Hydrology and Hydraulics of the Old Erie Canal

Old Erie Canal Annual Meeting
Chittenango Landing Canal Boat Museum
January 30, 2020

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

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John Wernly
U.S. Geological Survey
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Overview

- **The Old Erie Canal**
  - **History**
  - **Why survey it**

- **USGS Study**
  - **Study Area**
  - **Establish water surface elevation**
  - **Bathymetric Survey**
  - **Water Quality Survey**
  - **Mapped flow direction**
  - **Document Canal Infrastructure**

- **HEC-RAS Model**
  - **Tool to guide management decisions**

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Old Erie Canal

- **Built in 1825, superseded in 1918**

- **"Long Level"**
  - **36 miles between Dewitt and Rome**
  - **No locks**

- **Variety of stakeholders**
  - **Canal Corporation**
  - **State Parks system**
  - **3 Counties**
  - **Several communities**

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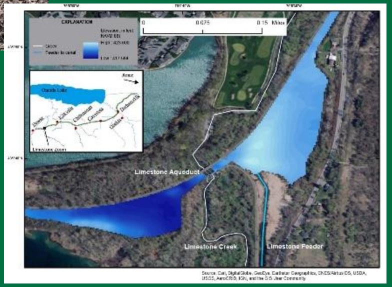
Cooperator

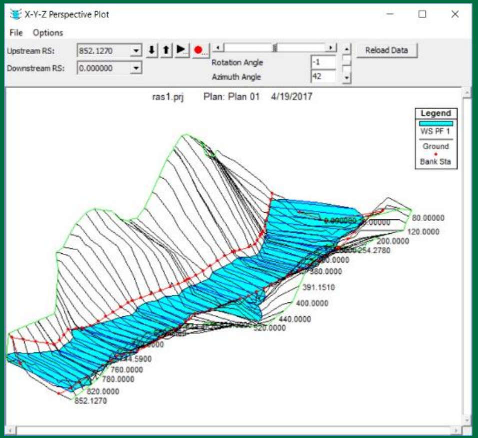
- **Madison County Planning Department**
- **Vision: Revitalize the Canal**
  - **Potential source of economic revitalization**
  - **Improve the water flow and quality**
    - **Eliminate Stagnation of water**
    - **Reduce Algae**
    - **Reduce Foul Odor**
- **Understand current condition and hydrology of the canal**

Project Objectives



- **Phase 1**
  - **Establish elevations**
  - **Bathymetric survey**
  - **Water Quality Survey**
  - **Flow Direction**
  - **Document and evaluate infrastructure**
    - **Series of Feeders**
    - **Aqueducts and outfalls**

- **Phase 2**
  - **HEC-RAS Model**
    - **Assess the feeder system**
    - **Improve flow through the system**



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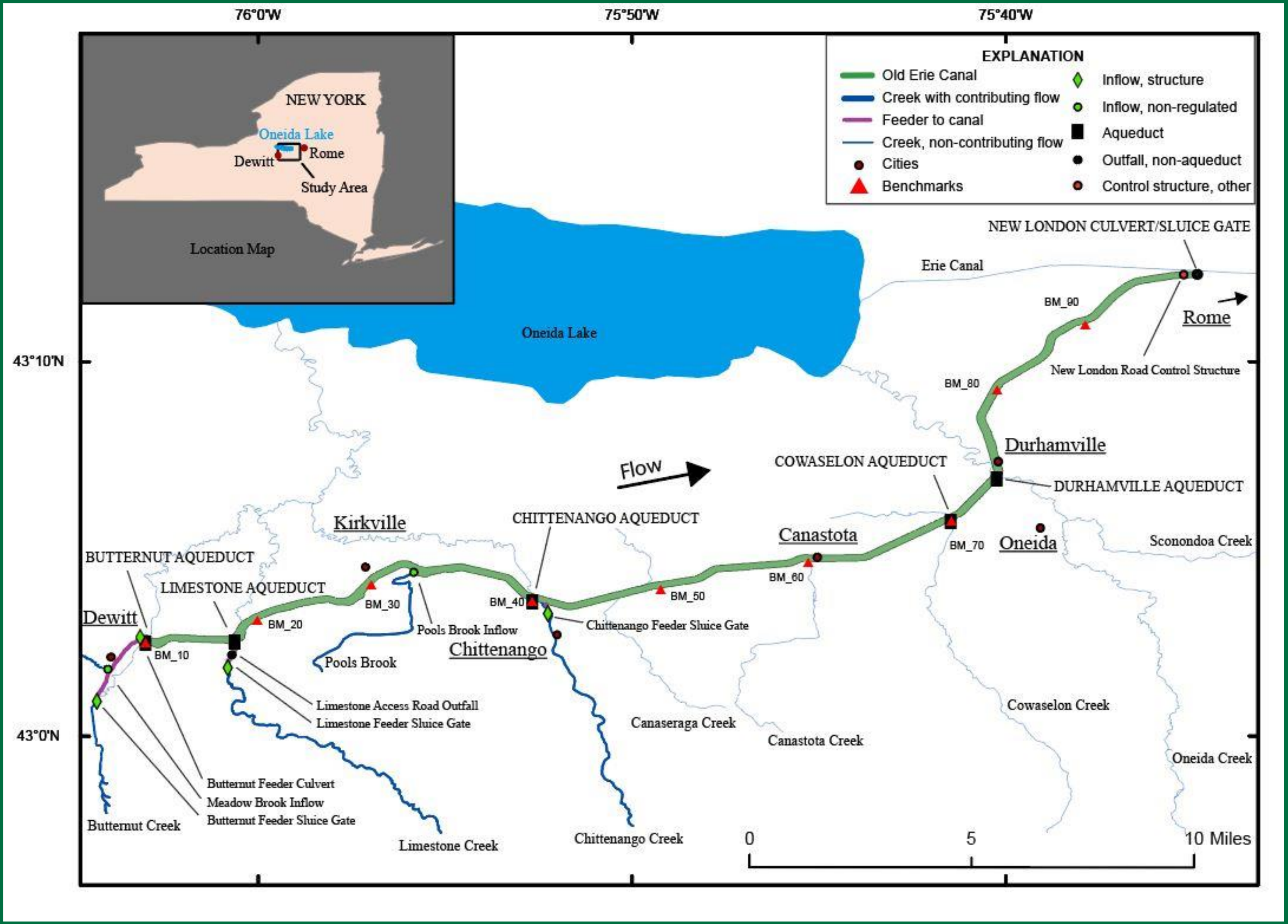
Study Area



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Establishing elevation

- **Water Level Changes**
  - **Need to establish elevation of water surface**

- **Installed 9 benchmarks**
  - **GPS Surveyed**
- **Staff Plates**
  - **Tied into Benchmarks**
  - **Read level of water surface**
- **Further use**
  - **Future studies**
  - **Citizen Scientists**

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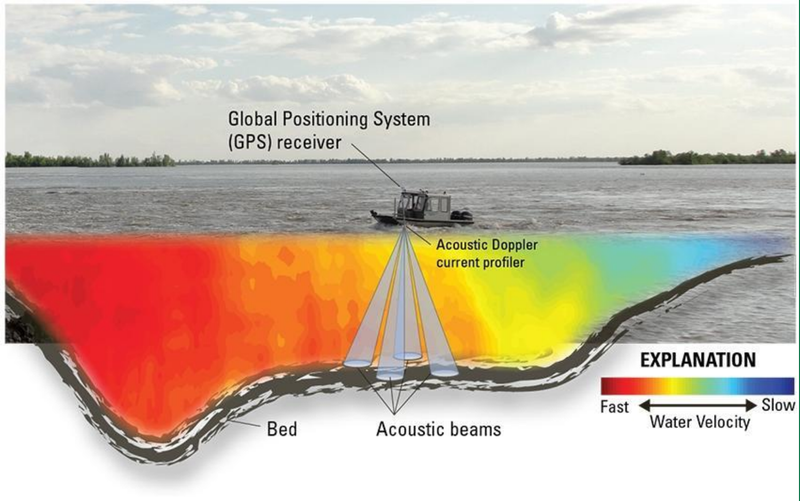
Bathymetric Survey

- Create a map of the canal's bottom
  - Depth of canal at any water level

- Acoustic Doppler Current Profiler
  - Measure depths
  - GPS provides coordinates
  - Advantage: measure velocity



- 30.8 Miles Surveyed
  - Boat (Dewitt to Durhamville)
  - Manually (Durhamville to NYS Barge Canal)

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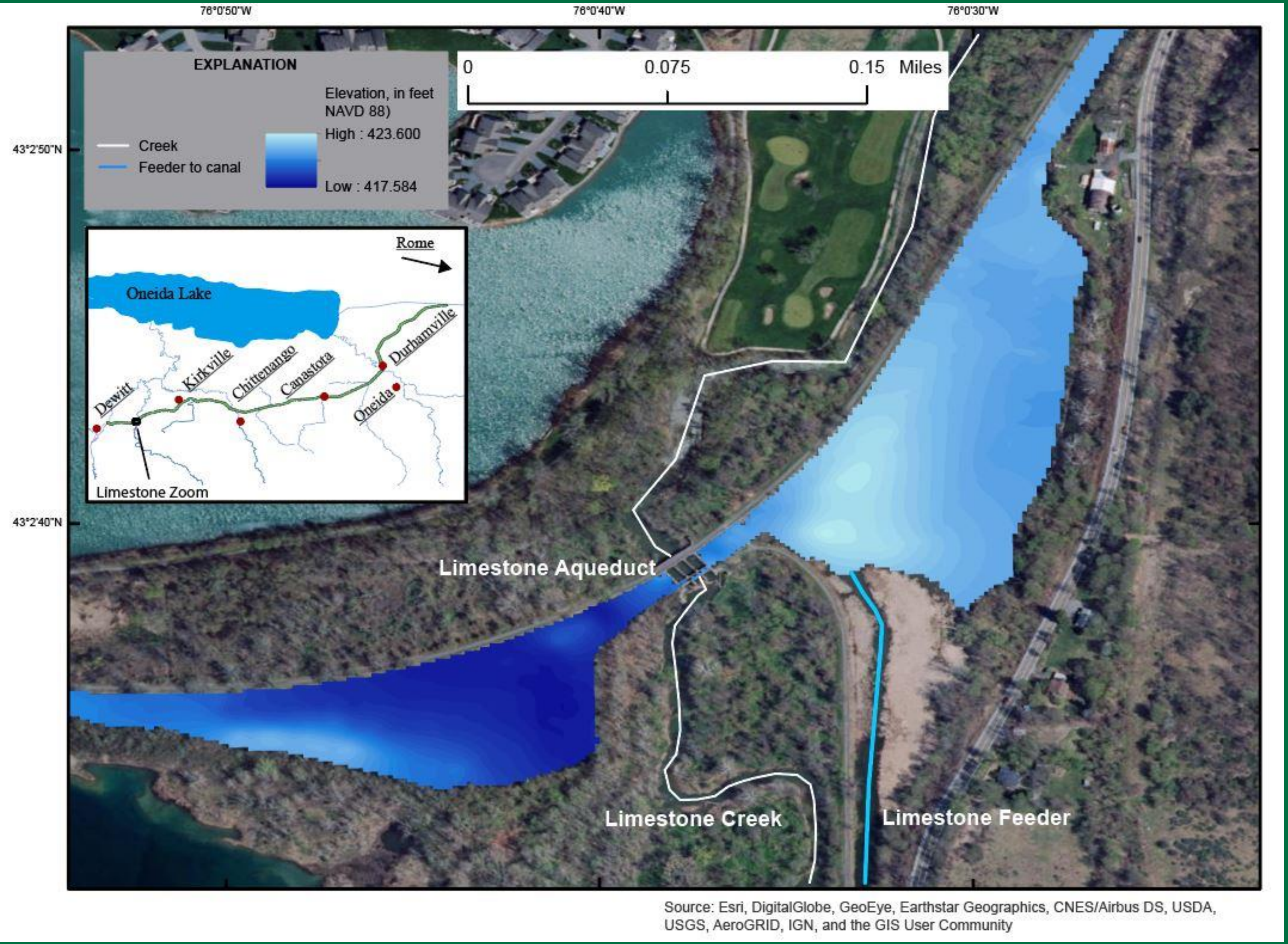
Bathymetric Map



<u>Dewitt to Durhamville</u>

- Average depth: 3.52 ft
- Range: 1.26 ft to 7.33 ft

<u>Durhamville to NYS Barge Canal</u>

- Average depth: 1.36 ft
- Range: 0.68 ft to 2.44 ft

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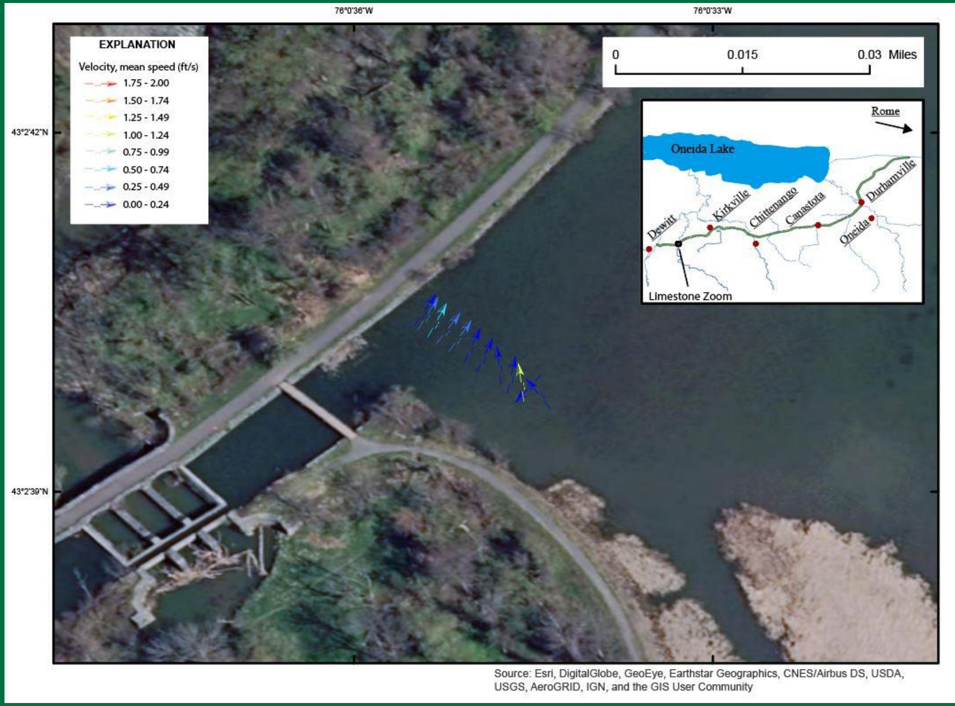
Flow Direction

- Generally in the downstream direction
  - Entire length of the canal
  - Confirmed by visual inspections
- Velocity increases downstream (Dewitt to Durhamville)
  - Likely due to shallower depth
    - Discharge = Velocity x Area



Benchmark Section	Flow Velocities (ft/s)
BM_10	0.214
BM_20	0.192
BM_30	0.188
BM_40	0.261
BM_50	0.289
BM_60	0.279
BM_70	0.365

Flow velocities in each benchmark section of the canal.

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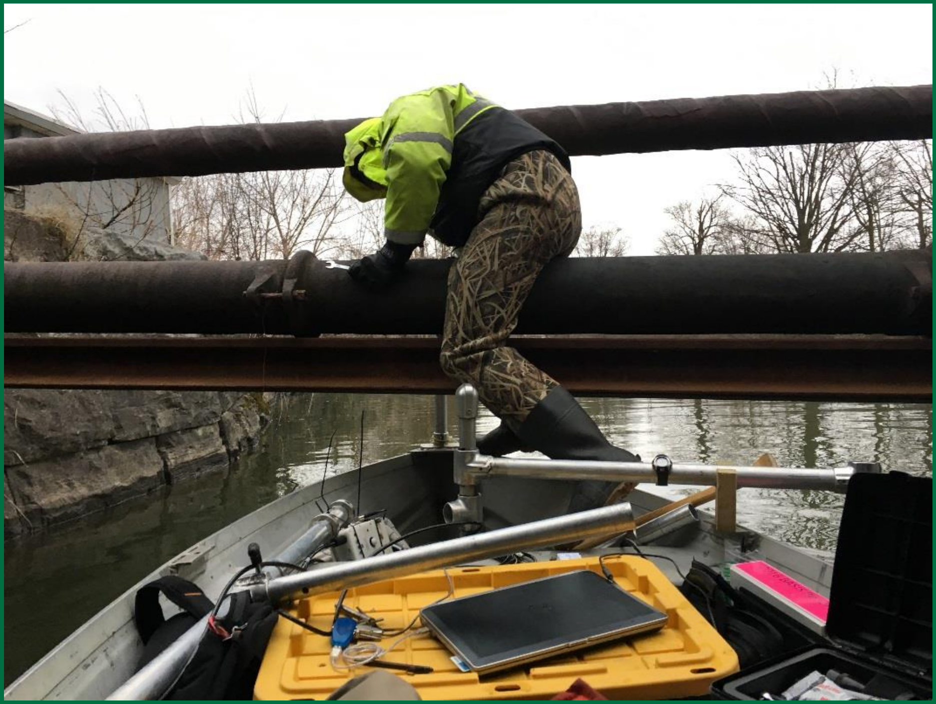
Bathymetric Survey

- Survey Length: 30.8 miles
  - 34 bridges to pass under
    - Many less than 3 feet above
    - Under I-90
  - Dozens of fallen trees
  - Zero boat ramps



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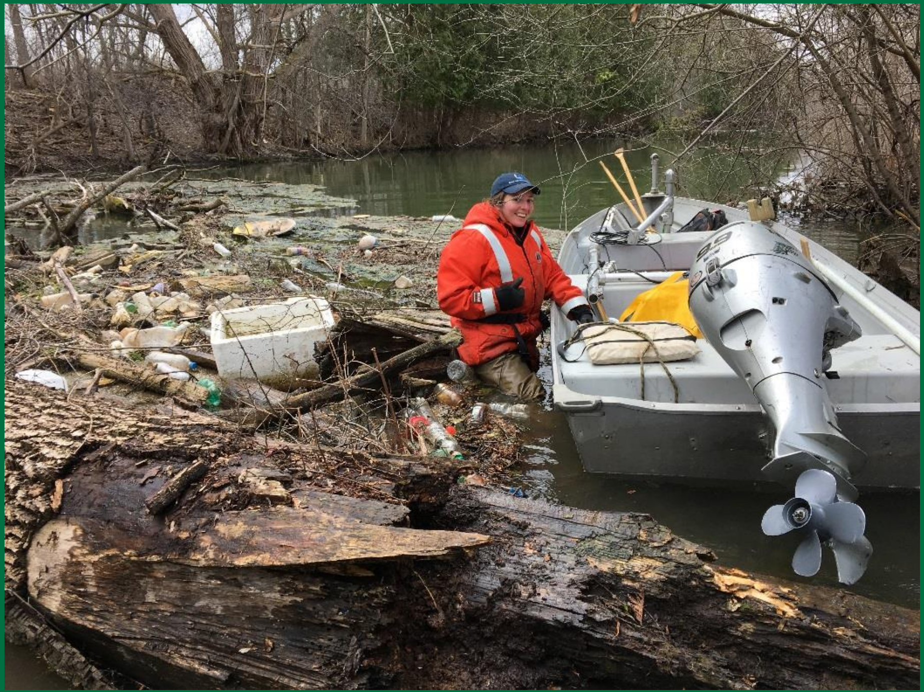
Bathymetric Survey

- **Passing under a low bridge**

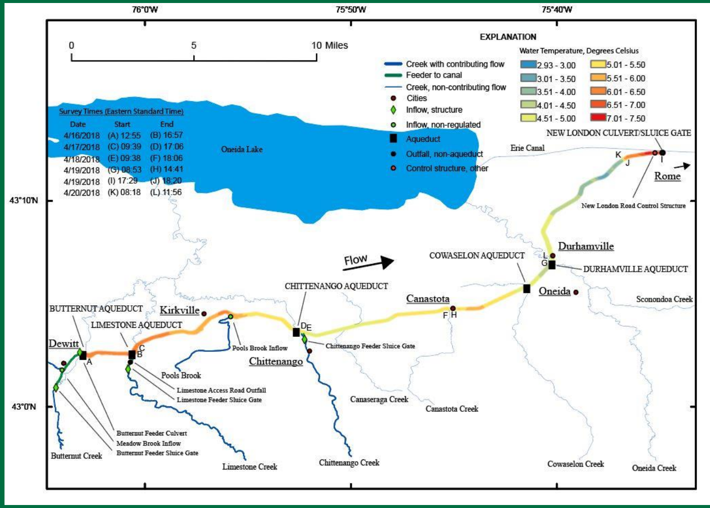
Bathymetric Survey

- **Obstacles**



Water Quality Survey

- Water Temperature
- Turbidity
- Specific Conductance
- Dissolved Oxygen levels
- pH



- Survey conducted April 2018
  - Data collected every minute
  - Provides a snapshot of the canal
    - Ideally repeat the survey
      - Seasonally
      - Pre- and post-storm
      - Collect samples

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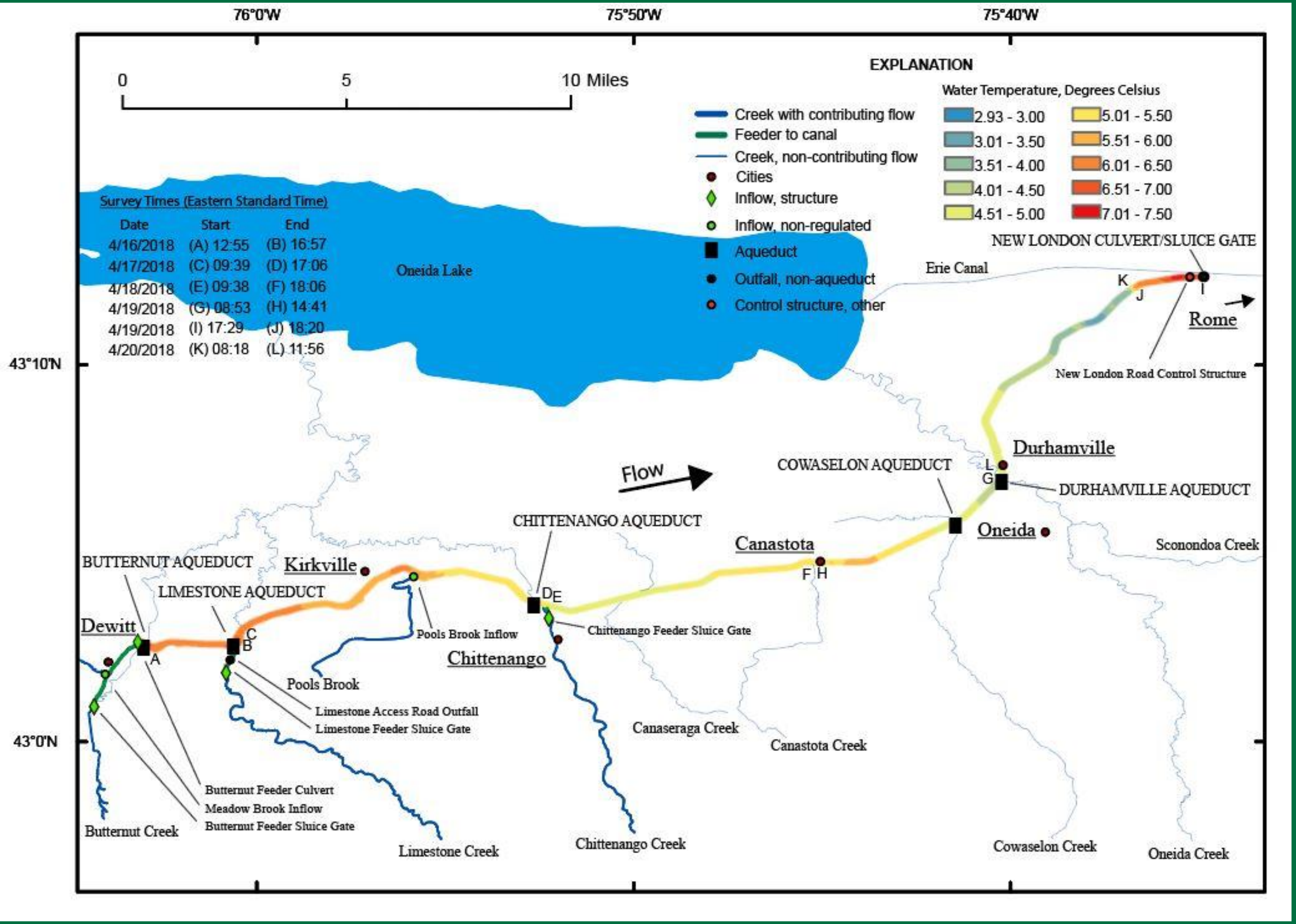
Water Temperature

- Range
  - 2.9 °C– 7.5 ° C
- Timing Matters
  - Relative to stormwater runoff
  - Time of measurement (especially in shallow areas)



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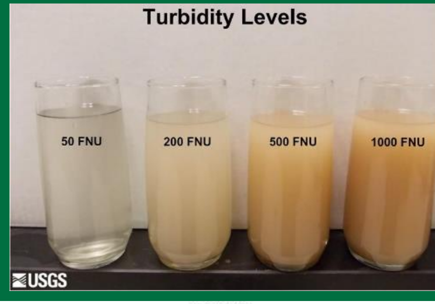
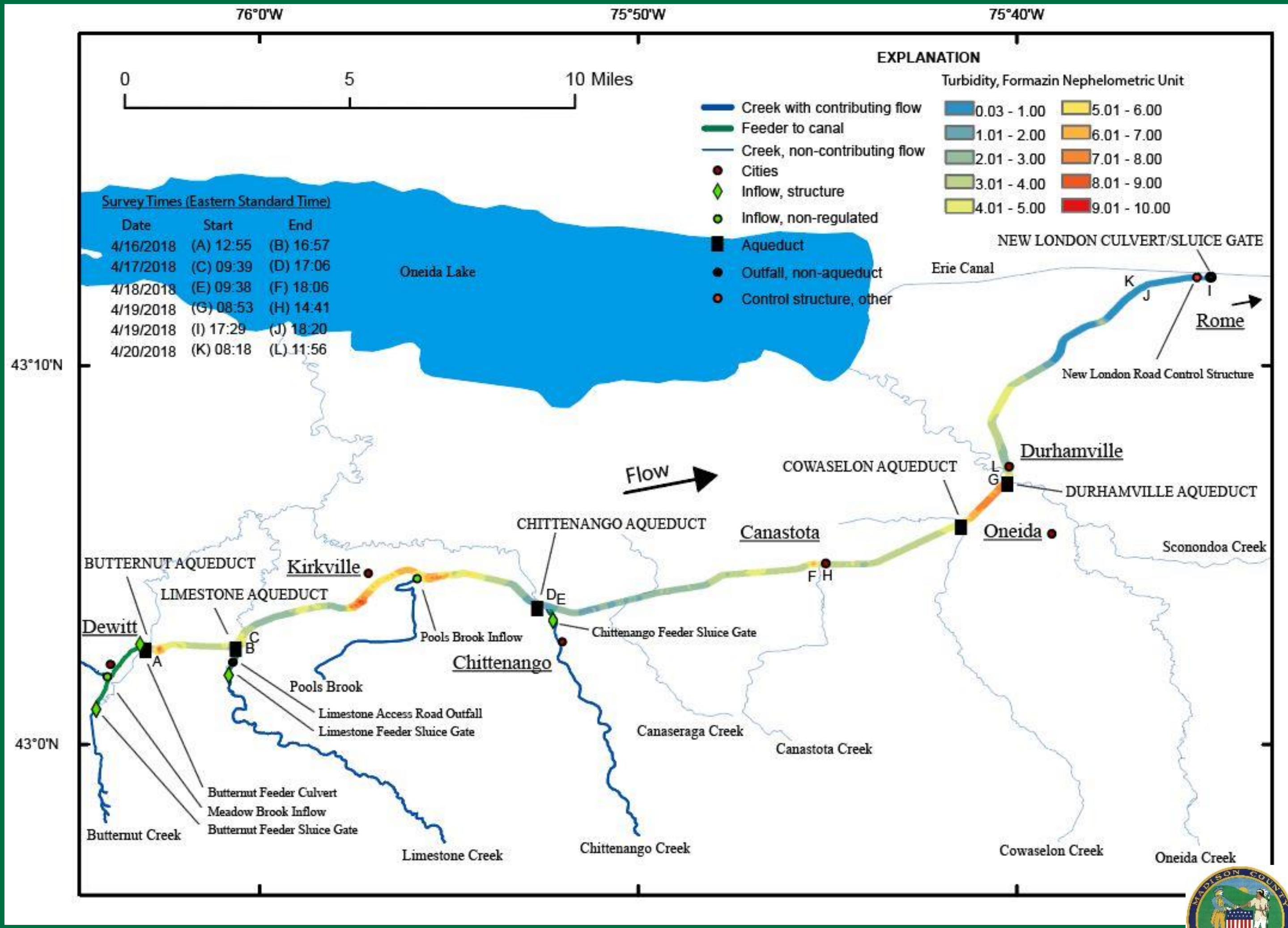
Turbidity

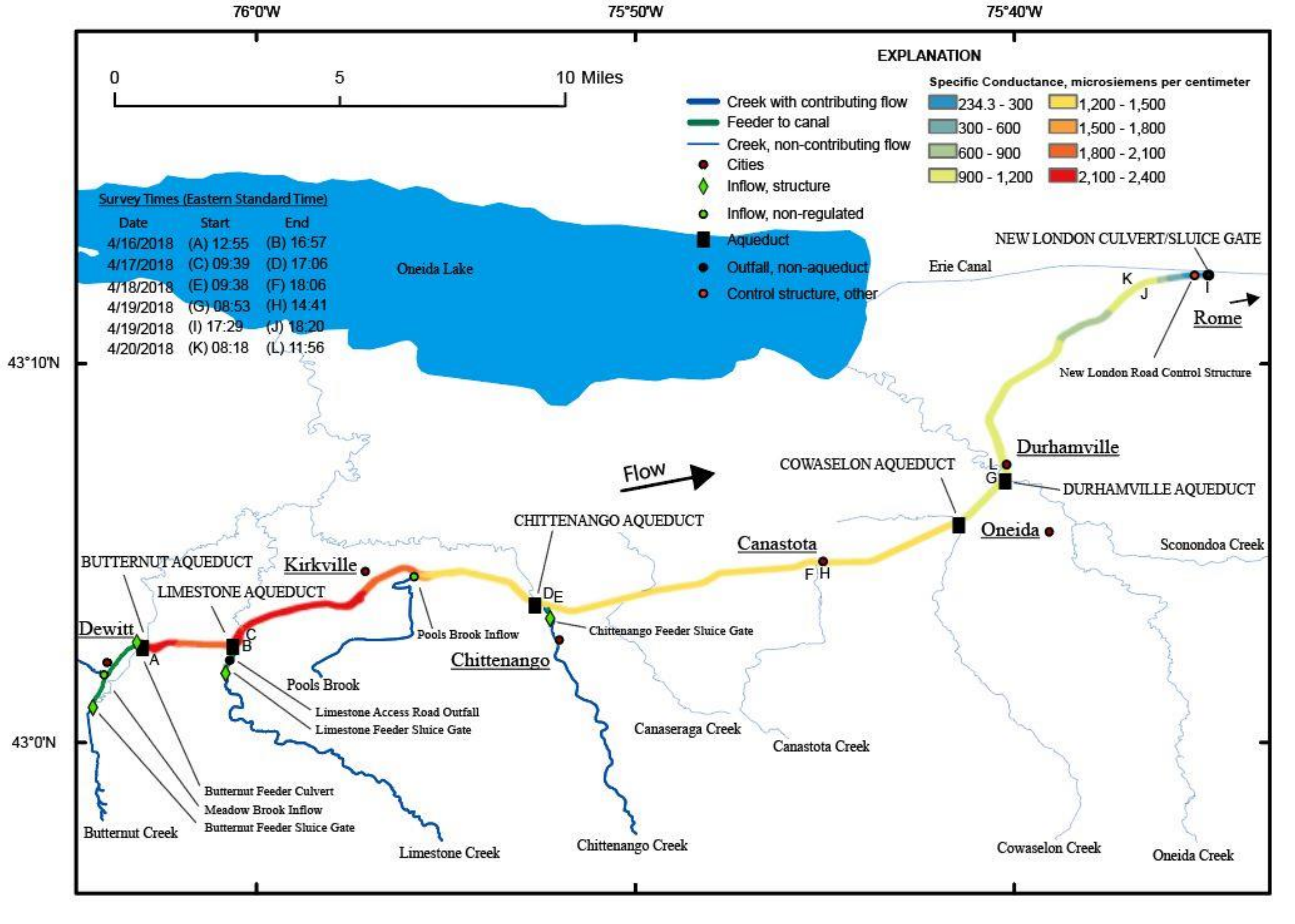


- “Cloudiness” or amount of particulate suspended in water
    - Silt, clay, and other solids
    - High Concentrations will lead to sedimentation
- Range
    - 0.03 – 10.00 FNU
- Explained by
    - Feeders and streams experiencing runoff
    - Stormwater runoff from low lying farm field
    - Very low near end of canal



Specific Conductance

- Measure of ability of water to conduct electrical current
  - Related to amount of dissolved solutes (such as salt) in solution
- Range
  - 234 – 2,400 us/cm
  - <500 us/cm ideal
- Likely explained by
  - Road salts entering system during stormwater runoff (Western end)
    - Not Static
  - Dramatic decrease at Pools Brook inflow *(-600)*



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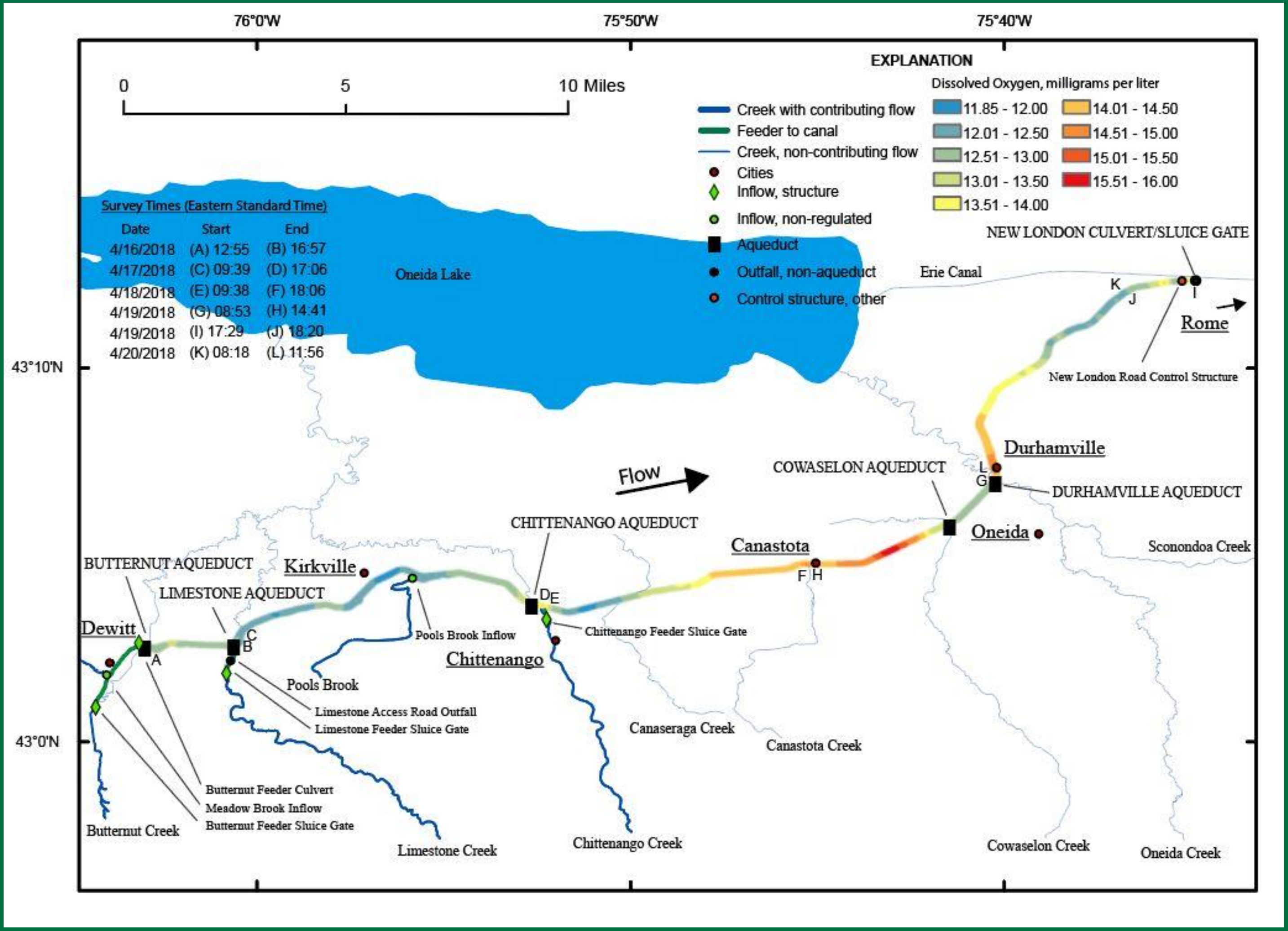
Dissolved Oxygen Levels

- Microscopic bubbles of oxygen mixed between water molecules
  - Used as an indicator of health in surface water
- Range
  - 11.8 – 16.0 mg/l
    - Expect this to change in summer
- Highest DO
  - Found downstream of Canastota
  - Also where highest amounts of submerged aquatic vegetation found during survey
  - Area of interest



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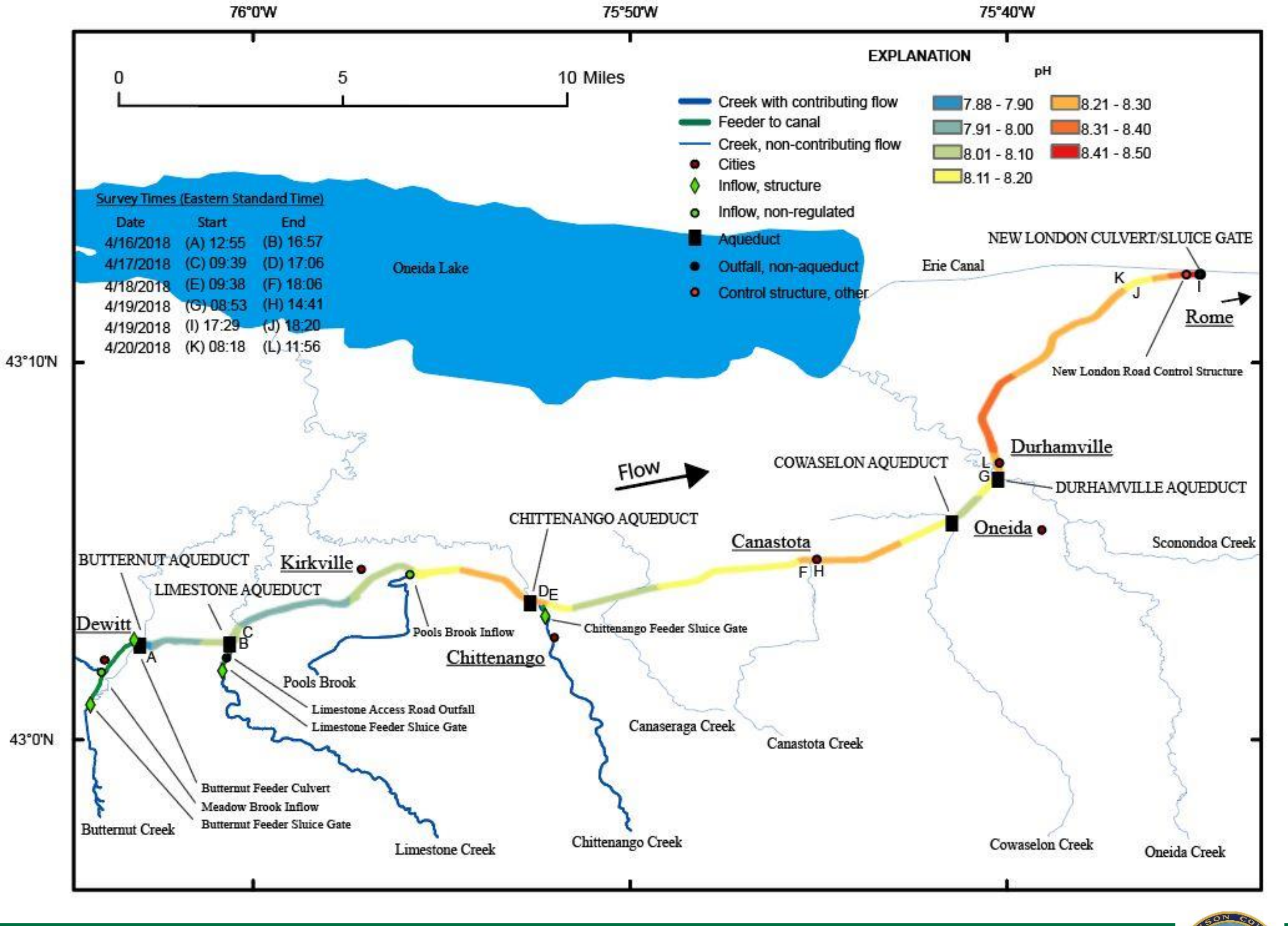
pH

- Measurement of hydrogen-ion activity, at a given temperature, in a dilute solution
    - Too high or too low can be toxic to organisms
    - Natural water range is 6 - 9
- Range
    - 7.88 – 8.50
- General increase in pH along length of canal
    - May correlate with increasing amounts of aquatic vegetation and higher levels of Dissolved Oxygen



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Documenting the Canal's Infrastructure

- Document
  - Current condition
  - Measure dimensions of for future model
- Structures that control water in canal
  - Feeder System that supplies water

  - Aqueducts and outfalls where water exits

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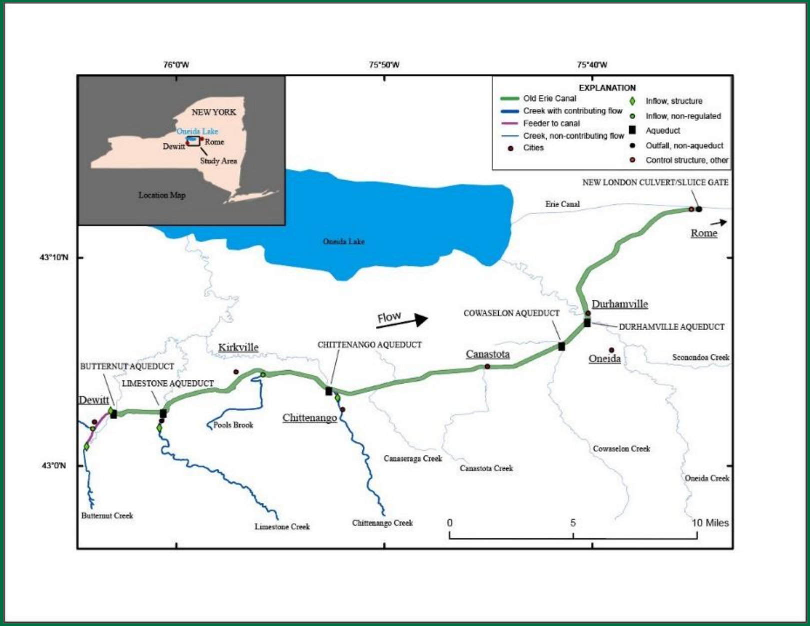
Feeder System: Bringing water to the Canal

- Inflow structures
  - Butternut Creek Sluice Gate
  - Limestone Creek Sluice Gate
  - Chittenango Creek Sluice Gate

- Feeders
  - Designed to continuously supply water
  - <u>Currently do not</u>

- Natural Streams into canal
  - Meadow Brook
  - Pools Brook

- Streams
  - Only source of continuous water supply



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Butternut Sluice Gate

Front of Sluice Gate

Backside of Sluice Gate

Control Structure (closed)

- No continuous flow
- Flow into canal only when creek overtops levee walls
- Potential to increase flow with repairs

No inflow

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Butternut Feeder and Meadow Brook

Groundwater contribution

Narrow US of Andrews Rd.

Widens downstream
(backwater)

Meadow Brook inflow

- Channel will convey flow well
- Dense weeds (phragmites) in one section

Dense weeds (phragmites)

Limestone Sluice Gate

Sluice Gate with location of removed dam in background

Gates open, designed to stem flooding in canal

Weir undercut and thus removed

- No continuous flow
- Weir removed in 2008
- Flow only during high water

Channel conveys flow well

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Pools Brook Inflow

Small stream

Enters via culvert

Canal seen in background

- Continuous flow

Chittenango Sluice Gate

Front side of sluice gate

Weir functionally raises water level

Sedimentation

- No continuous flow
- Flow only during high water
- As recent as 1996 opened and closed every year as needed

Flash boards could be manually set

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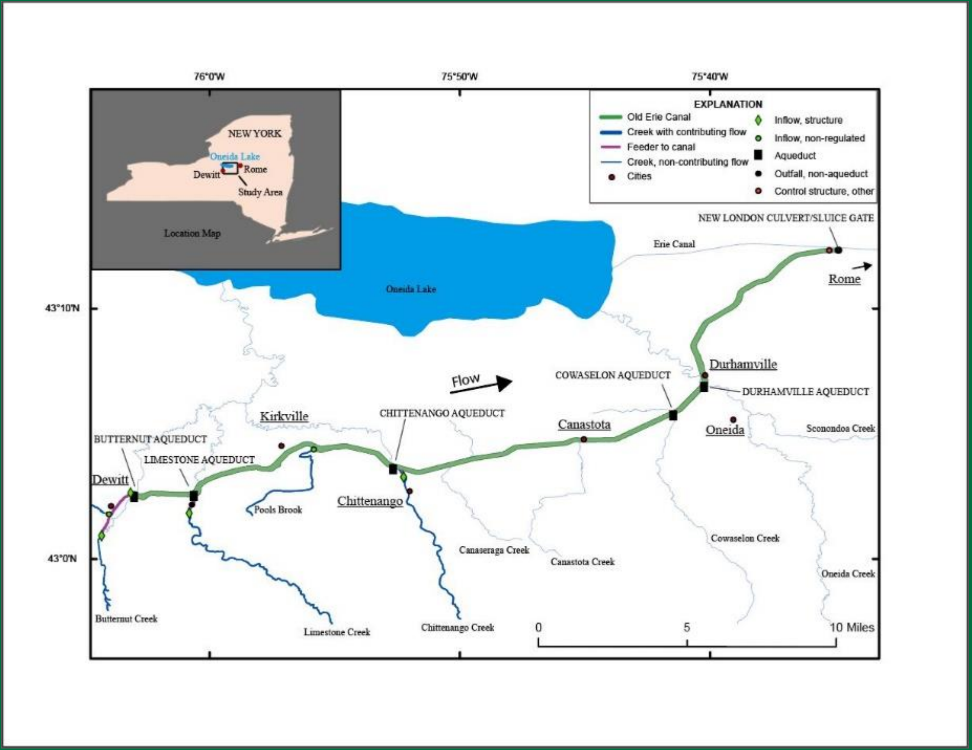
Aqueducts and Outfalls

- Outfall Structures
  - Butternut Aqueduct
  - Limestone Aqueduct
  - Limestone Access Road outfall
  - Chittenango Aqueduct
  - Durhamville Aqueduct
  - New London Road I-beam
  - New London Culvert/Sluice Gate
- Gated openings
  - Capable of controlling water level
  - Lot of water exiting the system
  - Potential to improve flow



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Butternut Aqueduct

Conveys canal over Butternut Creek

Butternut Aqueduct

Outfall Gate

- Capable of discharging into Butternut Creek
- Gates Closed – no outflow

Limestone Aqueduct

Conveys canal over Limestone Creek

- Capable of discharging into Limestone Creek
- Gate closed – No outflow

Limestone Aqueduct

Limestone Access Road Outfall

Backside of control structure

Discharging into Limestone Creek

- Discharging into Limestone Creek
- 1 of 3 gates partially open

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Chittenango Aqueduct

Conveys canal over Chittenango Creek


Old Erie Canal at Chittenango Aqueduct


Outfall gate partially closed with flashboards

- Discharging into Chittenango Creek
- Potential to increase height of flashboards


Considerable amount of water lost

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Cowaselon Aqueduct

Conveys canal over Cowaselon Creek

Cowaselon Aqueduct

Outfall gate partially closed

- Discharging into Cowaselon Creek
- Potential to increase height of flashboards

Flashboards – 1 outfall blocking outflow

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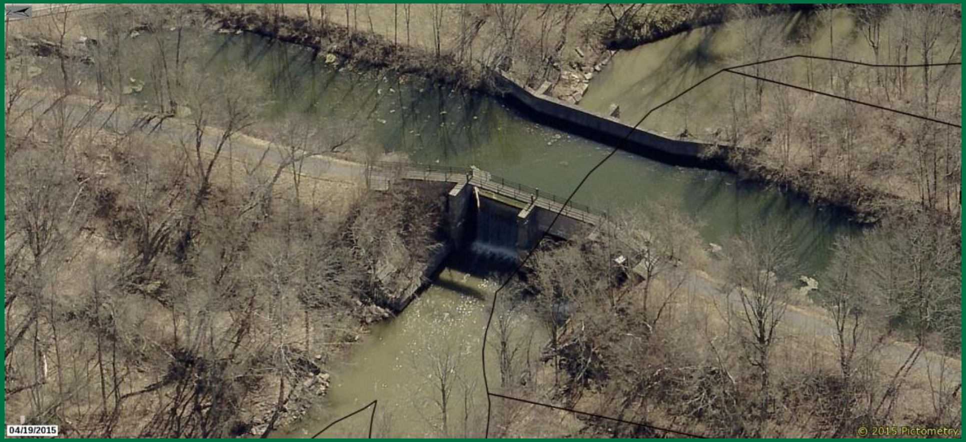
Durhamville Aqueduct



Conveys canal over Oneida Creek


Large rectangular opening


2 sets of flashboards

- Discharging into Oneida Creek
- Rectangular opening?


Spillway

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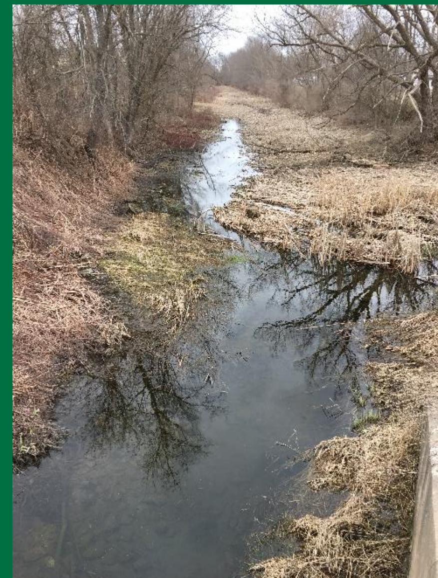
Canal Past Durhamville



New London Culvert/Sluice Gate

Screened outfall gate

- Old Erie Canal meets NYS Barge Canal
- Minimal flow

NYS Barge Canal in far background

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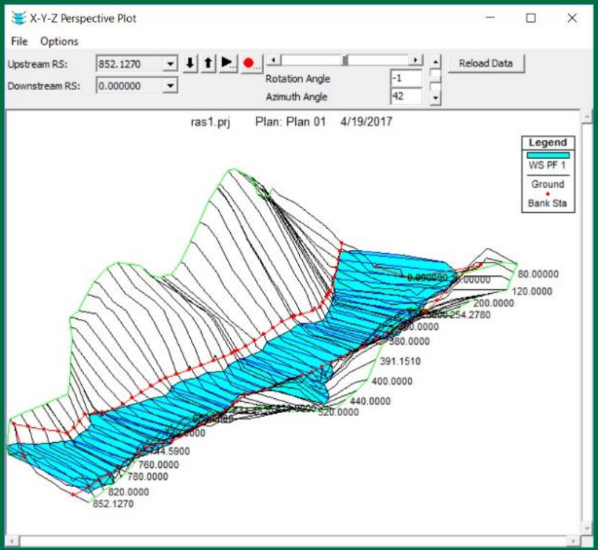
Phase 2 - Modeling changes



- **HEC-RAS Model**
  - **Elevations of water surface (staff plates)**
  - **Bathymetric Dataset**
  - **Dimensions of canal infrastructure**
- **Can we meaningfully increase flow within the canal?**
- **Tool for management decisions**
  - **How much will flow increase?**
    - **If we open Butternut Creek Sluice Gate 6 inches**
  - **How much will water level increase?**
    - **If we raise flashboards 1 ft, 2 ft, 3 ft, etc**
  - **Will flow improve downstream of Durhamville?**
    - **If we raise the flashboards**

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Questions?

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