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Analysis of Flooding and Sediment Transport by Numerical Modeling as Part of the Don River Mouth Naturalization Project, Toronto

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Introduction

- TRCA and Baird have undertaken an EA for the Don Mouth Naturalization and Port Lands Flood Protection Project (DMNP) in Toronto, Ontario, on behalf of Waterfront Toronto
- Key objective: address flooding south and east of Don River up to the Regulatory Flood
- Flooding and flood protection performance were evaluated through numerical modeling using the Delft3-D model

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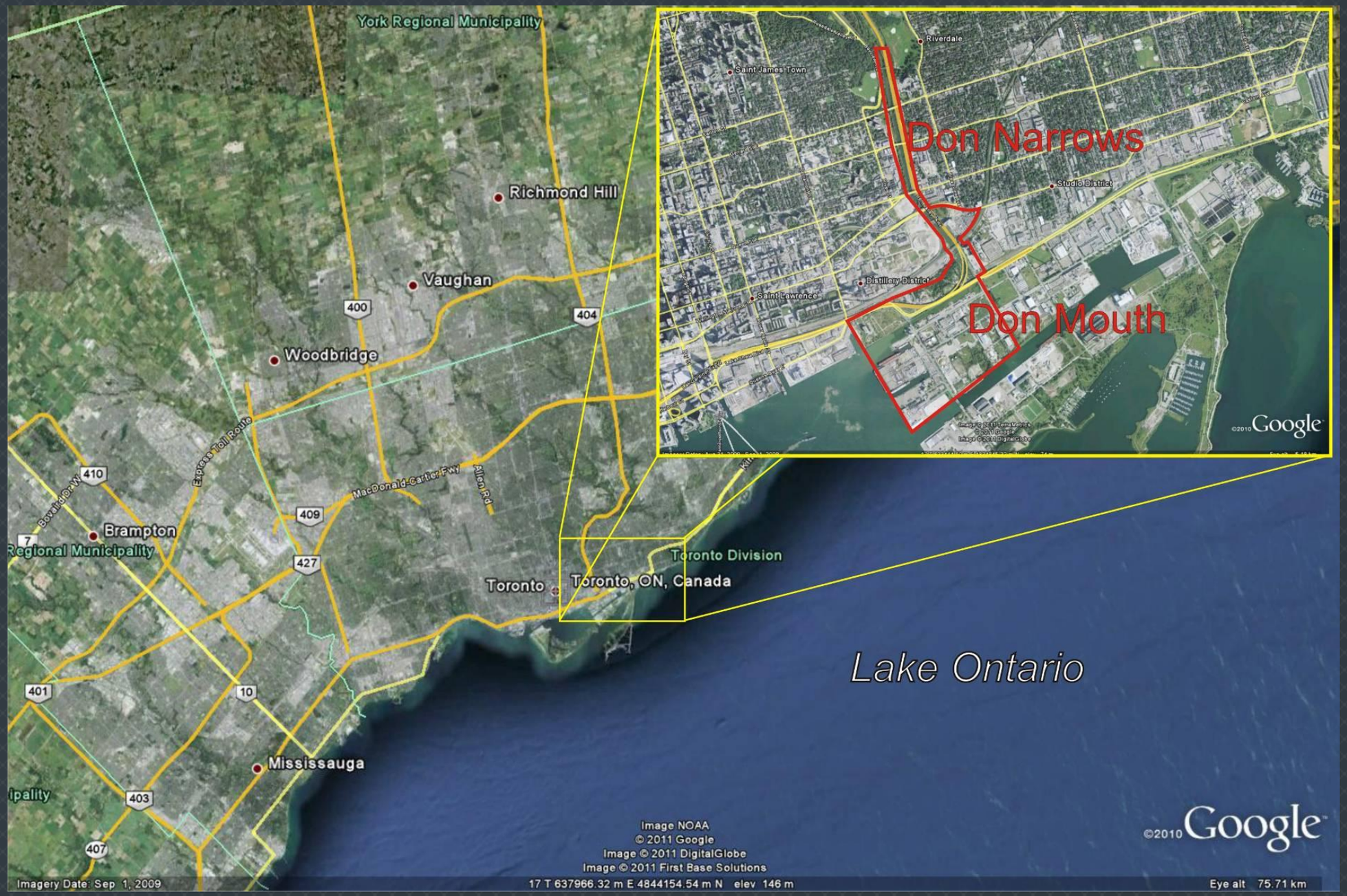
Project Location



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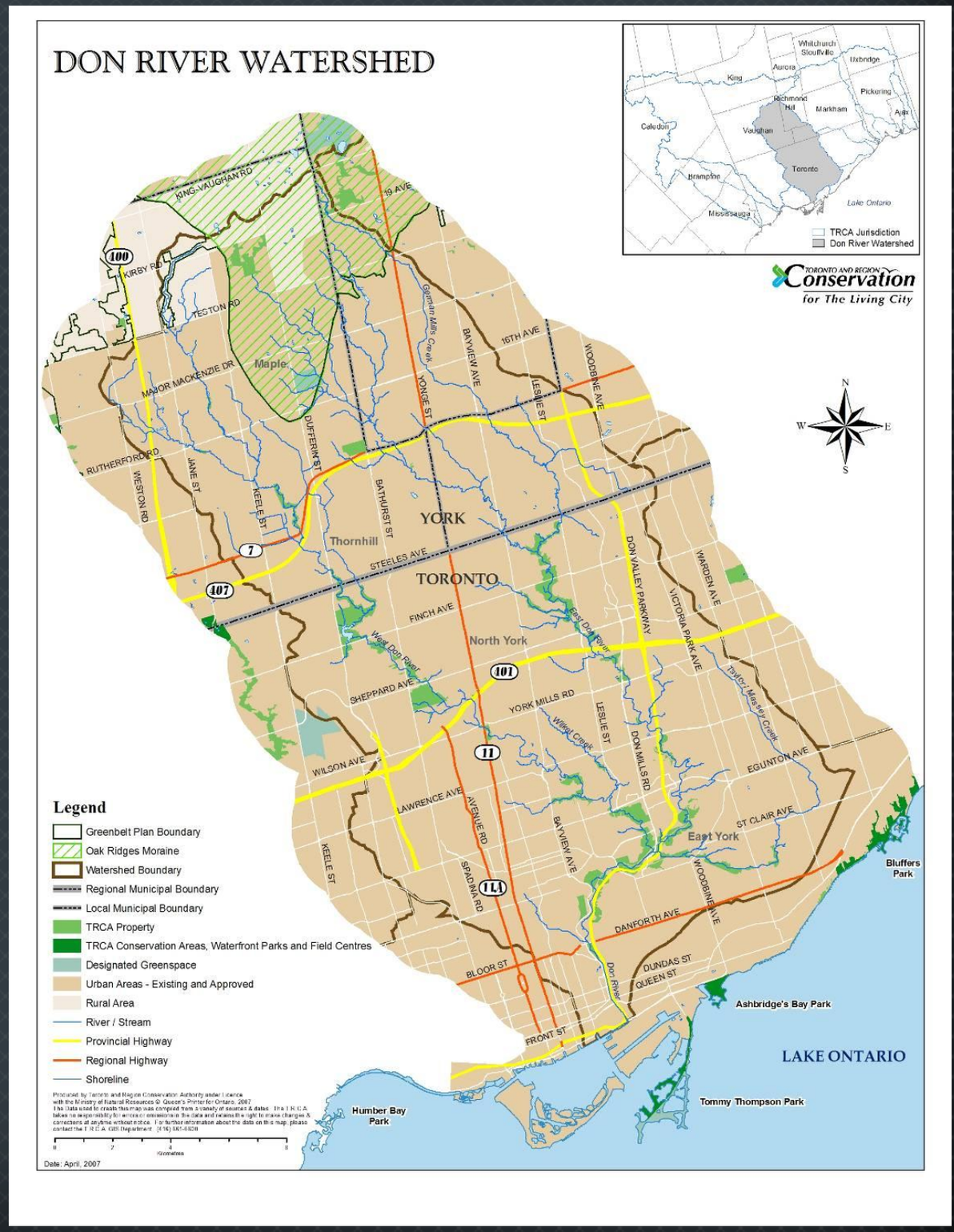
Project Objectives

- Naturalize and rehabilitate mouth of the Don River
- Remove flood risk (allow for intensification)
- Manage sediment, debris and ice
- Integrate infrastructure
- Encourage recreation, cultural heritage opportunities and accessibility
- Contribute to revitalization and sustainability of waterfront
- Design and implement this project in a sustainable manner

Don Watershed

KEY FEATURES:

1. Watershed covers 36,000 ha & 4 municipalities
2. 200 + years of urbanization
3. Land use: 80% urban, 4% agriculture, & 16% natural cover
4. Storm run-off from 80% of the urban areas discharges to the river without treatment
5. 33 CSOs discharge to Lower Don



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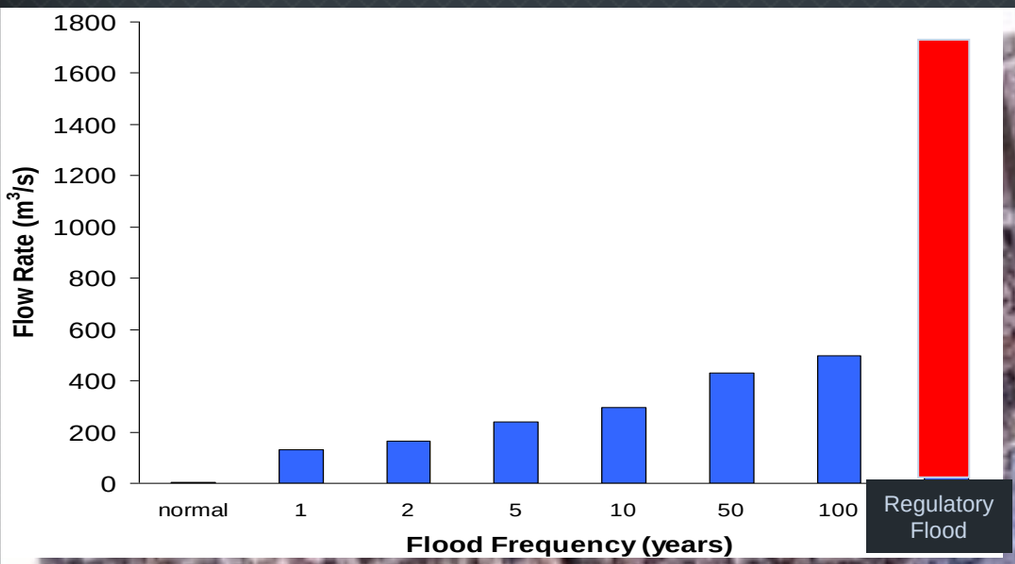
Extent of Existing Flooding



PLANNING IMPLICATIONS:

Provincial regulations preclude land use change that would result in greater risk to life or property damages

Flood risk needs to be removed to the Regulatory Flood level

Existing Habitat

- Concrete-capped sheet pile banks
- 35-60m (KC) & 35m (DN) width
- 5-6m (KC) & 1-2m (DN) depth
- Primarily sand & silt substrate
- Hydraulics: Lake level driven (backwater effect)
- Debris: 600 tonnes / year
- Riparian Habitat: None
- Adjacent Land Uses: Utilities, transport & municipal infrastructure
- Floodplain Quality: Impacted lake fill & derelict or industrial land uses

Channel Sedimentation

- Keating Channel: ~40,000 m^3/yr of sediment dredged & disposed in CDF
- Dredged material composition (1991-2008):
  - Gravel-M. Sand 17 %
  - F.-V.F. Sand 39 %
  - Silt 37 %
  - Clay 7%

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Integration – Don Mouth EA

To establish and sustain the form, features, and functions of a natural river mouth within the context of a revitalized City environment while providing flood protection up to the Regulatory Flood

Naturalization

Revitalized City Environment

Flood protection

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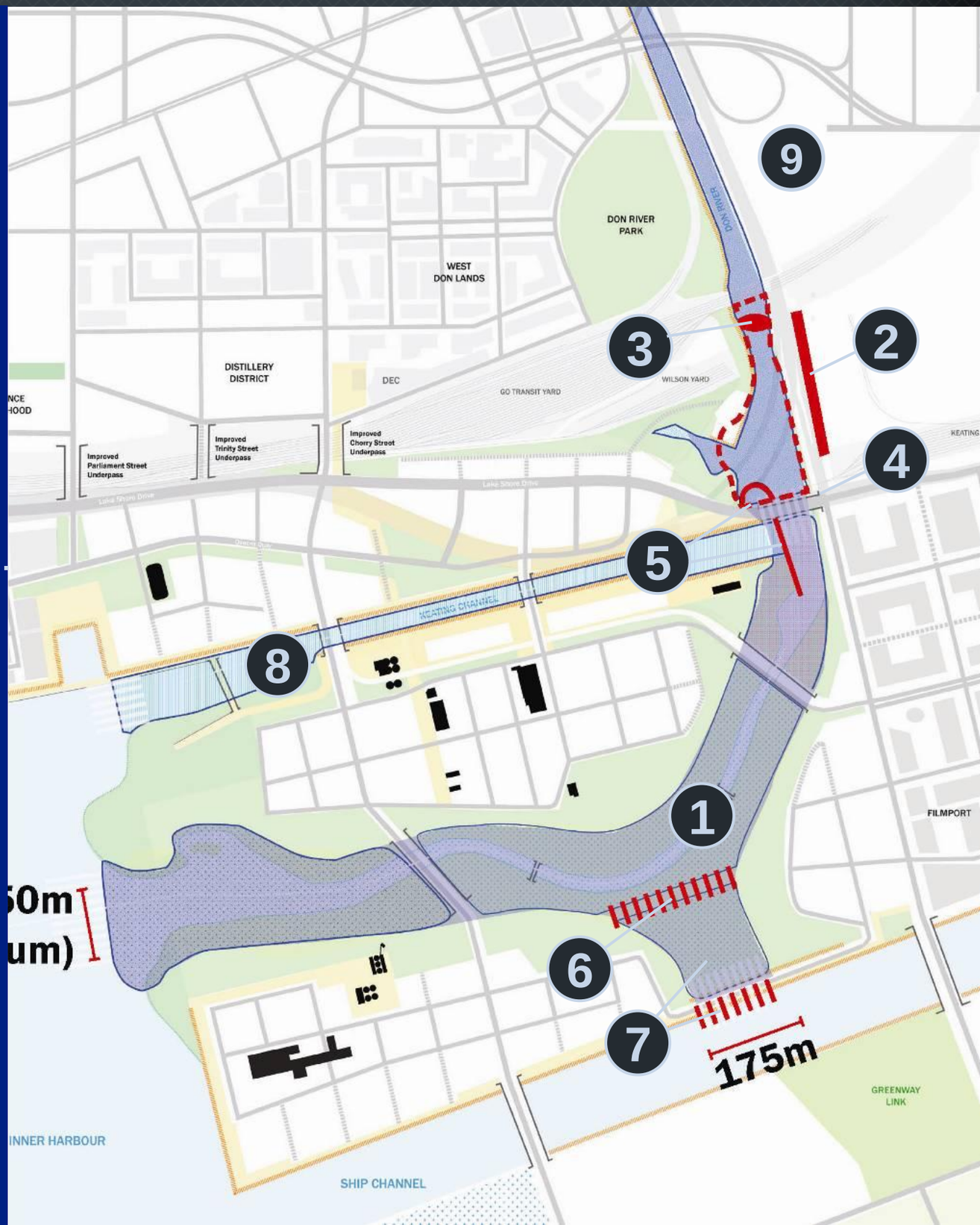
Preferred Concept - Summary Slide

1. River Valley Formation
2. East Bank Flood Protection Landform
3. Removal of Utility Bridge
4. Channel Modification & Sediment Basin
5. Bridge Lengthening & Weirs at Lake Shore Blvd.
6. Overflow Levee
7. Greenway Wetland and Floodway
8. Keating Channel Floodway
9. Minor Grade Modifications



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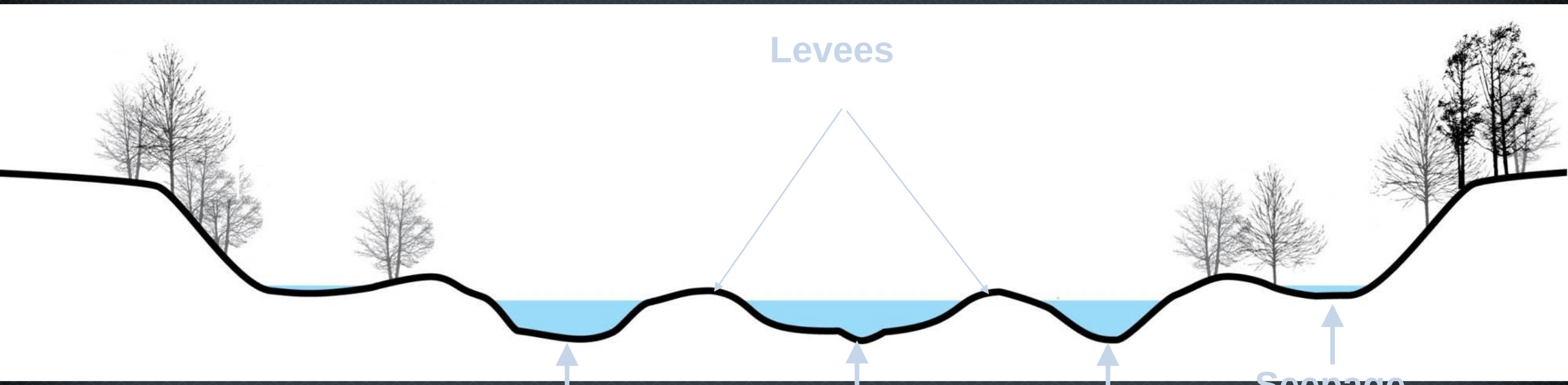
River Valley Creation



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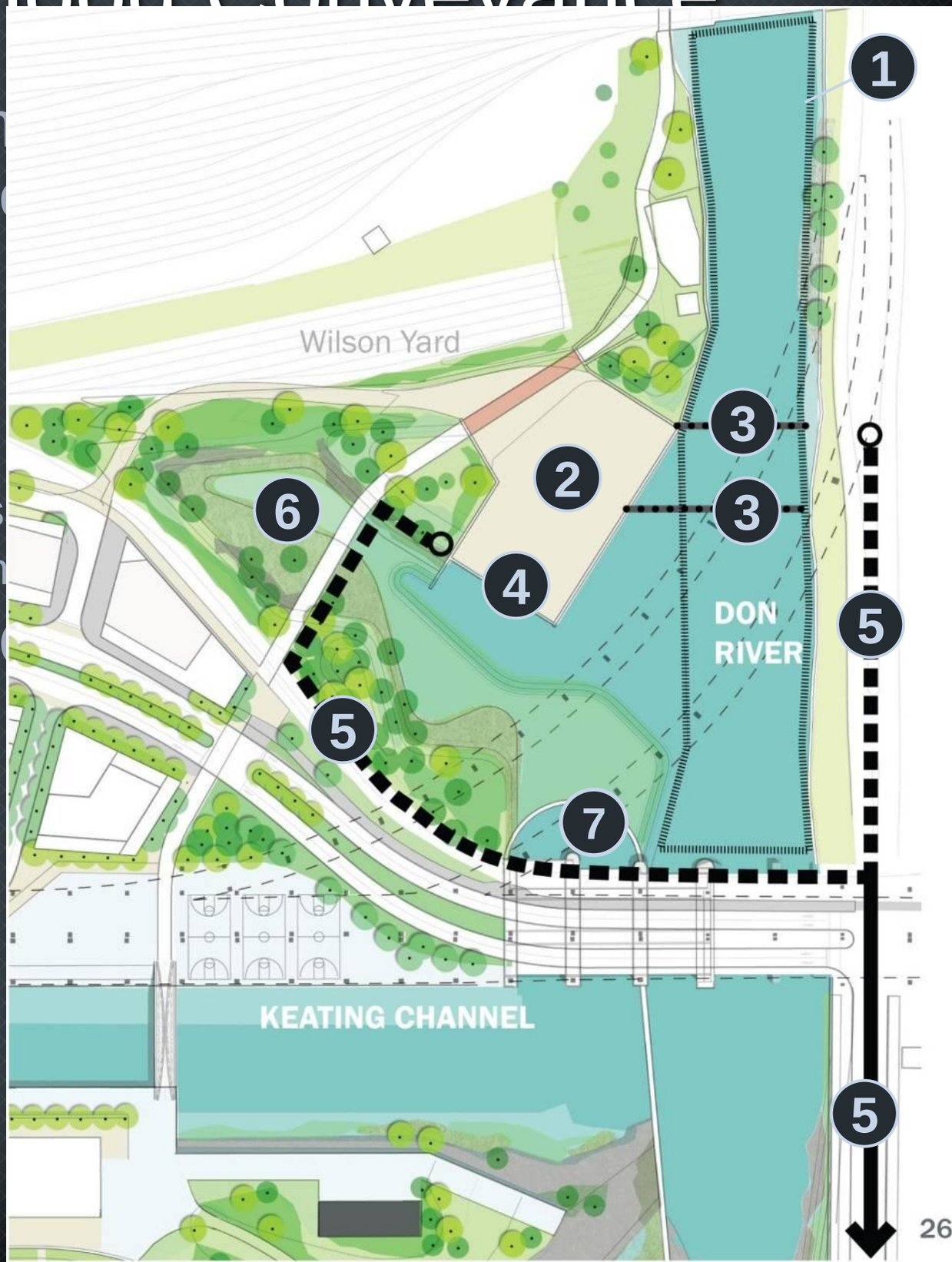
Naturalization Rendering

The Urban Estuary, Michael Van Valkenburgh Associates, Inc., 2008 (Image: Property of Waterfront Toronto)

Design Conditions: Flood Conveyance

- Regional flood containm
  modifications between
  Lakeshore (REACH 1):
  - FPL / Grading east
  - Channel widening
    - Lengthen Lakeshore cros
    - Sediment management in
  - Creation of Keating
    - Levels
    - Dynamic weir(s)
    - Flow split/balance
    - Adaptive management

1. Sediment Trap
2. Sediment/Debris Management Area
3. Debris Booms
4. Barge Dock
5. Sediment Hydraulic Conveyance Pipe
6. Accommodation for Access Shaft
7. Weirs



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Landscape Communities

- Open Space
- Valley Slope Transitions
- Levee System
- Lake Connected Wetlands
- Seepage Wetlands
- Aquatic

(Image: Property of Waterfront Toronto)

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Project Model Description

- Delft3D was selected as the project model:
  - 2-D and 3-D numerical hydrodynamic model
    - Curvilinear grid, finite-difference model
    - Sediment transport (cohesive and non-cohesive)
    - Morphologic change and water quality can be included

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Project Modelling Challenges

- Containment and conveyance of the Regulatory Flood in a drowned river mouth
- Sustainable sediment management
- Evaluating design alternatives for the restored channel, structures, wetlands and flood spillways
- Integrate flow and sediment design objectives with other ecological and urban-centric EA objectives

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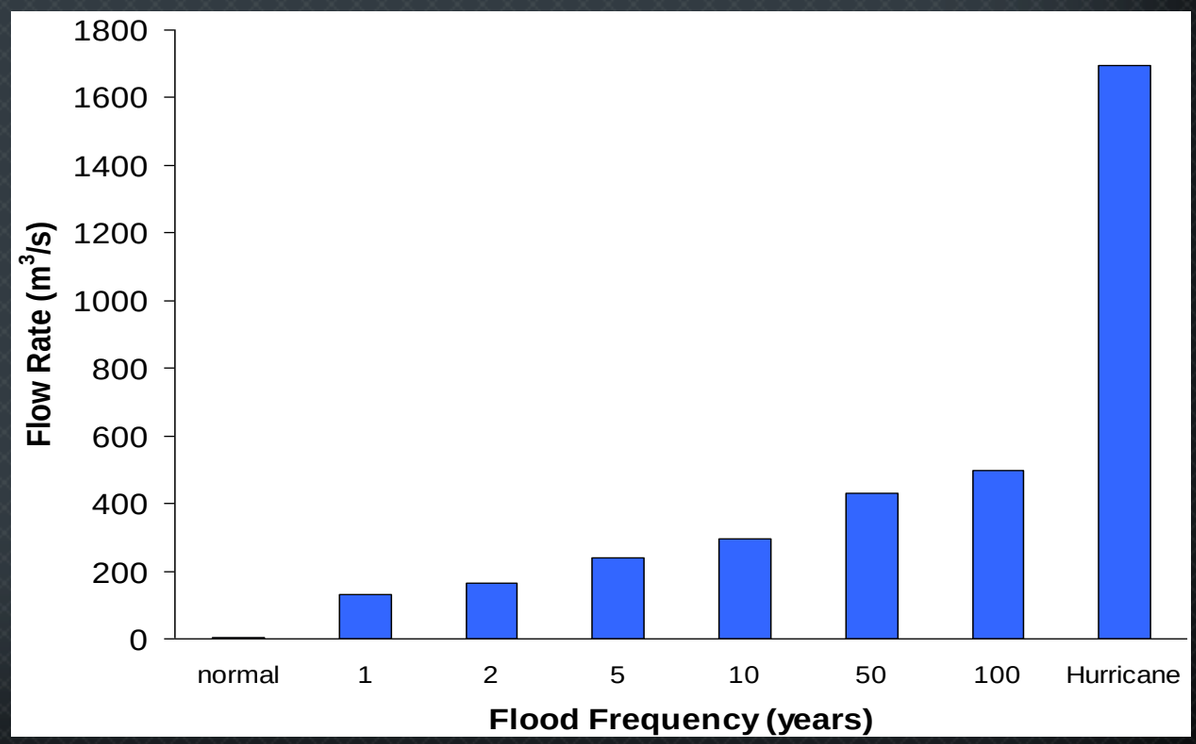
Modeling Challenges – Flooding

- Regulatory Flood is ~1,700 m3/s
- Potential for extreme in-channel velocities
- Lack of calibration data for large flood events
- Numerous structures – difficult to represent in 3-D hydrodynamic models
- Functional solutions require multiple outlets (flows need to be balanced)



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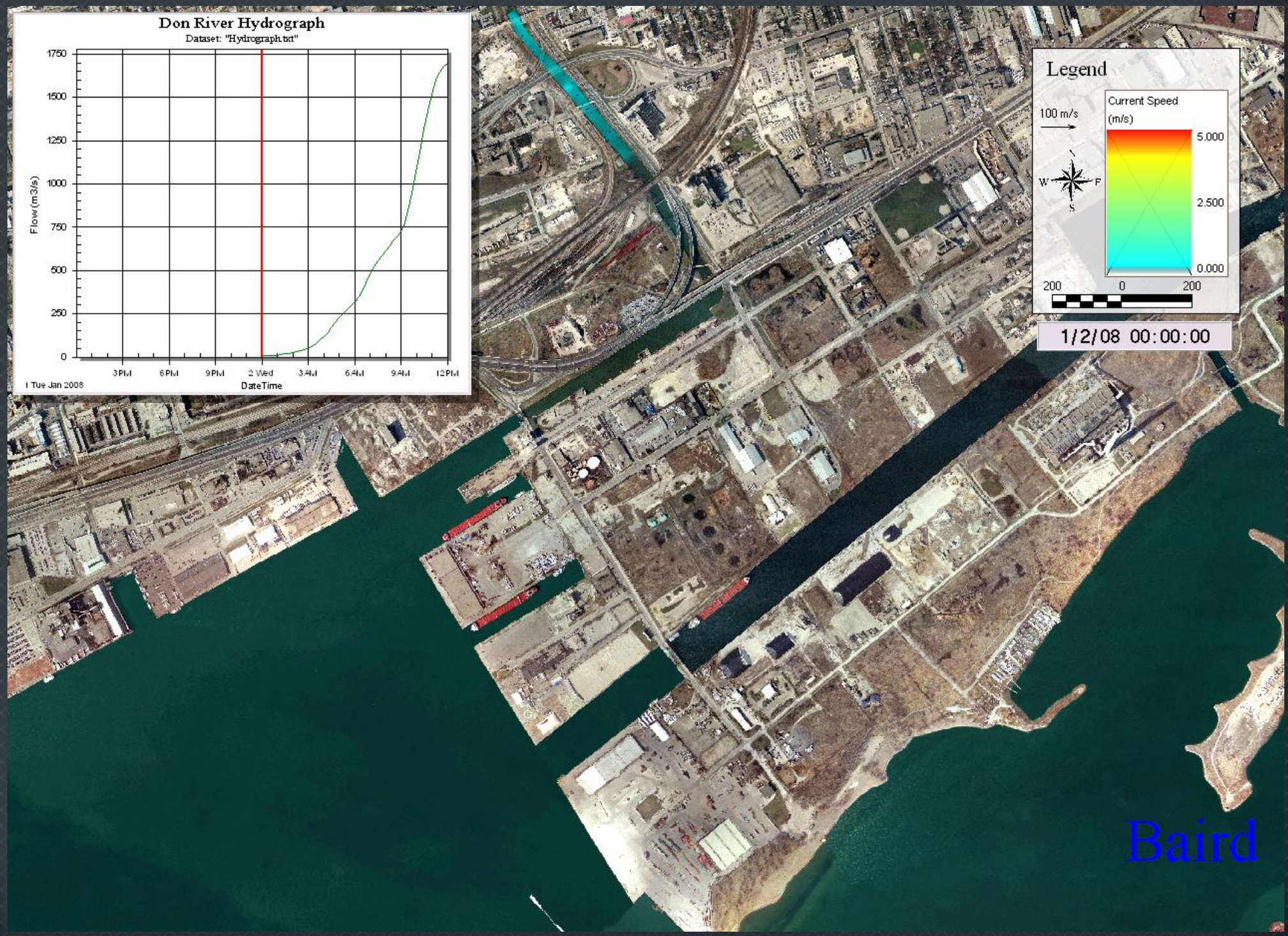
Flood Containment



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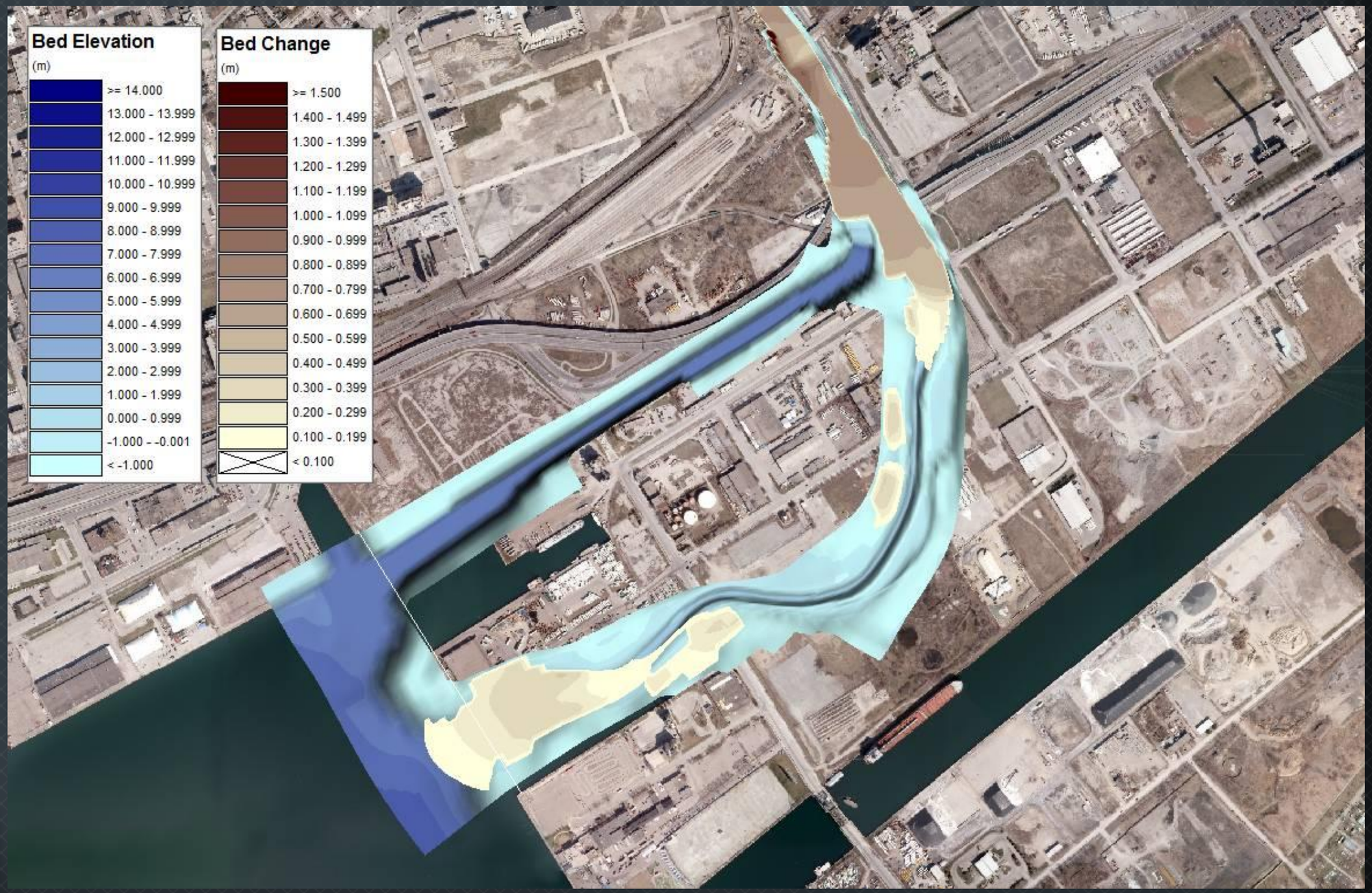
Sediment Trap Performance: 8 Month Simulation Period



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History and Benefits of Dual Modelling Approach

- Entire revitalization effort is dependant on ensuring flood containment in the study area
- Two parallel efforts using different numerical models have been used to test flood conveyance
- Delft3D and EFDC (Dekker et al.)

History and Benefits of Dual Modelling Approach

- The parallel, dual-model design approach allowed for an iterative design and EA process
  - Frequent interaction and sharing between the two teams ensured the success of this approach
- Good overall agreement between the two models has allowed the design process to move forward

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Future Challenges

- Extensive data collection program for model calibration and validation
- Detailed design:
  - Channel
  - Structures
  - Sediment management area
  - Weirs
  - Sediment transport – new river mouth
  - Flow and sediment impacts on new ecological features
  - Scour protection

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Thank You!

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