Predicting Blue-Green Algae Blooms at a Wheatley Drinking Water Intake in Western Lake Erie

Sharing Loading Estimation Experiences Workshop
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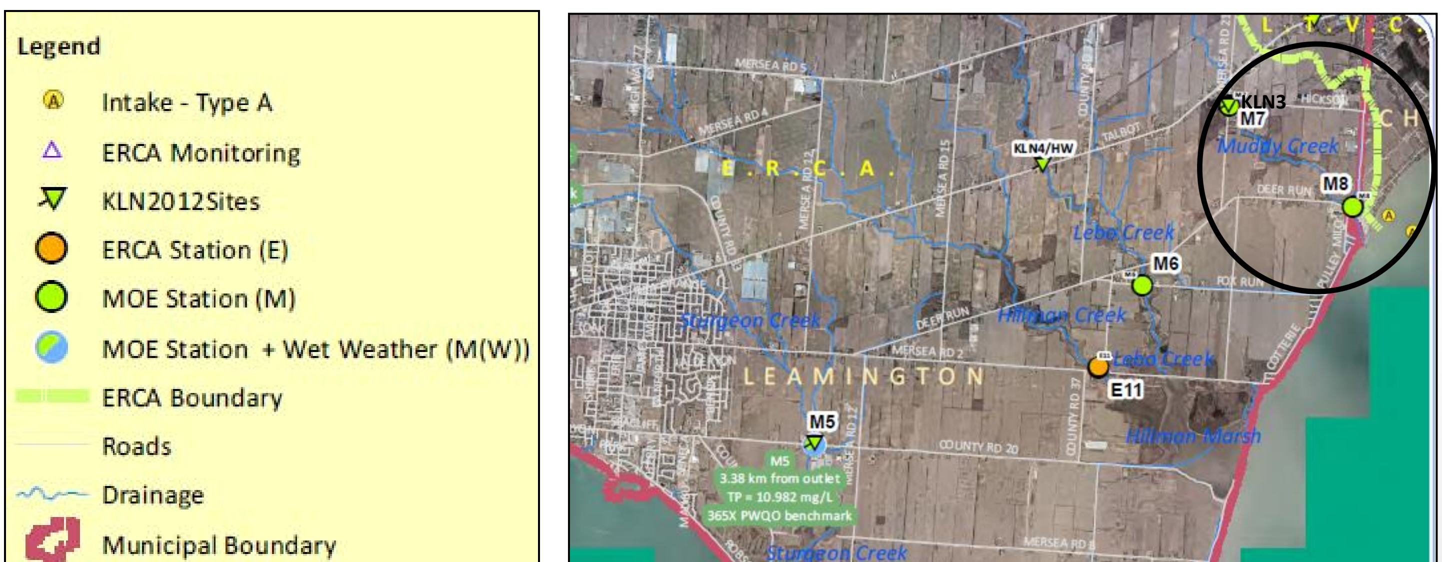
Overall Objective and Background

Gain a better understanding of total phosphorus (TP) concentrations and loadings contributed by various land uses in Muddy Creek sub-watershed that could result in algae growth impacting the Wheatley drinking water intake in Lake Erie.

This project was conducted to identify microcystin-LR (algae toxin) as a drinking water quality issue at the Wheatley intake under the Source Water Protection Program (Clean Water Act).

Project Steps

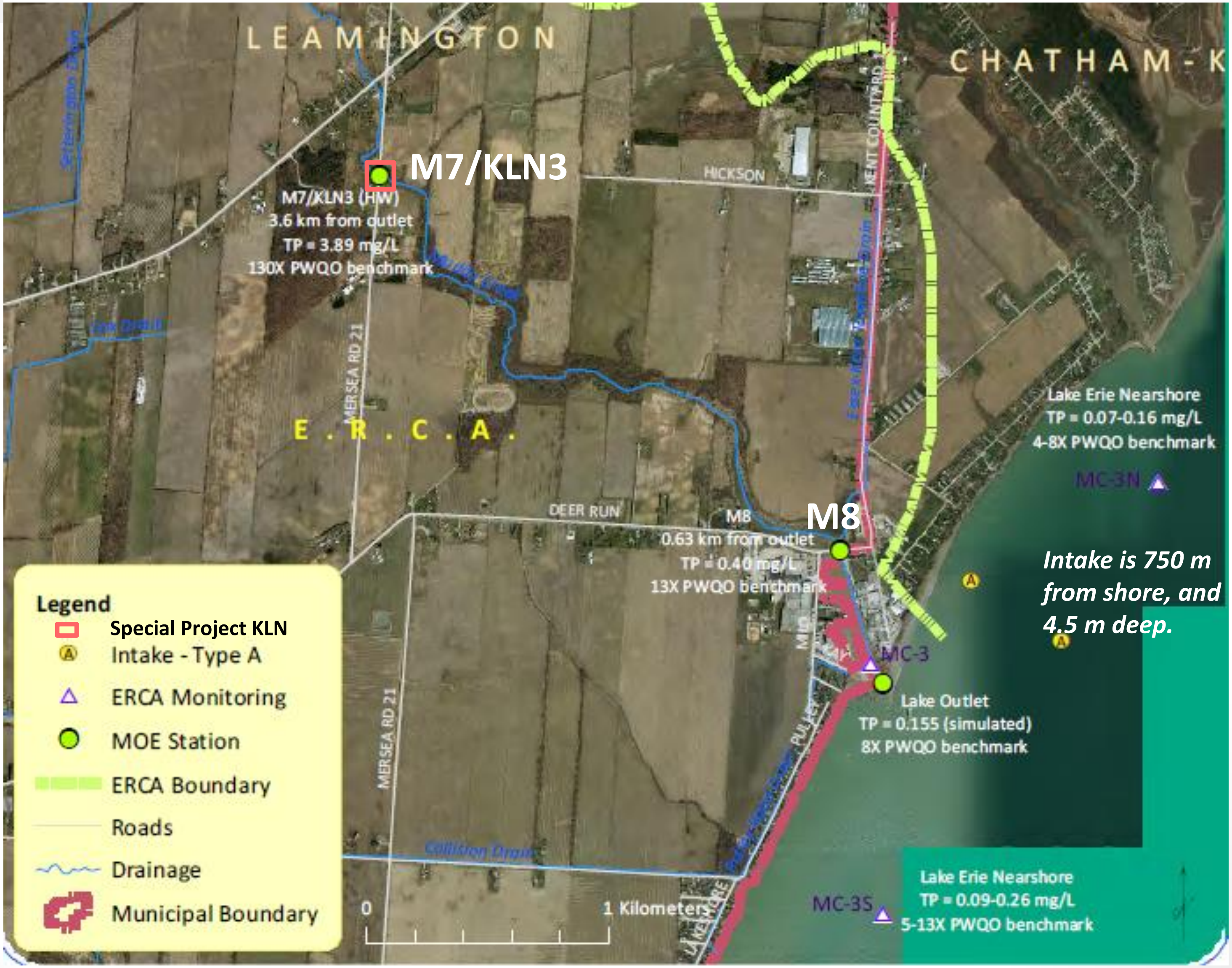
1. Comprehensive analysis of Muddy Creek TP data (2009-2013) to select rain event-based TP data for use.
2. Estimation of TP Loading at Muddy Creek sampling locations and from various land use types in the Muddy Creek sub-watershed.
3. Simulation of Muddy Creek mouth TP using a USEPA water quality model.
4. Estimation of TP at Wheatley drinking water intake, compared with provincial benchmark for nuisance growth of algae in lakes, 0.02 mg/L.



Data Collection

- Data sampling frequency:
  - Bi-weekly creek samples and flow (2012-2013) including samples taken during a rain event at KLN3 (special nutrient loading project 'KLN').
  - Monthly creek samples at M7 and M8 (2009-2013; April-November); checked against rainfall data to select event-based data (PWQMN).
  - Three to five rain event-based samples and flow, per year (2009-2013) at M7 and at Lake Erie nearshore sites (no flow measurements) MC3, MC-3S and MC-3N (ERCA's enhanced monitoring program).
- Water quality: grab samples for TP, DRP, TSS, NO3, etc.
- Flow (Discharge):
  - Instantaneous velocity using digital flowmeter where staff could enter creek; object time-distance method on bridges.
  - Staff took creek width and depth measurements along sampling site cross section. Staff calculated flow (discharge) by velocity-area method.

Data Collection



TP Data Analysis

- Considered data from May-October for a 5 year period (2009 – 2013) .
- Blue-green algae blooms are most likely to occur May-October due to high TP concentrations in water, warm ambient temperature and low wind conditions.
- Timing of rain event grab sampling and simultaneous flow measurements were based on established creek hydrographs.

Sampling Site	M7	M8
Creek	Muddy Creek	
Distance from Mouth (km)	3.60	0.63
Actual TP Min (mg/L)	0.31	0.390
Actual TP Max (mg/L)	8.22	0.770
Actual TP Mean (mg/L)	2.34	0.511
Rain Min (mm)	10	10
Rain Max (mm)	30	30
Rain Mean (mm)	19.5	19.5
Representative Month	July	July
Actual Input TP (mg/L)	3.89	0.40
Deviation from Mean TP	1.55	0.11
Rain (mm)	30	30
Simulated mouth Output TP (mg/L)	0.155	

130X TP benchmark
for nuisance growth of algae

13X TP benchmark

10X TP benchmark

TP Loading Calculation Methods

1. Loadings at sampling locations M7 and M8 on Muddy Creek were calculated using (TP conc. X Flow):
   - Actual TP Data with least deviation from 5-year TP average and
   - Flow measured at same time sample was taken.
2. Loadings from each property within sub-watershed calculated using literature resources based on land use: (TP load X Property Area).

Land Use Type	TP Loading kg/ha/year	Reference
Agricultural (clay soil, corn-soybean-cereal, 20 mm/day rain)	1.5 (Range: 1.28 to 1.71)	Coote, D. R., MacDonald, E. M., and Dickinson, W. T., eds. 1978. PLUARG Technical Report, including Essex County study area.
Residential (clay soil)	0.35	Much and Kemp, 1978.
Commercial (clay soil)	0.88	Much and Kemp, 1978.
Managed Forests	0.75	Maine Department of Environmental Protection (MDEP). 2000.
Natural Areas	0.21	Bediant et al. 1978.

Challenges

- Variations in data sampling frequencies.
- Budget limits meant no autosamplers.
- We aimed to capture 20 mm rain events, but had to expand to 10 to 30 mm events, otherwise there were not enough data.
- For some events, samples were collected on the falling limb of hydrograph (i.e. after peak flow).
- Loadings calculated using literature resources were not based on the same events conditions during which samples were taken. Also does not incorporate changing landscape information.
- Limitations in establishing a direct cause-effect relationship between loading from land use activities and lake intake concentrations; therefore a vulnerable area specific to the drinking water quality issue is yet to be delineated.

Considerations

- Event-based monitoring program:
  - Increase sampling and flow measurement frequency to capture larger variety of storms?
  - How to capture creek's hydrograph peak time when staff budget is limited?
  - Should we define the rain events for consideration: rainfall duration, amount, cross-watershed runoff?
- Loading calculation method:
  - Better averaging method?
  - How to update changing landscape activities?
- Linking land use activities' loading to intake impacts: suggestions for improvement?
- Other suggestions?

What Next?

- The stream water quality model can be used in the future for various event scenarios to simulate TP concentrations in the creek.
- The Essex Region CA recently established a few optical probe stations in the nearshore south-western Lake Erie for early detection of algae blooms. TP and DRP will also be measured at these stations.
- A nearshore model should be set up to model TP and DRP transport from the creek to the drinking water intake, considering in-lake processes, invasive species, loading from the US side, etc.
- Under the Clean Water Act ‘Drinking Source Water Protection Program’, the local governing committee decided to recognize microcystins-LR as a drinking water quality issue at the intake.
- The committee will address issue contributing activities (as required by the Clean Water Act) when stronger science-based information, such as more TP loading data, becomes available.

Thank you.

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