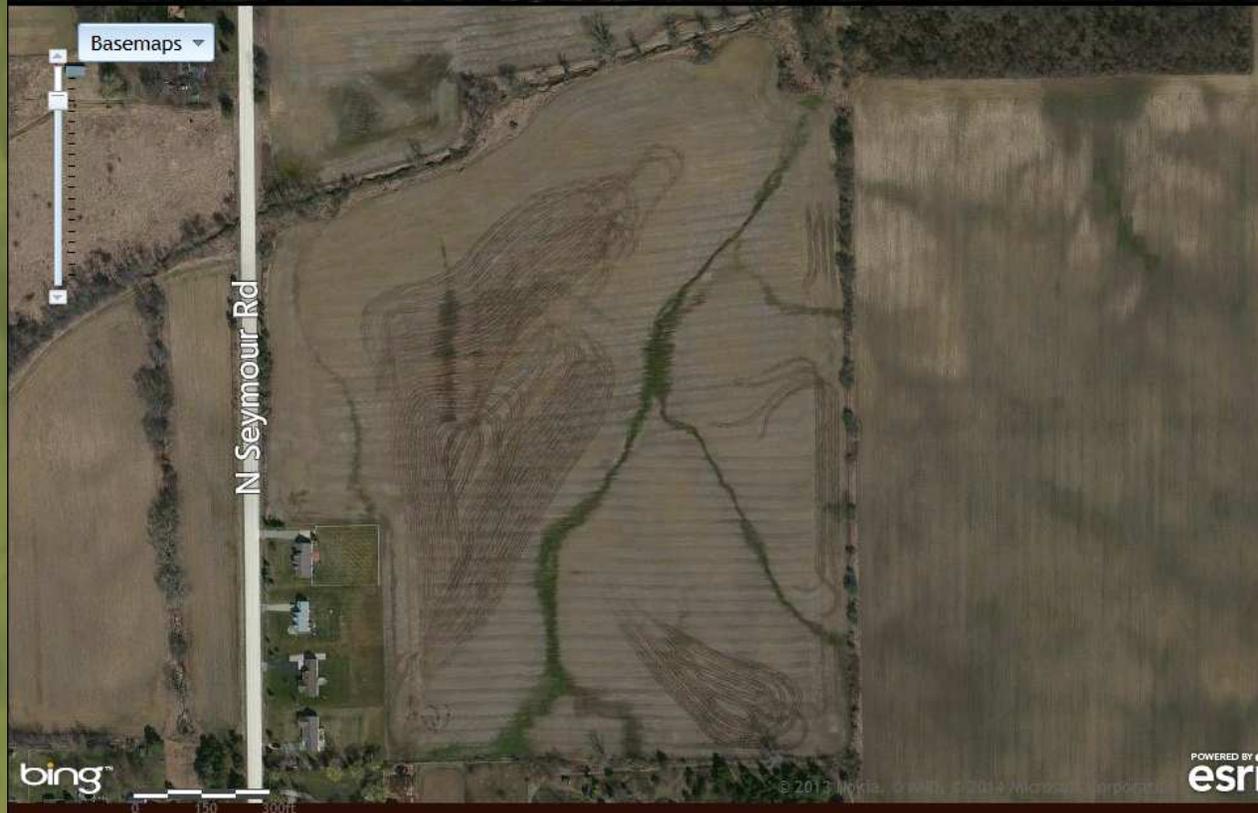


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# Great Lakes Watershed Management System

Great Lakes Watershed Management System

login/logout



## Introduction

The Great Lakes Watershed Management System (GLWMS) is an on-line tool that allows users to evaluate non-point source (NPS) pollution model estimates at watershed and field scales. The system links two water quality models, [High Impact Targeting \(HIT\)](#) from the [Institute of Water Research at Michigan State University](#), and the [Long Term Hydrologic Impact Assessment \(L-THIA\)](#) from [Purdue University's Department of Agricultural and Biological Engineering](#). HIT estimates sediment loading from agricultural lands to nearby streams; L-THIA estimates run-off volumes and pollutant loads.

The GLWMS allows users to view HIT and L-THIA estimates at watershed scales, and conduct field scale scenario evaluations of land cover changes or best management practices (BMPs).

The system is currently available for the priority basins of the [EPA's Great Lakes Restoration Initiative](#): the Fox River Basin of Wisconsin, the Saginaw River Basin of Michigan, the Maumee River Basin of Ohio, and the Genesee River Basin of New York.

Navigation

Map Layers

Legend

Analysis

About the Tool

Active Map Tool: **Identify features on-click**

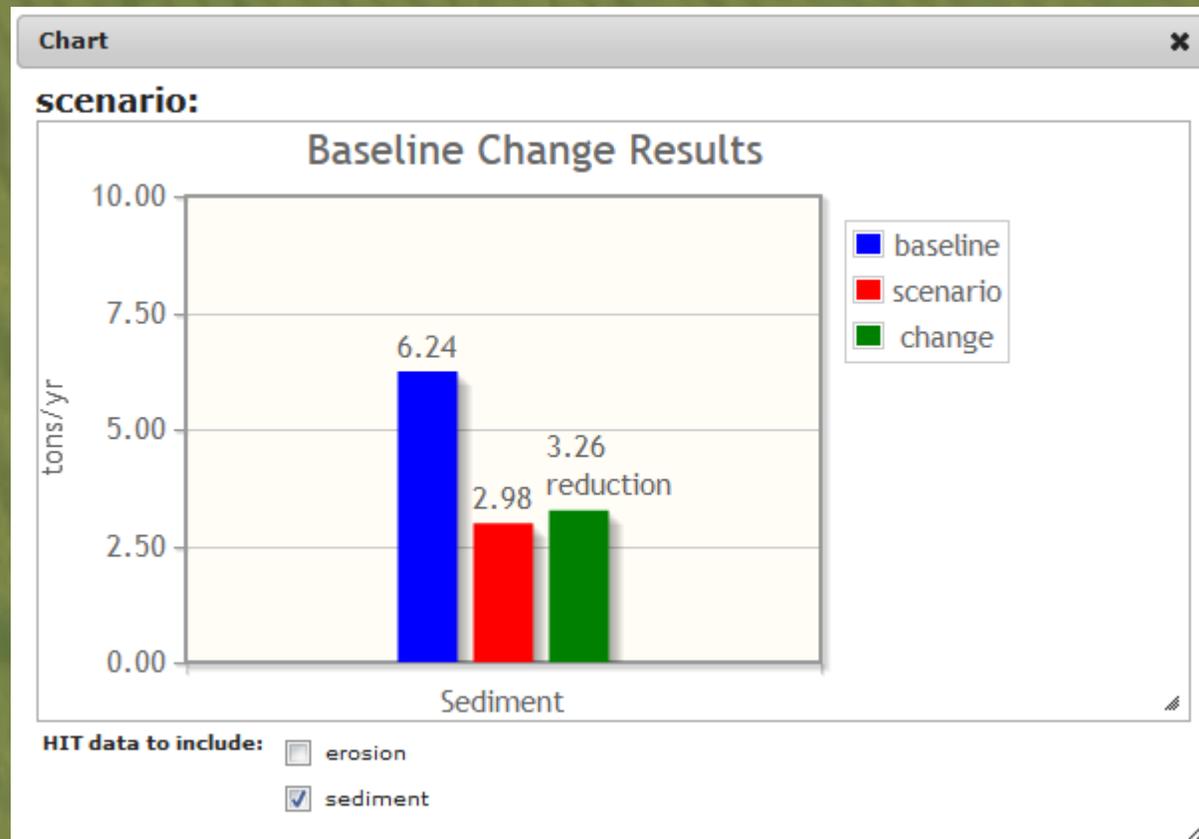
Banner photograph credit: [\[link\]](#)

Institute of Water Research at Michigan State University, all rights reserved 2014

-83.85593282, 43.03402045



# Great Lakes Watershed Management System



# Great Lakes Watershed Management System

**My Projects** ✕

Select the projects and associated scenarios to load map features and scenario results

**Projects:** ?  
(click to select)

- Baseline Runs
- **Field Buffer**
- May 14 Training
- May 7 Training
- Training Examples 2

**Scenarios:** ?  
(click to select)

- **Field Buffer**

**Project Details:**

Name:

**Scenario Details:**

Name:

Field Parameters:

Installed?: ?  yes  no (hypothetical scenario)

Install date:  Contract end date:

Contract Time Left:

Notes:

*successfully saved scenario details*

# Great Lakes Watershed Management System

## Reports

Build a report | Report | Saved Reports

### Baseline NPS for Fields

report period: Annual Save Report

**Acreage:**

Total acres (upland): ?	77.1 (0.0)
<b>Acrees by scenario type:</b>	
Baseline NPS -	77.1
Baseline Change -	0.0
Dual Scenario Change -	0.0

**Non-point Source Pollution:**

HIT sediment loading (tons/yr.): ?	14.20
HIT soil erosion (tons/yr.): ?	75.70
LTHIA total runoff (acre-ft./yr.): ?	19.70
LTHIA total Phosphorus (lbs./yr.): ?	64.84
LTHIA total Lead (lbs./yr.): ?	0.08
LTHIA total Copper (lbs./yr.): ?	0.12
LTHIA total Zinc (lbs./yr.): ?	0.87

# MAEAP



# FARM BILL

- ❖ REGIONAL CONSERVATION PARTNERSHIP PROGRAM (RCPP)



# Water Resource Study

## ○ Ottawa County

### Irrigation Water Quality Criteria

High concentrations of chloride make groundwater unfit for human consumption and for many agricultural uses and are detrimental to the environment. When salt water is introduced to areas unadjusted to saline conditions, it damages sensitive crops, causes habitat losses, adversely impacts groundwater dependent ecosystems, and contaminates drinking water.

The drinking water recommended standard for chloride is 250 mg/l.

The table below shows irrigation water quality criteria.

<b>Chloride (mg/L or ppm)</b>	<b>Effect on crops</b>	<b>Susceptible plants</b>
below 70	Safe for most plants	Rhododendron, azalea, blueberry, dry beans
70–140	Sensitive plants show injury	Onion, mint, carrot, lettuce, pepper, grape, raspberry
140–350	Moderately sensitive plants show injury	Potato, alfalfa, sudangrass, squash, wheat, sorghum, corn, tomato
above 350	Can cause severe problems	Sugarbeet, barley, asparagus, cauliflower

Source: Adapted from Ayers and Westcot (1985).

# Water Resource Study

## ○ Ottawa County

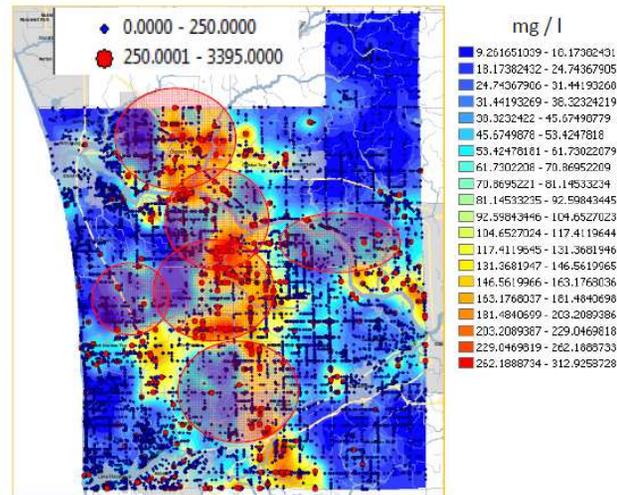
### Areas with Significantly Elevated Chloride Concentrations in Groundwater

This slide shows an overlay of scattered chloride concentration values (point symbols) and their moving window average (continuous color backdrop).

This map is useful in identifying the broad trends and patterns in the spatial distribution of chloride concentrations.

Note the chloride concentrations in the following areas are significantly elevated (>100 mg/L):

1. Crockery Township and Northern End of Robinson Township
2. West Allendale Township and East Robinson Twp.
3. Northern part of Blendon Township
4. Northeastern Corner of Olive Township
5. South of Zeeland, especially near the border with Allegan County
6. South of Tallmadge Township (north side of the Grand River Corridor).



# Water Resource Study

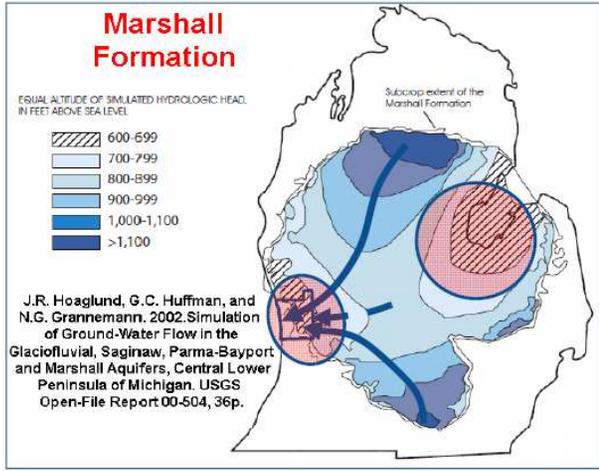
## ○ Ottawa County

### Basin-scale Groundwater Dynamics

Basin-scale hydrologic research also suggests that the naturally occurring saline water in the deep formations is inching upward toward the surface, particularly in the lowland areas, or the regional groundwater discharge areas of the state (e.g., Mandle and Westjohn, 1989; Westjohn et al., 1994; Westjohn and Weaver, 1996a, b, c; Holtschlag, 1996, 1997; Ging et al., 1996; Meissner et al., 1996; Wahrer et al., 1996; Hoaglund et al., 2002b).

Computer simulation showed that the Grand River flowing across the Lower Peninsula created both a topographic and water table depression. Model simulations inferred that these areas are likely to be basin-scale groundwater discharge regions, because of the presence of saline groundwater near the land surface in these lowlands.

Steady-state simulations of regional groundwater flow suggest that the presence of saline groundwater in the regional discharge areas results from the upwelling of deep saline groundwater within the regional groundwater flow system. (See also W90-08400) (Mandle and Westjohn, 1989).



Ottawa County is part of the western master discharge zone for the Marshall Formation

# Water Resource Study

## ○ Ottawa County

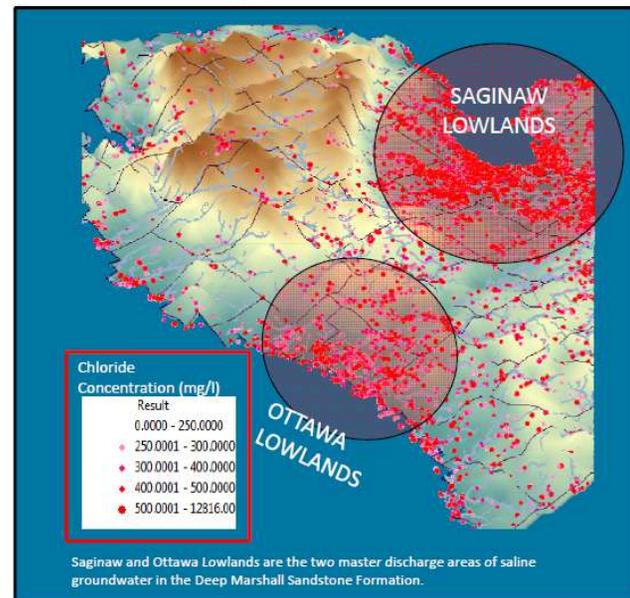
### Chloride Contamination in the Saginaw and Ottawa Lowlands

In this slide we visualize Ottawa Lowlands and Saginaw Lowlands in 3D and compare side by side their chloride concentration distribution. The red dots represent wells with chloride concentrations higher than the drinking water standard.

The results clearly show that the two master groundwater discharge areas of deep geological formations stand out in elevated chloride concentrations.

The Saginaw and Ottawa lowlands share the following common characteristics:

- Coastal areas at low elevations in Michigan.
- Master discharge areas of deep geological formations.
- Presence of an extensive surficial clay layer limiting natural recharge to the deep bedrock aquifer.



# Water Resource Study

## ○ Ottawa County

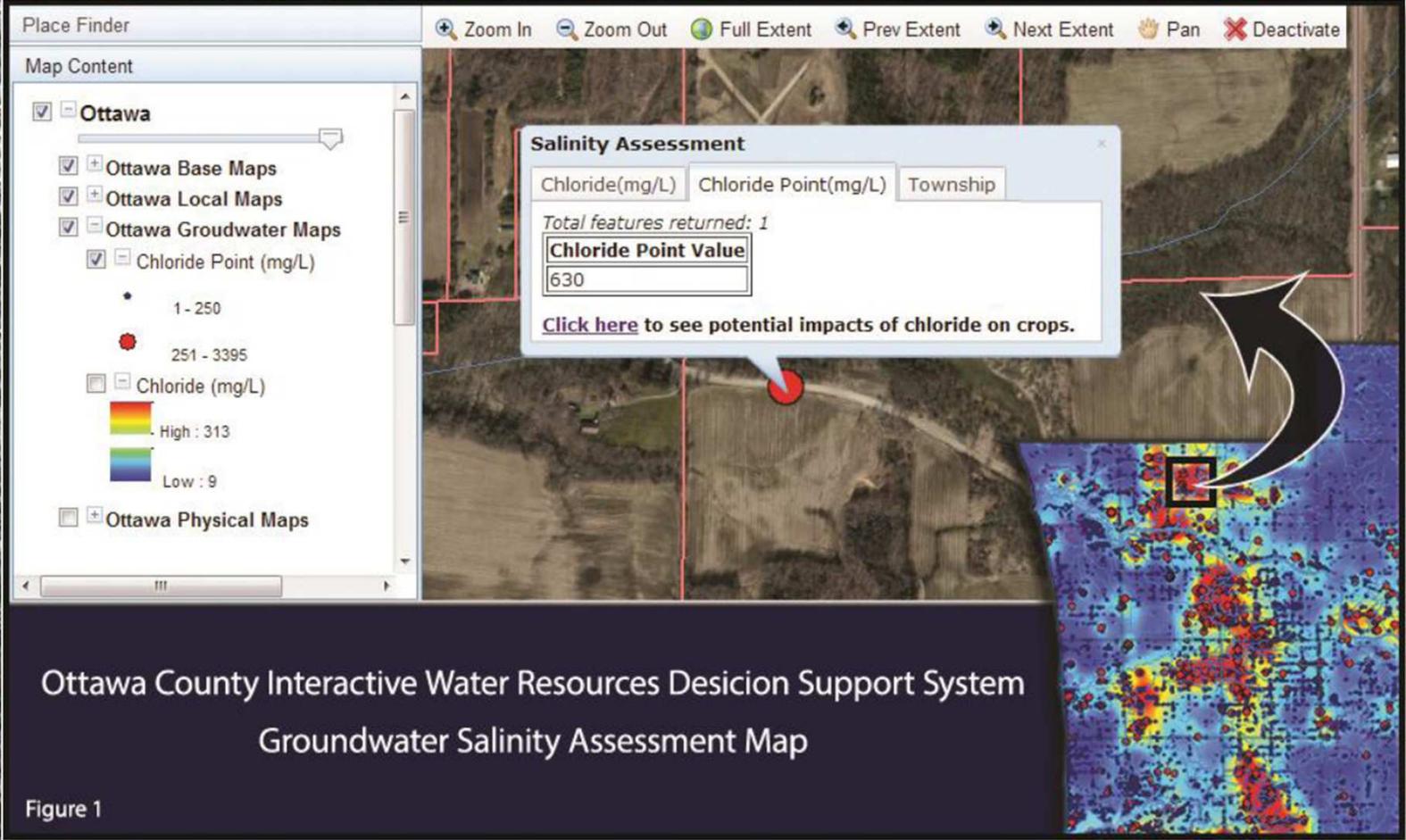


Figure 1

# Summary

- ❖ Increasing pressure on agriculture for food
- ❖ Water quality issues on a local and large-scale
- ❖ Information Technology assistance is available
- ❖ Collaboration can help solve existing problems

# Questions

- ❖ Questions? Contact Dr. Jon Bartholic: [bartholi@msu.edu](mailto:bartholi@msu.edu)
- ❖ Institute of Water Research at Michigan State University: <http://www.iwr.msu.edu/>

