

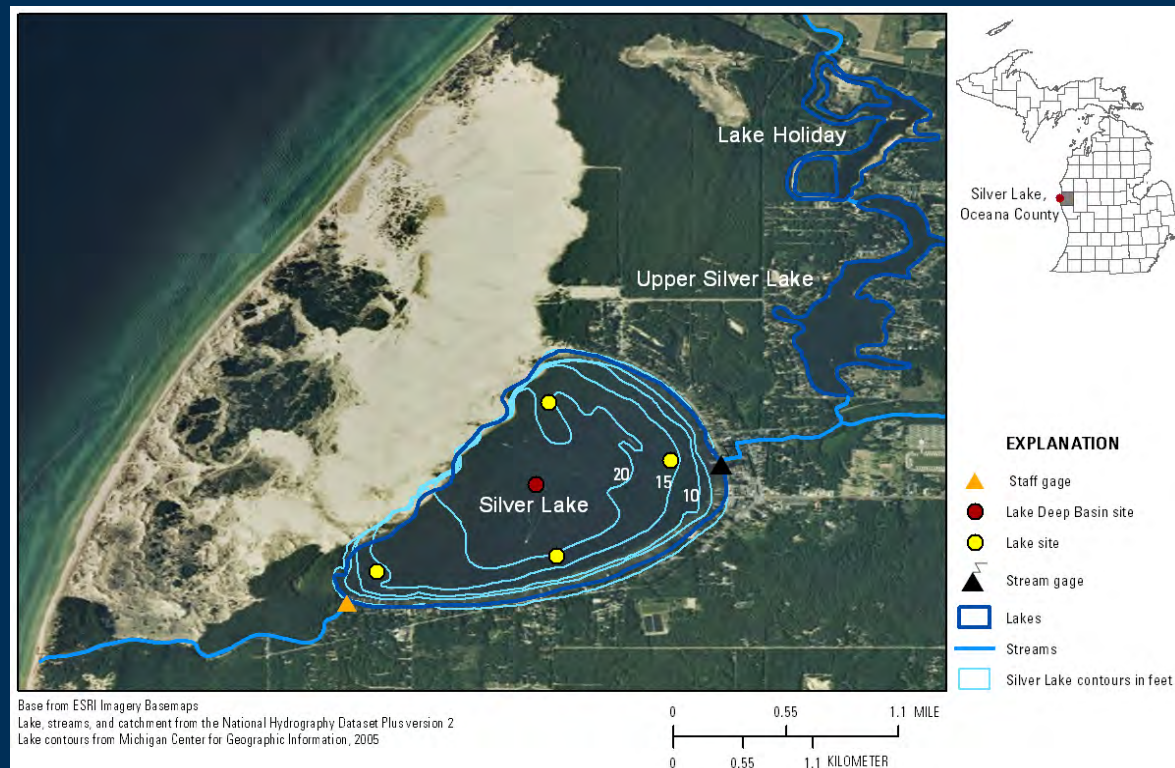


# Silver Lake Nutrient Loading Project

USGS-MI Water Science Center & GVSU-AWRI

In cooperation with the Silver Lake Improvement Board

U.S. Department of the Interior  
U.S. Geological Survey



# Project Objectives

- Develop water and nutrient budgets for Silver Lake
- Complete 8 separate tasks
- Provide information to local water managers & stakeholders



# Task 1:

## Groundwater & Septic Reconnaissance (COMPLETED, USGS)

- Temporary wells (piezometers) used to sample groundwater
  - pH, conductivity, DO, temperature, phosphorus, nitrogen, and chloride
- Results used to identify 4 locations for longer-term groundwater monitoring

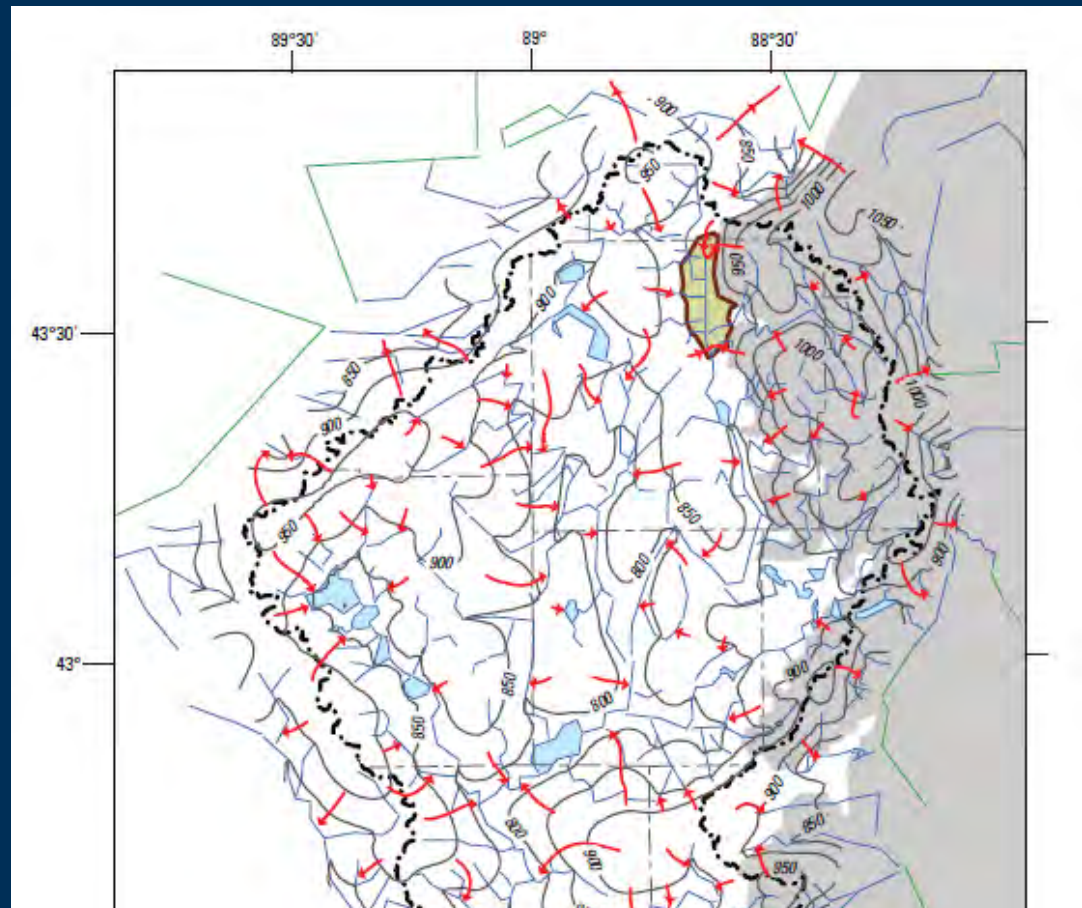
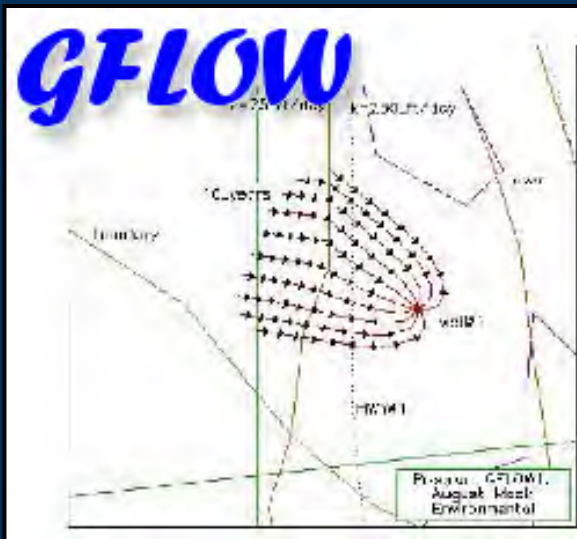
# Task 2: Septic and Groundwater Influence (ONGOING)

- Monitor groundwater for 2 years using 4 piezometers
- Measure ~10 private wells during the first year
- Observe groundwater flow by installing 4 seepage meters



# Task 2 cont...

- Produce a groundwater model
  - e.g., GFLOW or a similar analytical element model



Simulation of the Regional Ground-Water-Flow System and Ground-Water/Surface-Water Interaction in the Rock River Basin, Wisconsin  
By Paul F. Juckem

# Task 3: Monitoring Surface Water Flow & Water Budget Data Analysis (ONGOING)

- Install a continuous stream gage on Hunter Creek
- Install a staff gage at the Silver Lake channel dam
- Collect atmospheric data
  - precipitation
  - evaporation & evapotranspiration



# Task 3 cont...

- Establish a water budget

## Water Budgets: Foundations for Effective Water-Resources and Environmental Management

By Richard W. Healy, Thomas C. Winter, James W. LaBaugh, and O. Lehn Franke

### A The Water-Budget Equation

The water-budget equation is simple, universal, and adaptable because it relies on water movement and storage. A basic water budget for a small watershed can be expressed as

$$P + Q_{in} = ET + \Delta S + Q_{out}$$

where

$P$  is precipitation,

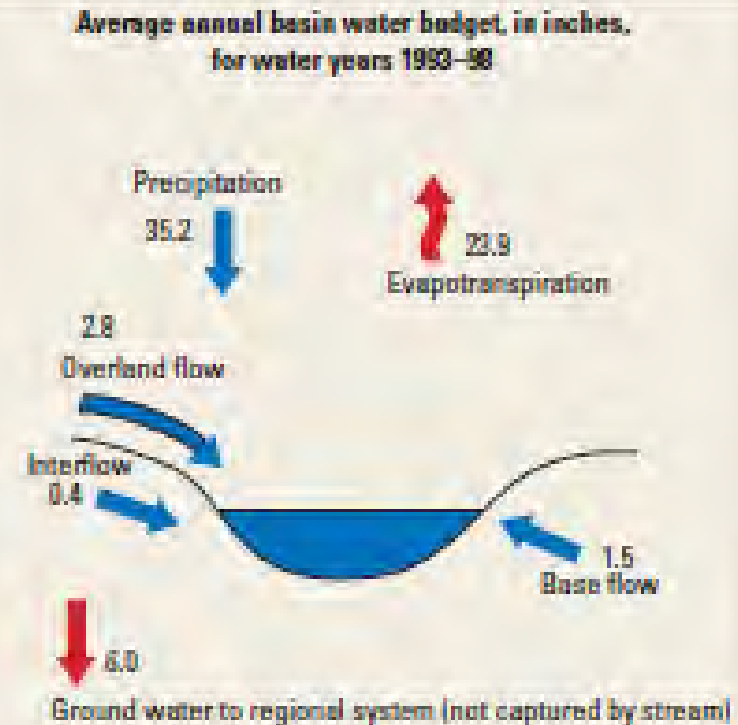
$Q_{in}$  is water flow into the watershed,

$ET$  is evapotranspiration (the sum of evaporation from soils, surface-water,

and  $\Delta S$  is change in water storage,

and

$Q_{out}$  is water flow out of the watershed.



# Task 4: Water Chemistry (ONGOING)

- Monitoring 4 times per year for 2 yr
- 5 monitoring locations
  - Water temp, DO, Conductivity, pH
  - Secchi disk transparency
  - Chl-a, phytoplankton, N, P (surface & bottom)
  - Common ions, color, turbidity, alkalinity, total dissolved solids, and silica (deepest basin only, 1x per year)
  - Au Sable Creek and Silver Creek: turbidity, chl-a, phytoplankton, N, P





## Task 4 cont...

- Discharge measurements at Hunter Creek and Silver Creek
- Groundwater chemistry for N & P
- Explore lake changes in response to reduction in nutrients from identified source(s)
  - Empirical eutrophication models (BATHTUB model)
  - Predict lake response to various % reductions in nutrients from identified sources

# Task 5: Other Potential Nutrient Sources or Conditions (2014)

- Precipitation
  - Wet (rain and snow) & dry (several days following no ppt) samples to determine nutrient deposition
- Nutrient inputs from lawn runoff and waterfowl
  - Estimated from previously published literature values



# Task 6: Identify Nutrient Controlling Algal Blooms (AWRI) (SPRING/SUMMER 2013)

- Determine whether N or P is the limiting nutrient
  - Nutrient bioassay: N-enriched, P-enriched, N+P-enriched
- Phytoplankton identification

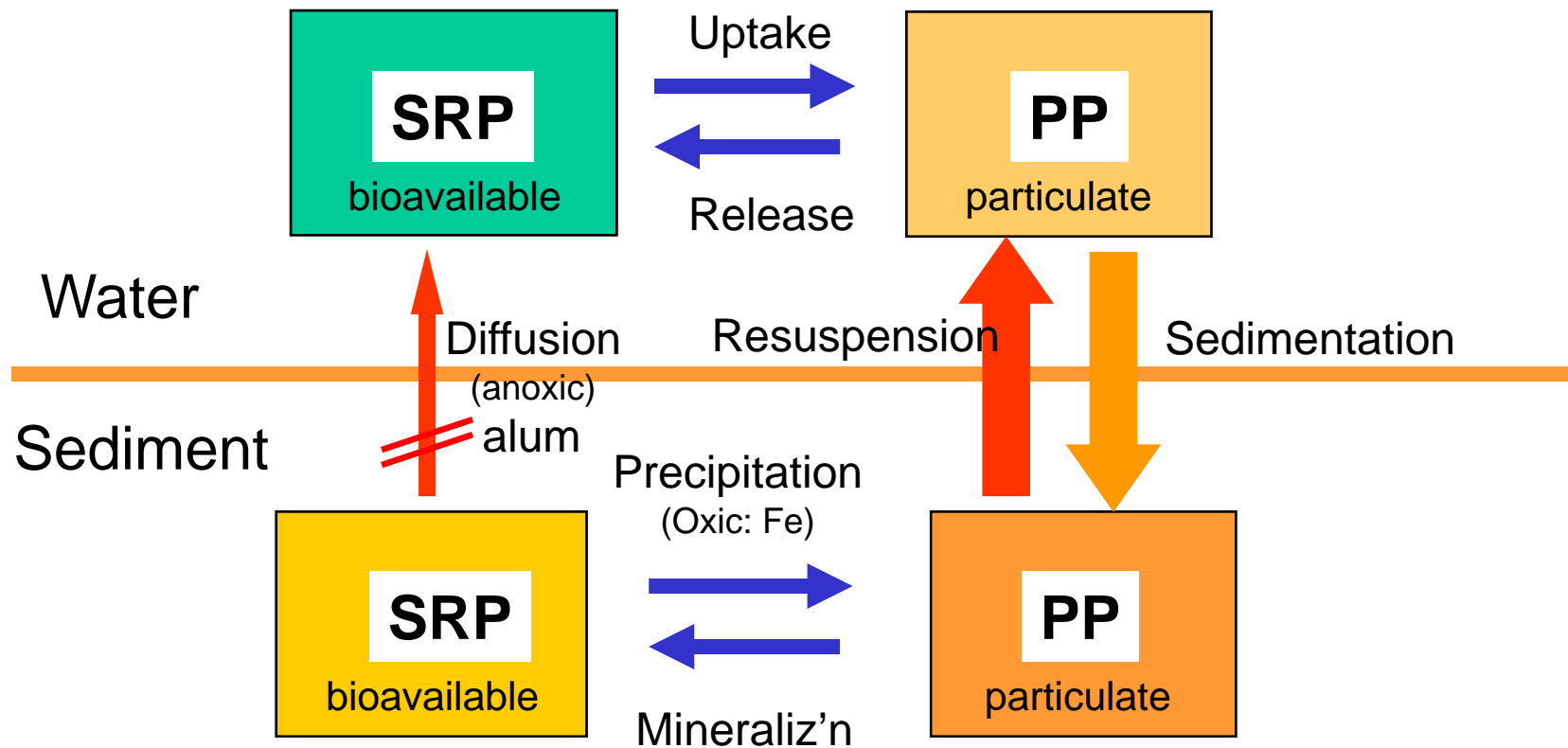


# Task 7: Internal Phosphorus Loading Estimates (AWRI) (2013-14)

- Determine flux of N & P from sediments
  - 2 sites
  - Early summer & late summer; 2 years
  - Oxidic and anoxic treatments
- Measure diel dissolved oxygen
  - 2 sites
  - 4 events during summer



# Sediment-Water Interactions



# Task 8: Data Interpretation and Reporting

(ONGOING)

- Annual presentation of project results to the Silver Lake Improvement Board
- Interpretive report of project study results (Year 3)
  - Data summary and analysis
  - Water budget, nutrient budget, groundwater and eutrophication models

# Timeline & Progress to Date: Year 1

- Completed
  - Establish new sites
  - Reconnaissance groundwater sampling
  - Gage and staff installation,
  - Piezometer installation, surveying, and instrumentation



# Timeline & Progress to Date: Year 1

- Ongoing/Planned Summer 2013
  - Routine sampling of surface and groundwater
  - Routine monitoring of stream gage and staff
  - Phytoplankton bioassays
  - Diel dissolved oxygen profiles
  - Internal phosphorus loading study
  - Compile data, preliminary findings presentation



# Timeline: Year 2 (2014)

- Routine monitoring of surface and groundwater
- Collect precipitation samples
- Literature review for lawn runoff and water fowl nutrient contributions
- Internal phosphorus loading study
- Compile data, preliminary findings presentation



# Timeline: Year 3 (2015)

- Compile final data
- Build models
- Scenario testing
- Report writing, editing, and publication
- Final presentation



## **Lake water sampling/testing completed by Friends for Silver Lake**

**From the past 12+ months six sets of water samples have been taken and tested to determine water quality from several sample points.**

**Tested water for total phosphorus and ortho-phosphate.  
total P includes water insoluble and soluble forms.  
ortho P is only the water soluble form.**

## Units of Measure

- All results are reported in parts per billion.
- What is the quantity of 1 ppb?
- Silver Lake contains 9,800 acre feet of water.
  - Or 3,200,000,000 (billion) gallons of water.
- 1 ppb would equal 3.2 gallons of water.
- Or 1 ppb of Phosphorus would equal ~ 27 lbs in SL.

## Phosphorus Results from 2012, 4 sample sets.

2012								
2012	April 24		May 7		July 7		Sept 29	
	TP	ortho P	TP	ortho P	TP	ortho P	TP	ortho P
Drain pipe, north side	22	20			48	46	16	15
Hunter's Creek	12	<10	21	11	17	<10	13	<10
NW corner & north side	69	65	39	15	16	<10	21	<10
South side	20	<10			43	<10	<10	<10
Termite Bridge	30	<10			50	<10	36	<10
SP, out from boat launch					71	<10	10	<10
Middle of Silver Lake					15	<10	14	11
Upper SL at drain							<10	<10

## Phosphorus Results from 2013, 2 sample sets.

2013				
2013	April 8		April 20	
	TP	ortho P	TP	
Drain pipe, north side	52	42	85	
Hunter's Creek	13	<6	18	
North side	16	<6	20	
South side	25	<6	24	
Termite Bridge	28	6.4	26	
East Side	35	6.7	23	

April 20th was after several days of rain.  
Only tested for total P.

## **Future**

- **Next step is to take samples at the same time the USGS and/or GVSU takes their water samples. Run tests side by side and compare results.**
- **Continue to take water samples for balance of the 2013 season and into fall.**