# The Use of SWMM for Wetland Hydrological Assessment

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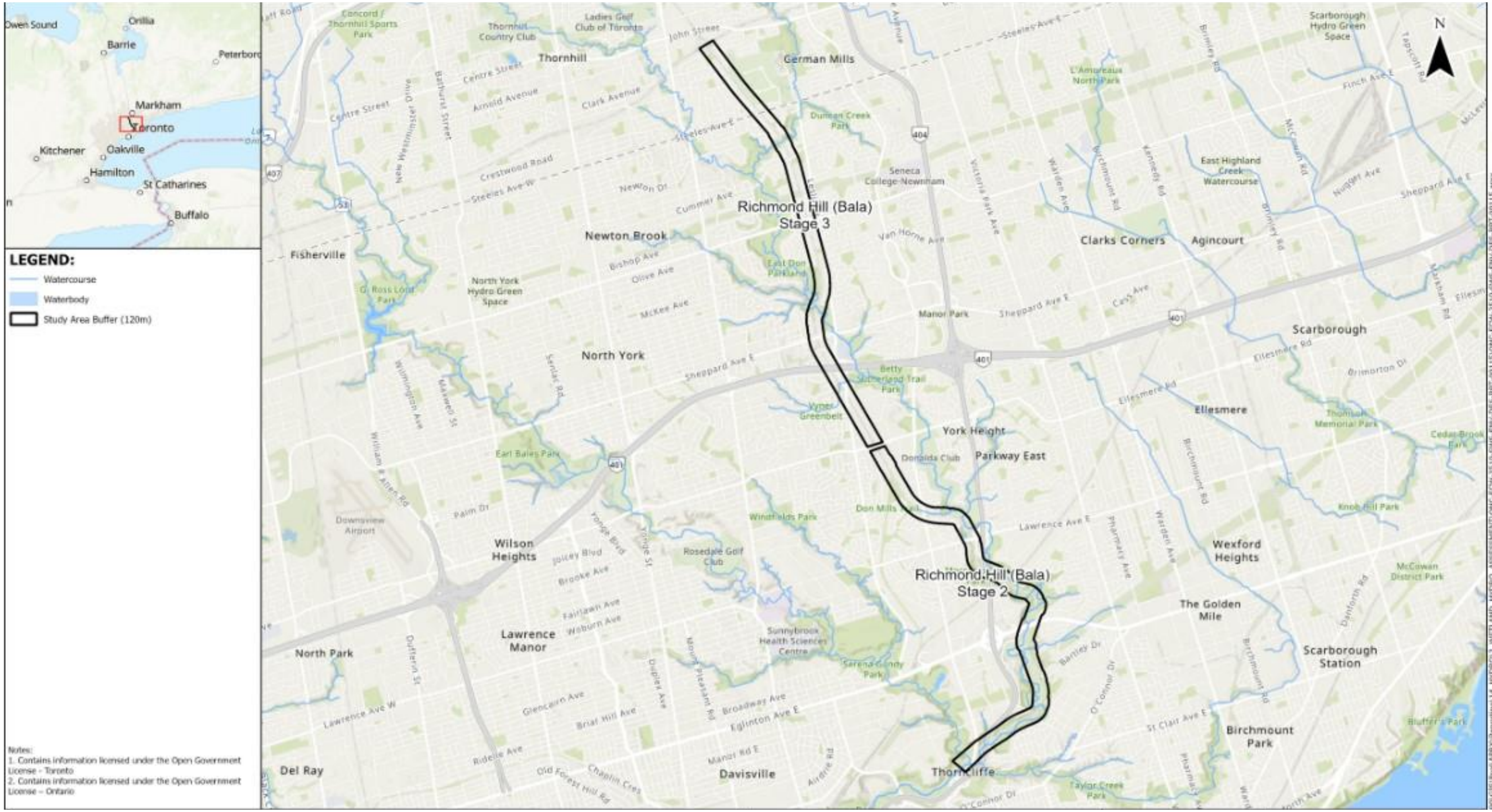
# Background



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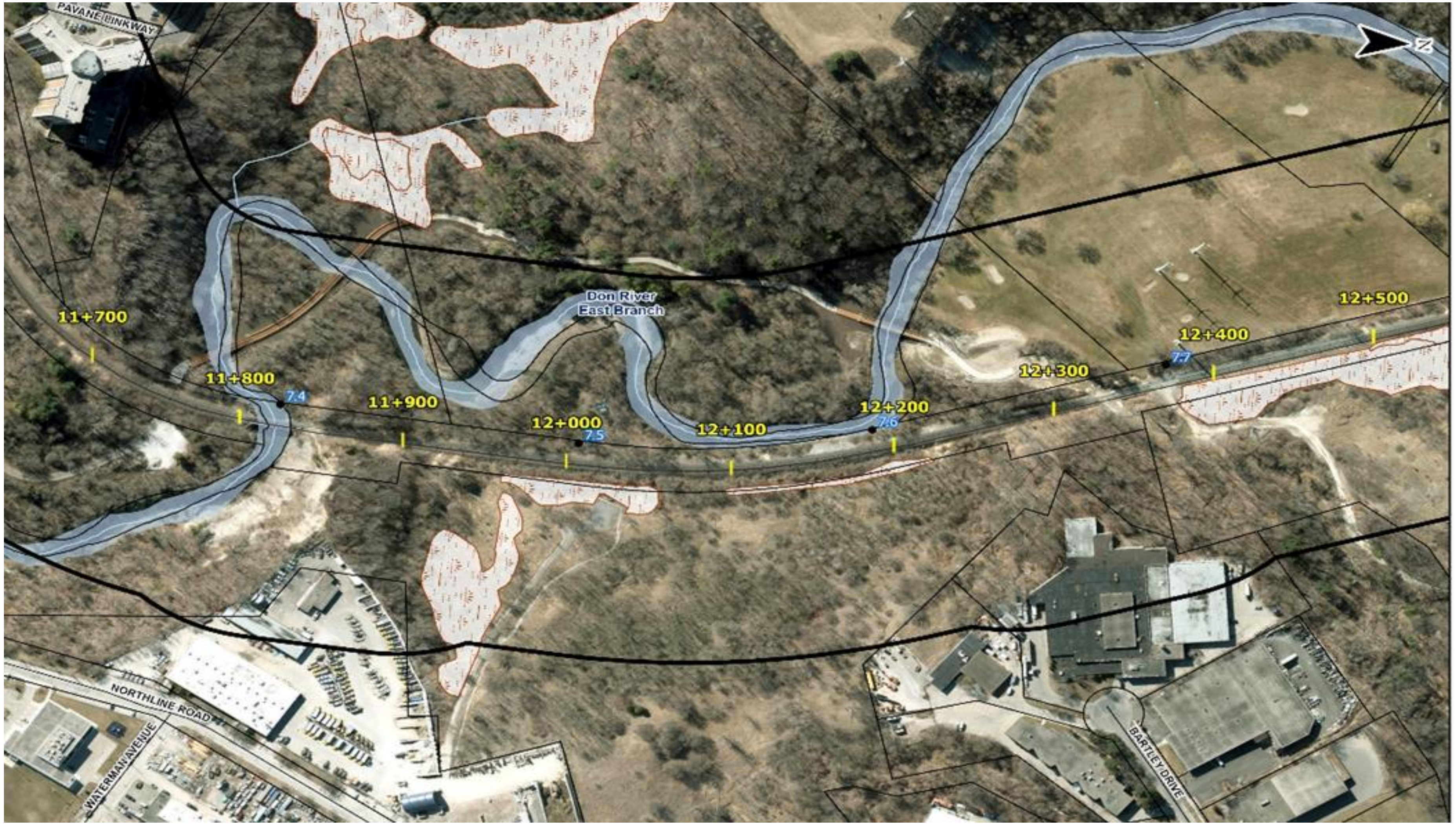
# Background


PAVANE LINKWAY
Don River
East Branch
11+700
11+800
7.4
11+900
12+000
7.5
12+100
12+200
7.6
12+300
12+400
7.7
12+500
N
NORTHLINE ROAD
WATERMAN AVENUE
BARTLEY DRIVE

# Introduction

- Wetlands are key for ecology, biodiversity, water purification, and flood control
- Ontario's laws require permits for certain activities near wetlands
- Assessing hydrological impacts is vital for wetland study
- Minor changes to hydrology can significantly affect the ecohydrological system

Source: https://kortright.org/2018/01/31/wetland-discovery/

# The need for Wetland Hydrological Analysis

- Regulatory Compliance/Environmental Stewardship
- Assess Potential Impacts of Development to wetlands
- Indicator of Ecological Health
- Sensitivity to Hydrological Changes

# Riverine Wetlands

- **Characteristics:**
  - Location
  - Hydroperiod
  - Soils: Predominantly hydric
- **Ecological Functions:**
  - Biodiversity: habitats for a diverse range of plant and animal species
  - Water Quality Improvement: Natural filters
  - Flood Attenuation



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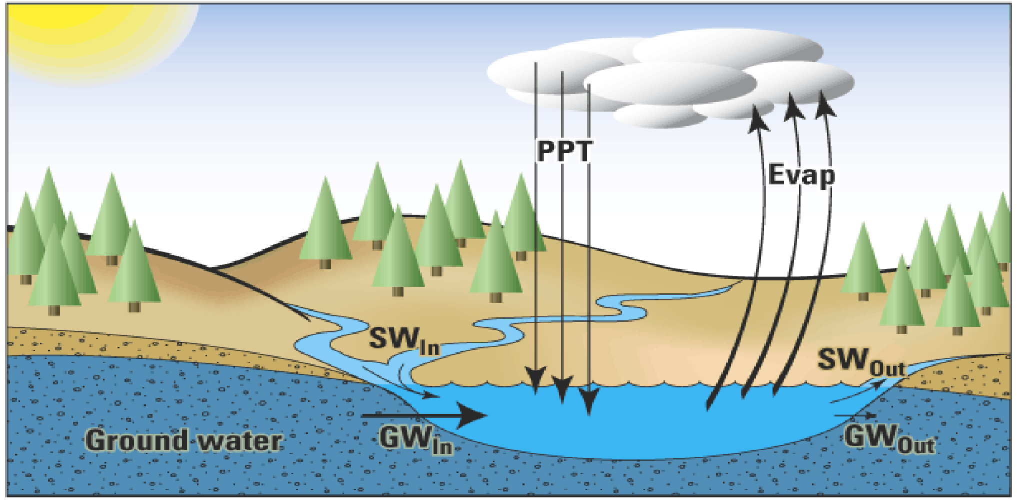
# Wetland Hydrology

Hydrological indicators of wetlands include:

- Inundation timing, duration, and frequency
- Soil saturation (groundwater depth, duration, frequency)
- Sediment depositions
- Drainage patterns in wetlands

# Modelling Approach

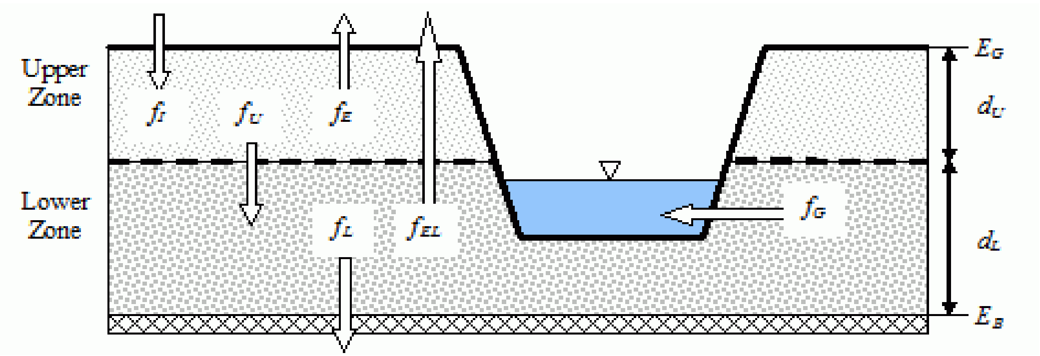
- Assessment of wetlands requires water balance analysis
- Widely used software for surface water modeling include HEC-HMS, OTTHYMO, **EPA SWMM** and PCSWMM
- Groundwater/Interflow plays an important role in wetlands hydrology
- SWMM5 has a groundwater module that conceptually represents the groundwater system in simplified terms




NOT TO SCALE

EXPLANATION

| | |
|---|---|
| Evap | Evaporation |
| $GW_{In}$ | Ground-water inflow |
| $GW_{Out}$ | Ground-water outflow |
| PPT | Precipitation |
| $SW_{In}$ | Surface-water inflow |
| $SW_{Out}$ | Surface-water outflow |



# Modelling Approach

- The water balance analysis solves the following equation :

$$P + SWI + GWI = ET + SWO + GWO \pm \Delta S$$

P – Precipitation, mm

SWI – Surface water input, mm

GWI – Groundwater input, mm

ET – Evaporation/Evapotranspiration, mm

SWO – Surface water output, mm

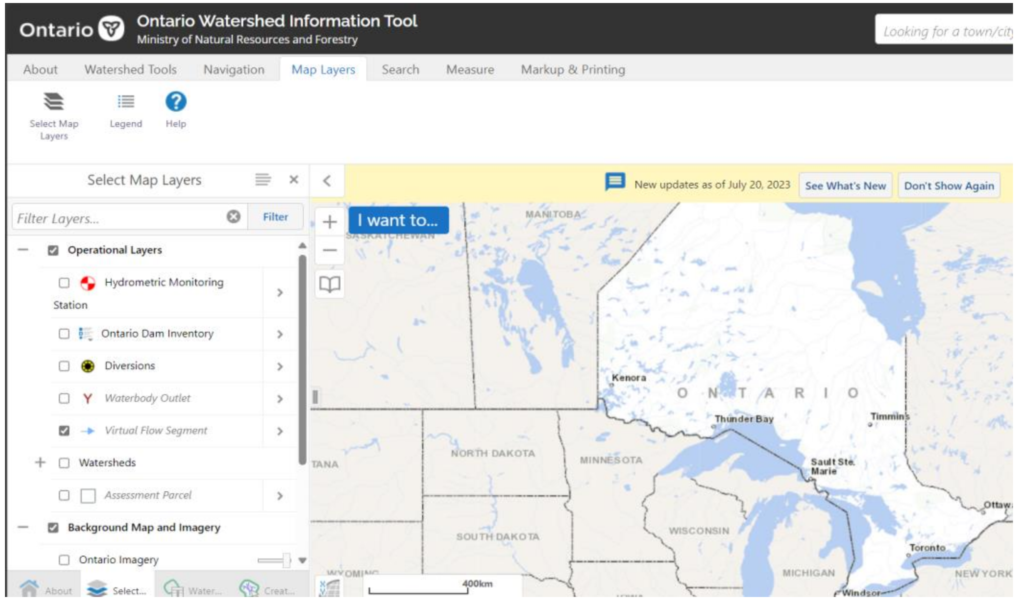
GWO – Groundwater output, mm

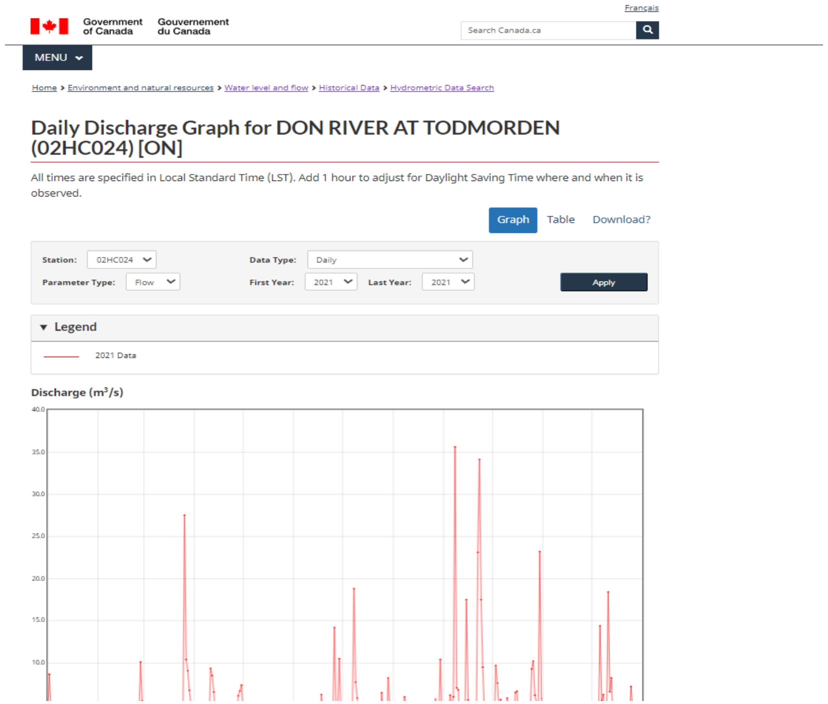
# Data Collection

- Precipitation, Temperature (obtained from ECCC : >20 years)
- DEM , Landcover (OWIT), Soil types (Ontario GeoHub)

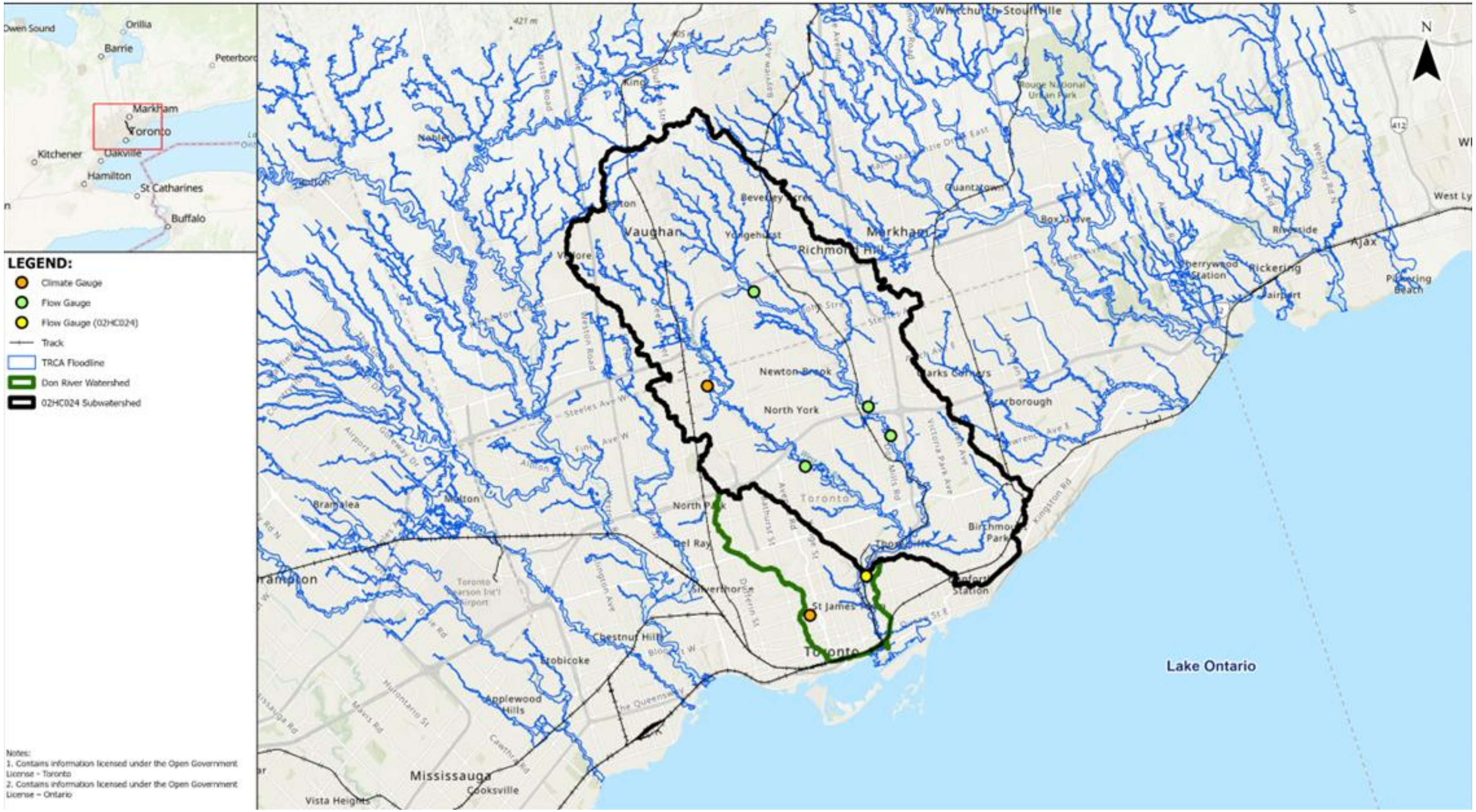
Potential Evapotranspiration Methods:

1. Hargraves
2. Thomthwaite
3. **Blaney-Criddle**

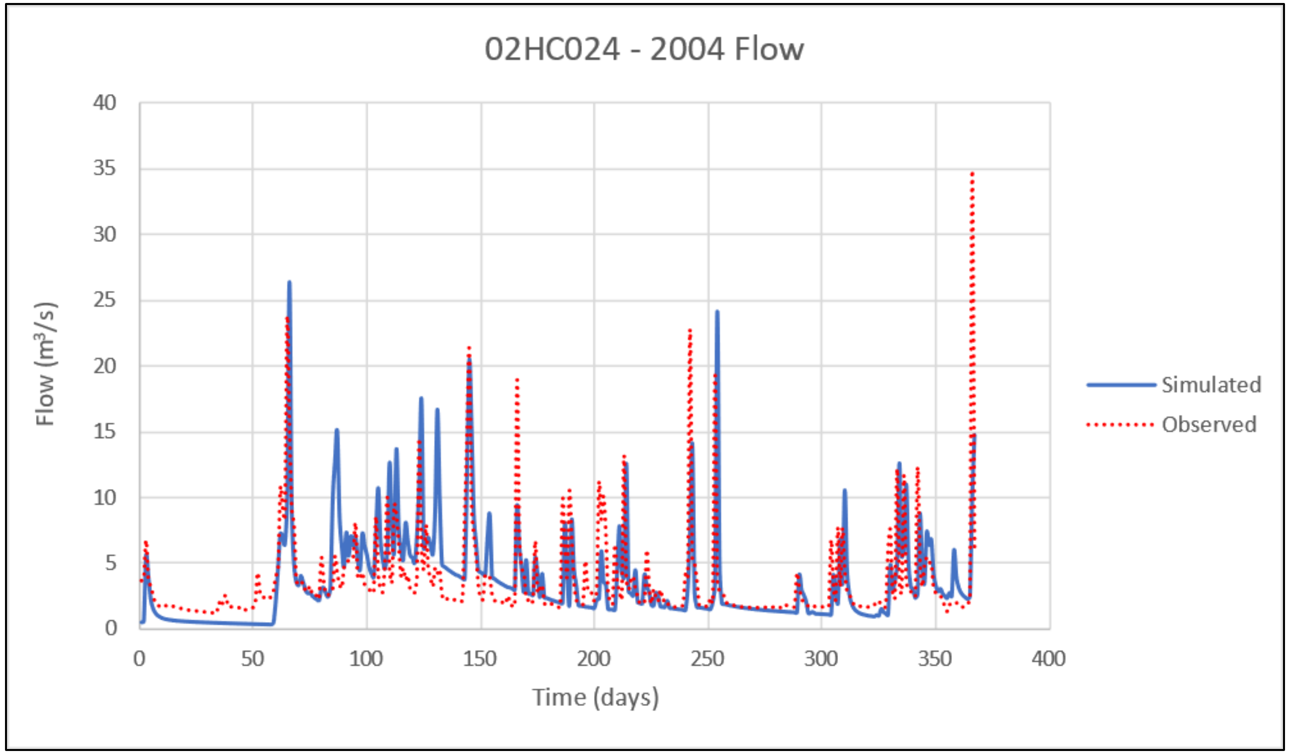


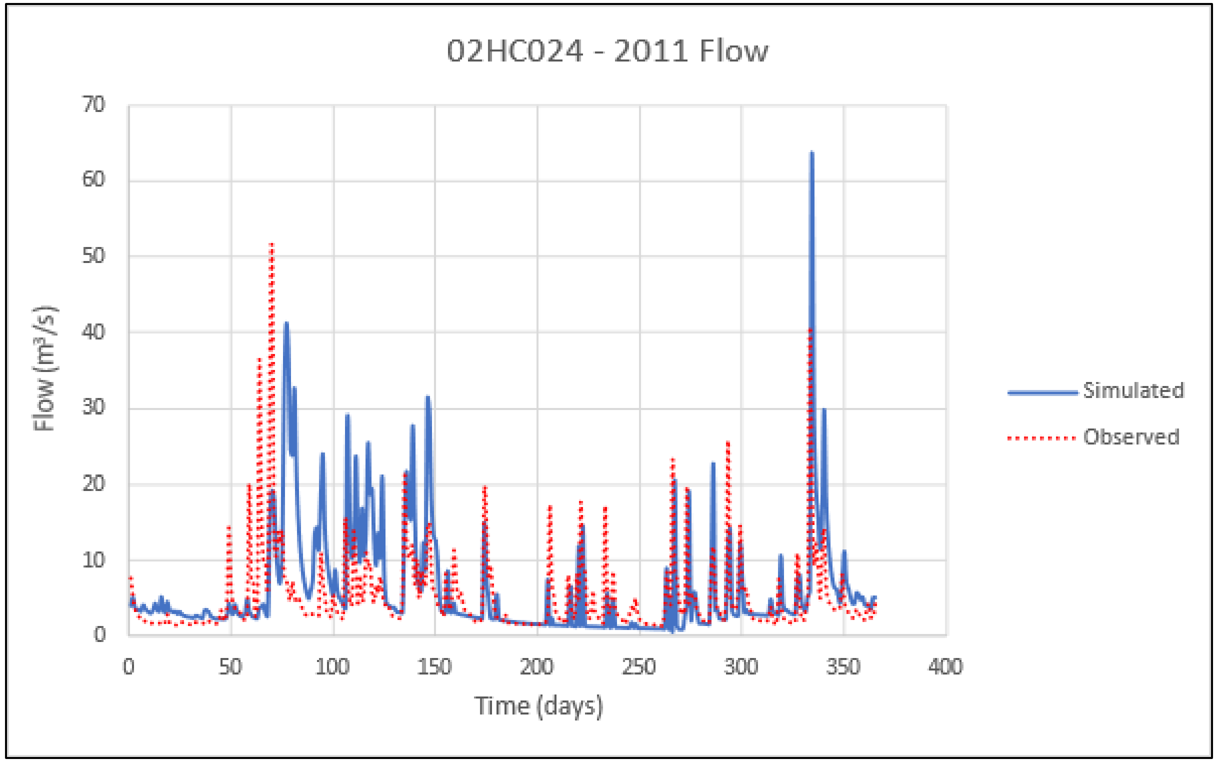



# Study Area


LEGEND:
Climate Gauge
Flow Gauge
Flow Gauge (02HC024)
Track
TRCA Floodline
Don River Watershed
02HC024 Subwatershed
Notes:
1. Contains information licensed under the Open Government License - Toronto
2. Contains information licensed under the Open Government License – Ontario
N
Owen Sound
Orillia
Barrie
Peterborough
Markham
Toronto
Kitchener
Oakville
Hamilton
St Catharines
Buffalo
Whitchurch-Stouffville
Vaughan
Markham
Richmond Hill
Newton Brook
North York
Scarborough
Pickering
Ajax
Brampton
Mississauga
Etobicoke
Toronto
Lake Ontario

# Model Calibration and Validation




- Calibration
- PBIAS = 14% - Good

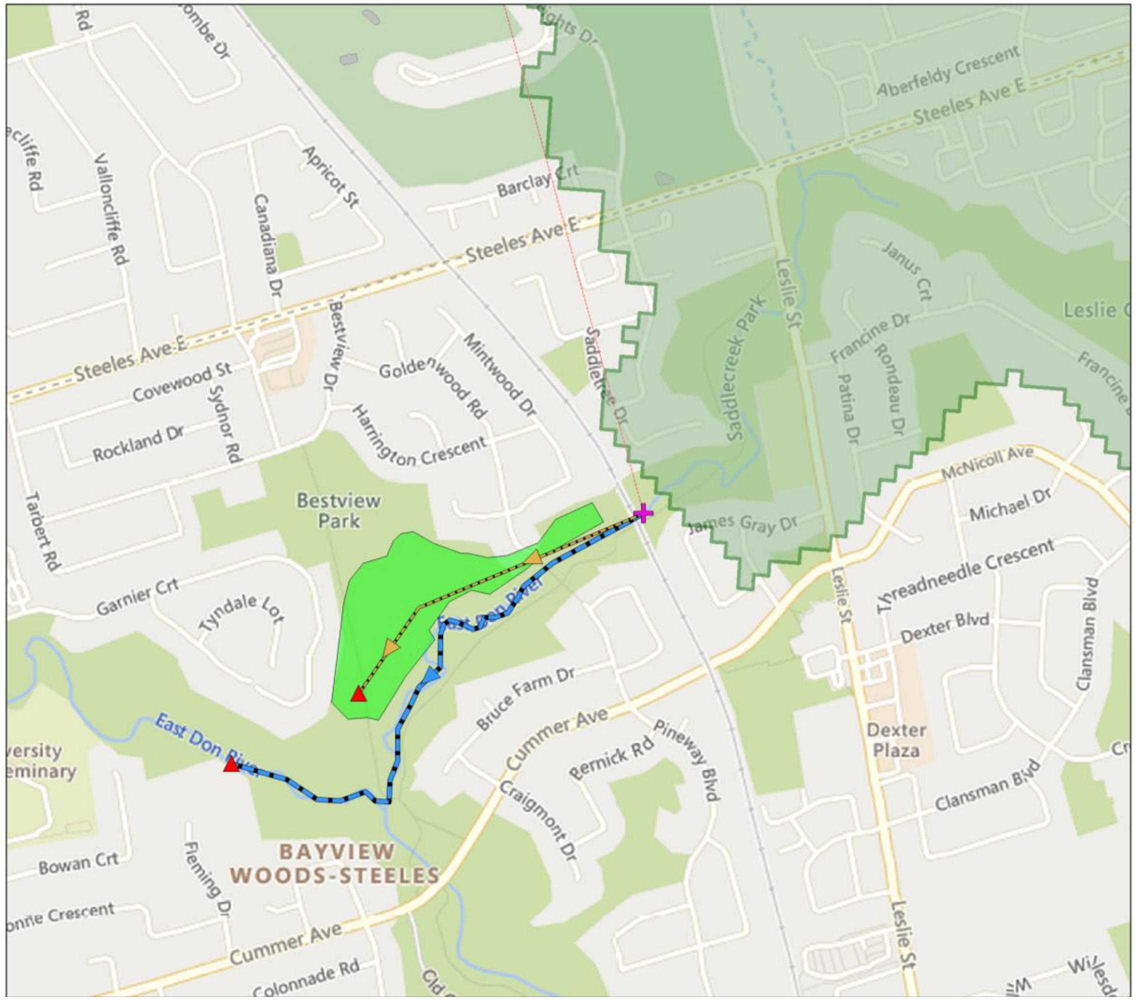
- Validation
- PBIAS = 22% - Satisfactory

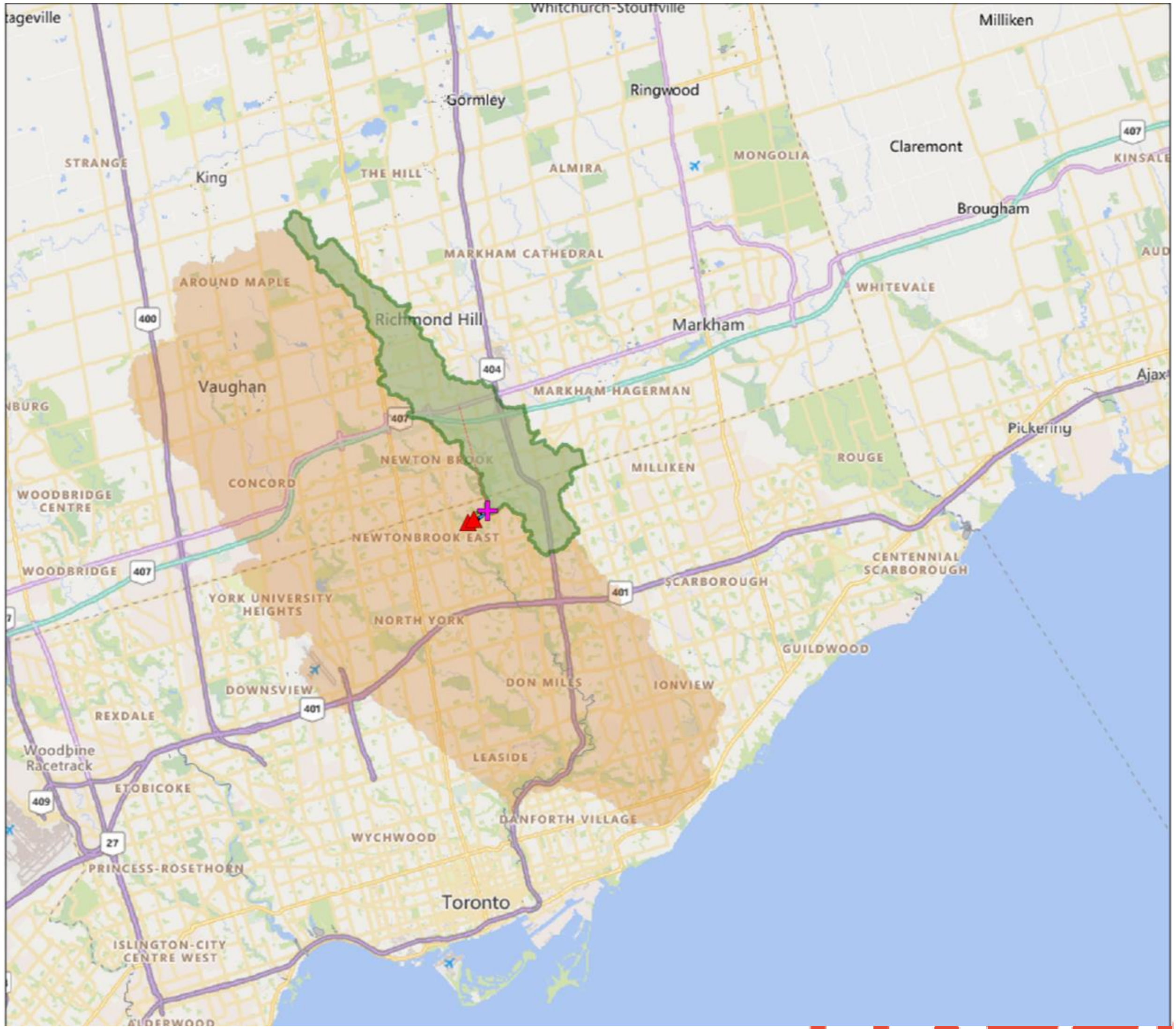
# Model Calibration and Validation

**Moriasi et al. 2007**

| Performance Rating | PBIAS (%) |
|---|---|
| Very Good | PBIAS < ±10 |
| Good | ±10<PBIAS<±15 |
| Satisfactory | ±15<PBIAS<±25 |
| Unsatisfactory | ±25>PBIAS |

# SWMM Model Setup



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# Sensitivity Analysis

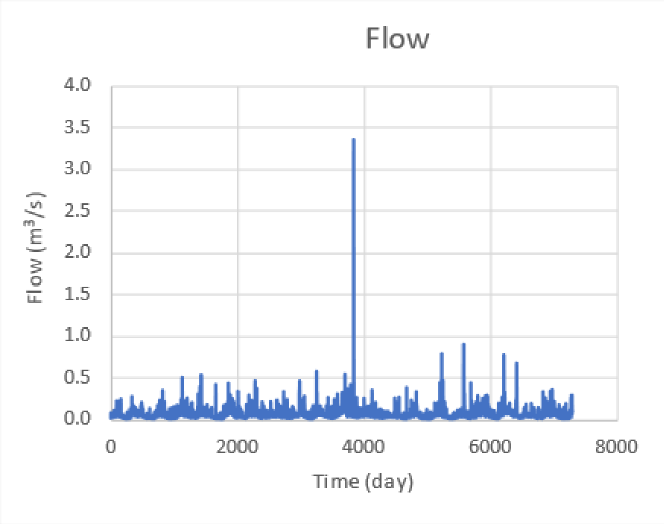
## Aquifer

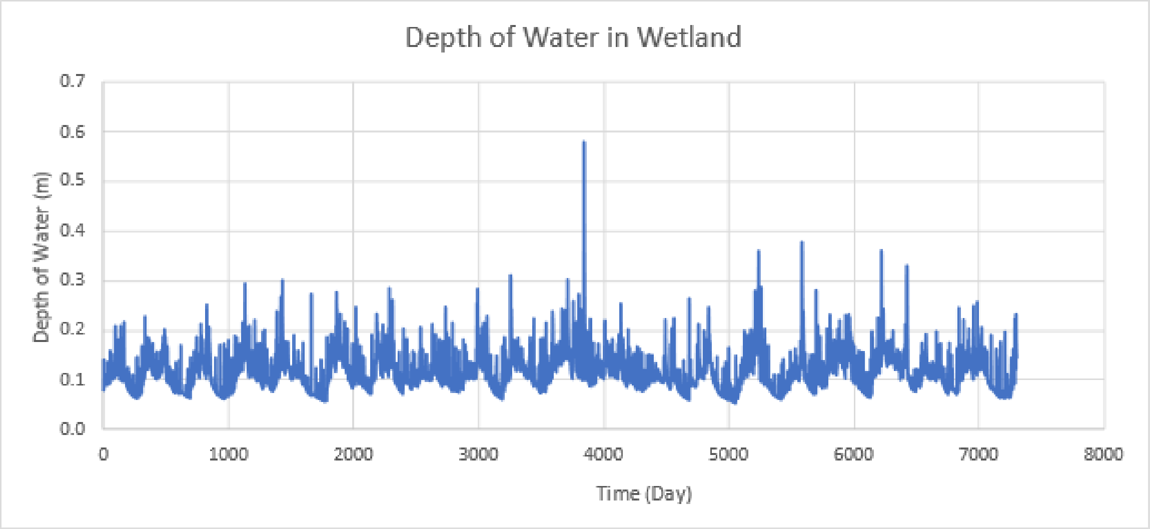
| Parameter | Value | Sensitivity | Effects of Changes |
|---|---|---|---|
| Porosity | 0.49 | High | Higher value leads to higher peak, and lower baseflow, Lower value leads to lower peak and higher baseflow |
| Field Capacity | 0.39 | High | Higher value leads to rapid change in ground water, Lower value leads to slower changes in groundwater |
| Conductivity (mm/hr) | 0.03 | High | Higher value leads to higher baseflow volume, lower value leads to lower baseflow volume |
| Upper Evaporation fraction | 0.5 | High | Higher value leads to lower baseflow volume, lower value leads to higher baseflow volume |

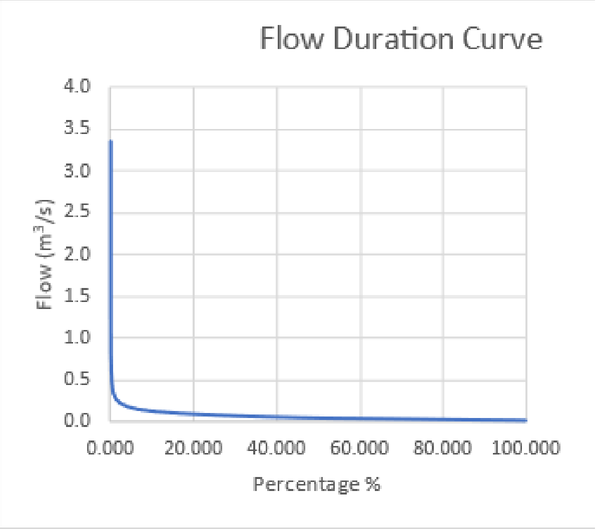
## Groundwater

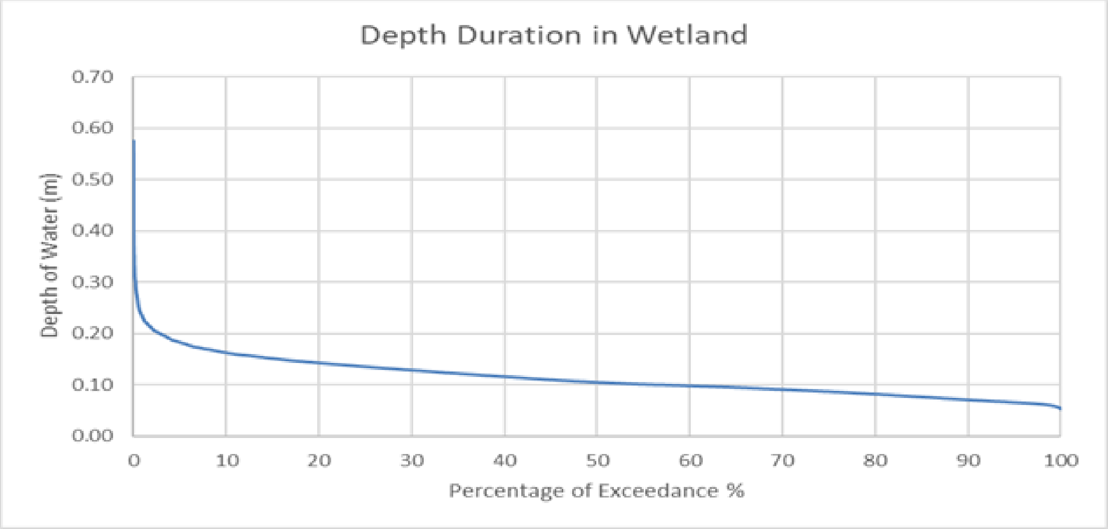
| Parameter | Value | Sensitivity | Effects of Changes |
|---|---|---|---|
| A1 | 0.002 | High | Higher value leads to rapid baseflow decline. Lower value leads to gradual baseflow decline |
| B1 | 5.5 | High | Lower value leads to high peak flow and less baseflow, higher value leads to lower peak and higher baseflow |
| A2, A3 | 0 | High | Significantly affect the groundwater flow pattern. |
| B2 | 1 | High | Significantly affect the groundwater flow pattern. |
| Threshold Groundwater Level below surface (m) | 0.9 | High | Lower value lead to higher lateral ground water flow into the stream |

# Model Results

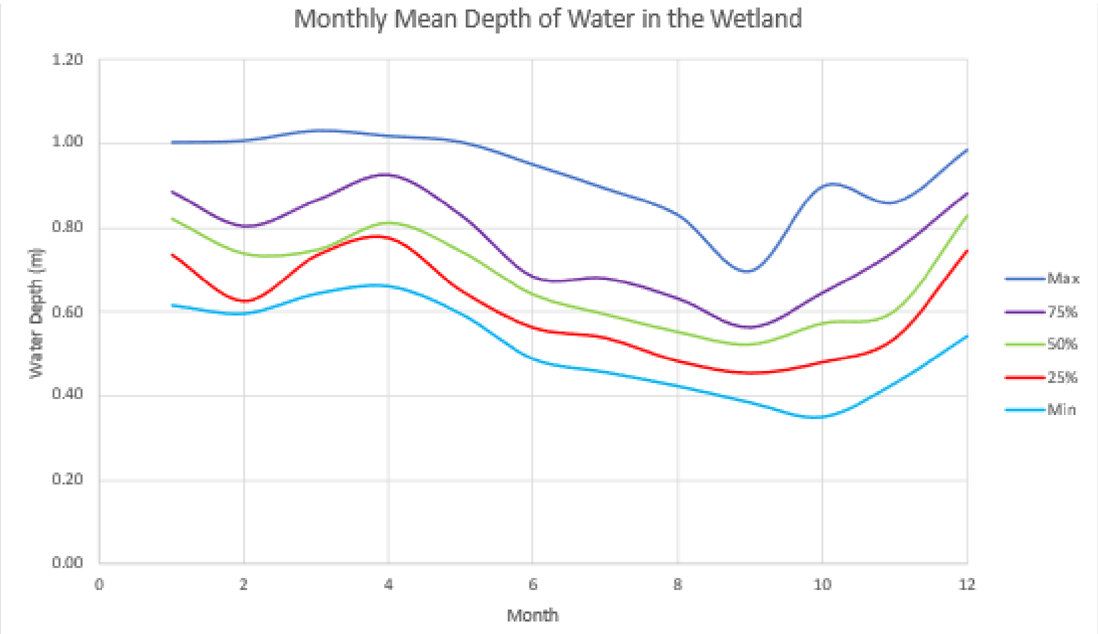


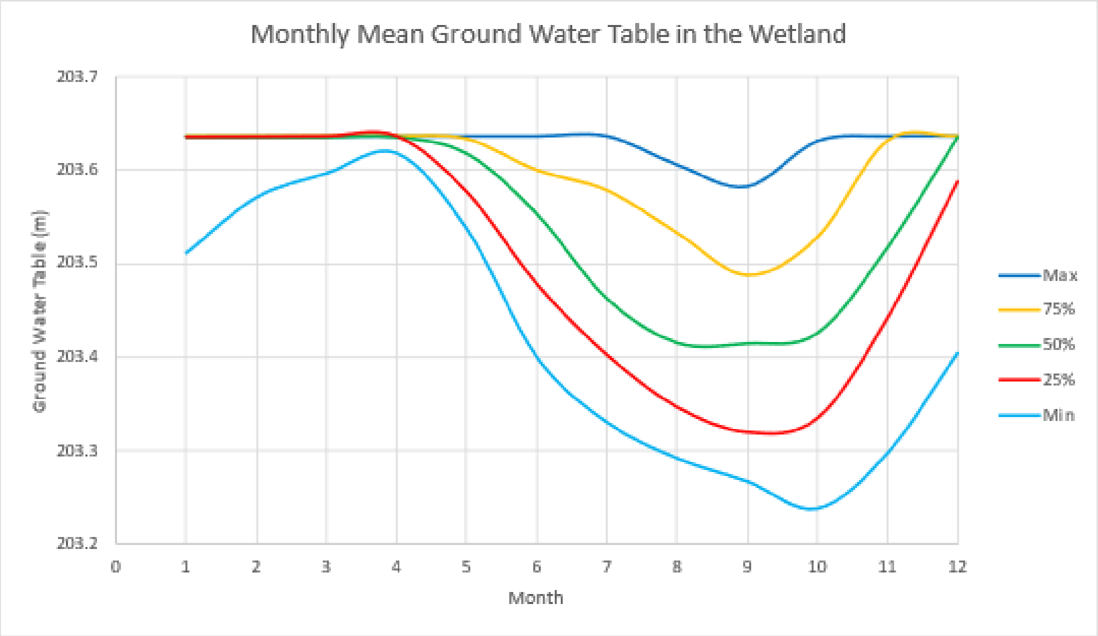



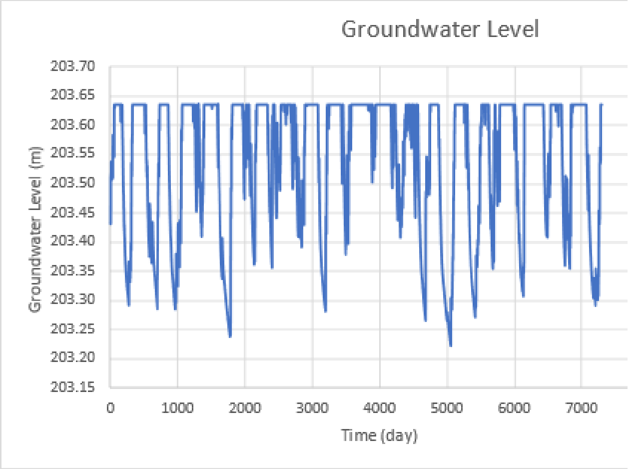



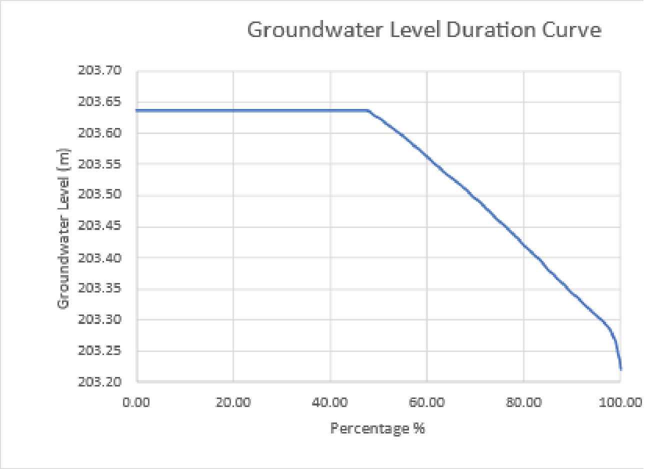



# Model Results



# Conclusions

- Successfully applied the EPA SWMM model for wetland hydrology assessment
- The SWMM model satisfactorily simulates wetland's hydrological processes.
- Groundwater module calibration is crucial for model accuracy, highlighting the importance of groundwater parameters.
- Multiple combinations of groundwater parameters can achieve similar simulation accuracy, indicating flexibility in parameter selection.
- The hydrological assessment sets a vital foundation for further evaluations of wetland's ecological and biological functions.



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# Recommendations

- Monitor changes in runoff processes, water levels, groundwater elevations and seasonal variations of these important parameters are required.
- Sediment Control is essential during construction period.
- Avoid significant disturbance to wetland/surface characteristics especially the vegetation cover.
- Establish new vegetation cover after the construction activities.
- Full impacts of the project cannot be evaluated since the detailed design is still not fully undertaken. Therefore, the impacts assessment requires updating when the design details are available.

# Thank you!

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