Stump Brook Flow Restoration Priority Project

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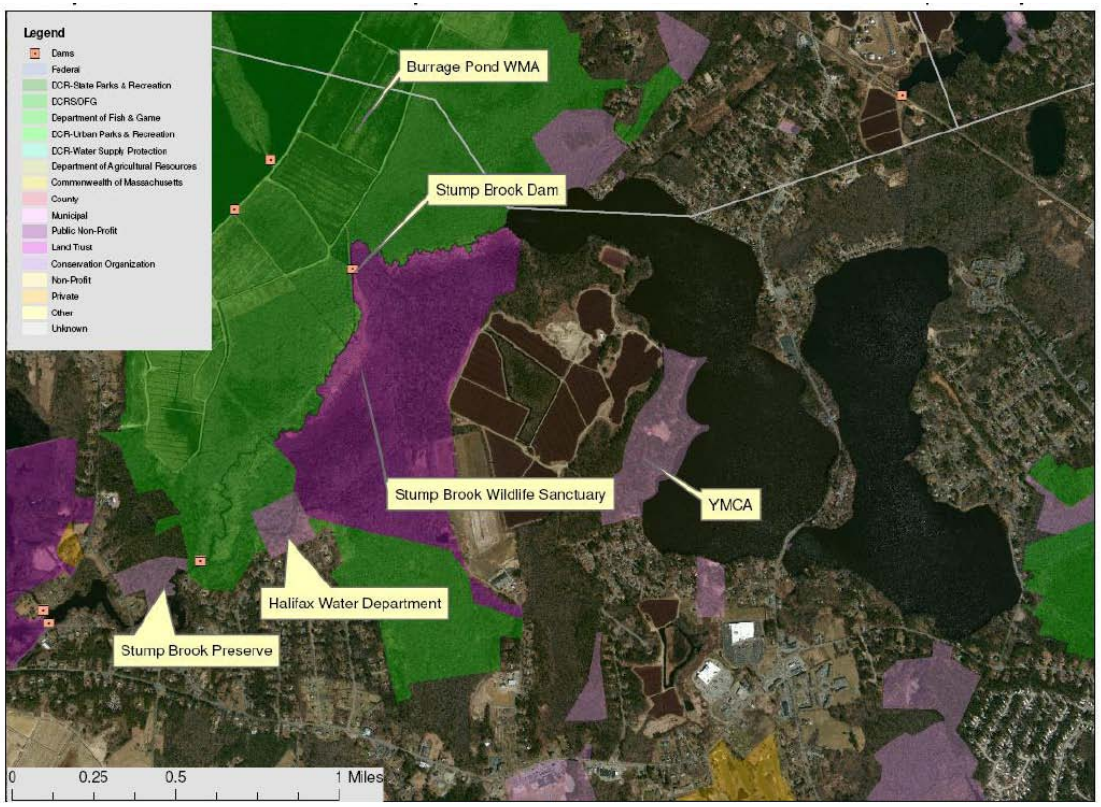
Stump Brook Flow Restoration

- Increase flow through Stump Brook
- Improve habitat conditions downstream
  - Burrage Pond WMA
  - Stump Brook Wildlife Sanctuary
  - Stump Brook Preserve
- Improve water quality
- Improve fish passage



Stump Brook Flow Restoration

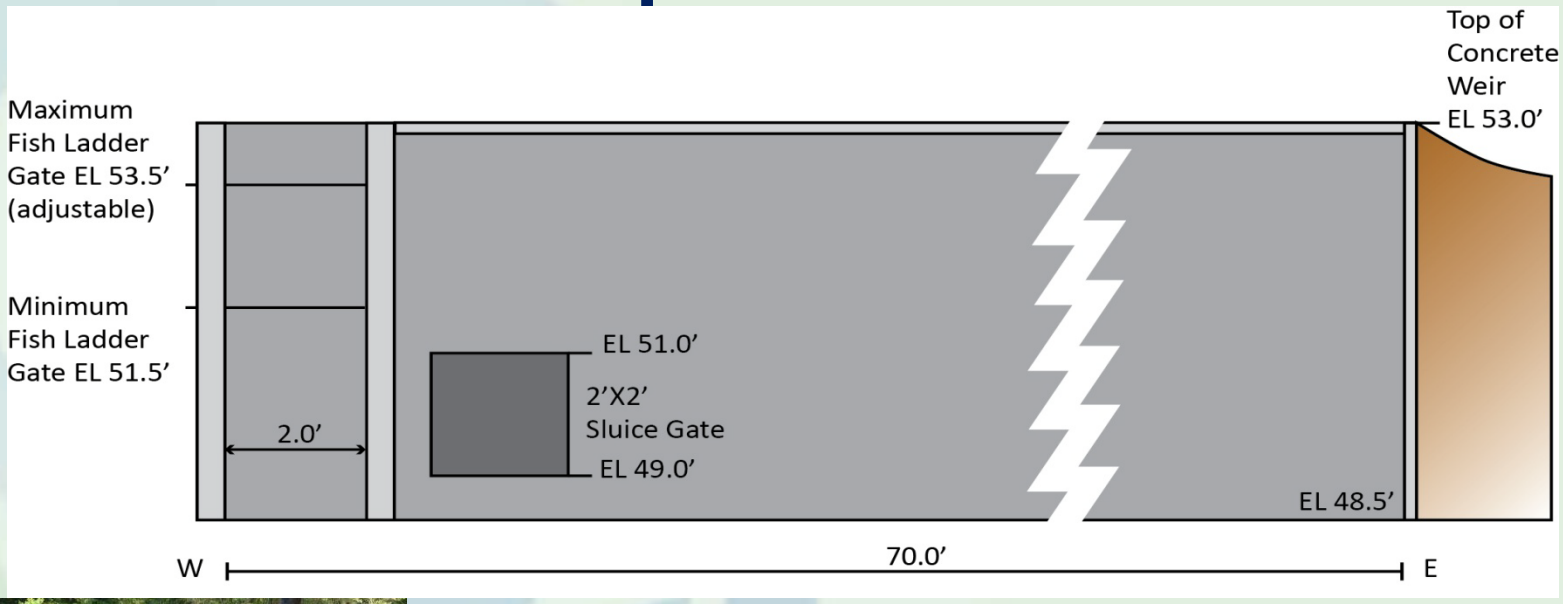
- Can water quality in the ponds be improved by increasing outlet flow to Stump Brook and, if so, what increased quantity of outflow would be required?
- What does this look like in terms of natural flow and how does it impact pond level?
- DER funded a study to try to answer these questions

HW Study Objectives

1. Evaluate Hydrologic Impacts of Different Pond Management Scenarios (Diversion Schedule and Dam Operations)
2. Evaluate Water Quality Impacts of Pond Management Scenarios

Key Features

Stump Brook Dam



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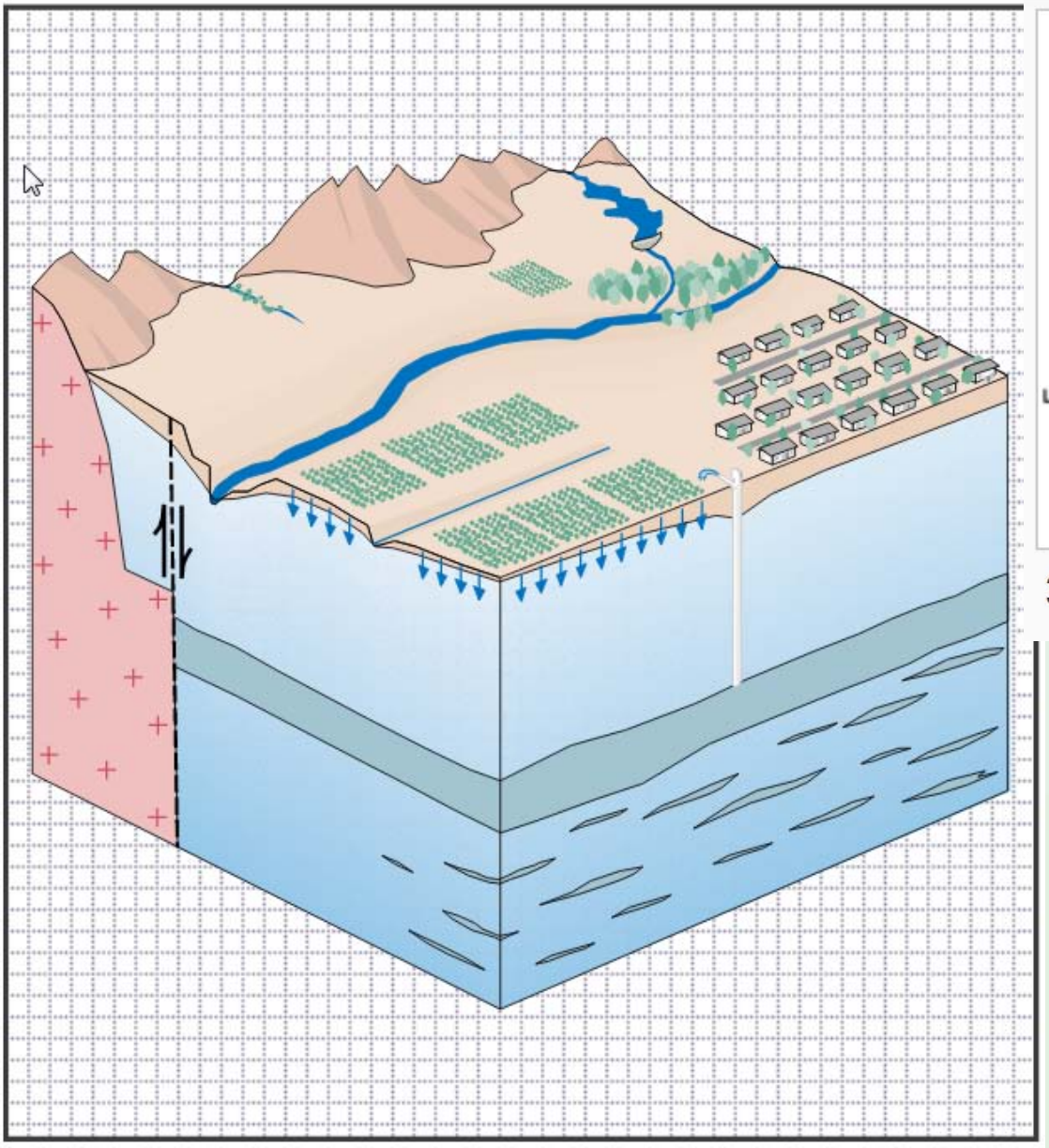
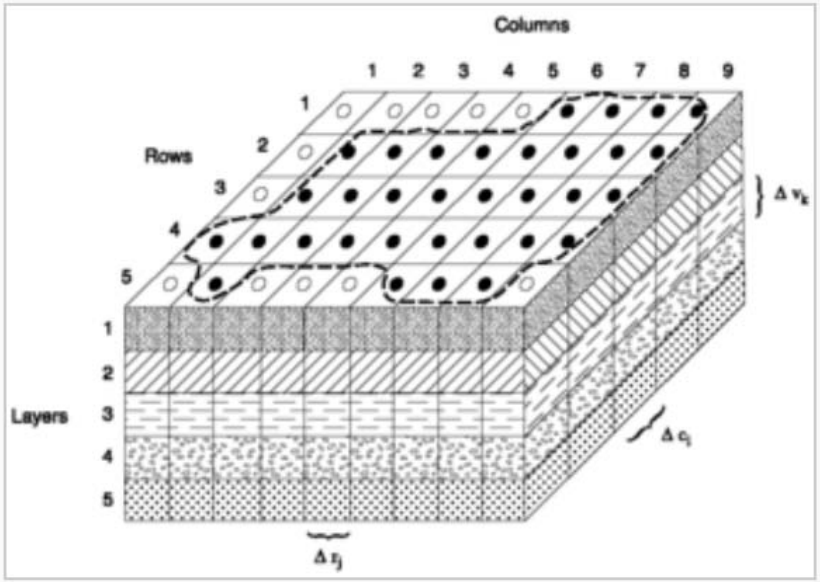
Methods

1. Hydrologic Impacts – Use USGS Regional MODFLOW Groundwater Model & Engineering Calculations for Dam Flow
2. Water Quality Impacts – Use LLRM Spreadsheet Mass Balance Model

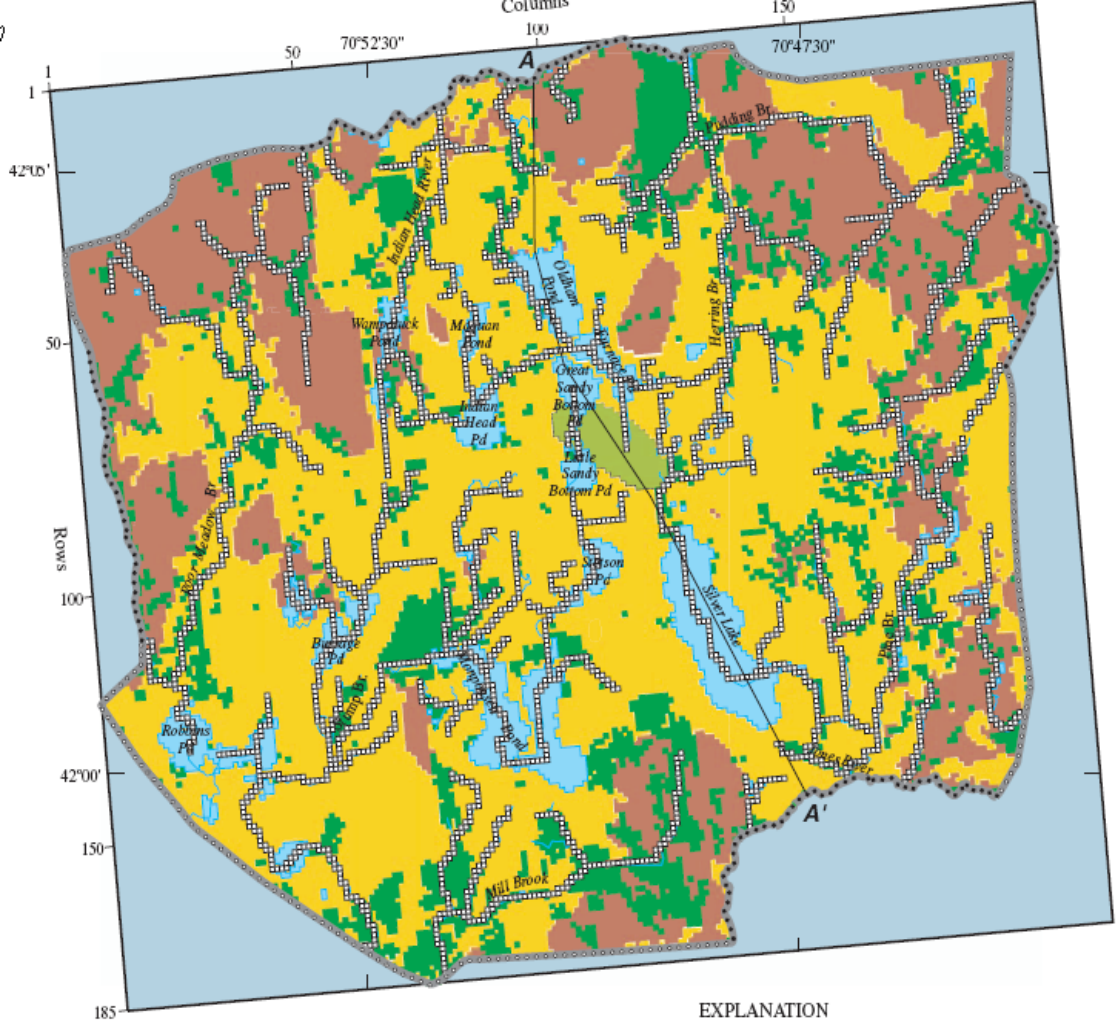
MODFLOW





3-dimensional grid

USGS Regional MODFLOW MODEL - Great Sandy Bottom Pond, Pembroke, MA



EXPLANATION

Base from U.S. Geological Survey digital data, 1:25,000, 1991, Lambert conformal conic projection, 1983 North American datum

0 1 2 3 MILES
0 1 2 3 KILOMETERS

MATERIAL, LAYER, AND MODEL-ASSIGNED HYDRAULIC CONDUCTIVITY, IN FEET PER DAY

- Till and bedrock within 20 ft of land surface, Layers 1 and 2; 10
- Sand and gravel, Layers 1 and 2; 45
- Sand and gravel (high hydraulic conductivity zone), Layers 1 and 2; 80
- Wetland, Layer 1; 1,000
- Pond, Layer 1; 50,000

- STREAM CELL
- CONSTANT-HEAD CELL—Placed at stream locations
- NO-FLOW CELL—Placed at drainage-divide locations
- A A' LINE OF CROSS SECTION (shown on fig. 5)

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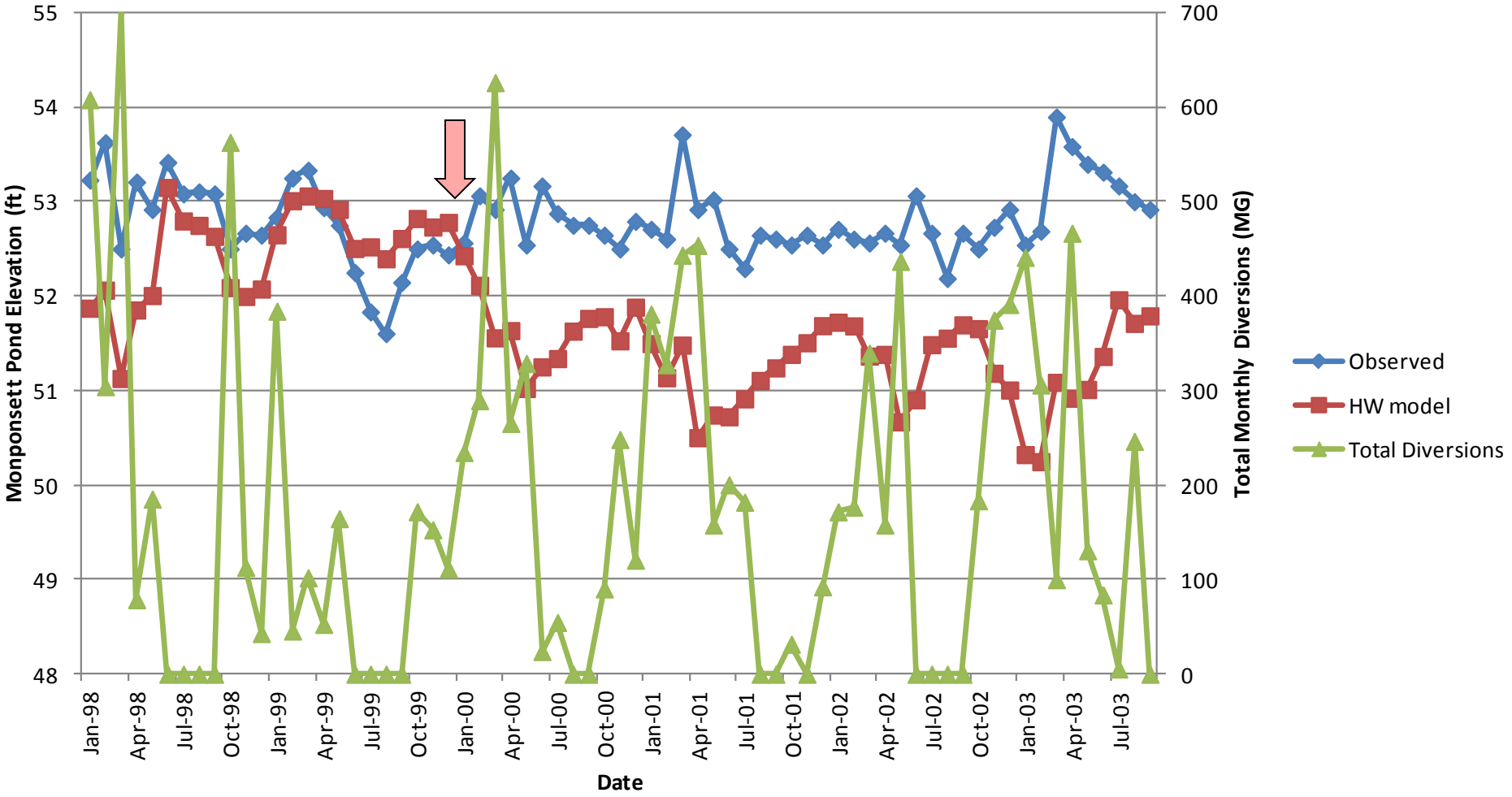
Monponsett Pond & Stump Brook in Model

1. Pond Simulated as a High Conductivity/ High Storage Zone
2. Stump Brook Simulated With Stream Package
3. Dams Not Included in MODFLOW. Dam Calculations Done Manually Outside Model
4. Diversions Simulated By Extraction Wells in East Pond and Injection Wells in Silver Lake
5. Mass Balance Analyses for Each Pond and Brook

Observed and Modeled Monponsett Pond Elevations versus Total Monthly Diversions

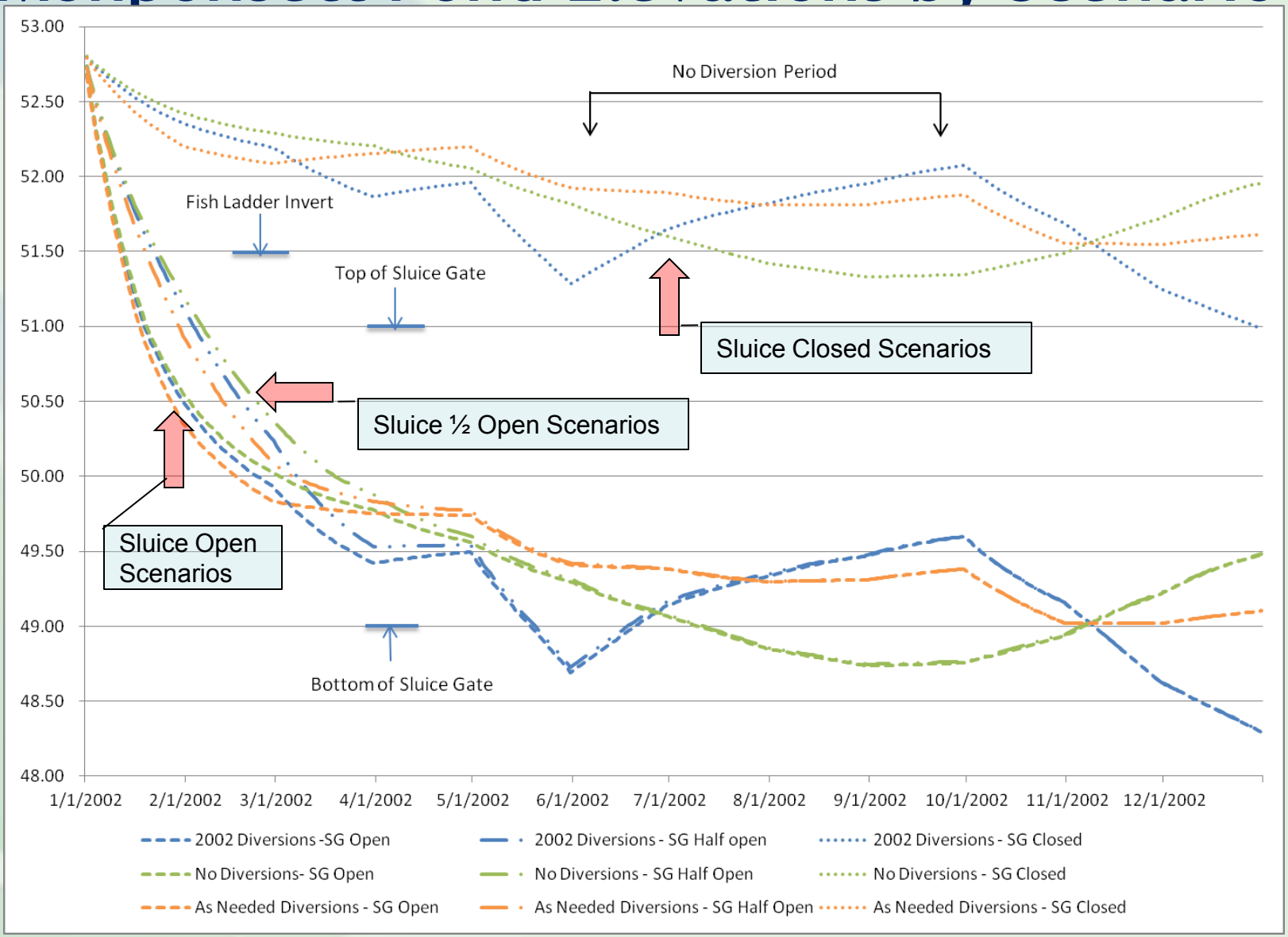


Modeled Stump Brook Flows Approximate Measured Fish Ladder Flows

Management Scenarios

1. Average Monthly Diversions to Silver Lake(from historical record)
2. No Diversions
3. As-Needed Diversions Only When Silver Lake Below Its Dam Spillway Elevation
4. Low-Flow Sluice Gate Closed, Half Open, and Fully Open
5. Fish Ladder Open in All Scenarios

Monponsett Pond Elevations by Scenario



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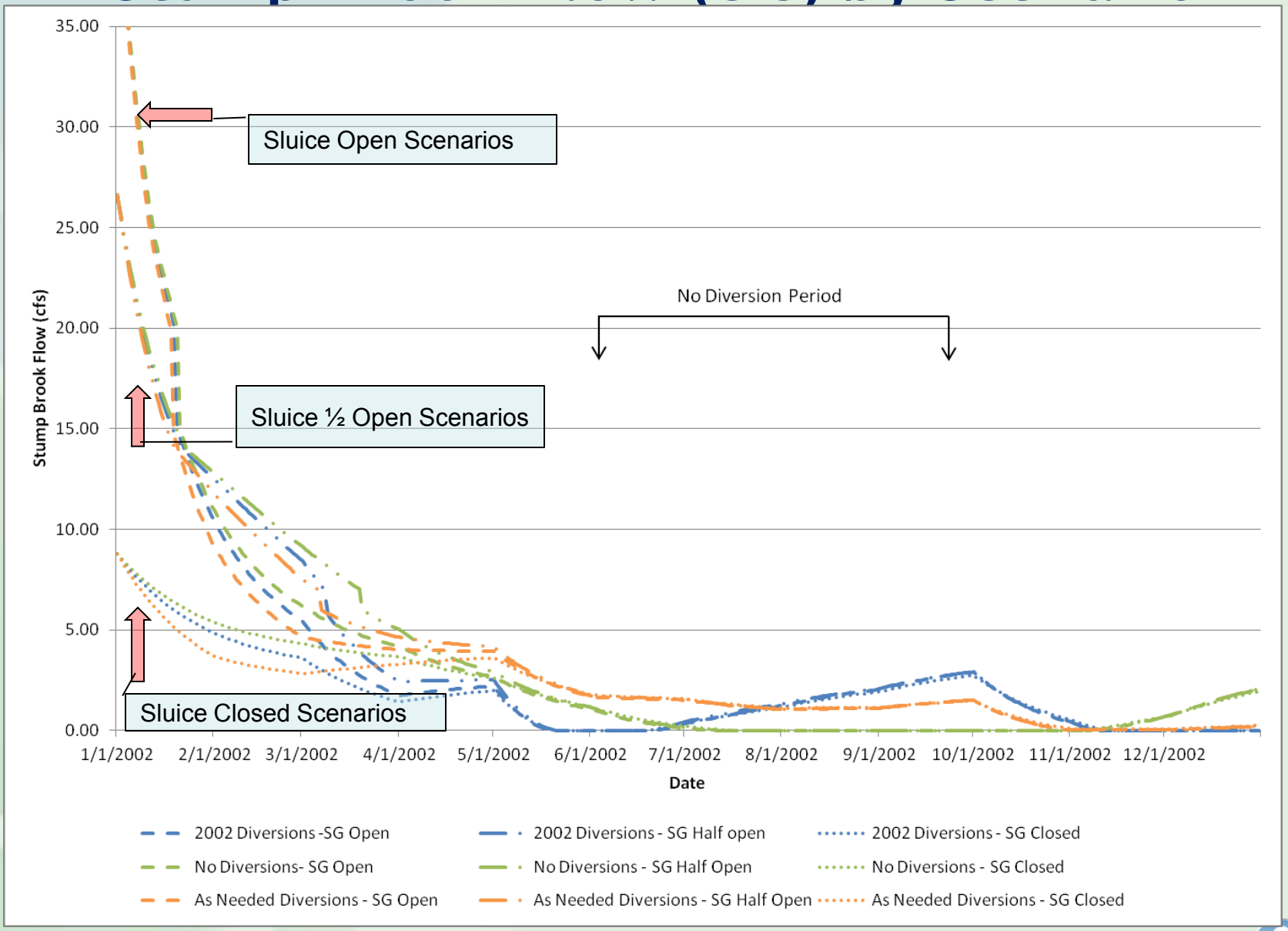
Note: All Pond Elevations Likely Underestimated

Stump Brook Flow (cfs) by Scenario



Hydrologic Observations

- Monponsett Pond Elevation Approximately 2 + Feet Higher Under No Diversion Scenario & A Little less than 2 Feet Higher Under As-Needed Scenario. (No Change to Dam Management)
- Stump Brook Flow Less Impacted by Diversion Scenarios Alone Because Dam Management More Important (All Flow Must Still Pass Through Fish Ladder)

Hydrologic Observations

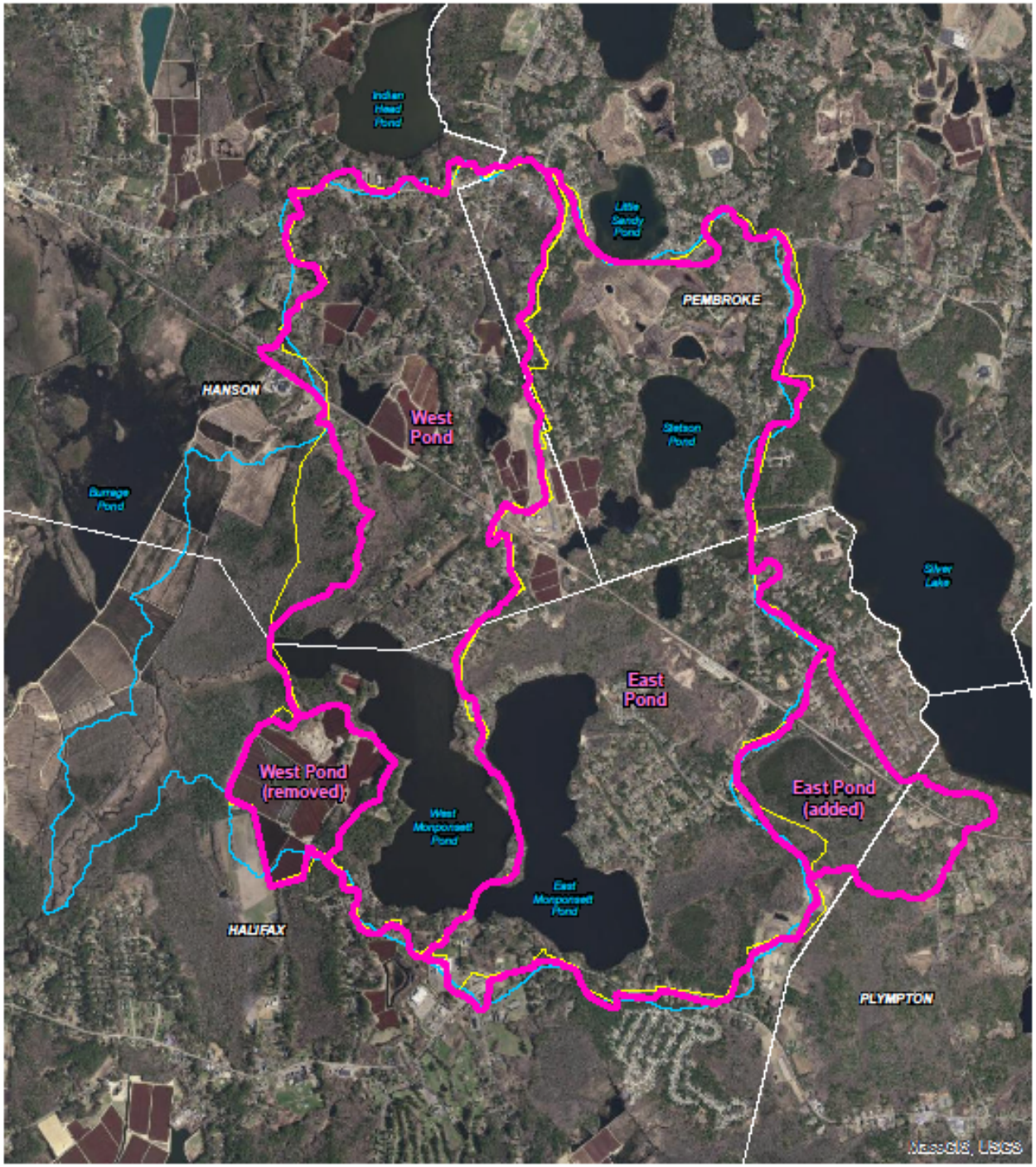
- Sluice Gate Calculated to Convey Significant Quantity of Water and Impact Both Pond Level and Stump Brook Flow
- Open Sluice Gate Scenarios Significantly Increase Stream Flow for Several Months Until Pond Levels Drop Below Top of Sluice Gate
- Open Sluice Gate Scenarios Calculated to Drop Pond Levels by Approximately a Foot Under Average Diversions Scenario & By Closer to 3 Feet Under As-Needed and No Diversion Scenarios

Caveat

- Modeling and Calculations Appear to Over Estimate Pond Drawdown Resulting From Both Diversion and Dam Management Scenarios
- Model Appears to Under Predict the Amount of Groundwater That Enters Pond in response to Lowered Pond Levels - At Least Over Relatively Short Time Periods
- Modeled Pond Levels Dropped Twice as Much Over a 1 Month Period as Observed From 2015 Open Sluice Gate Experiment
- Average Annual BWC Diversions (2BGY) Double the Calculated Flow Through Open Sluice Gate But Calculations Show Greater Pond Drawdown From Open Sluice Gate Than Currently Observed From Diversions

Monponsett Ponds Water Quality

- Update of Prior Water Quality Study Completed by Princeton Hydro in 2013 Under a SWMI Grant
- LLRM (AECOMM, 2009) Mass Balance Spreadsheet Model
- Includes Watershed Nutrient Loadings, Internal Loadings, and Water Inputs and Outputs
- Water Budget Information From This Study to Inform Assessment of Water Quality Impacts From Scenarios
- Calibrated to Available Water Quality Data


Indian Head Pond
Little Sandy Pond
PEMBROKE
HANSON
West Pond
Stetson Pond
Burrage Pond
Silver Lake
East Pond
West Pond (removed)
East Pond (added)
West Monponsett Pond
East Monponsett Pond
HALIFAX
PLYMPTON
MassGIS, USGS

Water Quality Scenario Results

Scenario	West Pond		East Pond	
	TP (mg/L)	TN (mg/L)	TP (mg/L)	TN (mg/L)
Sub-region 59 Nutrient Criteria for Oligotrophic and Mildly Impaired Lakes	**0.008**	**0.320**	**0.008**	**0.320**
Calibration	0.084	1.487	0.029	0.686
No Diversion	0.057	1.092	0.019	0.571
No Internal Load	0.037	0.849	0.029	0.686
Fully Open Stump Brook Dam Low-Flow Sluice Gate and Fish Ladder	0.073	1.357	0.021	0.509
50% Reduction in Land Loads	0.064	1.280	0.004	0.324

Big Picture

- Reducing Diversions Could Significantly Increase Water Available for Increased Stump Brook Flow
- Low Flow Sluice Gate Has Capacity to Convey Significant Water
- Recommend Incremental, Monitored Sluice Gate Opening at Targeted Time Periods to Observe Impacts to Pond Level
- Aggressive Suite of Watershed Load Reductions Necessary to Move Closer to Water Quality Goals

Questions?

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