Effects of a Stream Restoration on Water Quality and Fluxes of Nutrients and Suspended Solids

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Muddy Creek Restoration

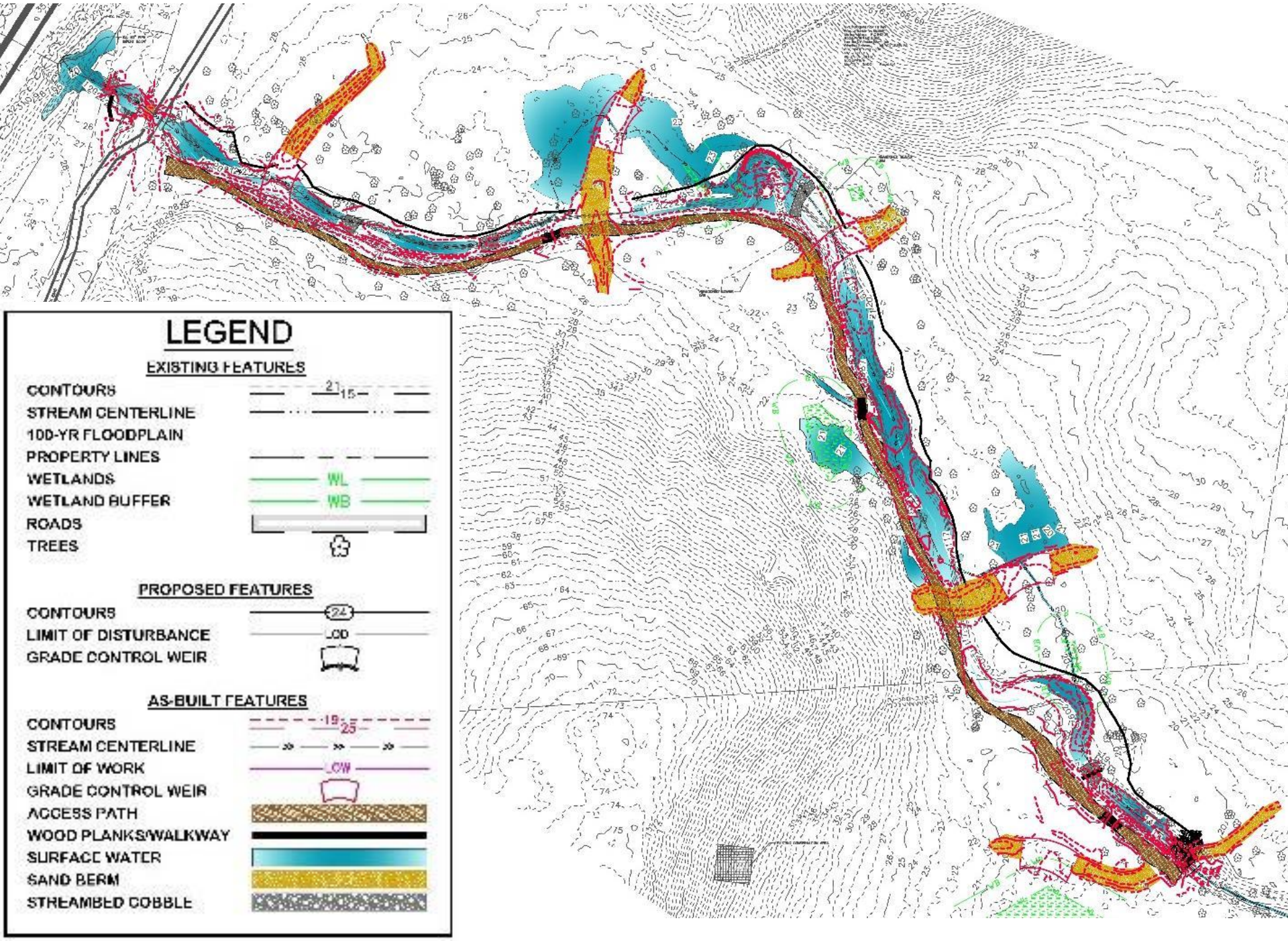
RSC:

Regenerative Stormwater Conveyance

Installing weir at outlet of Muddy Creek RSC

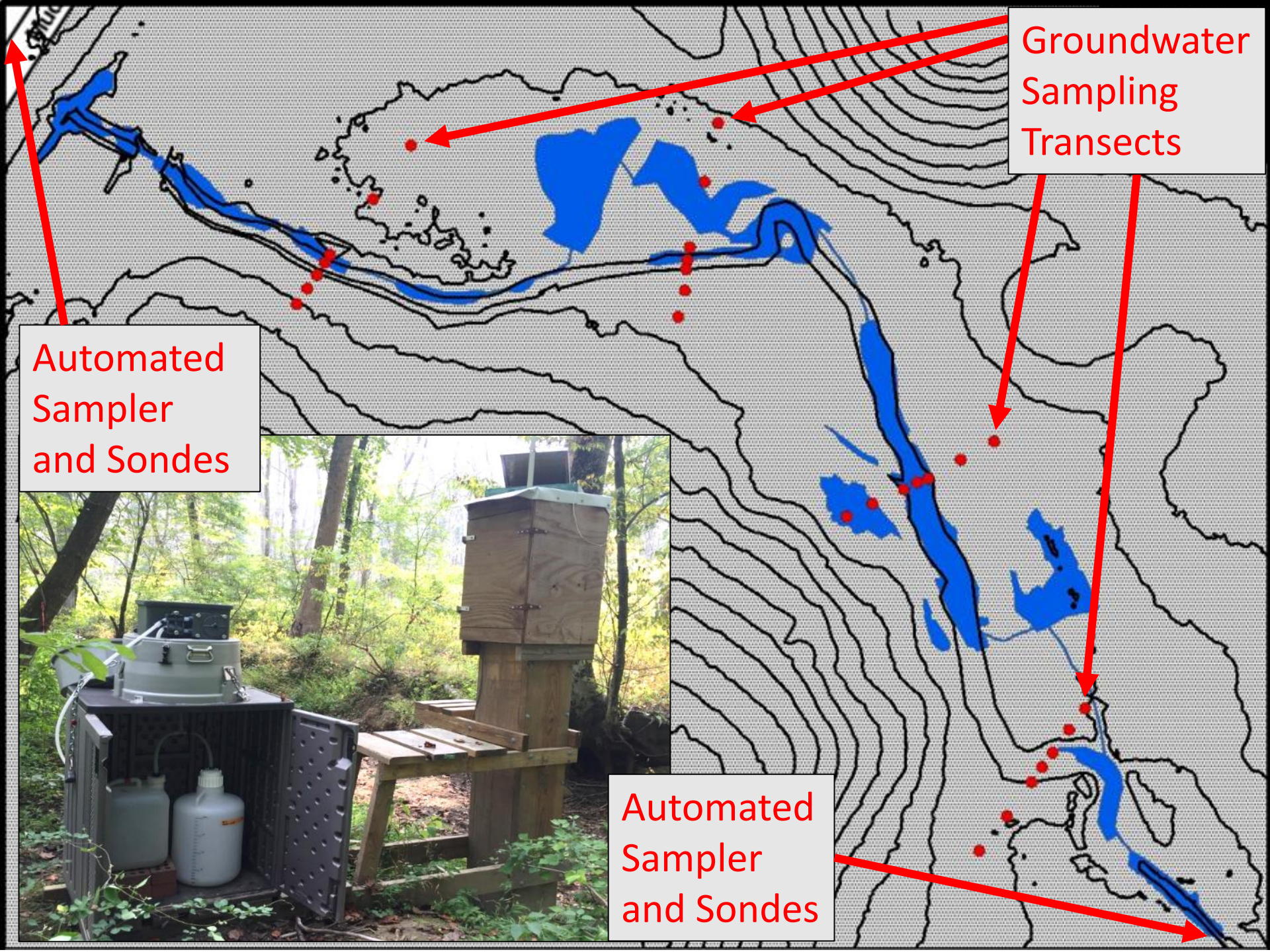
A Riffle Restored in Muddy Creek

A Pool Restored in Muddy Creek

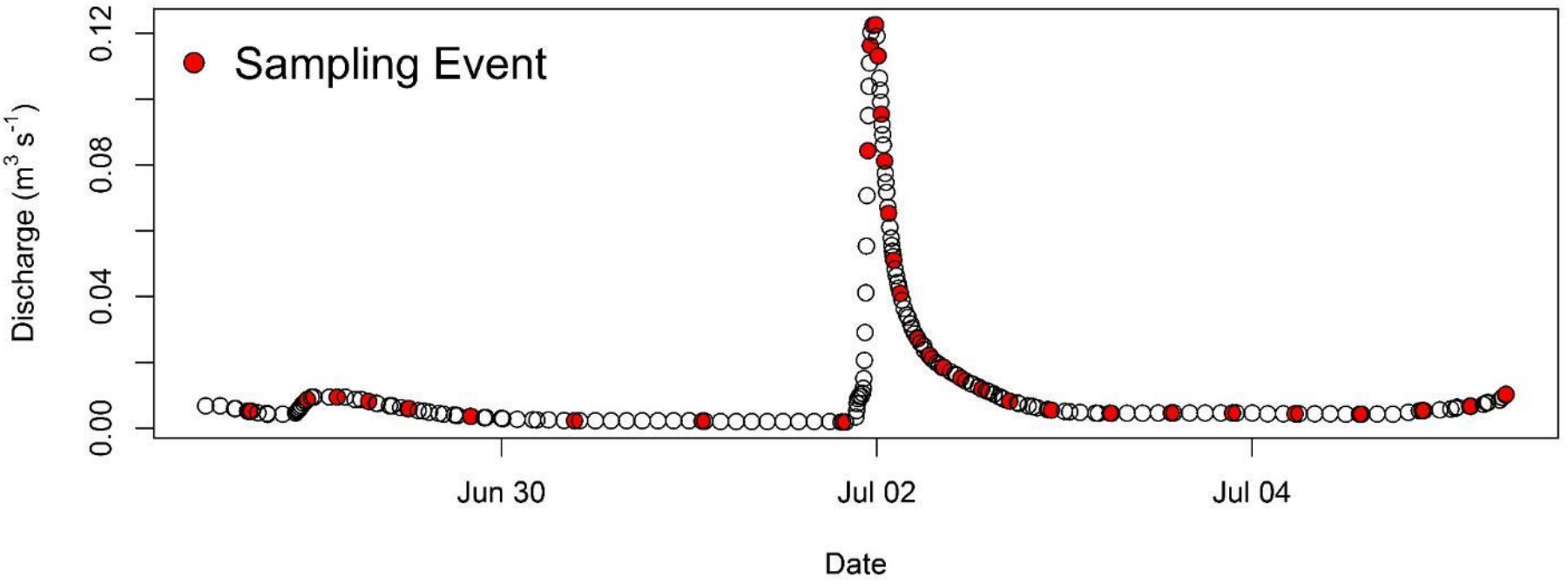

LEGEND
EXISTING FEATURES
CONTOURS
21
15
STREAM CENTERLINE
100-YR FLOODPLAIN
PROPERTY LINES
WETLANDS
WL
WETLAND BUFFER
WB
ROADS
TREES
PROPOSED FEATURES
CONTOURS
24
LIMIT OF DISTURBANCE
LOD
GRADE CONTROL WEIR
AS-BUILT FEATURES
CONTOURS
19
25
STREAM CENTERLINE
LIMIT OF WORK
LOW
GRADE CONTROL WEIR
ACCESS PATH
WOOD PLANKS/WALKWAY
SURFACE WATER
SAND BERM
STREAMBED COBBLE

Research Goals

- Assess the effects of the stream restoration:
  - On the removal of suspended solids and nutrients from surface water; and...
  - On the chemistry and flow of groundwater as they may impact removal of nutrients and precipitation of iron in the stream.


Groundwater
Sampling
Transects
Automated
Sampler
and Sondes
Automated
Sampler
and Sondes

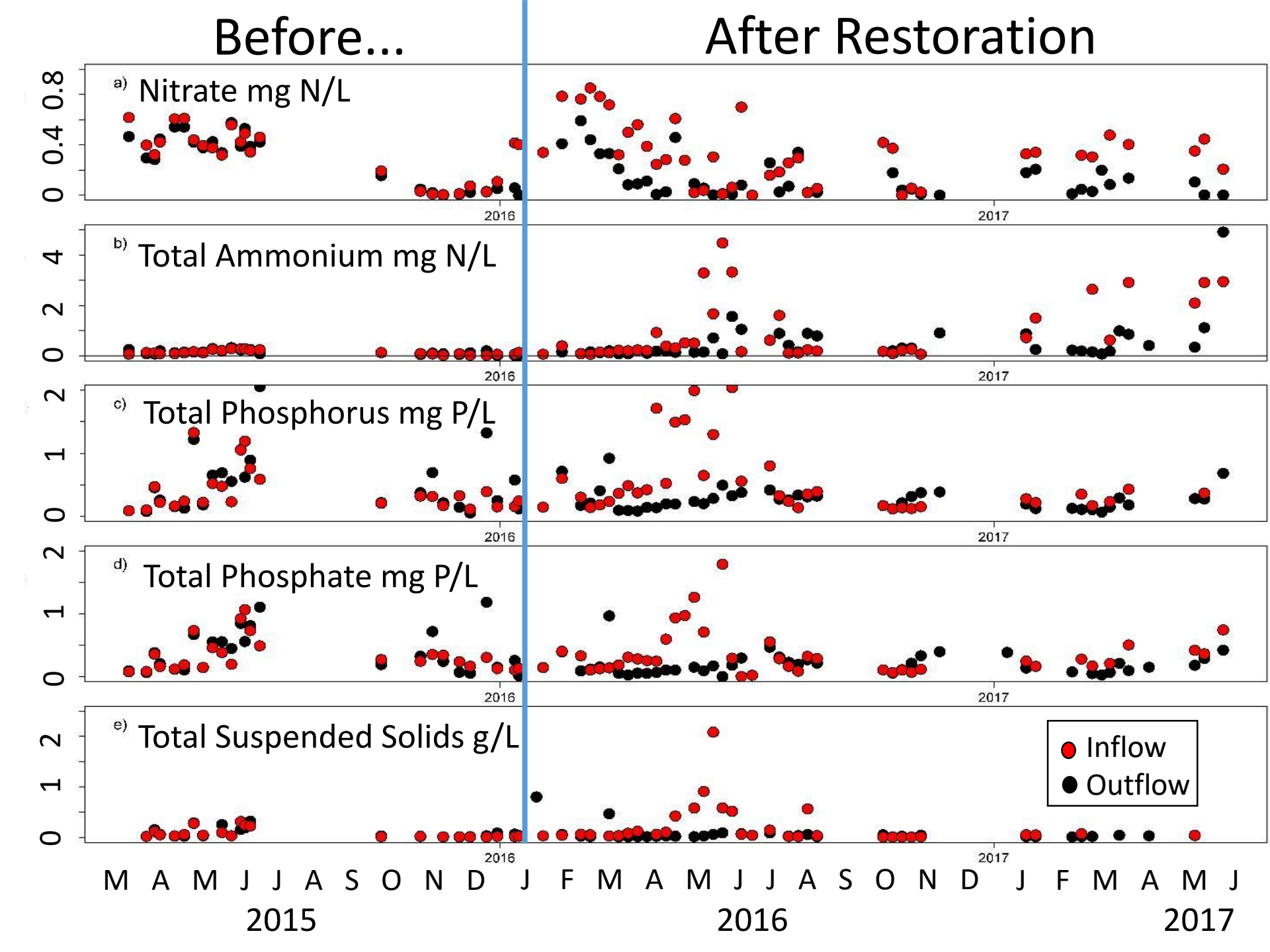
Automated Flow-Paced Sampling



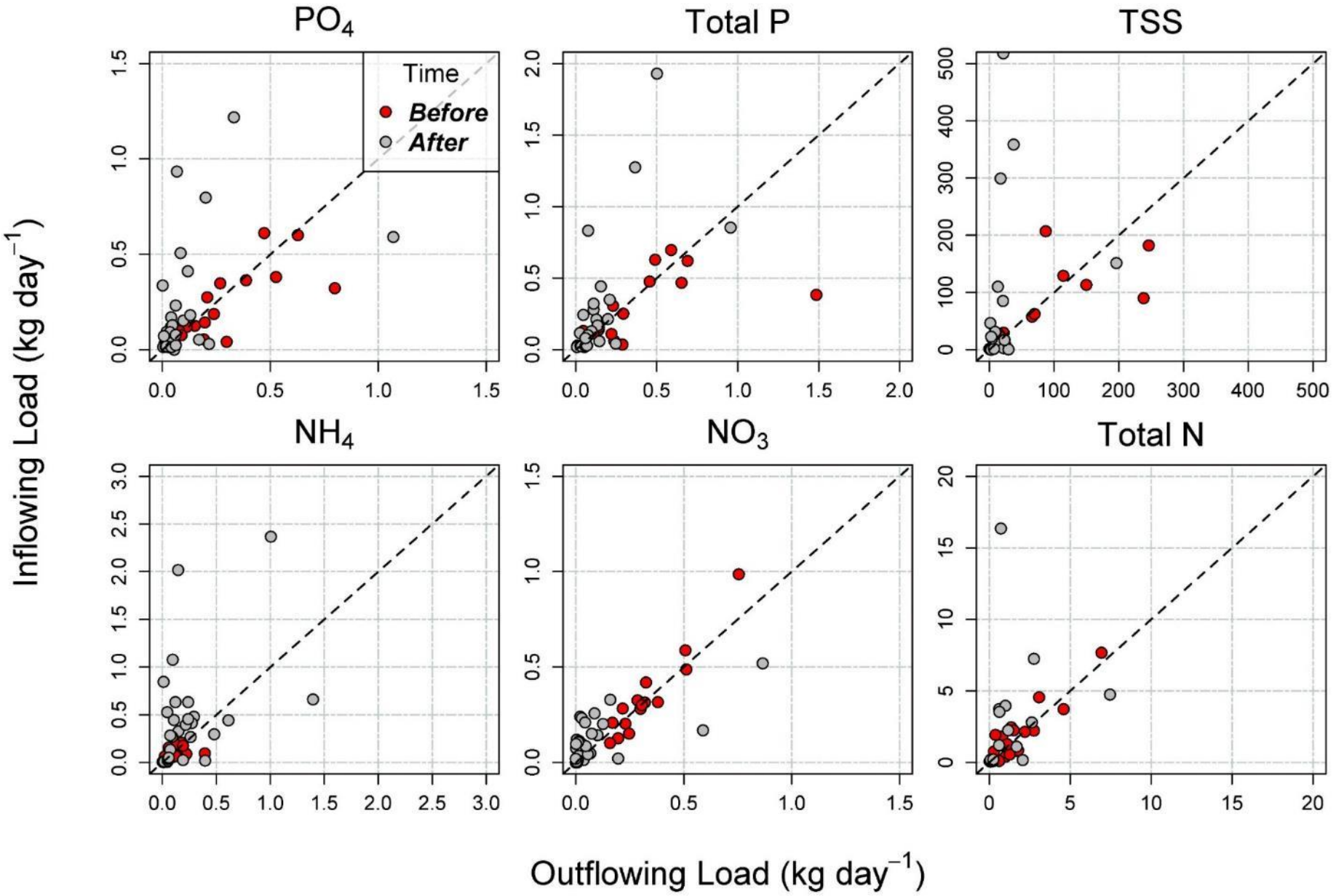
- Samples pumped after a set amount of flow has occurred (e.g. 30-60 water samples per week).
- Water samples composited for a weekly mean concentration.
- Concentration X weekly water flow = Weekly load.

Sulfuric acid preservative for nutrients

- Acid extracts particulate ammonium and phosphate
- No acid for total suspended solids


Before...
After Restoration
a) Nitrate mg N/L
b) Total Ammonium mg N/L
c) Total Phosphorus mg P/L
d) Total Phosphate mg P/L
e) Total Suspended Solids g/L
Inflow
Outflow
2016
2017
M A M J J A S O N D J F M A M J J A S O N D J F M A M J
2015
2016
2017

Inflowing vs. Outflowing Loads

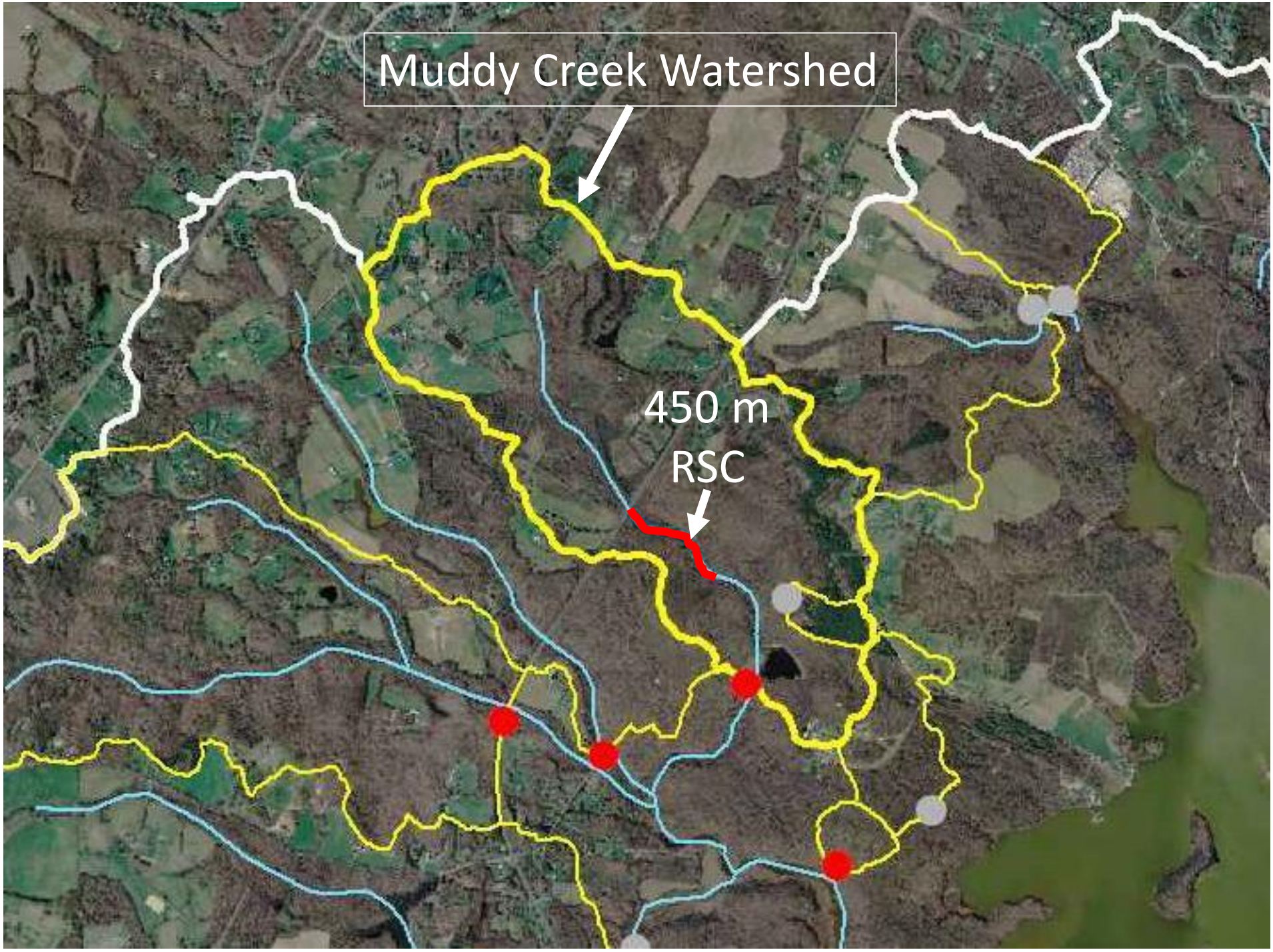


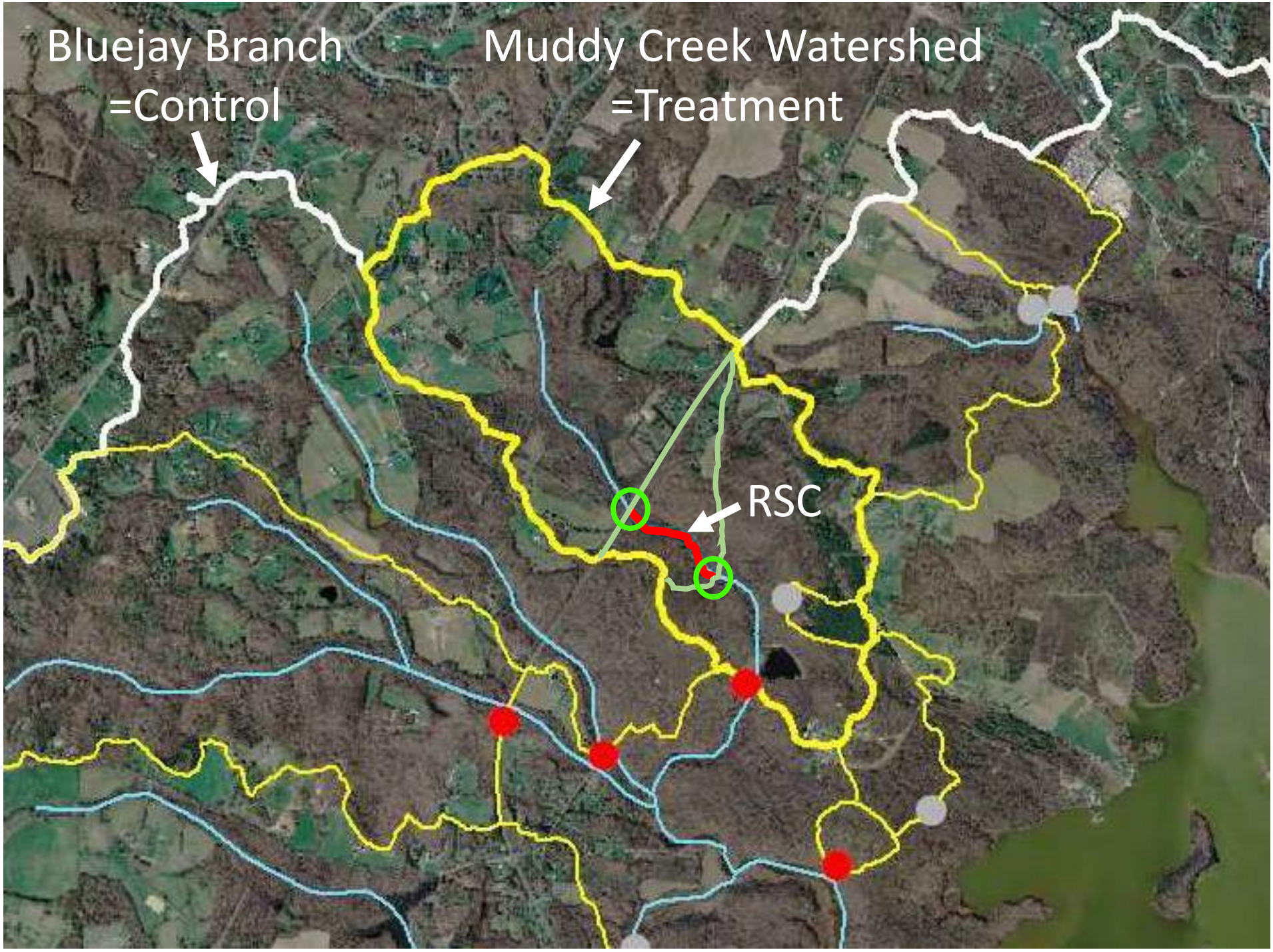
Calculating Retention

Concentration X Water Flow = Load

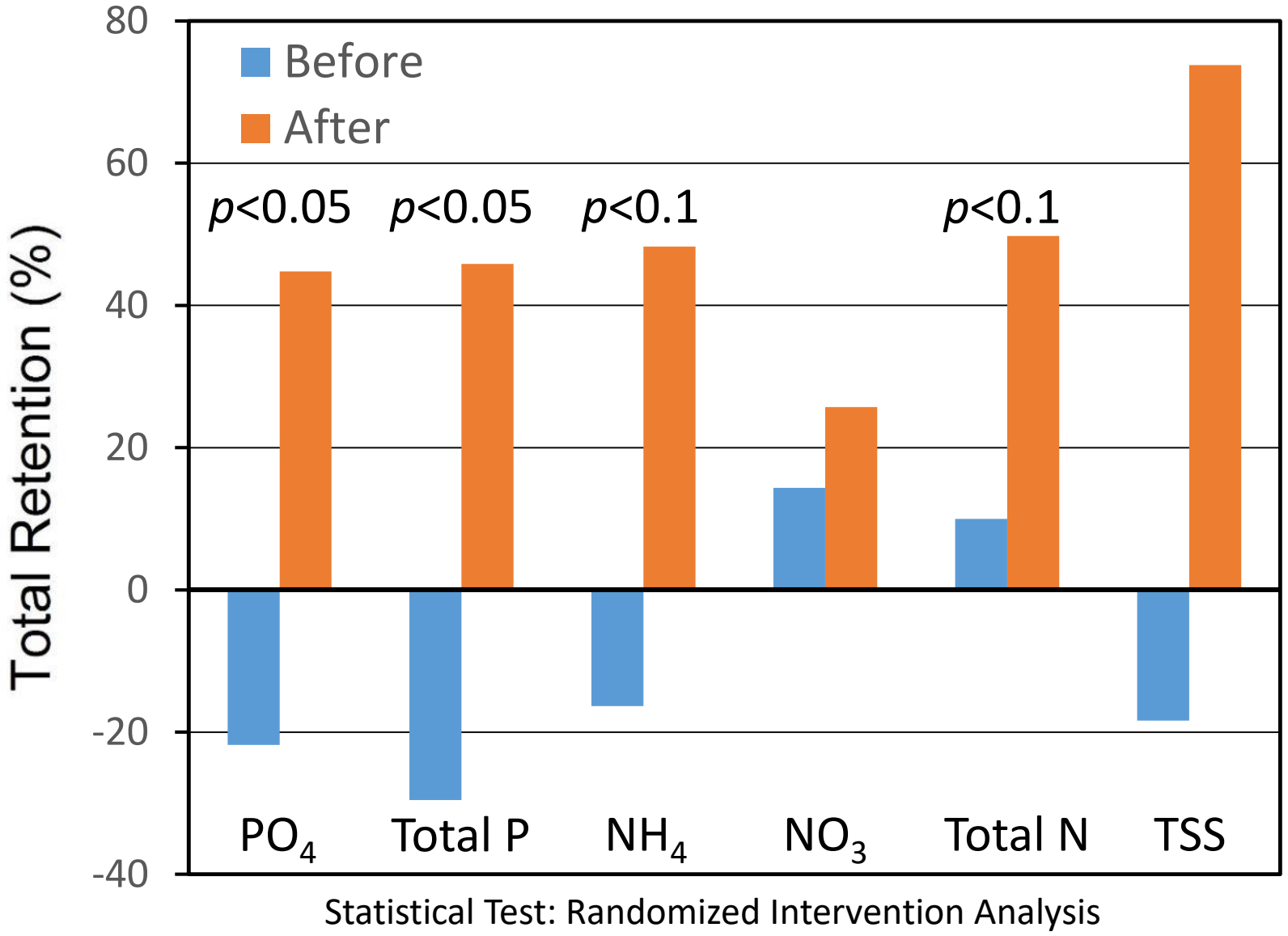
Load in – Load Out = Amount Retained

% Retained = (Amount Retained / Load In) X 100

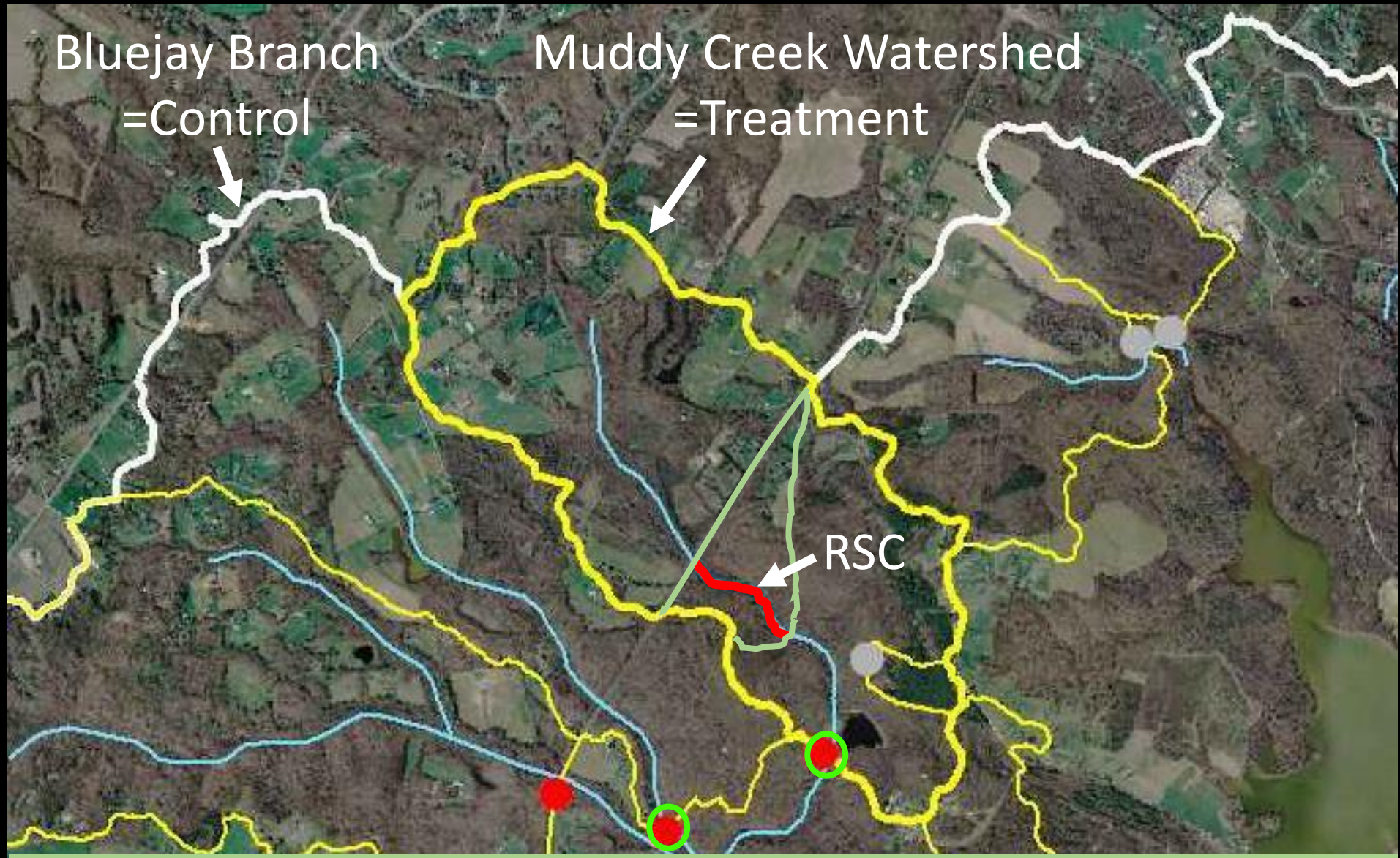

Muddy Creek Watershed
450 m
RSC


Bluejay Branch
=Control
Muddy Creek Watershed
=Treatment
RSC

Comparing the inlet and outlet of the restored reach: Percentage of inflow retained increased after restoration



Statistical Test: Randomized Intervention Analysis

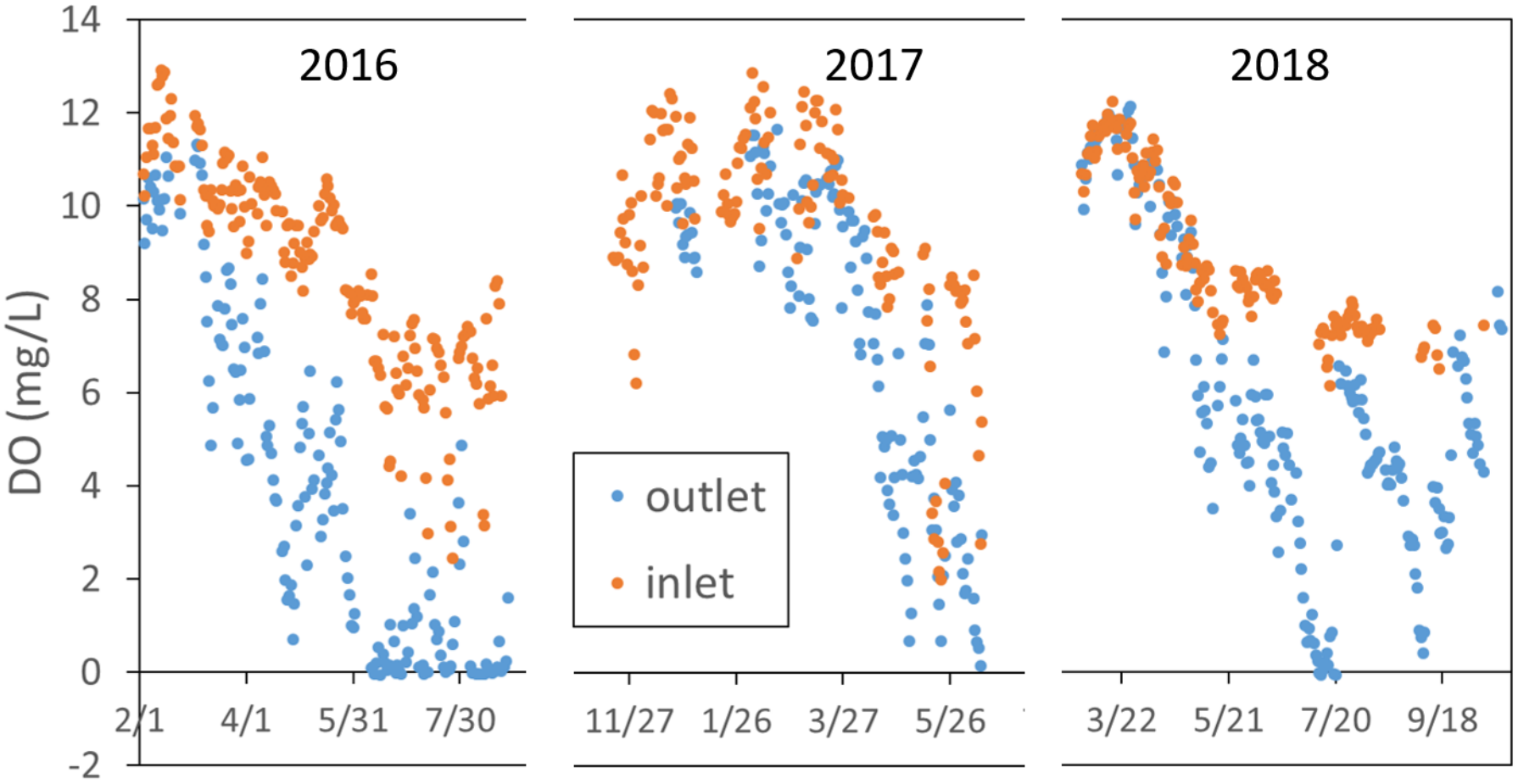


Comparing the treatment and control watersheds:

No statistically significant changes in loads could be attributed to the restoration.

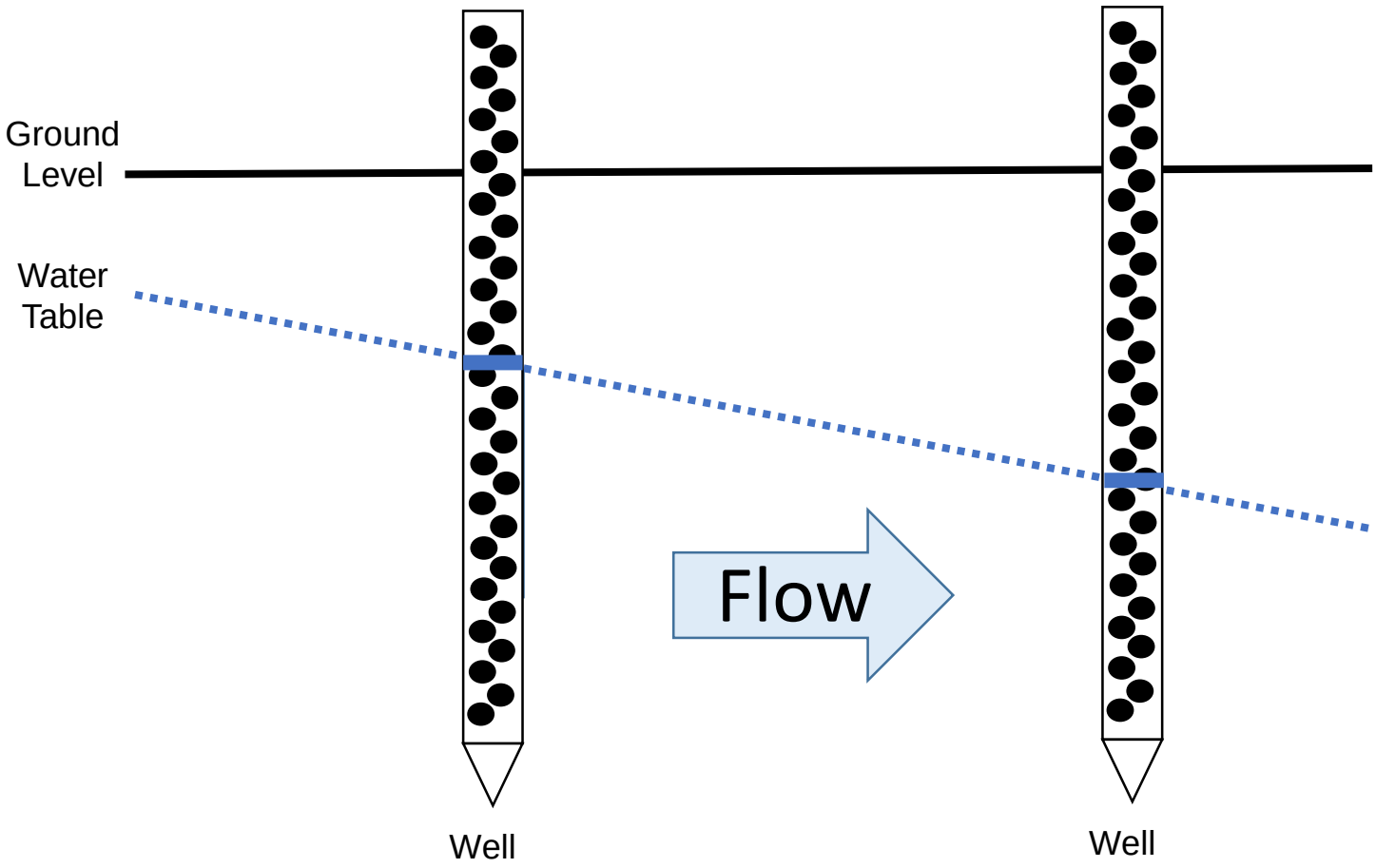
The effects may have been masked by the effects of beaver ponds downstream of the restoration.

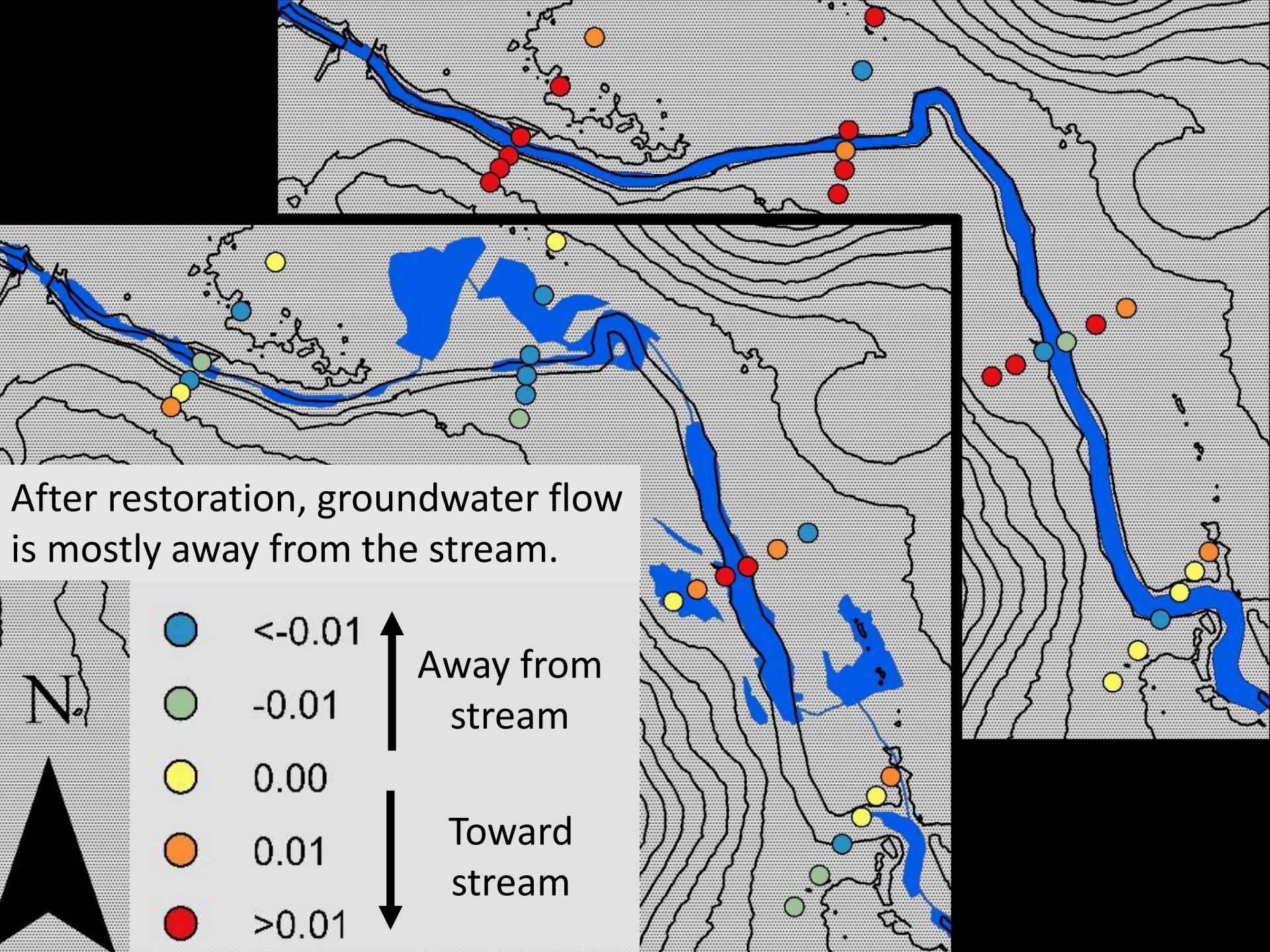
Dissolved Oxygen Concentration at Inlet and Outlet



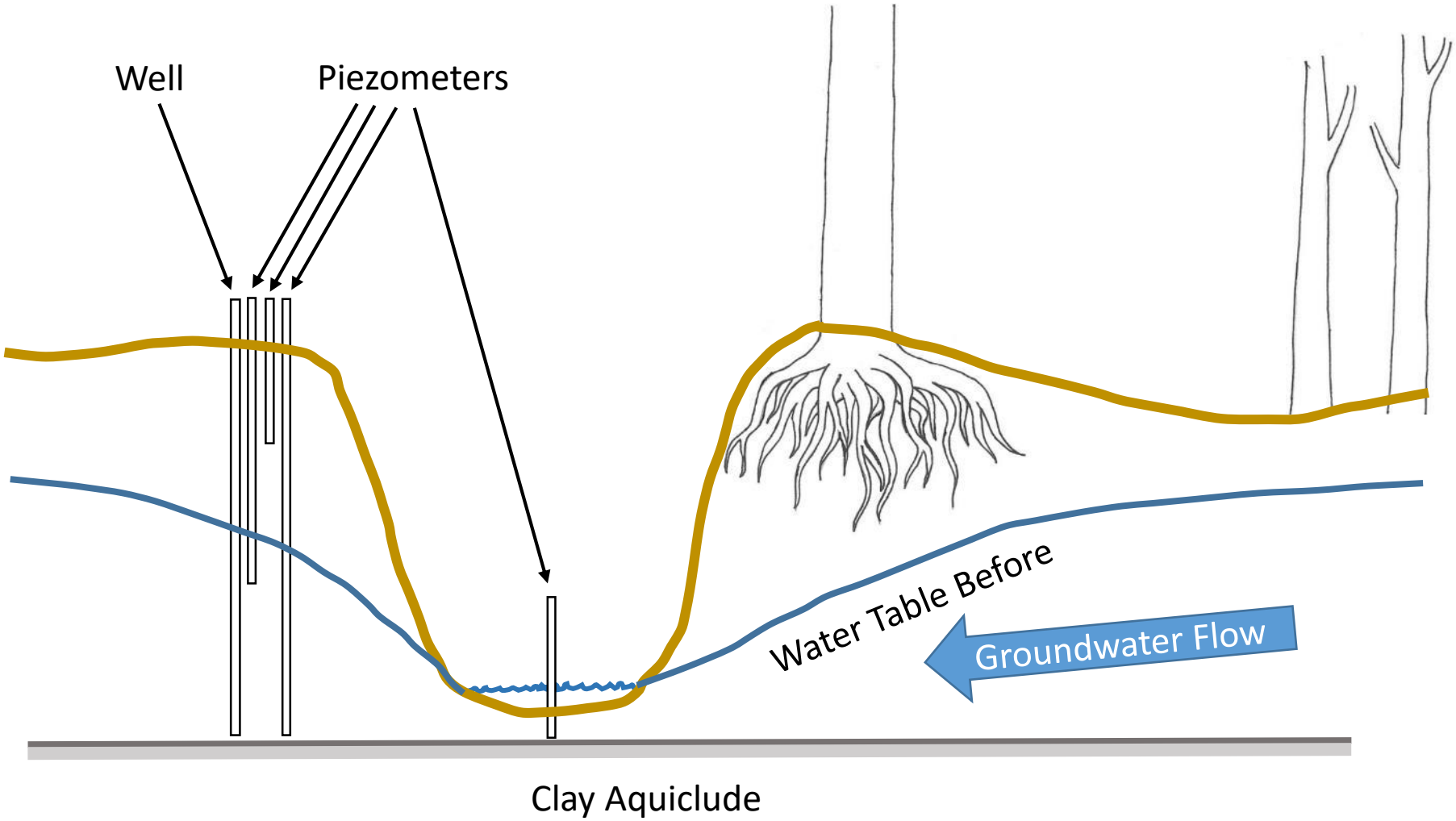
Transect of Wells and Piezometers

Horizontal Pressure Gradient

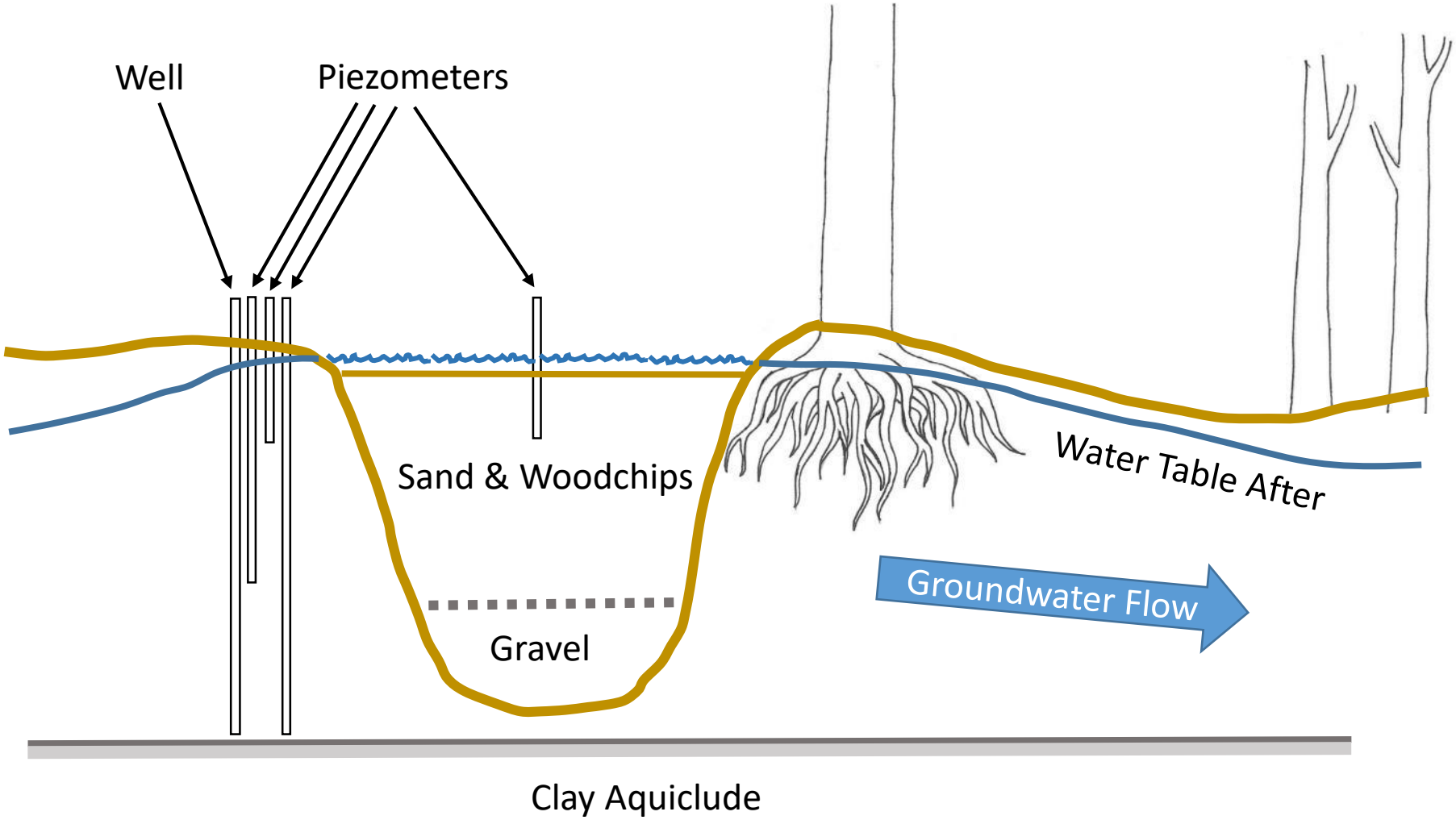



After restoration, groundwater flow is mostly away from the stream.
N
<-0.01
-0.01
0.00
0.01
>0.01
Away from stream
Toward stream

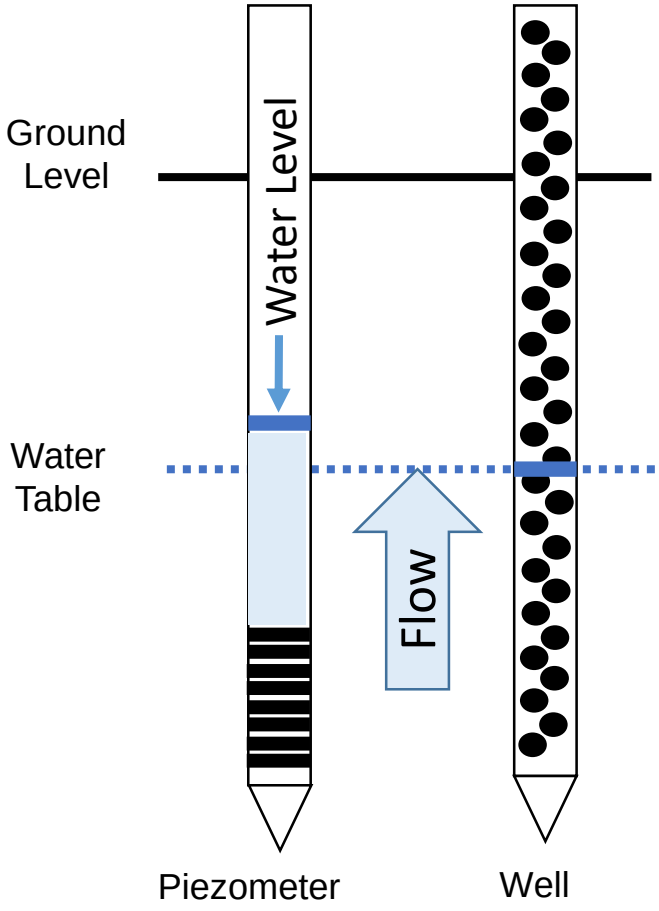
Before restoration, the eroded channel drained the banks.

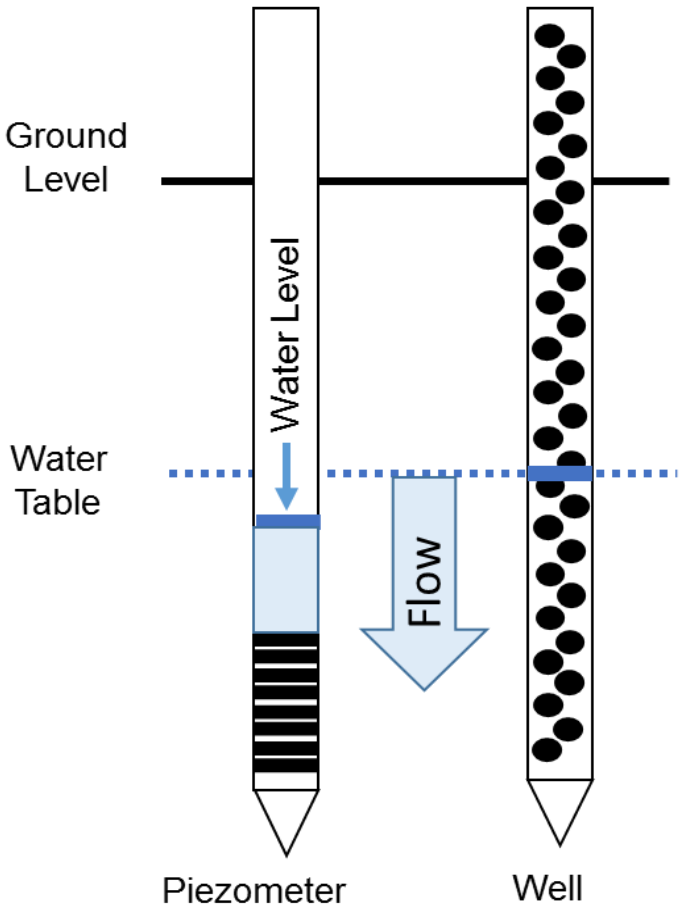


After restoration, the water table elevation increased.



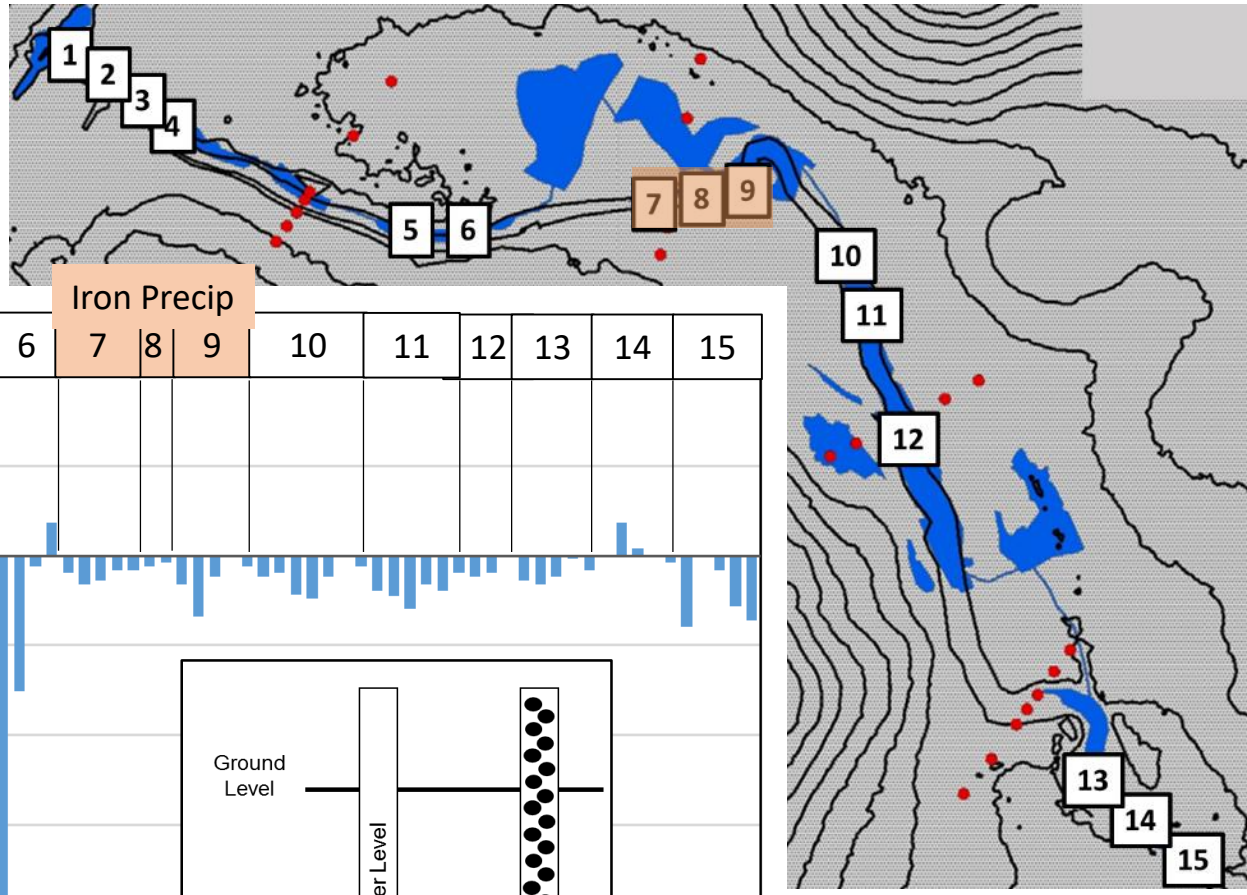
Vertical Pressure Gradients

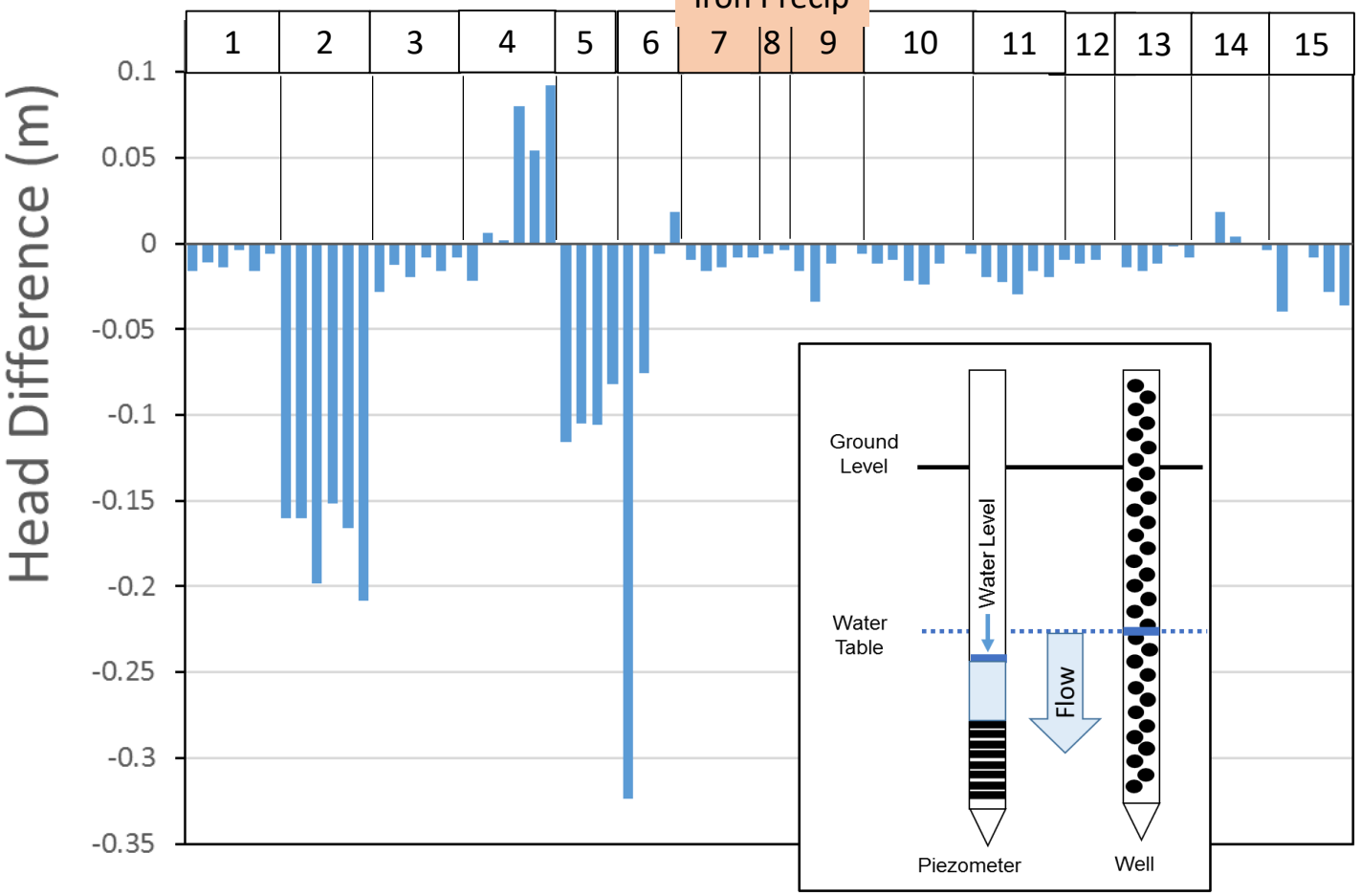




Vertical pressure gradients in streambed groundwater: Negative values suggest infiltration

May-June 2018 data from SERC intern Christina Klein:



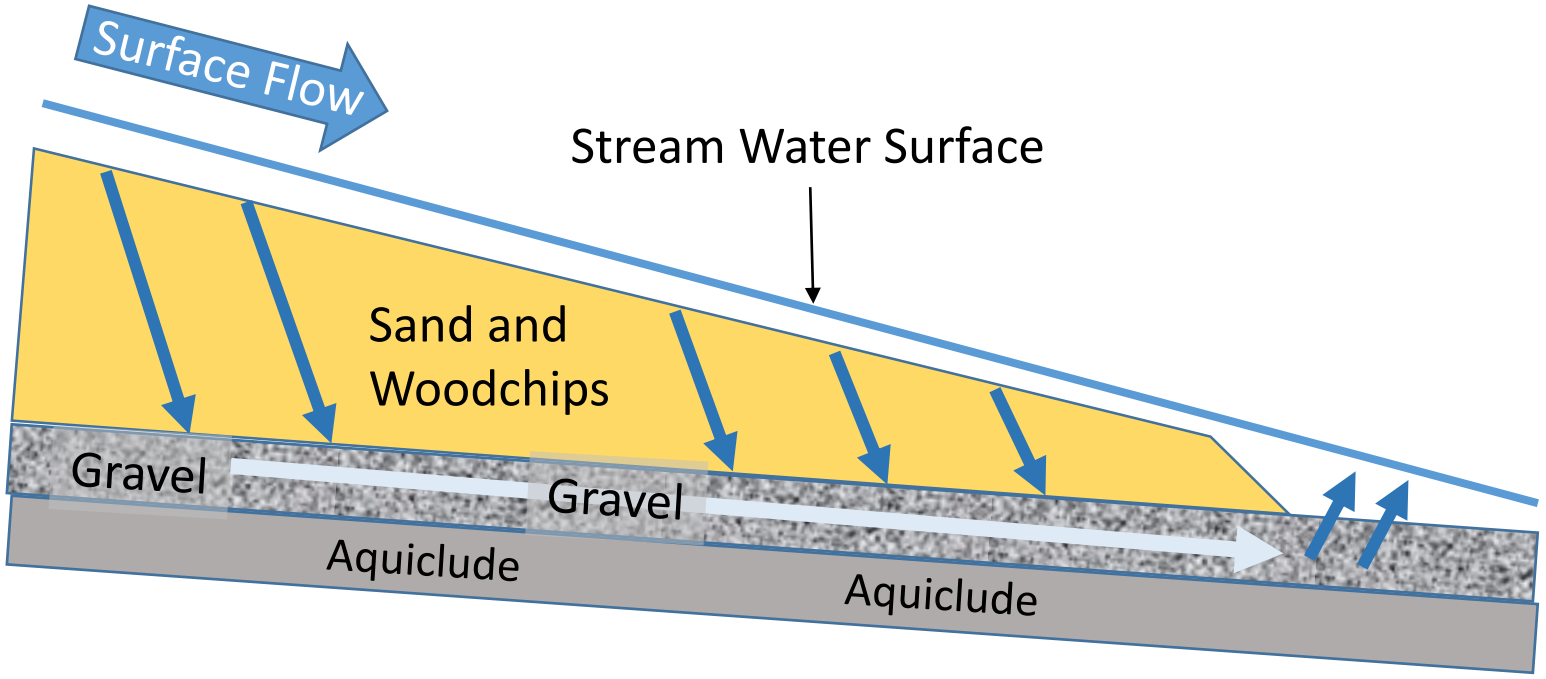


Sand Filter Concept:

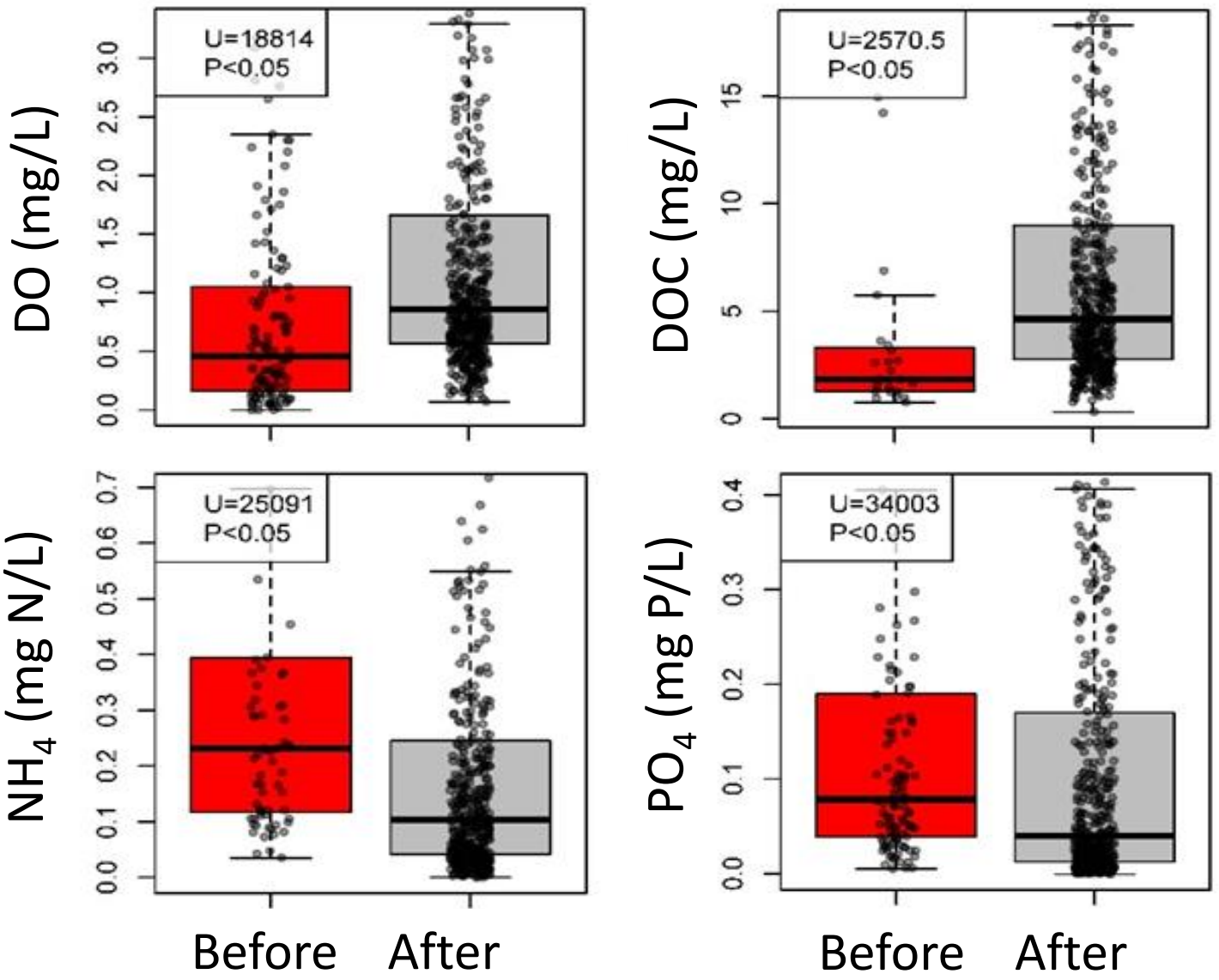
-The gravel layer allows faster groundwater flow than the overlying sand.

-This pulls water downward through the sand.

-At the end of the restored reach groundwater carried through the gravel is released back into the surface flow.



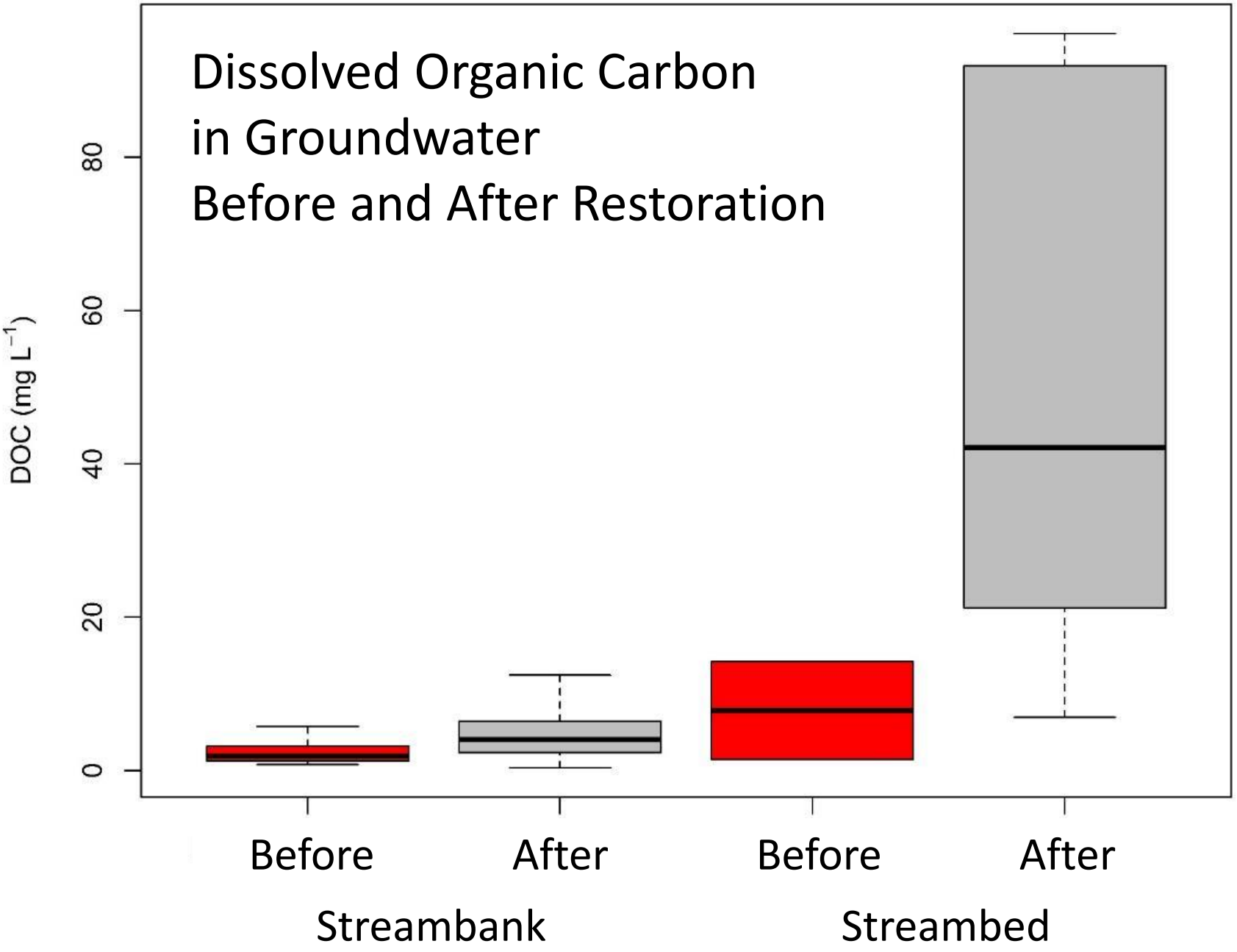
Concentrations in Groundwater Before and After Restoration



Groundwater chemistry after restoration:

Statistically significant changes in dissolved concentrations

Decreased:	Increased:	No change:
Phosphate	Organic C	Nitrate
Ammonium	Iron	
Sulfate	Oxygen	
pH	Conductivity	


Dissolved Organic Carbon
in Groundwater
Before and After Restoration
DOC (mg L^{-1})
0
20
40
60
80
Before
After
Before
After
Streambank
Streambed

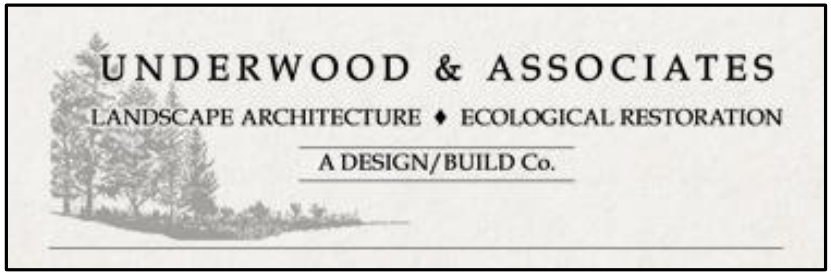
Summary: Surface Water

- The restoration reconnected the stream to its floodplain.
- Flow diversions created pools on the flood plain.
- The pools may alter flow of suspended particles through the restored reach.
- Concentrations and loads of nitrogen, phosphorus, and suspended solids were reduced after the restoration.
- Dissolved oxygen concentration declined and iron oxide precipitated in some places along the restored reach.

Summary: Groundwater

- The restoration altered the distribution and flow of groundwater around the restored reach.
- Groundwater chemistry changed after the restoration.
- Enhanced exchanges of surface water and groundwater may contribute to nutrient retention, dissolved oxygen depletion, and iron oxide precipitation.

We thank these organizations for support:



Rathmann Family Foundation