



SOURCE FOR STREAM

2023 Conference

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Stormwater and Erosion
and Sediment Control
Conference

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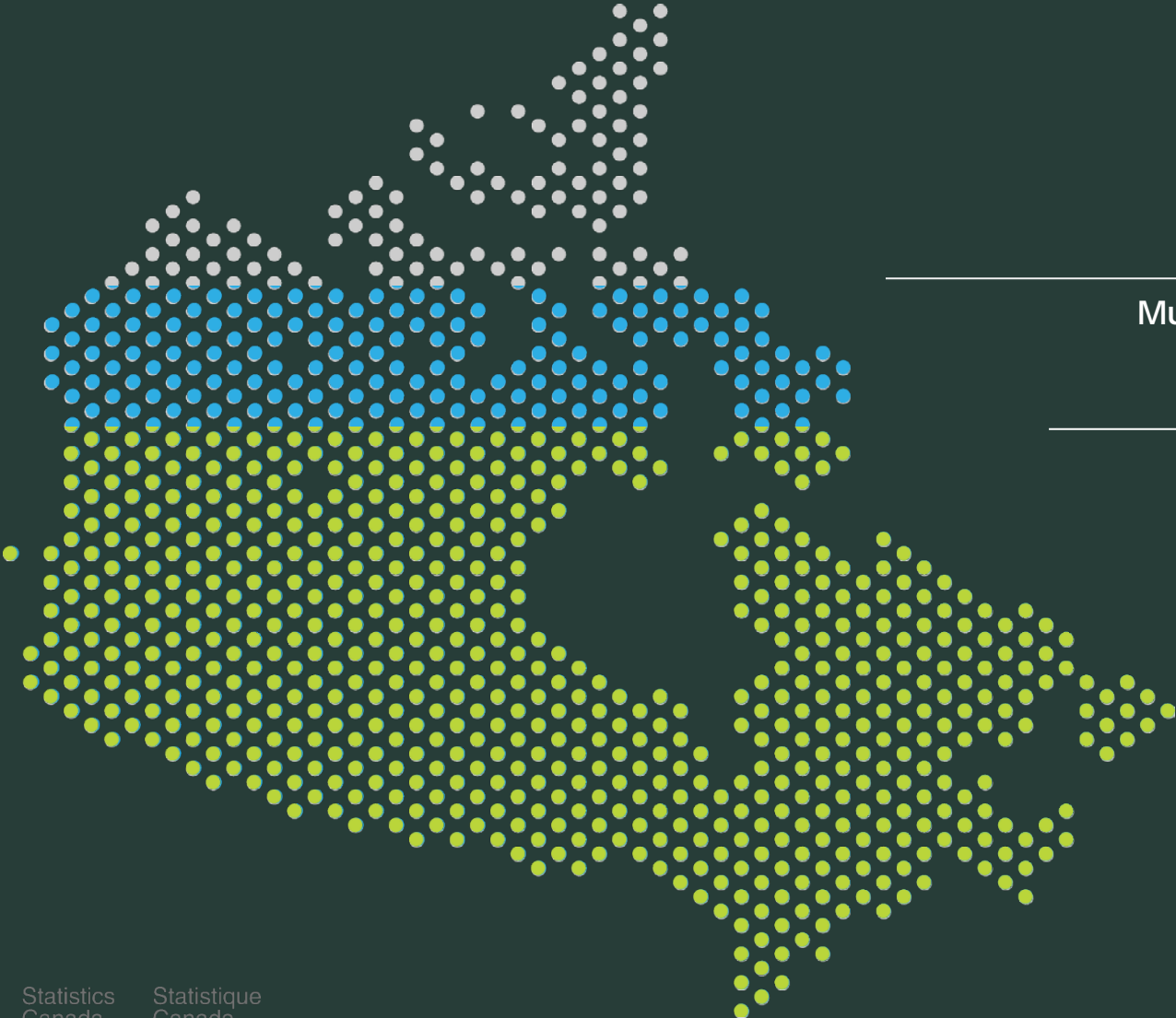
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Existing Stormwater Management Facilities



Over 15,000

Municipal Stormwater Management Facilities

Over 2/3

Constructed after 1999

Source



Statistics
Canada

Statistique
Canada

ASSESSING THE FUNCTION OF STORMWATER MANAGEMENT FACILITIES IN A CHANGING CLIMATE

Source to Stream Conference | March 2023

Presented by Dr. Kevin Stevens & Amanda Pinto



The Team



Nick
Mocan



Amanda
Pinto



Dr. Kevin
Stevens



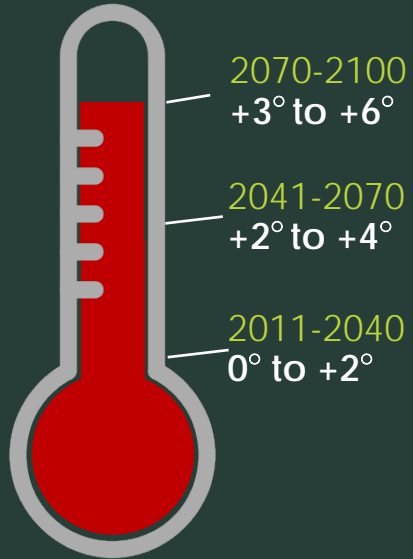
Mitchell
Elstone



Engage
Grant



The Climate



WINTER
Increased
average winter
temperature



RAINFALL
Increased
winter runoff



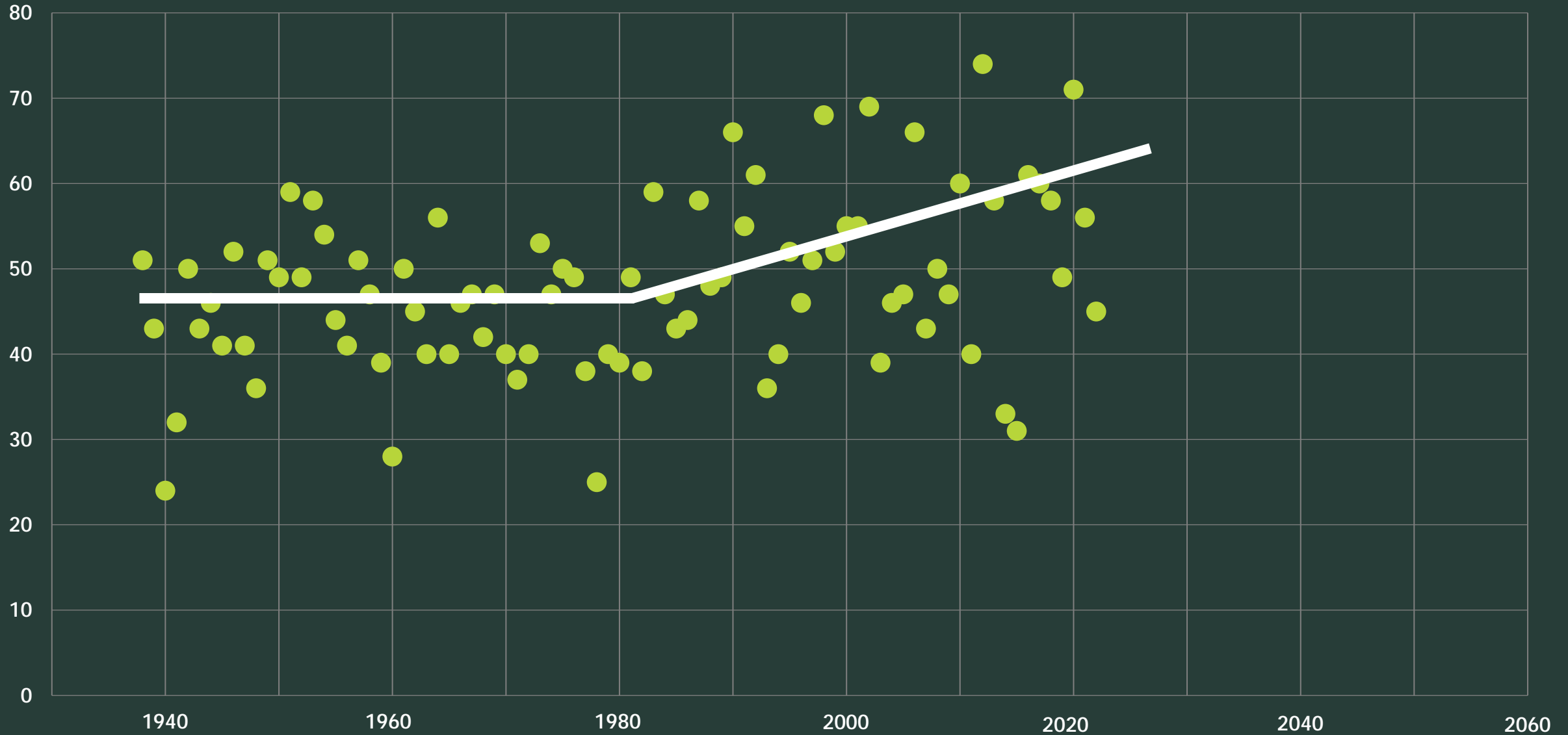
CONTAMINANTS
Increased transport
of water-soluble
contaminants



INVASIVE
Increased
northern limits of
invasive species

Winter Climate Trends

WINTER DAYS ABOVE ZERO



The Challenges

1

How well are existing SWM facilities performing?

2

How effective are current monitoring efforts?

3

How are seasonal patterns affecting water quality parameters?

4

Can we optimize year-round function of SWM facilities?



The Program

Winter Dynamics of
SWM Ponds:
KW Region

2020 - 2021



2021 - 2023



Vegetation in SWM
Ponds and
Receiving Waters



2019

SWM Pond
Monitoring –
Black Creek
Halton Region



2021

Winter Tolerance in Three
Aquatic Plant Species

Year-round
SWM Pond
Performance:
KW Region



2021 - Present

The Goals

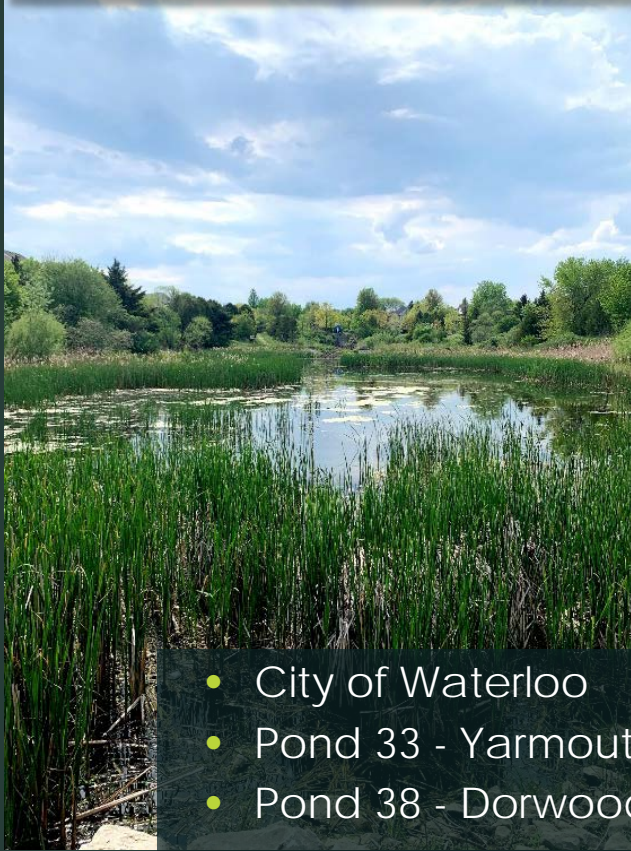
1. Monitor influent/effluent flow in SWM Ponds over one-year period
2. Assess year-round removal efficiency under various guidelines
3. Evaluate potential ecological impacts in SWM Ponds



The Project



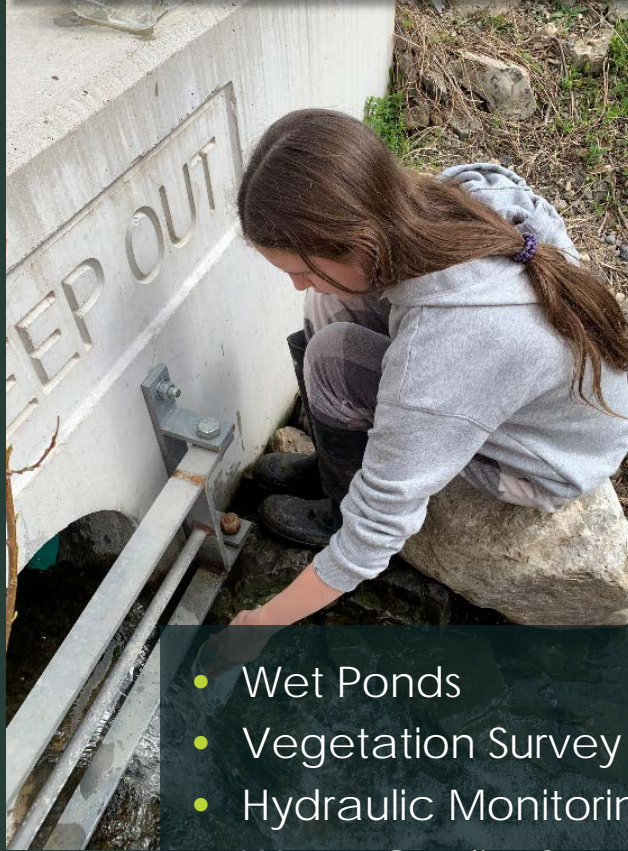
LOCATIONS



- City of Waterloo
- Pond 33 - Yarmouth
- Pond 38 - Dorwood



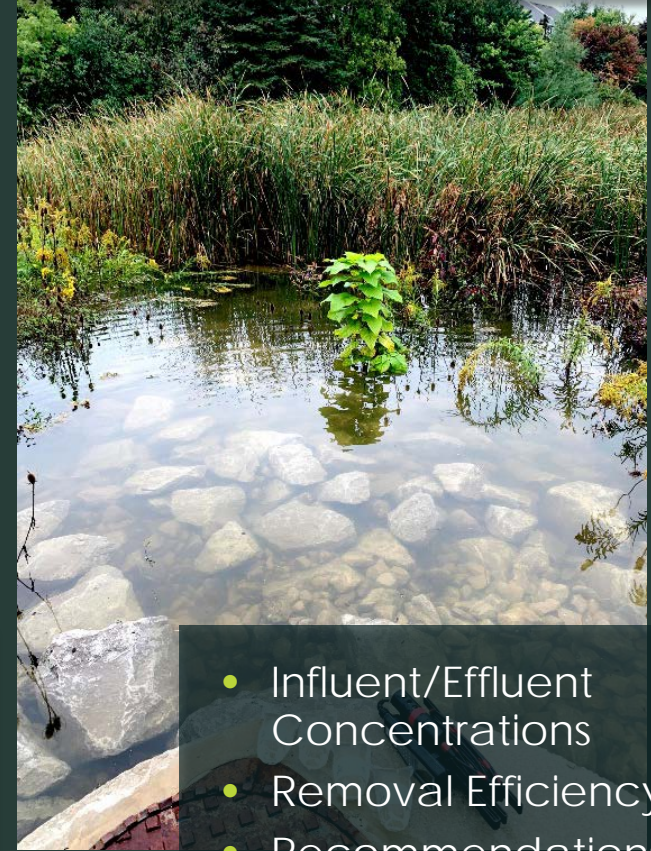
SAMPLING



- Wet Ponds
- Vegetation Survey
- Hydraulic Monitoring
- Water Quality Sampling



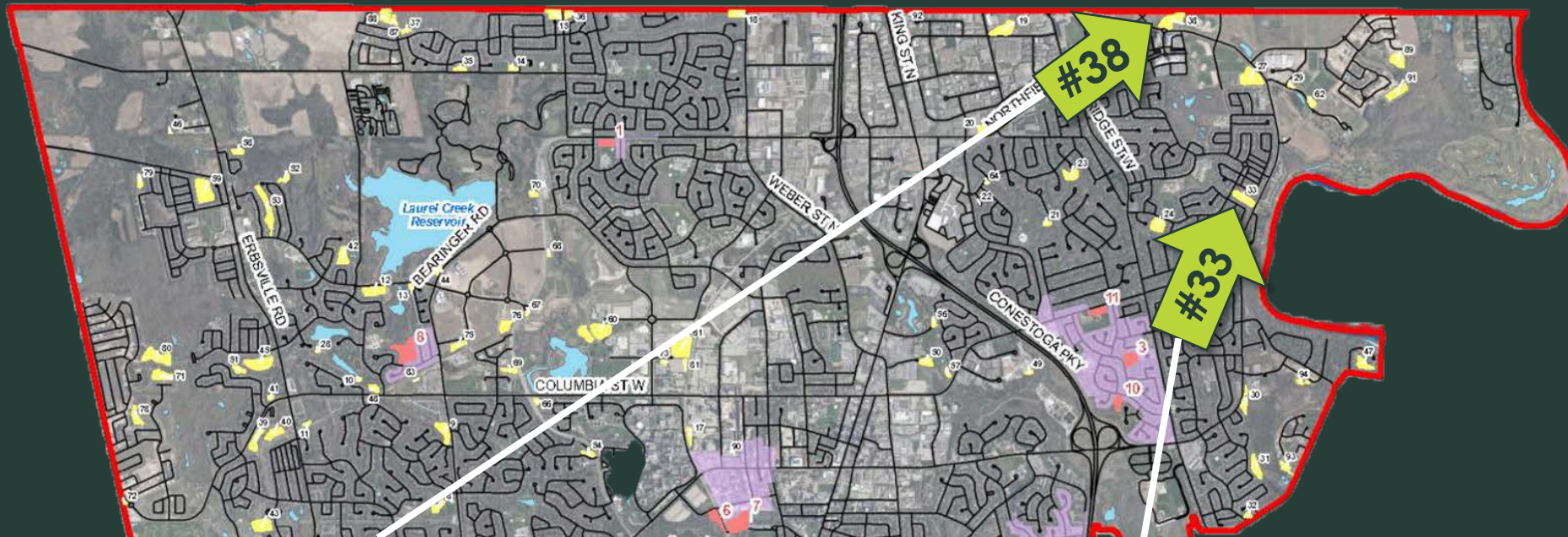
ANALYSIS



- Influent/Effluent Concentrations
- Removal Efficiency
- Recommendations

The Sites

<https://www.waterloo.ca/en/government/resources/Documents/Cityadministration/October-8-open-house-stormwater.pdf>



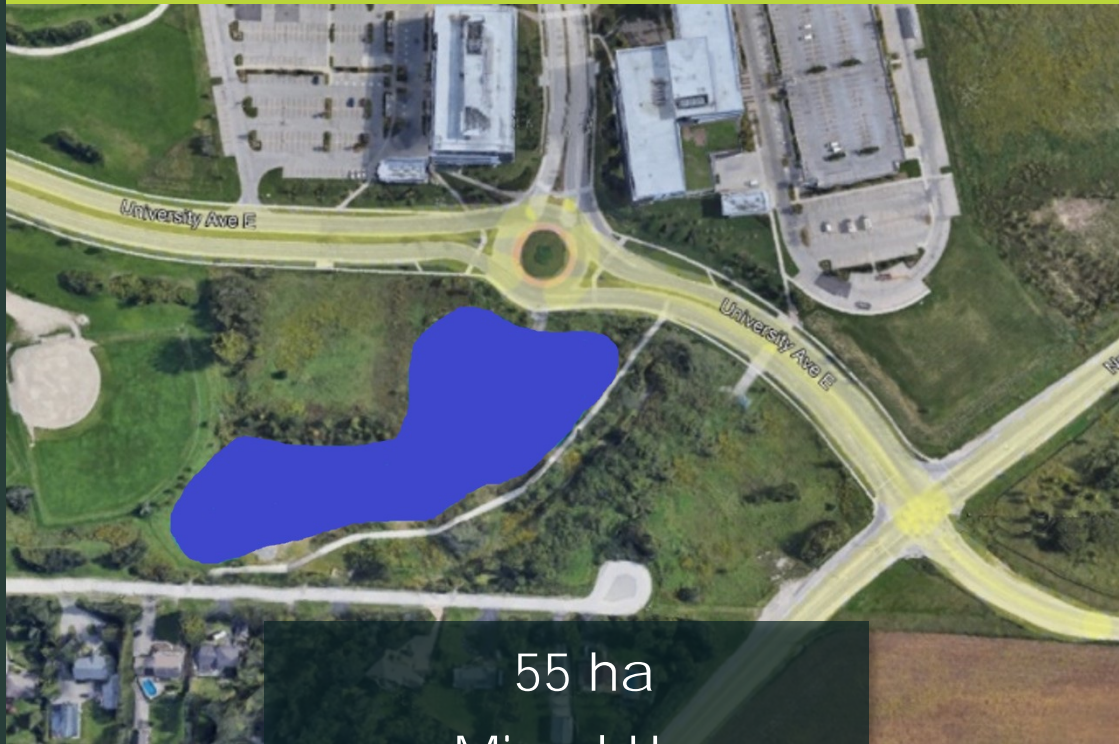
DORWOOD



YARMOUTH

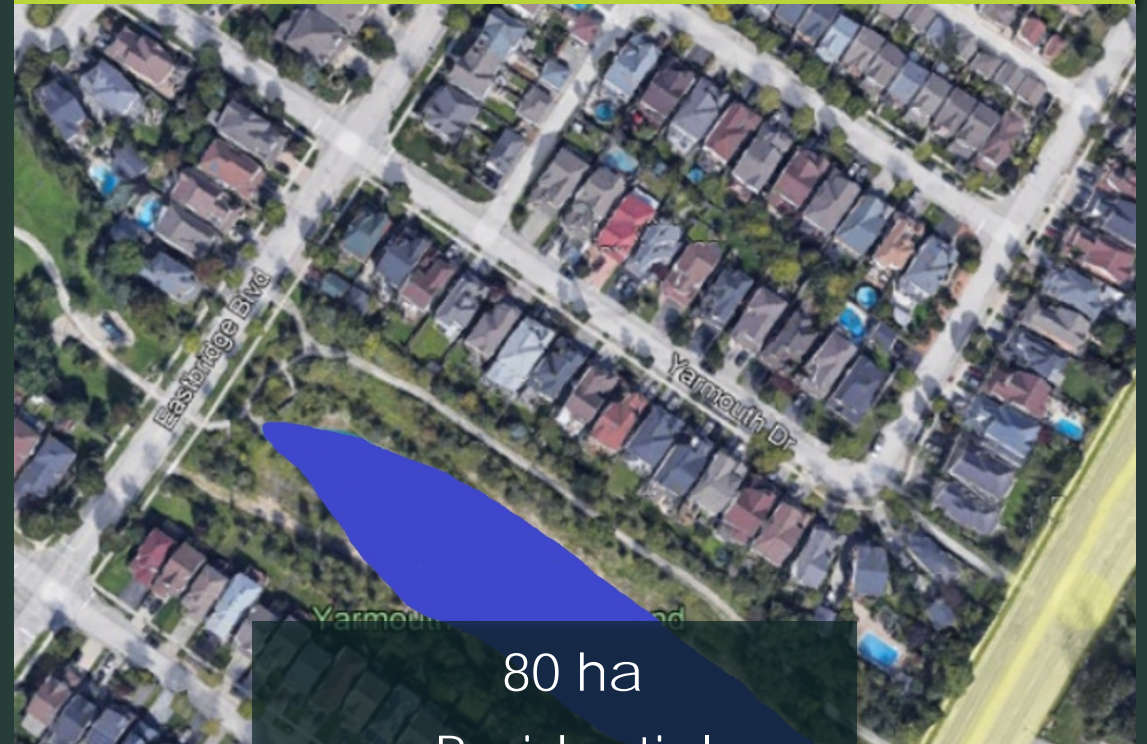
The Sites

DORWOOD



55 ha
Mixed-Use
13,000 m³
70% imperviousness

YARMOUTH



80 ha
Residential
6,000 m³
35% imperviousness

The Field Work

Hydraulic Monitoring

- Water depth:
Water level data logger
- Rainfall/Temp:
Environment Canada



Water Quality Sampling

- Daily inflow/
outflow
- TP, DO, Cl, pH,
TDS, conductivity,
ORP, water temp,
color, turbidity,
TSS



Data Analysis

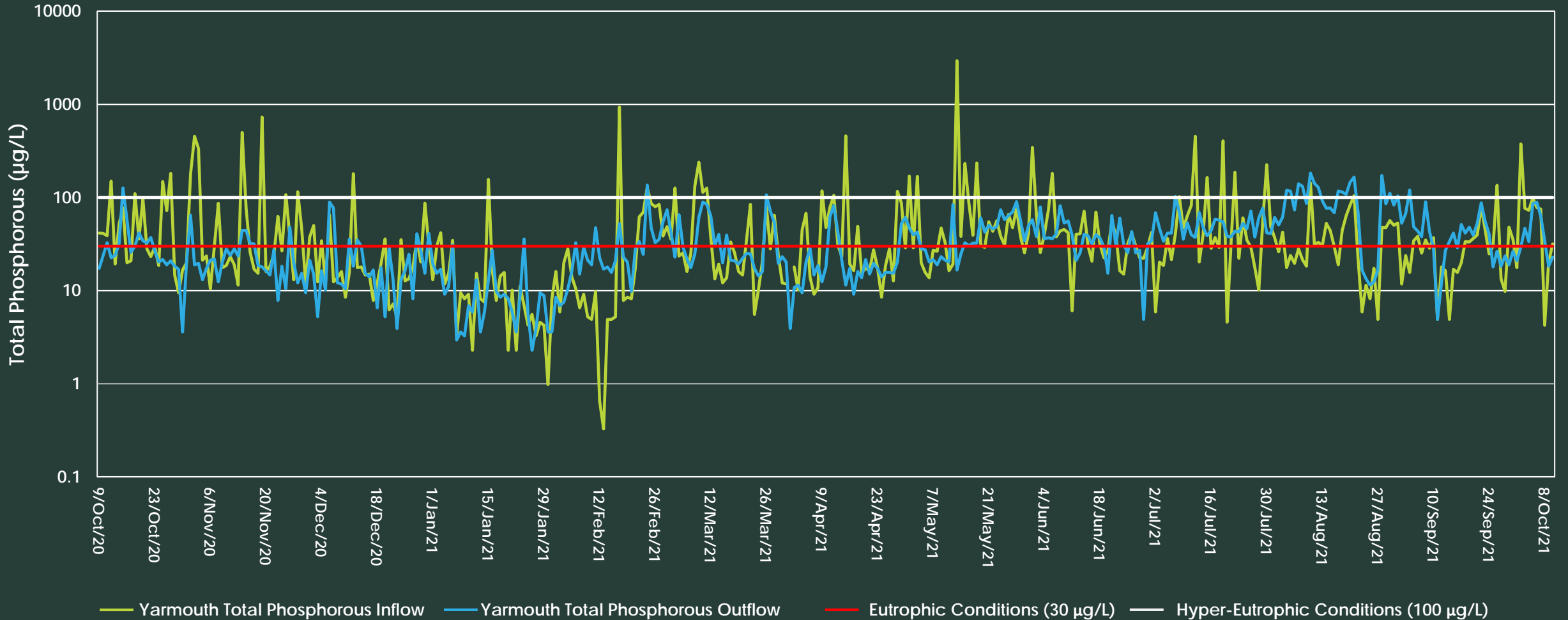
- Seasonal Trends
- Removal Efficiency
- Compliance
- Biotic Effects



ANALYSES: YSI Professional Plus Multi-parameter Meter, Hach SR3900 Spectrophotometer, Gravimetric: Total Suspended Solids

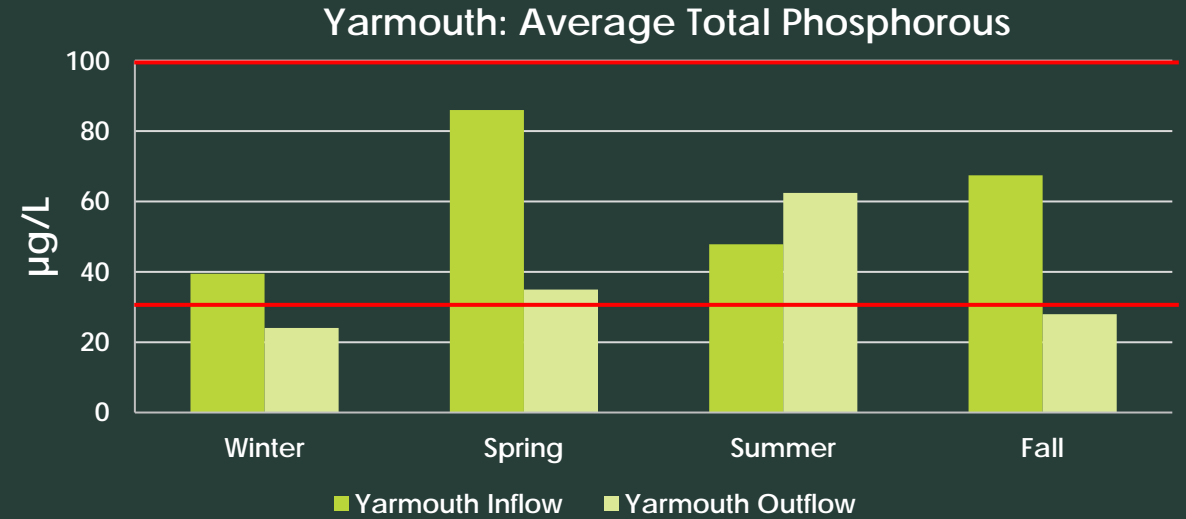
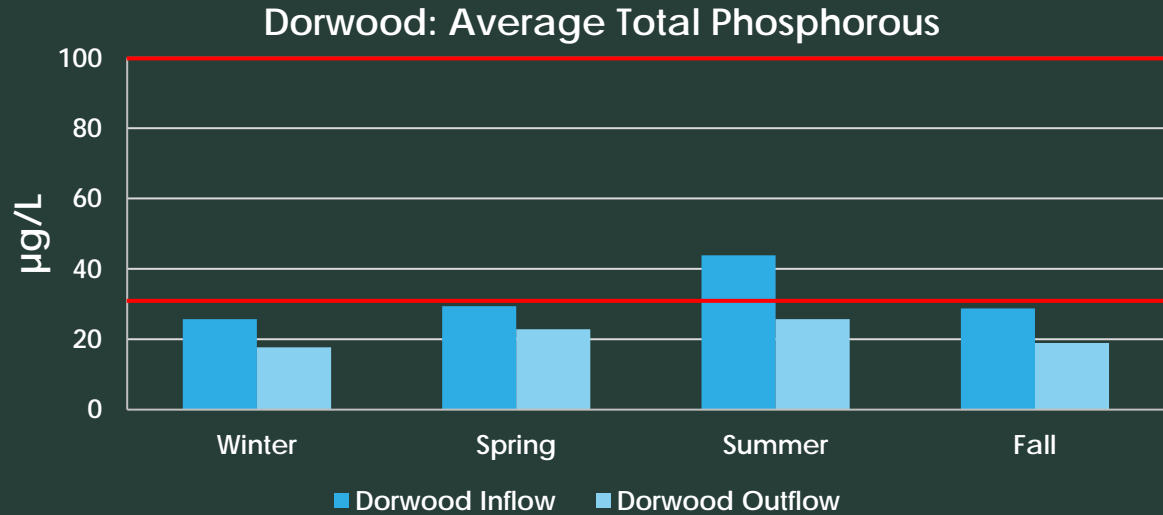
Total Phosphorous: Inflow and Outflow

Yarmouth: Total Phosphorous (Log10)

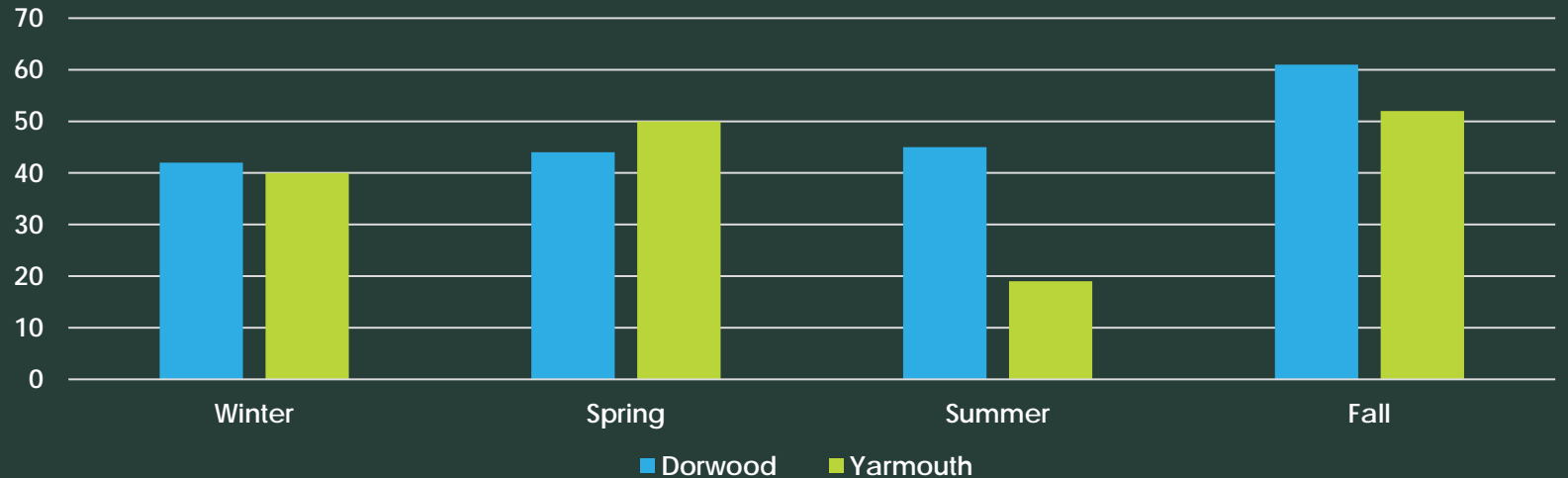


— Yarmouth Total Phosphorous Inflow — Yarmouth Total Phosphorous Outflow — Eutrophic Conditions (30 µg/L) — Hyper-Eutrophic Conditions (100 µg/L)

Seasonal Trends – Total Phosphorous



Total Phosphorous Days with Removal



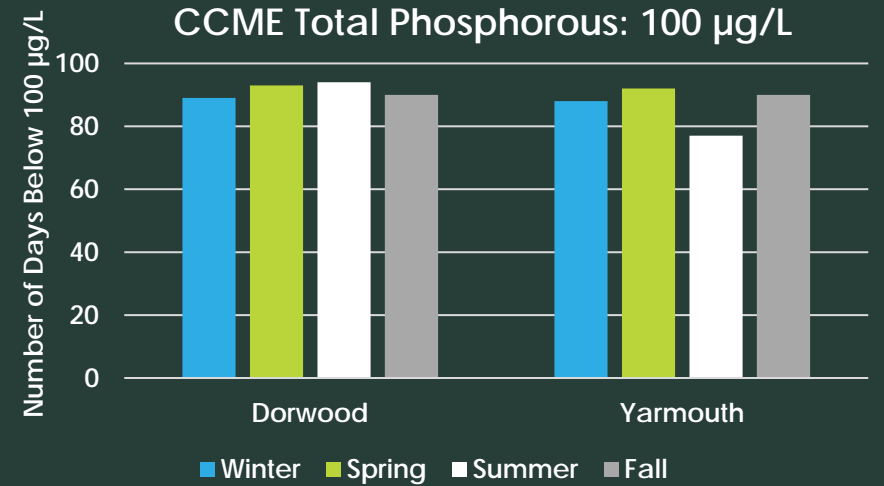
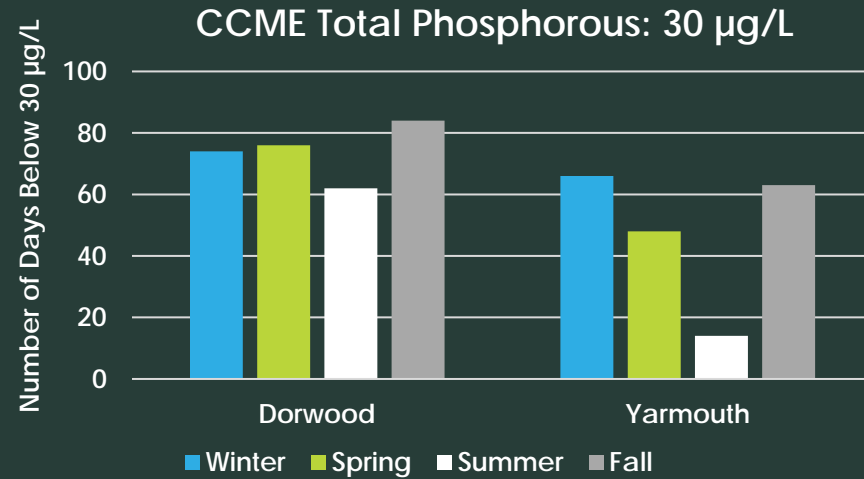
TROPHIC STATUS	TRIGGER RANGE (µg/L)
Eutrophic	30-100
Hyper-Eutrophic	>100

Adapted from CCME (2004)

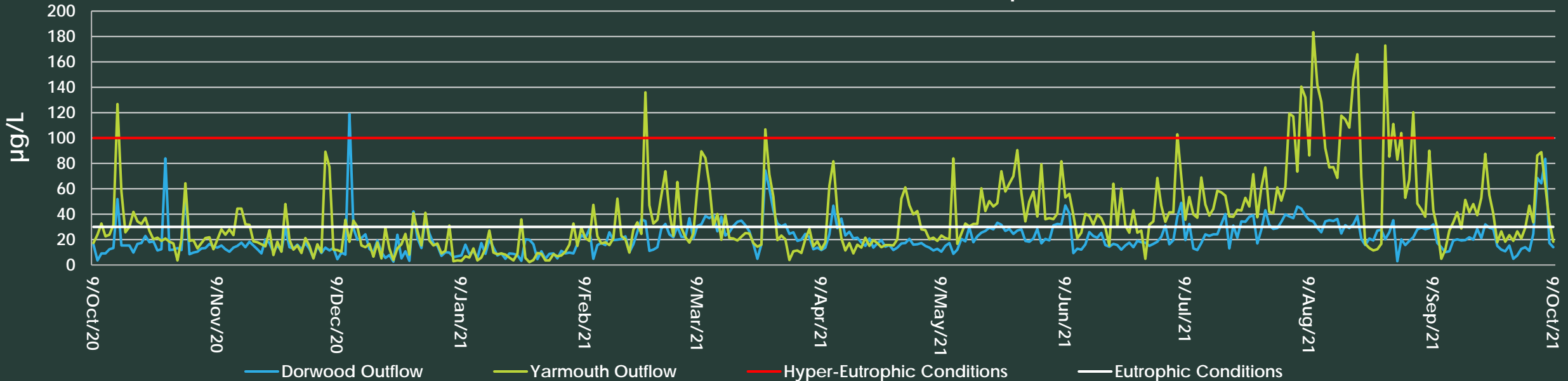
Performance & CCME Guidelines - Total Phosphorous

TROPHIC STATUS	TRIGGER RANGE (µg/L)
Eutrophic	30-100
Hyper-Eutrophic	>100

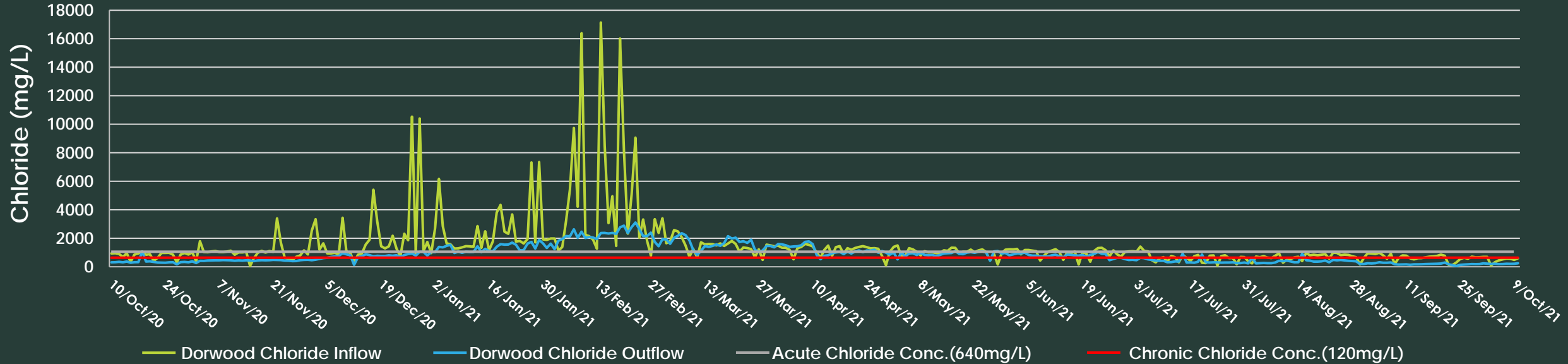
Adapted from CCME (2004)



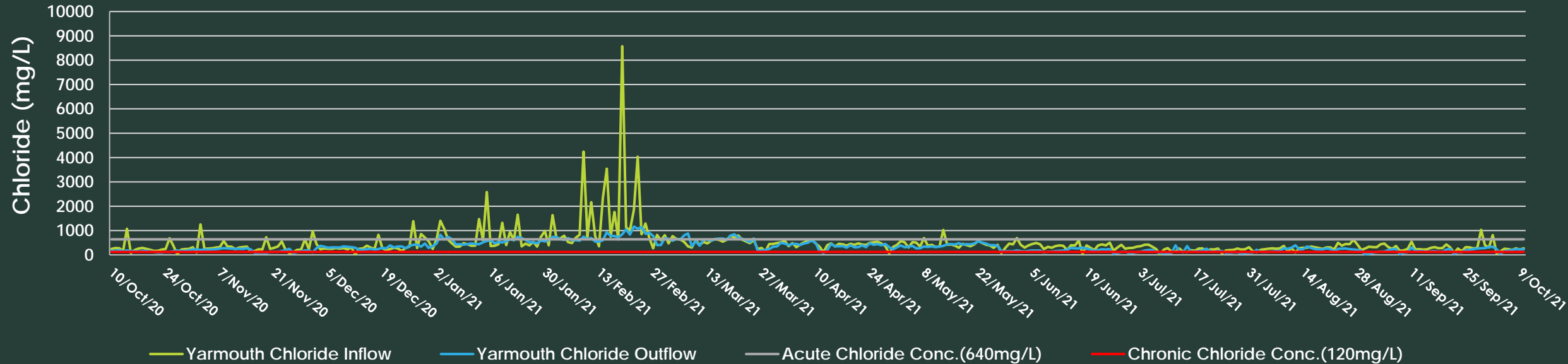
Dorwood & Yarmouth Outflow: Total Phosphorous



Dorwood: Chloride Inflow vs Outflow



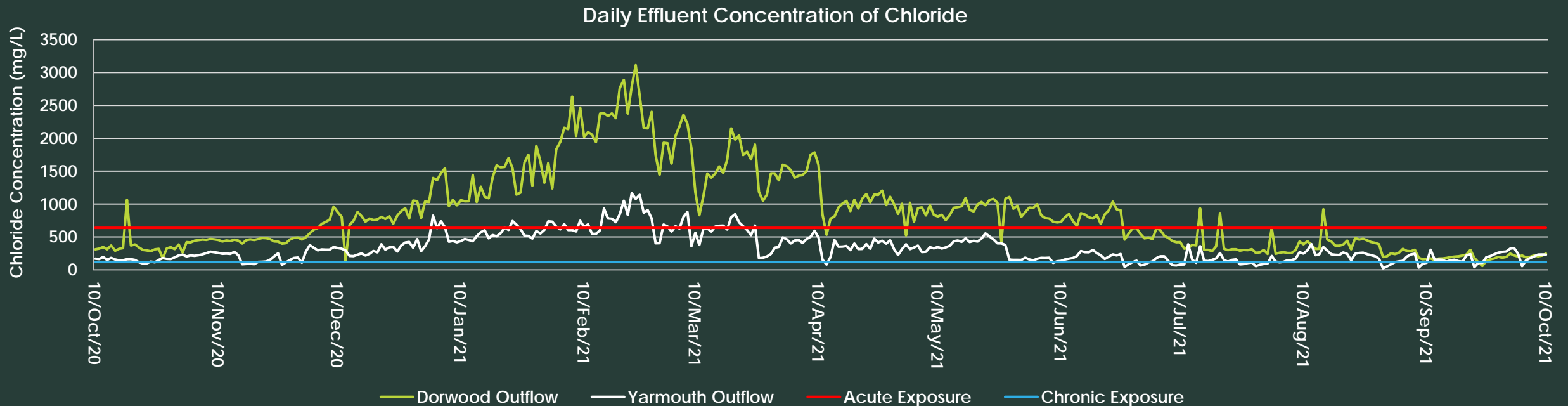
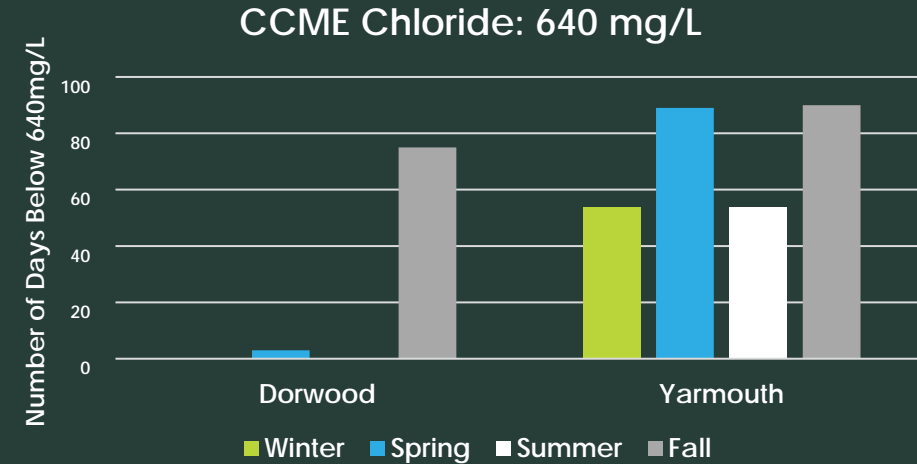
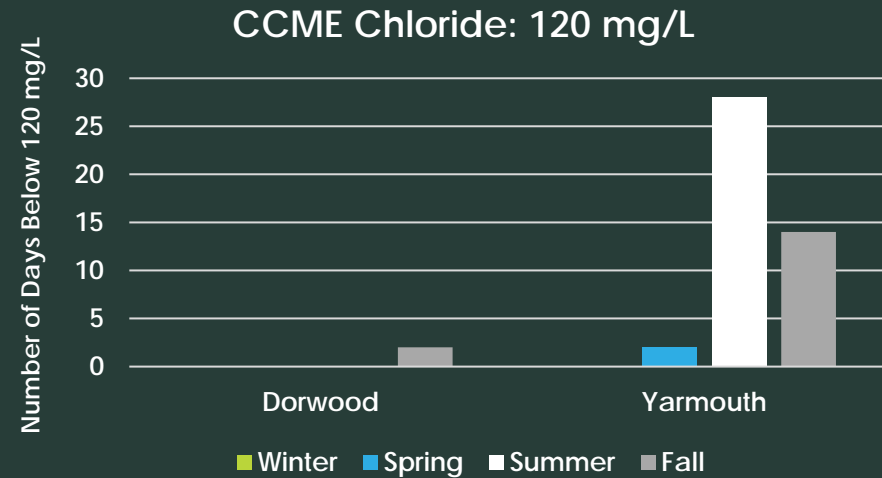
Yarmouth: Chloride Inflow vs Outflow



Performance & CCME Guidelines - Chloride

EXPOSURE	TRIGGER RANGE (mg/L)
Chronic	>120
Acute	>640

Adapted from CCME(2011)



Biotic Effects of Chloride: Acute Exposure

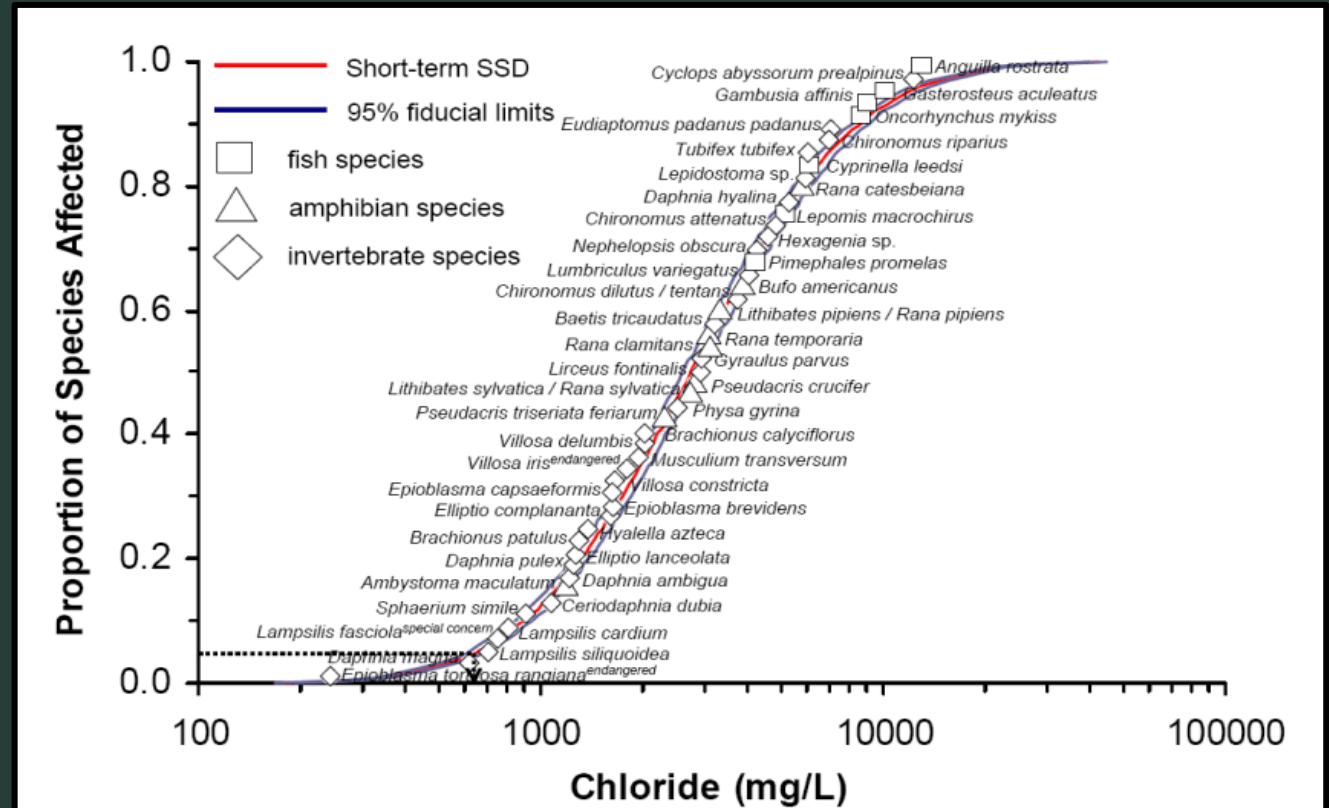
24, 48 & 96 hour tests conducted for acute toxic effects (LC50)⁵

DORWOOD:

Acute = 52.87% of the year
 Highest concentration = 3,113 mg/L

YARMOUTH:

Acute = 10.66% of the year
 Highest concentration = 1,141mg/L



Biotic Effects of Chloride: Chronic Exposure

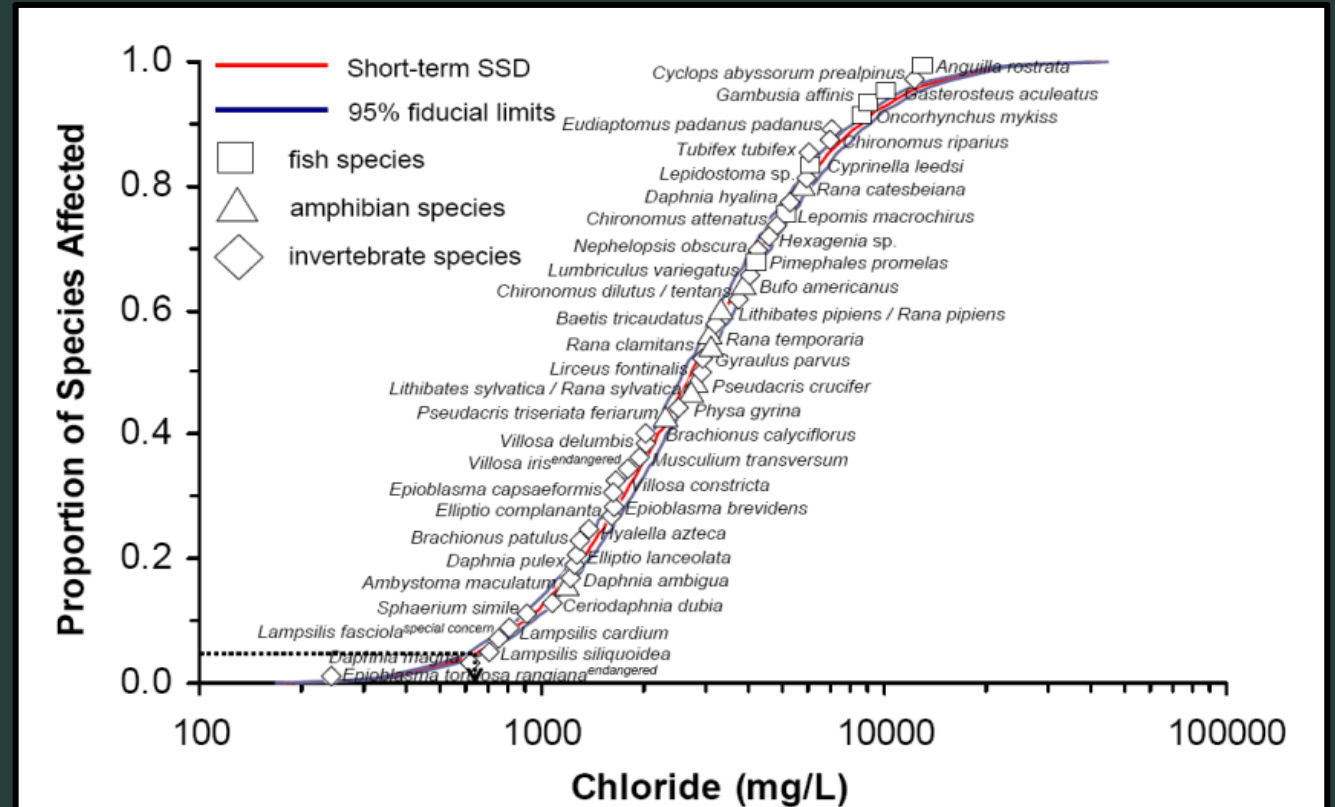
≥7 day exposure for fish
& invertebrates
≥24 hours for aquatic
plants & algae

DORWOOD:

Chronic = 99.45% of the year
Highest ≥7 day exposure: ~2,050 mg/L

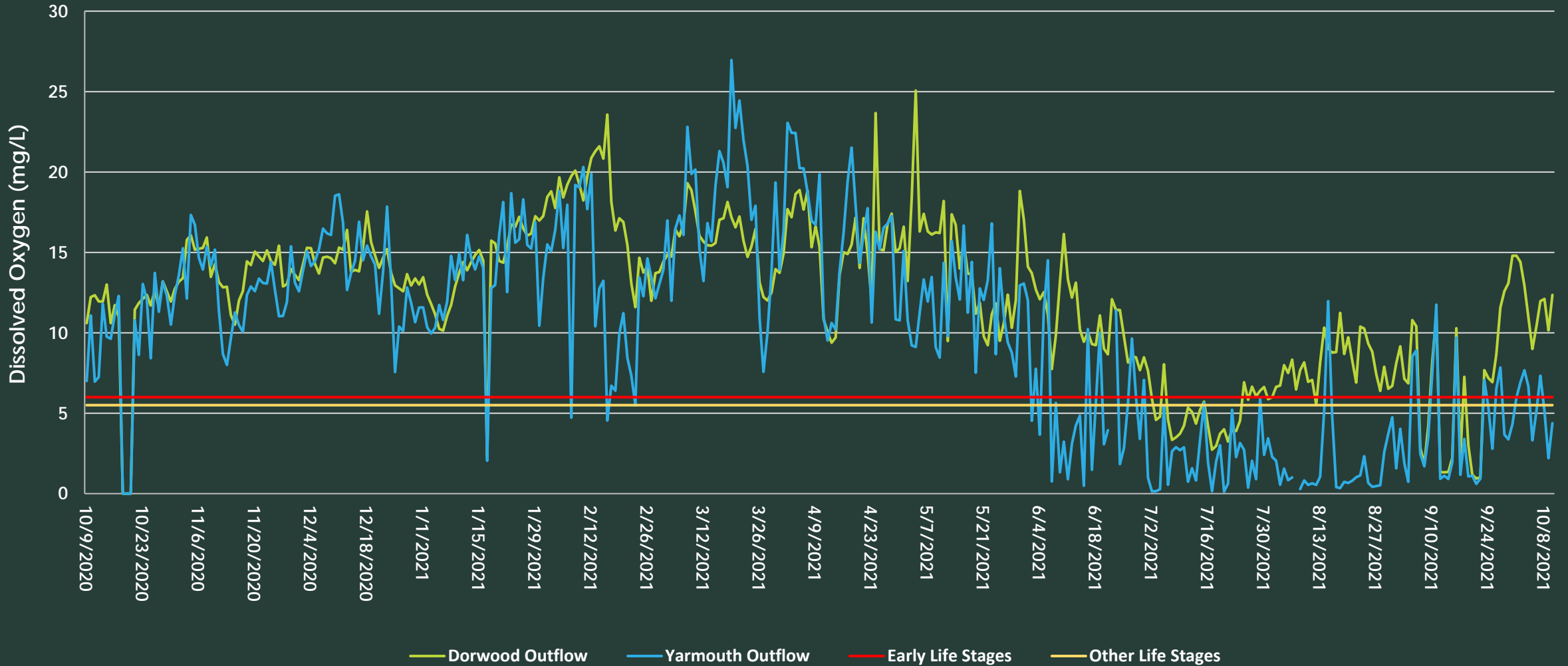
YARMOUTH:

Chronic = 80.60% of the year
Highest ≥7 day exposure: 800 mg/L



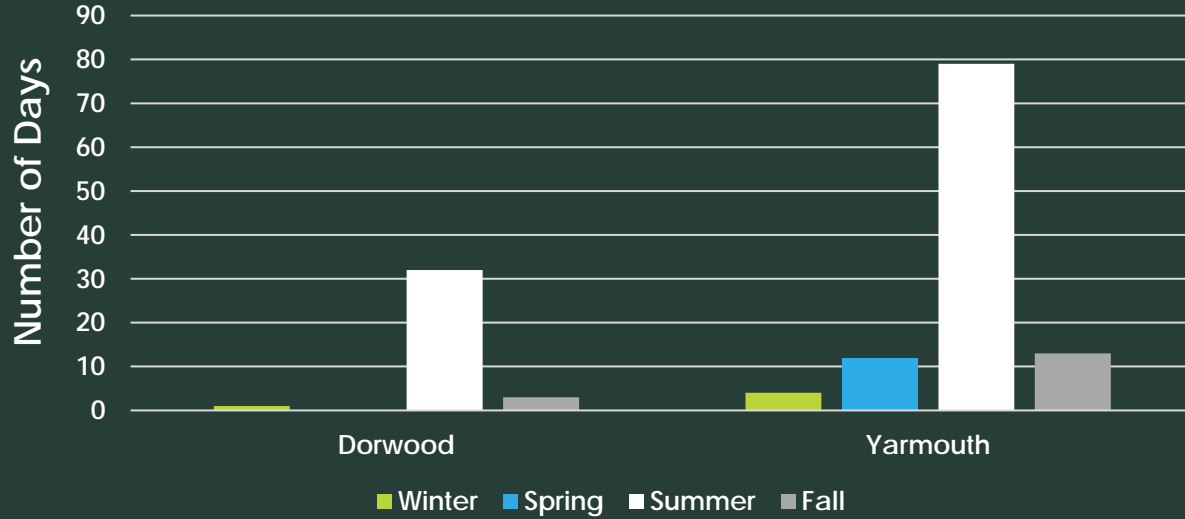
Seasonal Trends – Dissolved Oxygen

Dissolved Oxygen Effluent Concentration in Stormwater Ponds

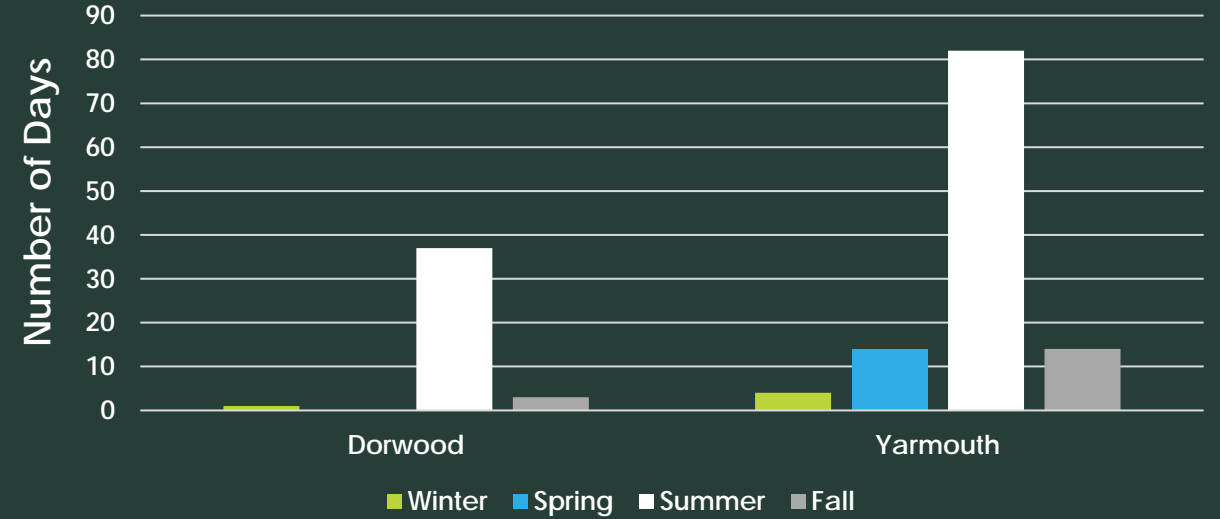


Performance & CCME Guidelines – Dissolved Oxygen

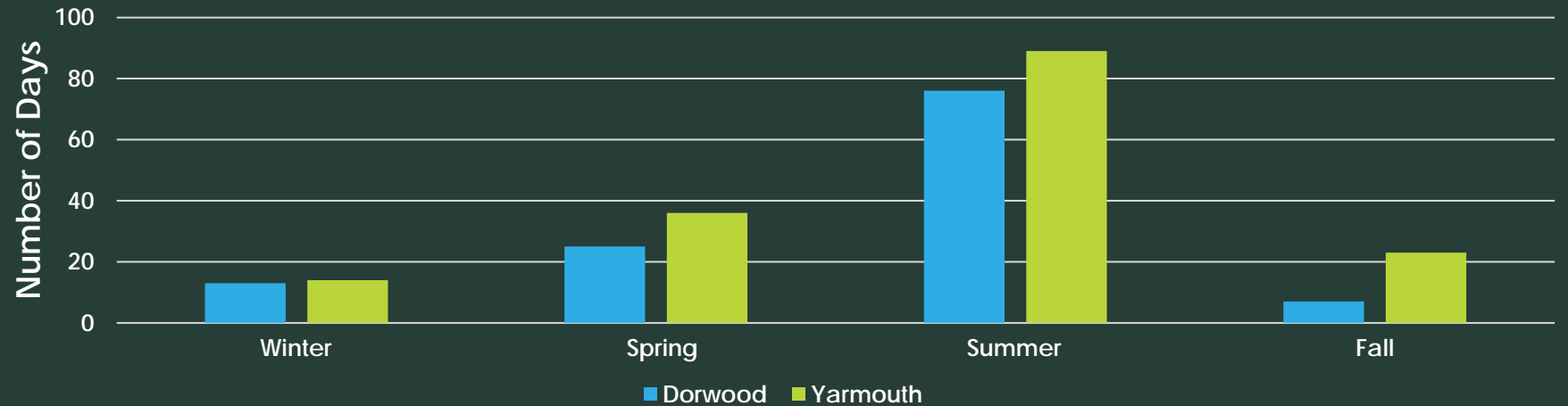
CCME Guidelines: Number of Days DO < 5.5 mg/L



CCME Guidelines: Number of Days DO < 6 mg/L



Increased Dissolved Oxygen within Ponds



EXPOSURE	TRIGGER RANGE (mg/L)
Early	>5.5
Other	>6

Adapted from CCME (2011)

Summary of Results

- **Total Phosphorous:** removal efficiencies 50:50; frequent release of eutrophic waters (1/3); differences among ponds
- **Chloride:** mitigating conditions but often exceed levels considered protective of aquatic organisms
- **Oxygen:** levels in Yarmouth from June-Oct often below levels required for protection for aquatic organisms; Dorwood below guidelines in July



Dorwood Inflow, Sept 2021

Overall Conclusions

- Potential for downstream effects but multiple contributing factors
- Current monitoring and assessment may be insufficient to evaluate biotic effects (chronic exposure requires prolonged conditions)
- Status of SWM ponds – sacrificial or not; if not, how should they be populated?



Next Steps



RESEARCH

Salinity
Tolerance of
Wetland Plants
Cold Chamber
Field Studies



MONITORING

Year-Round Analysis
of Additional SWM
Ponds
Underwater
Monitoring Systems



EDUCATION

Centre for Urban
Watershed
Research



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NSERC
Private-sector
Municipal/
Conservation



High School

Wilfrid Laurier University
Centre for Urban Watershed Research

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Region of Waterloo

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