

Green Infrastructure CAC Meeting

Business Case for Don Mills Channel Flood Control Infrastructure

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OUTLINE

- 1) Infrastructure Cost Policies
- 2) History of Cost-Benefit Analysis
- 3) Research Gaps and National Guidelines
- 4) Green Infrastructure Costs
- 5) Markham Case Study – Don Mills Channel Flood Control

Regulating Infrastructure Cost in Ontario

Provincial Policy Statement (2014):

“Infrastructure ... shall be provided in a coordinated, **efficient and cost-effective manner**”

Infrastructure for Jobs and Prosperity Act (2015) O. Reg. 588/17 (2017) :

Asset management plans must show “For each asset category, the lifecycle activities that would need to be undertaken ... **and the costs of providing those activities.**”

These activities must also consider “**the lowest cost to maintain the current levels of service**”

Class Environmental Assessments (2015):

For wastewater projects “Economic Environment includes commercial and industrial land uses and activities. It also **includes the financial costs** associated with the alternatives, including **construction, operation, maintenance, and property costs.**”

History of Cost-Benefit Analysis (CBA)

- Long-standing requirement to evaluate feasibility of flood reduction projects:

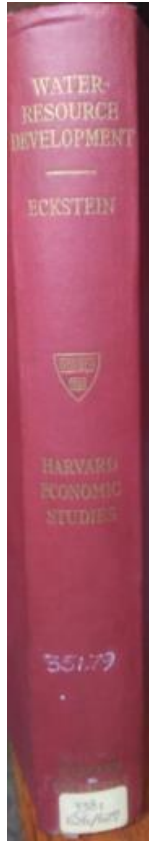
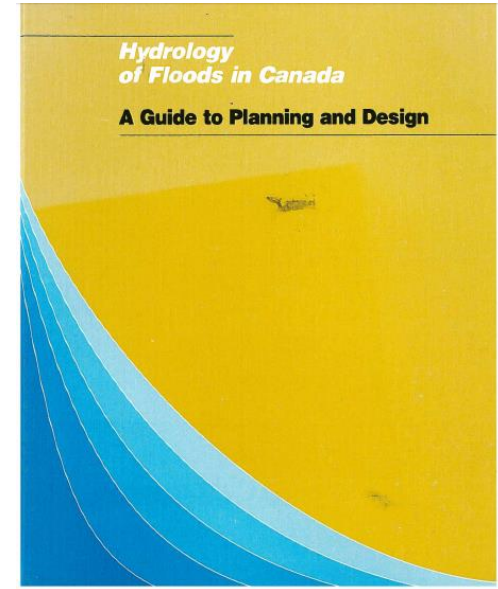
Eckstein 1958: “Feasibility is interpreted to mean that ‘**the benefits**, to whomever they may accrue, **are in excess if the estimated costs**’, following a requirement specified in the Flood Control Act of 1936.”

Watt 1989: “It is therefore reasonable to require that all projects that provide or **improve flood protection be justified economically** before public funds are allocated”

“benefits should exceed cost by a sufficient margin”

Watt 1984:

https://files.onhttps://nparc.nrc-cnrc.gc.ca/eng/view/accepted/?id=7b18d8c9-6c5f-425f-8338-ac4a24f8170bario.ca/infrastructure_update_2017-_eng_0.pdf



Made-in-Ontario Environment Plan

- “This plan will ensure we **balance** a healthy **environment** with a healthy **economy**.”
- Highlights frustration of taxpayers who see “hard-earned tax-dollars being put towards policies and programs that don’t **deliver results**”.

Ontario Environment Plan:

<https://prod-environmental-registry.s3.amazonaws.com/2018-11/EnvironmentPlan.pdf>



National Research Council Guidelines

- NRC is developing *Guidelines on Undertaking a Comprehensive Analysis of Benefits, Costs and Uncertainties of Storm Drainage Infrastructure in a Changing Climate*



Green Infrastructure Capital Cost Review

- Costs from various sources (1200+ projects) confirmed magnitude of costs needed for High (flood & CSO control) and Low (watershed) control.

Ontario & Alberta Tenders

City / Town	LID Type (Project Name)	Capital + Soft Cost (\$)	Service Area (ha)	Cost / Hectare (\$ / ha)
Markham	Bioswale & Infiltration Trench (Green Rd)	\$783,602	1.9	\$412,422
Markham	Rain Garden (Glencrest Park)	\$216,000	1.6	\$135,000
Brampton	Bioswale (Cousens Court Blvd)	\$130,534	1.9	\$68,755
Whitchurch-Stouffville	Various Measures (Cousins Park & CC P. Lot)	\$106,671		
Ottawa	Bioretention (Sunrise / Road)	\$282,887		
Ottawa	Bioswale (Hewitt / Road)	\$169,807		

\$581,000 per ha

London	Rain Garden & Infiltration Trench (Dunlop Phase 2)	\$68,400
London	LID 540 sq.m (Waterloo Street)	\$448,955
London	LID 1550 sq.m (Sarnia Road)	\$441,105
London	LID 580 sq.m (Commissioners Road)	\$334,656
London	LID 1440 sq.m (Southwest Community Centre)	\$233,708
London	LID 150 sq.m (No. 13 Fire Station)	\$65,708
Newmarket	Enhanced Swale (Woodland Court)	\$37,860
East-Whitby	P.Pavement/Bioswale (Municipal Office)	\$155,433
Bradford West-Whitby	P.Pavement/Bioswale (LID Parking Lot)	\$471,385
Whitby	Bioswale (Recreation Complex)	\$85,087
Aurora	Permeable Pavement, Rain Garden (Recreation Complex Roof and Parking)	\$339,005
Innisfil	Permeable Pavement, Rain Garden (Fire Station Parking Lot and Road)	\$84,003

Philadelphia Clean Waters / SWM Program

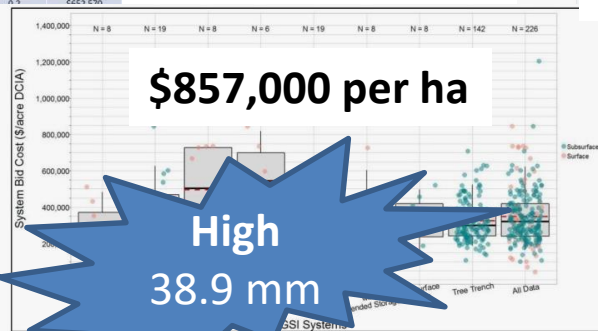
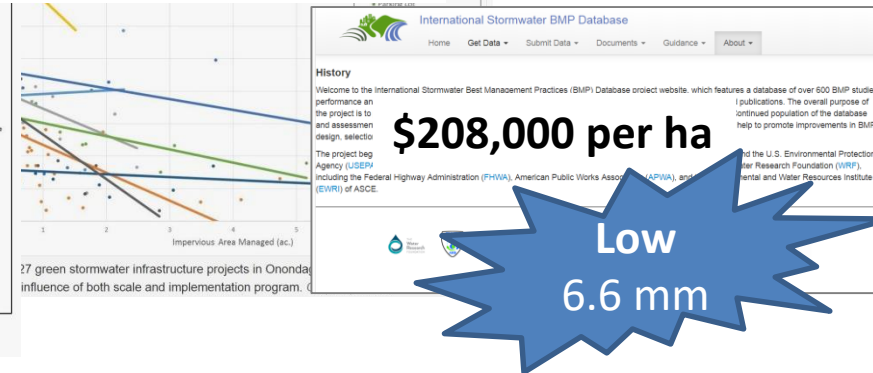


Figure 4-9: Bid Cost per Managed Impervious Area (2015 USD) by GSI System Type

New York State



EPA BMP Database



Philadelphia Clean Waters, NY Costs :

<https://www.cityfloodmap.com/2018/07/green-infrastructure-capital-and.html>

Ontario & Alberta Tenders, Philadelphia 2018, EPA Summary :

<https://www.cityfloodmap.com/2018/05/are-lids-financially-sustainable-in.html>

Some Research Overstates Benefits, Incomplete on Costs

- Cites ‘**meta-analysis**’ **benefits** as real “Performance **monitoring results**” for flood damage reduction (e.g., Pelly’s Lake wetland case study).
- Omits cost-effectiveness of the recommended measures: “**cost rankings are not normalized** with consideration of performance effectiveness”
- However Press Release promotes “**solutions that can be deployed practically and cost-effectively** within communities”



ICCA Weathering the Storm Report Review:
<https://goo.gl/Y3vWzx>

IBC Report Review
STORM WARTS:
<https://goo.gl/iCFoys>

Some Research Overstates Costs (Flood Damages) & Risks

- Average **flooded basement cost overstated** based on actual claim data.
- Frequency of extreme **100-year storms overstated** based on Environment and Climate Change Canada Engineering Climate Datasets observations.



**CBC Ombudsman
Review of 100 Year
Storm Frequency:**

<http://bit.ly/2lsWWBg>

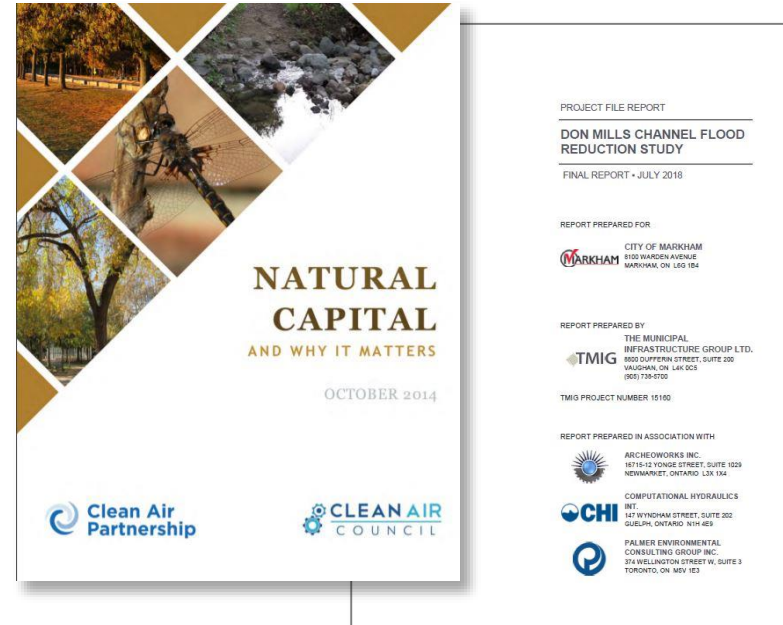
**Flooded Basement Cost Review
CBC Ombudsman (Sept. 2019):**

<http://bit.ly/2lxUYzK>



Reconciling Assessments of Flood Reduction Benefits

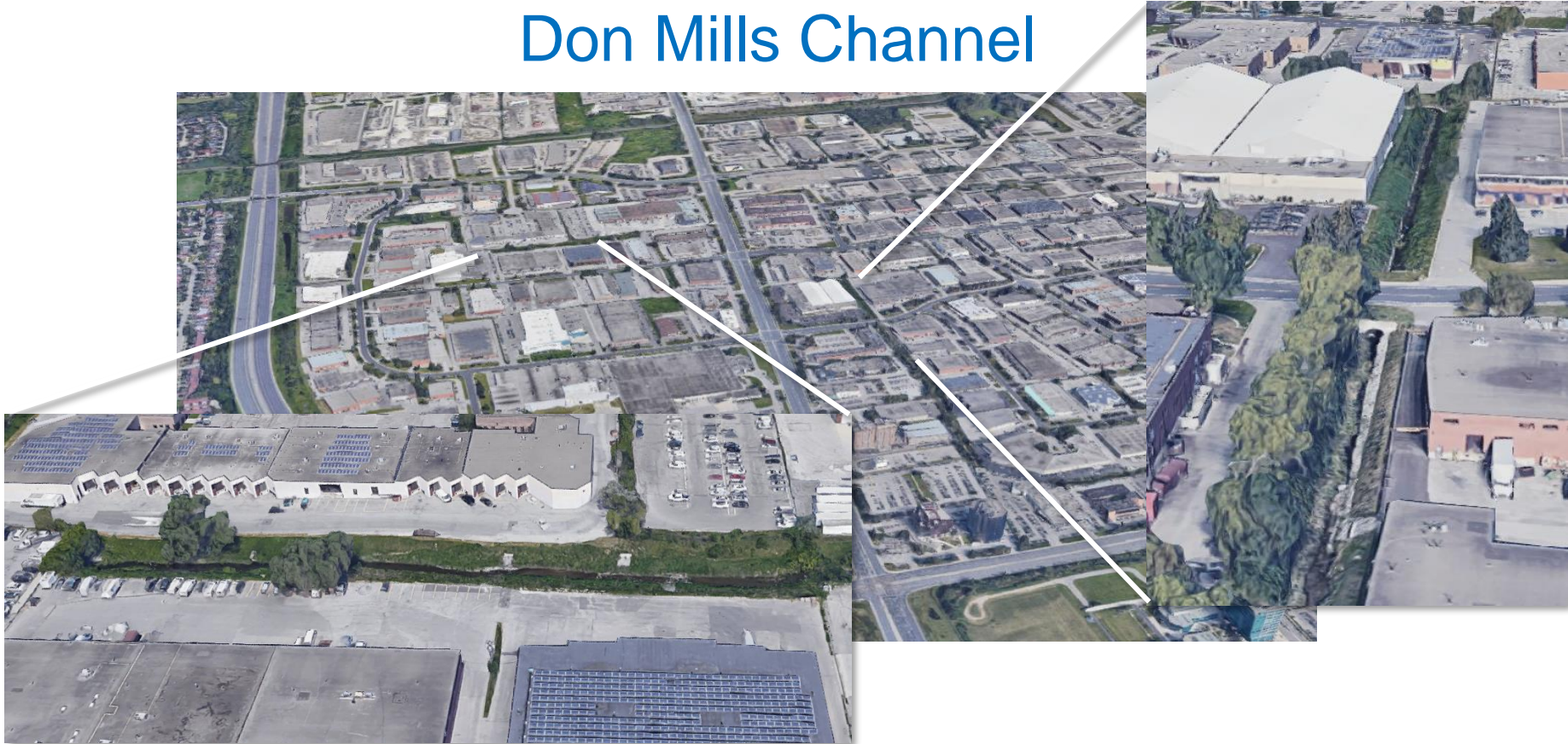
- NRC guideline research suggests expected annual flood damages as:
 - \$695 - 819 M in Canada
 - \$262 - 289 M in Ontario
 - \$6.4 – 7.1 M in Markham
- Don Mills Channel estimated annual damages
 - \$1.7 M
- Niagara Escarpment “vegetation structure providing storm protection and flood control”:
 - \$314 M (*9-19% above total Ontario flood damages*)



Natural Capital:
<http://bit.ly/2lZ5q2Z>

Don Mills Class EA Report :
<http://bit.ly/2kMDpeZ>

Don Mills Channel



Don Mills Channel



Shallow Deep

Estimated Extent of Flooding – August 2005 Storm



Alternative Solutions

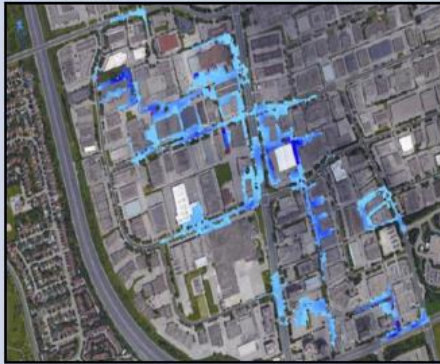
Enhanced Channel Maintenance



Channel Widening



Acquisition of Flood Prone Properties

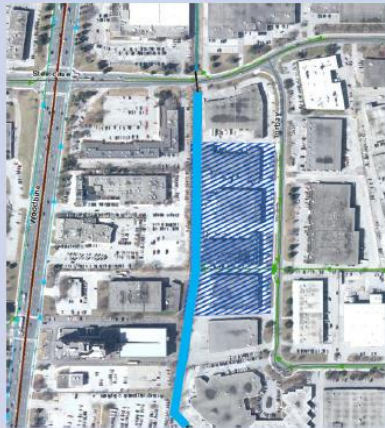


Underground Flood Storage / LID



Alternative Solutions

Central Municipal Flood Storage



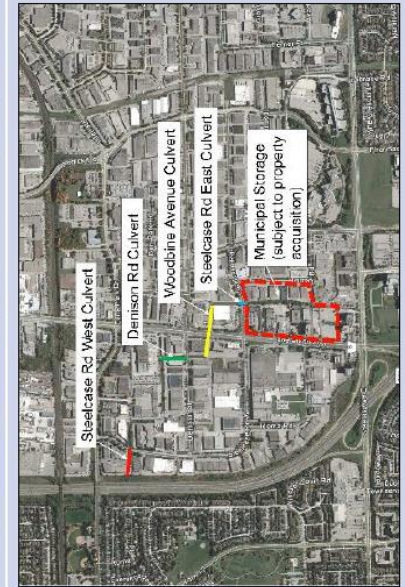
Flow Diversion



Flood Proofing and Education



Combined Option



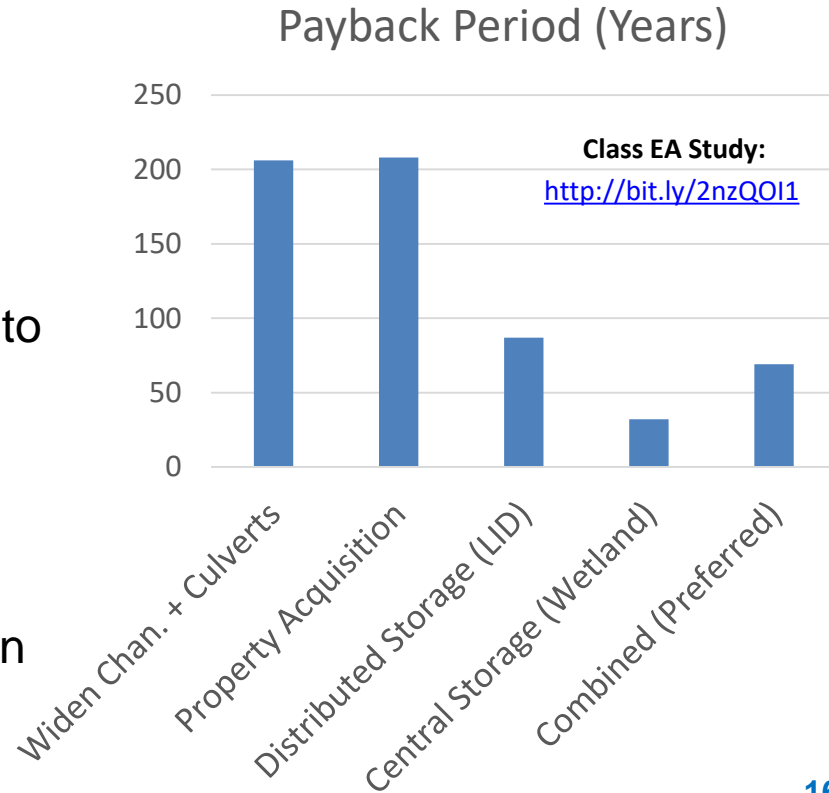
Preferred: Central Storage (incl. Property Acquisition) & Culvert Upgrades



Average Annual Damages Decrease from \$1.7M to \$0.2 M (\$1.6M Annual Benefit)

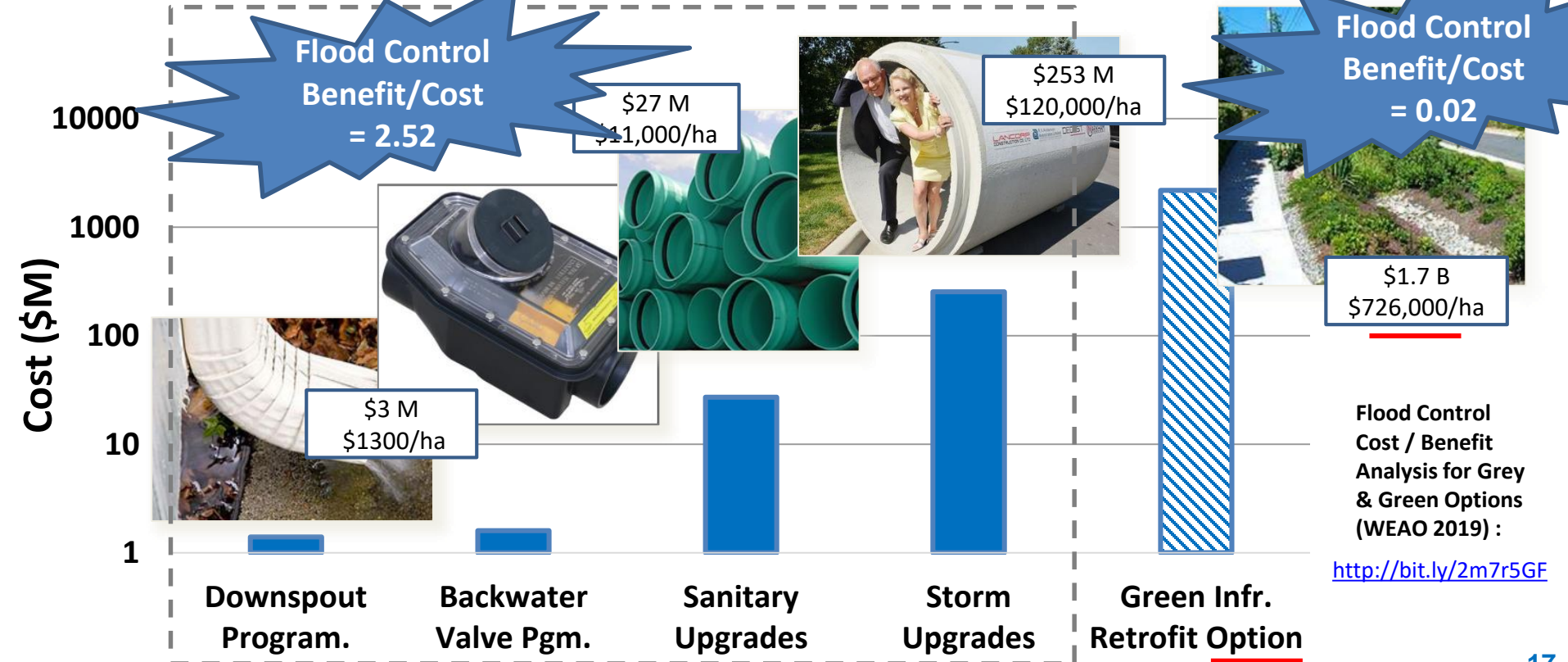
Alternative Evaluation - Financial

- Class EA process requires assessment of costs, no formal cost-benefit analysis.
- ESR identified for each alternative annual:
 - **Costs:** capital and long-term O&M
 - **Benefits:** deferred flood damages
- Payback periods to recover cost varied used to rank alternative cost-effectiveness:
 - **Central storage** 28 years
 - **Distributed storage (LID)** 87 years
 - **Property acquisition** 208 years
- Disaster Mitigation Adaptation Fund Return on Investment assessment of preferred:
 - $\text{Benefit} / \text{Cost} = 2.8$ (*insured only*)





Markham Flood Control Program Benefit / Cost Analysis



Accounting for Triple Bottom Line Benefits

- Assessed qualitatively in the Don Mills Channel Class EA study
 - Environmental benefits of floodplain restoration not quantified or monetized
- City-wide cost-benefit analysis of conventional and green options considered (WEAO 2019) monetized benefits including:
 - Flood control benefits (*improving accuracy with claim data*)
 - Watercourse erosion repair prevention (*small value*)
 - Willingness-to-pay for water quality improvements (*high uncertainty*)

Conclusions

- Cost-benefit analysis for infrastructure investments is making a comeback (mandatory for disaster mitigation grant applications (DMAF)).
- NRC's upcoming cost-benefit guidelines can support more consistent & thorough cost-benefit analyses, improving reliability & decision making.
- Markham projects and programs evaluate grey and alternative green infrastructure strategies and show:
 - Central storage/wetland facility preferred in Don Mills Channel
 - City-wide Flood Control Program (extensive grey infrastructure projects, strategic green projects) is cost-effective with benefits more than double the costs.
 - Benefits for green infrastructure warrant study of willingness to pay for quality improvements given low benefit/cost ratios.

Thank You

Questions ?

More Rob :

Blog: www.CityFloodMap.com

Podcast: [Open During Construction](#) on iTunes

Twitter: [@RobertMuir_PEng](#)



More City of Markham :

Web: www.markham.ca

Twitter: [@CityofMarkham](#)