OPWA Right of Way Management Conference
Ajax, Ontario, November 13, 2018

Thinking Fast and Slow in the ROW
Mission Possible Strategies to Make Room for Bike Lanes and Bioswales in a Crowded Environment

Robert J. Muir, M.A.Sc., P.Eng.
Manager, Stormwater, City of Markham

Flood Constraints in the ROW (August 19, 2005)

ROW Infrastructure Back-up (July 16, 2017)

The Solution (After)

MARKHAM FLOOD CONTROL PROGRAM

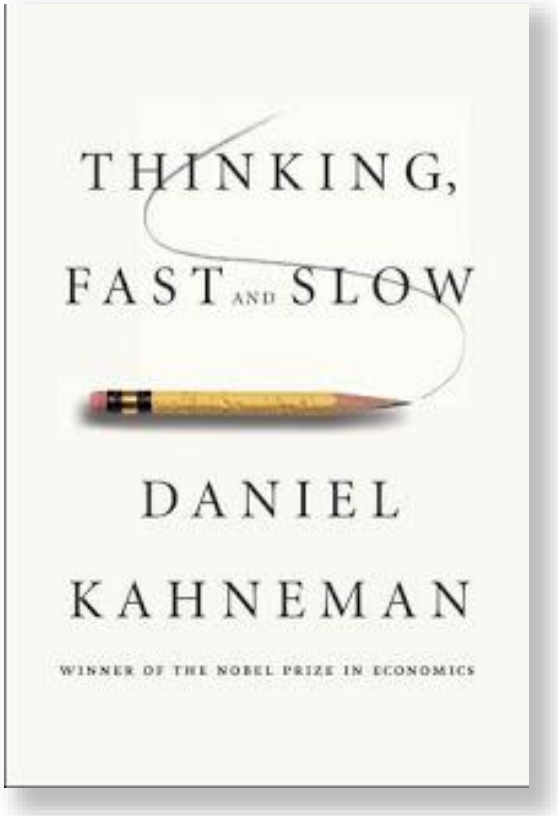
- 30 year program
- $234 M cost

The Solution (During)

It's Even Crowded for Staging

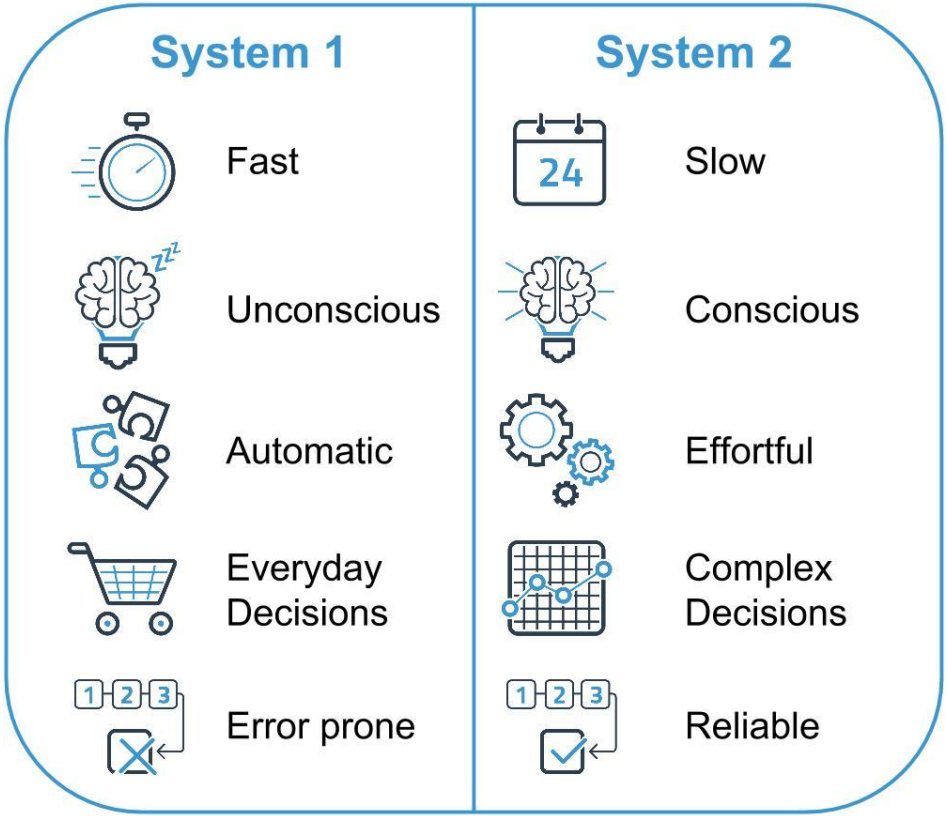
Thinking Fast and Slow

- Daniel Kahneman's best-selling book summarizes decades of research into thinking – how we frame and solve problems, and the heuristic biases can cloud effective thinking.



Thinking Fast and Slow

- Fast
- Errors due to heuristic biases, or "short-cuts" in problem solving.



- Slow
- Needed for today's complex, constrained, and conflicted design challenges.

Complex, Constrained, Crowded

Why Are New Sewers Bigger ? Are They Big Enough?

- Capacity upgrades up to 400% required to meet today's 100 year level or service.

Media and "Insurance Facts" on Bigger Storms

- Many statements about more extreme rainfall that would make sewers bigger come from:
  - i) the insurance industry, and
  - ii) some conservation authorities.
- A 2012 report called "Telling the Weather Story" for the Insurance Bureau of Canada stated:

"Weather events that used to happen every 40 years are now happening once every 6 years in some regions in the country."

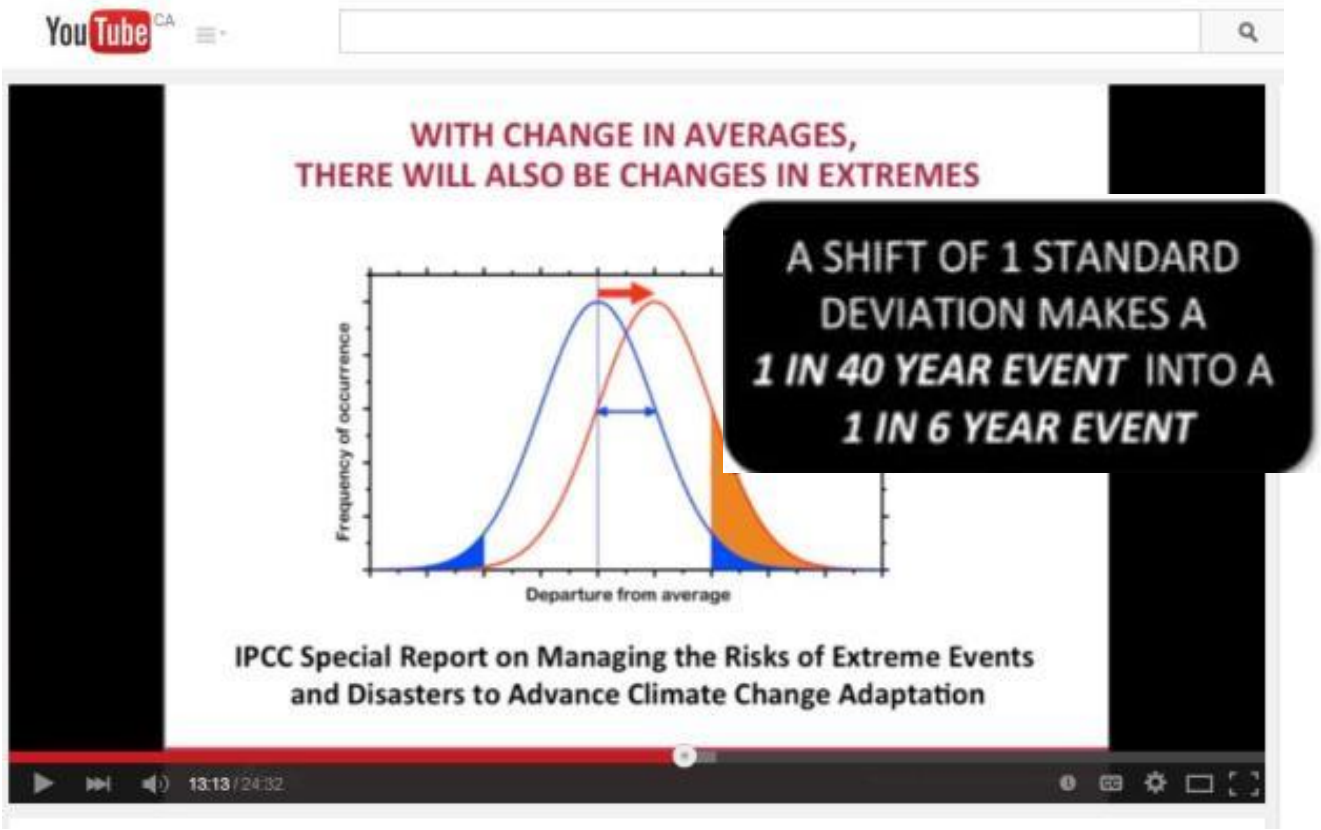
Media and "Insurance Facts" on Bigger Storms

- Main author from the University of Western, directed me to the Institute for Catastrophic Loss Reduction (ICLR) for the data.
- ICLR director shared ***future*** climate predictions research papers, and asked for patience to find the Engineering Climate Dataset data referenced in the report (***past data***).
- Months went by …

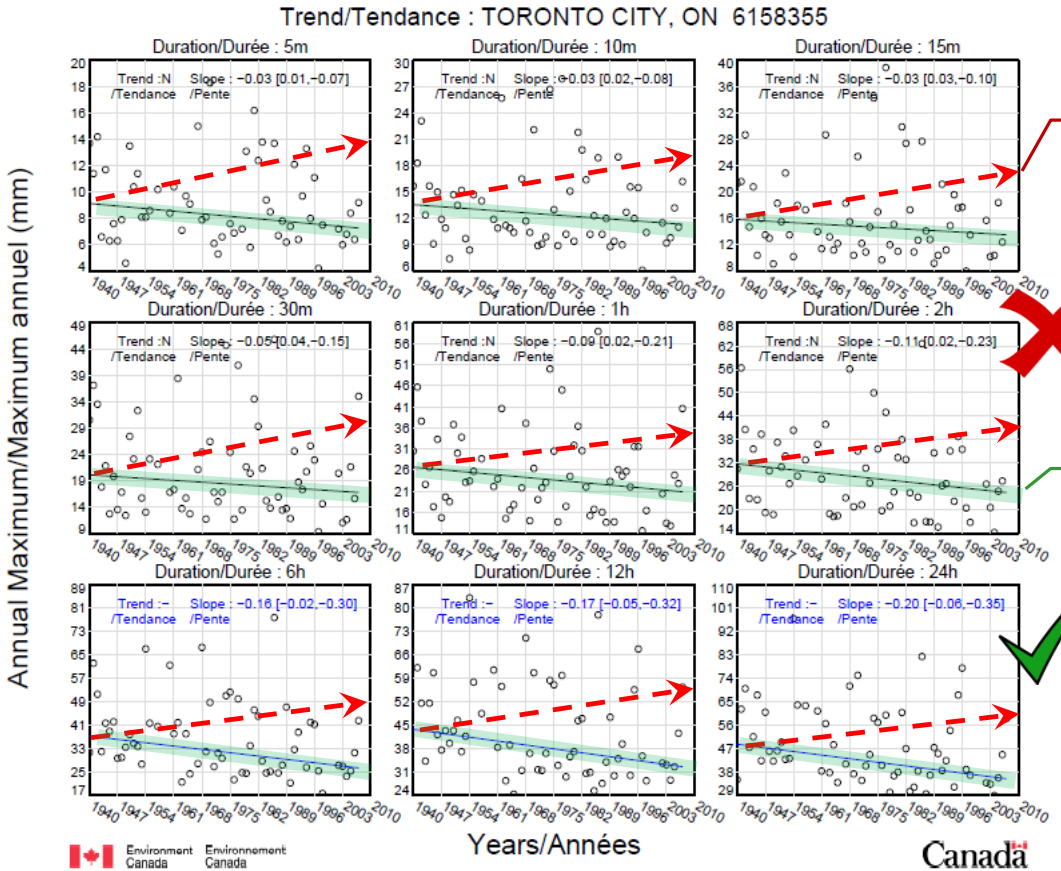
The real data … on YouTube

Just a Concept … a "Bell Curve" shift … no data

TD CBCnews intact INSURANCE AVIVA thestar.com IBC CivicAction CALGARY SUN RSA



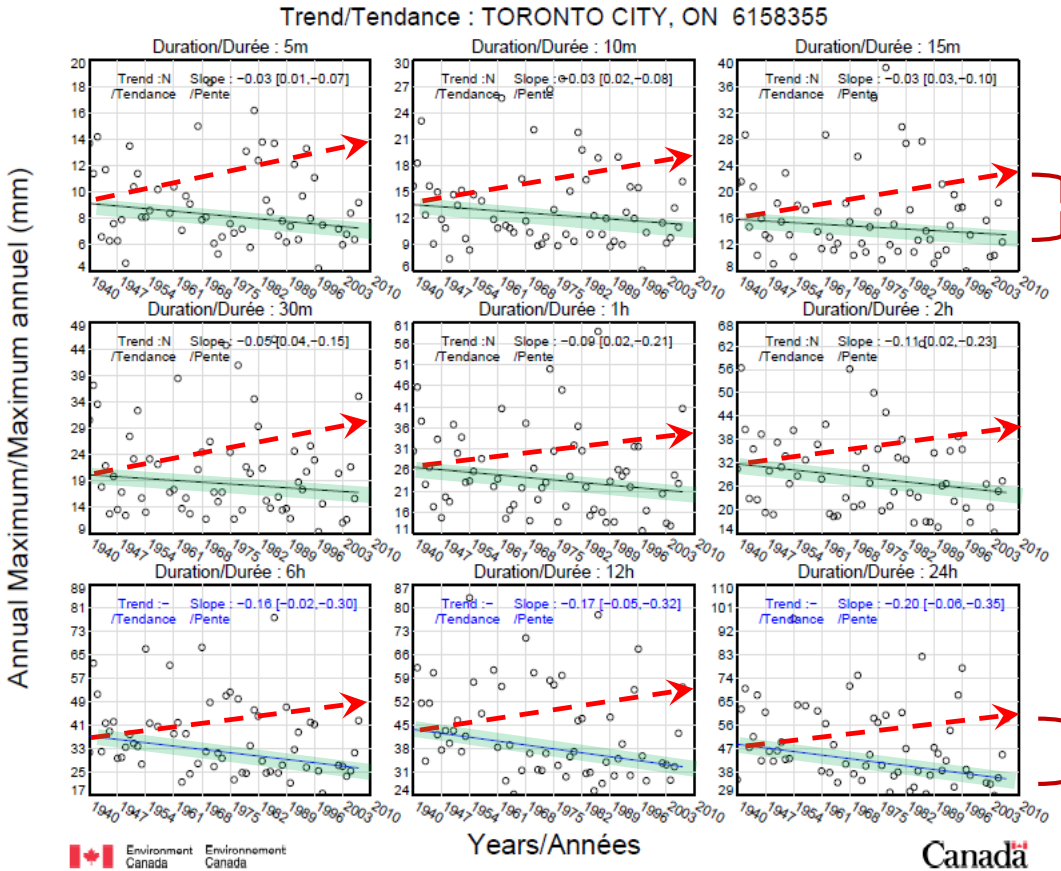
Real Data Trends on Extreme Rainfall – Lower Intensities



Insurance Bureau of Canada "Telling the Weather Story" Increase ?
(but no data)

Environment Canada Data Maximum Rain Decreasing
(statistically significant over 6 to 24 hrs)

What it Means to Sewer and Pond Design



Conceptual shift in a SHORT duration intensity would increase sewer sizes

Conceptual shift in a LONG duration intensity would increase pond & storage volumes

Less Extreme Rain at Many Ontario Stations Too

- **Stations with 45+ years of record and recent data.**
- **More rain decreases than rain increases.**
- **S. Ont. twice as many significant decreases.**

Climate Station Name		Station ID	Engineering Climate Datasets Annual Maximum Rainfall Trend and Significance								
			5 min	10 min	15 min	30 min	1 hr	2 hr	6 hr	12 hr	24 hr
Ontario											
Ear Falls (Aut)	ON	6012199									
Geraldton A	ON	6042716									
Thunder Bay Cs	ON	6048268									
Timmins Victor Power A	ON	6078285									
Kingston Pumping Station	ON	6104175									
Ottawa Cda Rcs	ON	6105978									
St Thomas Wpcp	ON	6137362									
Windsor A	ON	6139525									
London Cs	ON	6144478									
Toronto City	ON	6158355									
Toronto Intl A	ON	6158731									

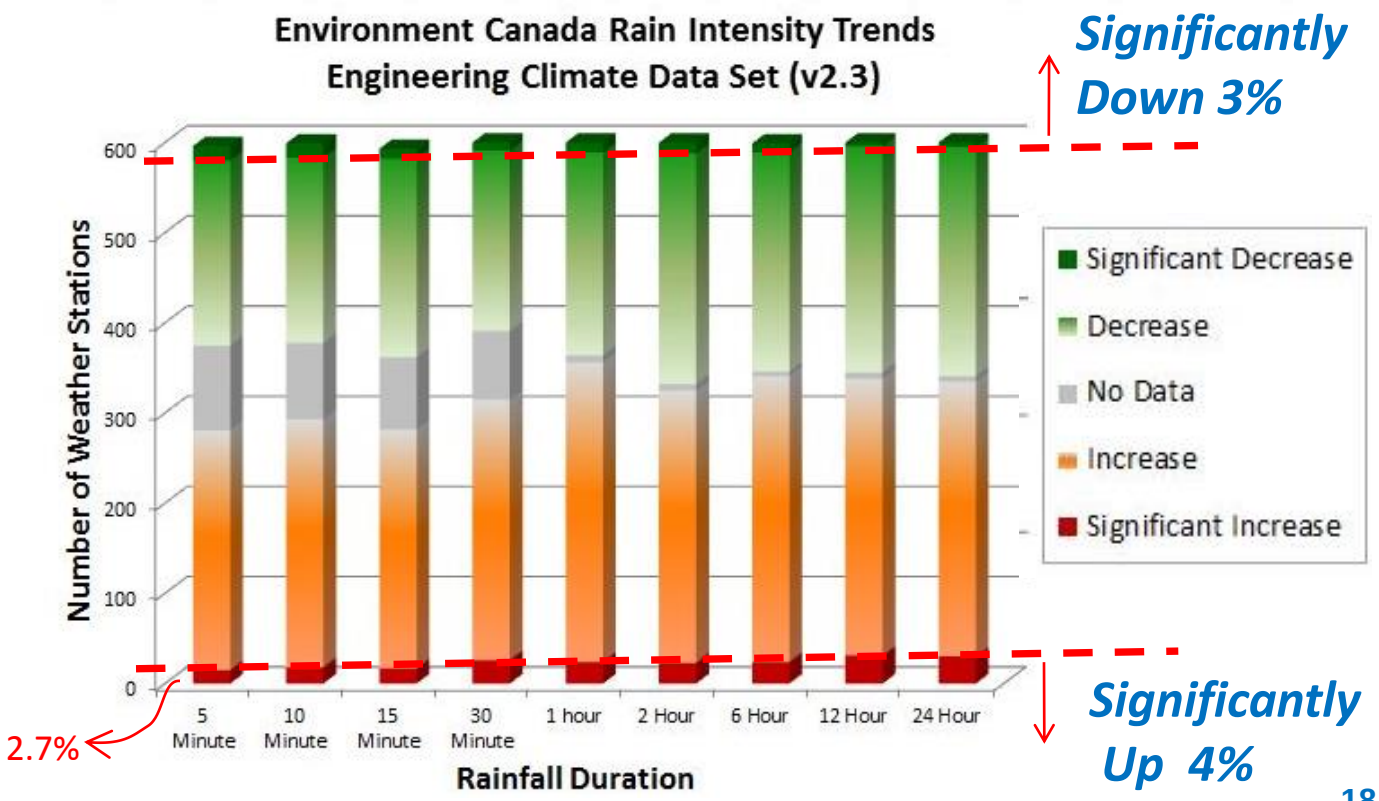
Significant Decr.
Decrease
Increase
Significant Incr.

Source:
Environment Canada Engineering Climate Dataset ftp://ftp.tor.ec.gc.ca/Pub/Engineering_Climate_Dataset/IDF/Idf_v2-3_2014_12_21_trends.txt in IDF_Additional_Additionnel_v2.30.zip

http://www.cityfloodmap.com/2016/01/climate-change-ontario-short-duration.html

Few statistically significant increases in Canada

- 5-minute rainfall maxima have significant increases at only 2.7% of climate stations.
- 93% of trends are insignificant or 'no data'.
- ***A whole lotta nothin' goin' on***



	5 Minute Extreme Rainfall Trend Province Station Count													
Trend / Significance	AB	BC	MB	NB	NL	NS	NT	NU	ON	PE	QC	SK	YT	Canada
Decrease/ Significant		2		1	1	1			2	1	7		1	16
Decrease/ Not Significant	17	20	8	3	6	2	2	1	51	1	61	15	2	189
No Data	1	56	2	1	1	2	1	5	15		8	1	1	94
Increase/ Not Significant	12	50	15	8	10	10	4	3	60	1	55	19	4	251
Increase/ Significant		1	2	1	1				5		4		1	15
Canada	30	129	27	14	19	15	7	9	133	3	135	35	9	565

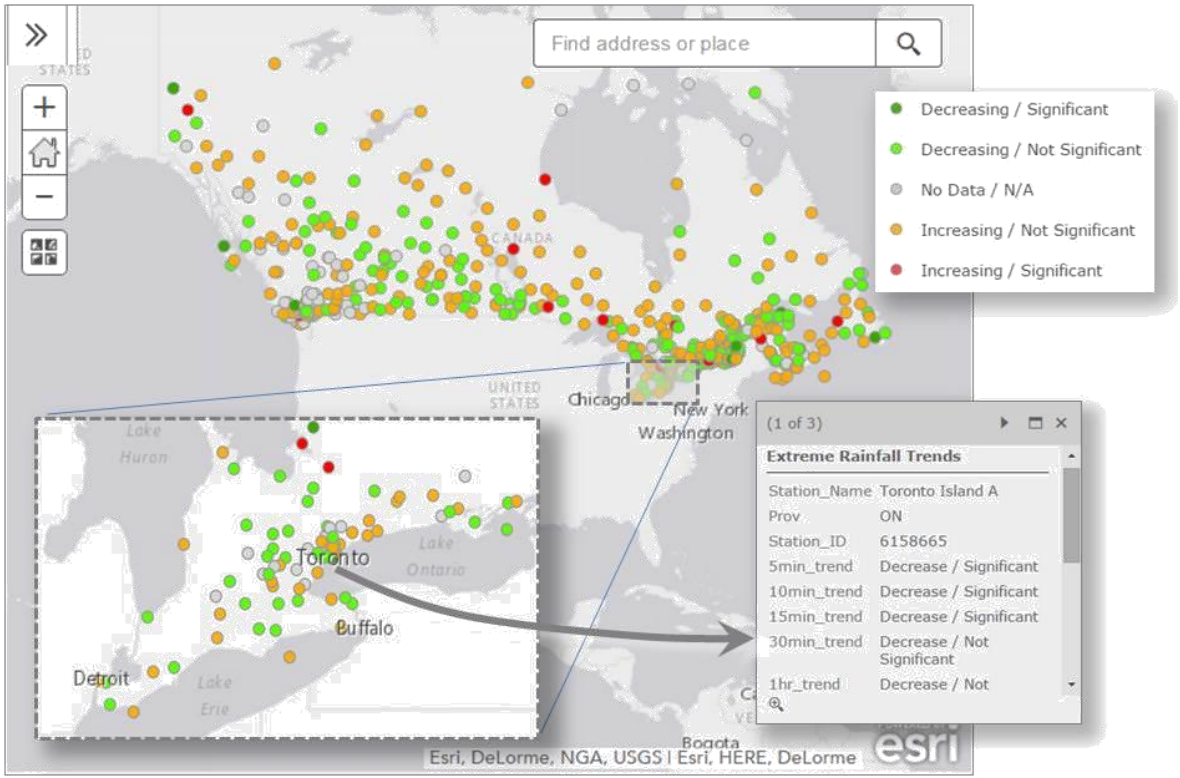
	10 Minute Extreme Rainfall Trend Province Station Count													
Trend / Significance	AB	BC	MB	NB	NL	NS	NT	NU	ON	PE	QC	SK	YT	Canada
Decrease/ Significant		1	1			1			3	1	9			16
Decrease/ Not Significant	15	27	9	6	8	3	2	2	42	1	57	15	2	189
No Data	1	52	1		1	2	1	1	13		11		2	85
Increase/ Not Significant	14	47	14	8	10	9	3	6	69	1	53	19	4	257
Increase/ Significant		2	2				1		6		5	1	1	18
Canada	30	129	27	14	19	15	7	9	133	3	135	35	9	565

	15 Minute Extreme Rainfall Trend Province Station Count													
Trend / Significance	AB	BC	MB	NB	NL	NS	NT	NU	ON	PE	QC	SK	YT	Canada
Decrease/ Significant		2	1		1	1			2		4			11
Decrease/ Not Significant	16	26	8	4	7	3	3	3	49	2	64	19	5	209
No Data	1	51	1	2		2	1		13		8		1	80
Increase/ Not Significant	13	49	14	8	11	9	2	6	63	1	55	15	2	248
Increase/ Significant		1	3				1		6		4	1	1	17
Canada	30	129	27	14	19	15	7	9	133	3	135	35	9	565

	30 Minute Extreme Rainfall Trend Province Station Count													
Trend / Significance	AB	BC	MB	NB	NL	NS	NT	NU	ON	PE	QC	SK	YT	Canada
Decrease/ Significant		4	1	1				1			3			10
Decrease/ Not Significant	16	23	10	4	5	3	4	3	42	2	57	18	3	190
No Data	1	51	2	1		1	1	1	12		6			76
Increase/ Not Significant	13	49	11	8	12	10	1	4	67	1	68	14	5	263
Increase/ Significant		2	3		2	1	1		12		1	3	1	26
Canada	30	129	27	14	19	15	7	9	133	3	135	35	9	565

Canadian Extreme Rainfall Trends - Interactive Map

(click on symbol for 5 minute to 24 hour rainfall trends and climate station details)



http://www.cityfloodmap.com/2015/12/canadian-extreme-rainfall-summary-by.html

http://www.cityfloodmap.com/2015/12/canadian-extreme-rainfall-map-climate.html

Rain Intensity Trends – Lower in Southern Ontario

- **Lower observed annual maximums cause IDF values to decrease.**
- **Toronto City "Bloor Street" trends lower for all durations & all return periods.**
- **Design standard 'old' IDF is conservative.**

Toronto IDF Trends (5 Min)
ID 6158355 (Toronto City)

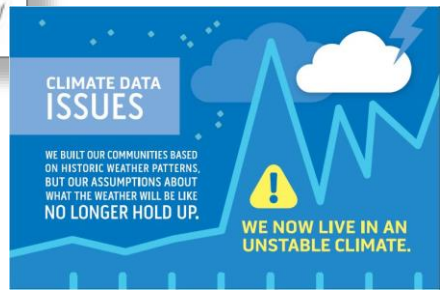
Return Period (Years)	Intensity (mm/hr)		Change
	1990	2007	1990 - 2007
2	113.9	109.2	-4.1%
10	189.6	180.1	-5.0%
25	227.7	215.8	-5.2%
100	284	268.5	-5.5%

Source:
Environment Canada Engineering Climate Dataset
ftp://ftp.tor.ec.gc.ca/Pub/Engineering_Climate_Dataset/IDF/
Up to 2007 per Dataset v2.3, to 2003 per Dataset v1, to 1990 per hardcopy records

http://www.cityfloodmap.com/2016/01/toronto-climate-change-extreme-rainfall.html

Data Facts Comes Out in Media & Marketing

- **Insurance 'facts' & other infographics:**



- **Data facts from ECCC:**
  - "Lack of a detectable trend signal" (Atmosphere-Ocean, 2014)
  - Advertising Standards Canada complaint resolutions 2015-2018 (no rain shift data)
  - "No significant change in rainfall events over several decades" (CBC letter, 2015)
  - "ECCC studies have not shown evidence to support statement" (Cdn Underwriter, 2016)
  - "If this is used as the basis for statements about actual changes in extreme rainfall in Canada, then I would have concerns." (personal communication ECCC, 2018)

http://https://www.slideshare.net/RobertMuir3/storm-intensity-not-increasing-factual-review-of-engineering-datasets

Are Sewers Big Enough? **YES !**

- Capacity upgrades up to 400% required to meet today's 100 year level or service. **Its big enough and has a safety fact because intensities have been decreasing**.

Only
Milli Vanilli
"Blame It
On The
Rain"

That's Crazy Talk Rob ! Flood Damages Are Up !!!

Insurance Industry "Fact":

- "Water Damage" is key driver to growing costs after 2008

http://http://assets.ibc.ca/Documents/Resources/IBC-Natural-Infrastructure-Report-2018.pdf

IBC BAC | INTACT CENTRE ON CLIMATE ADAPTATION | IISD | UNIVERSITY OF WATERLOO | intact

Combatting Canada's Rising Flood Costs:

Natural infrastructure is an underutilized option

Executive Summary

The financial impacts of climate change and extreme weather events are being felt by a growing number of homeowners and communities across Canada. The increase in P&C insurance losses is indicative of the growing costs associated with these events. These losses averaged $405 million per year between 1983 and 2008, and $1.8 billion between 2009 and 2017. Water damage is the key driver behind these growing costs. Fortunately, as documented in this report, flood risk can be limited through conservation and restoration of natural infrastructure features, such as ponds, wetlands and vegetated areas. This report demonstrates how to quantify the benefits

Not long ago, in many cities not far away ….

STORM WARTS

THE FLOODS AWAKEN

Cities were built a long time ago. Poorly ...

Engineers did not plan for extreme rain. So these gaps in sewer systems were called 'STORM WARTS'. And after decades of urbanization the FLOODS awakened !

Some blamed the Dark Force Climate Change and sought quick fixes. Our hero, Engineer Master Storm-whacker arrived with a sustainable, evidence-based approach ...

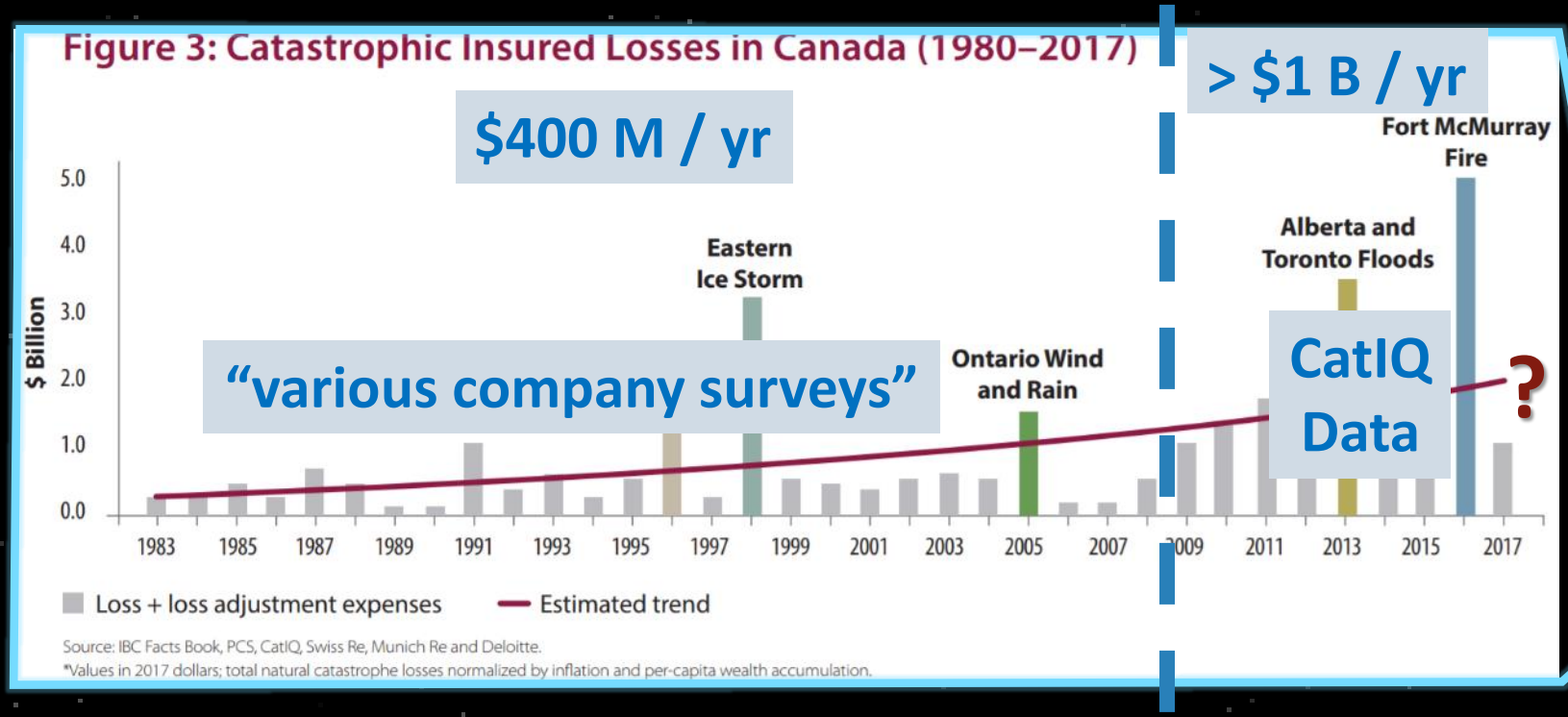
... and shared “A New Hope” for Cost-Effective Flood Control

STORM WARTS

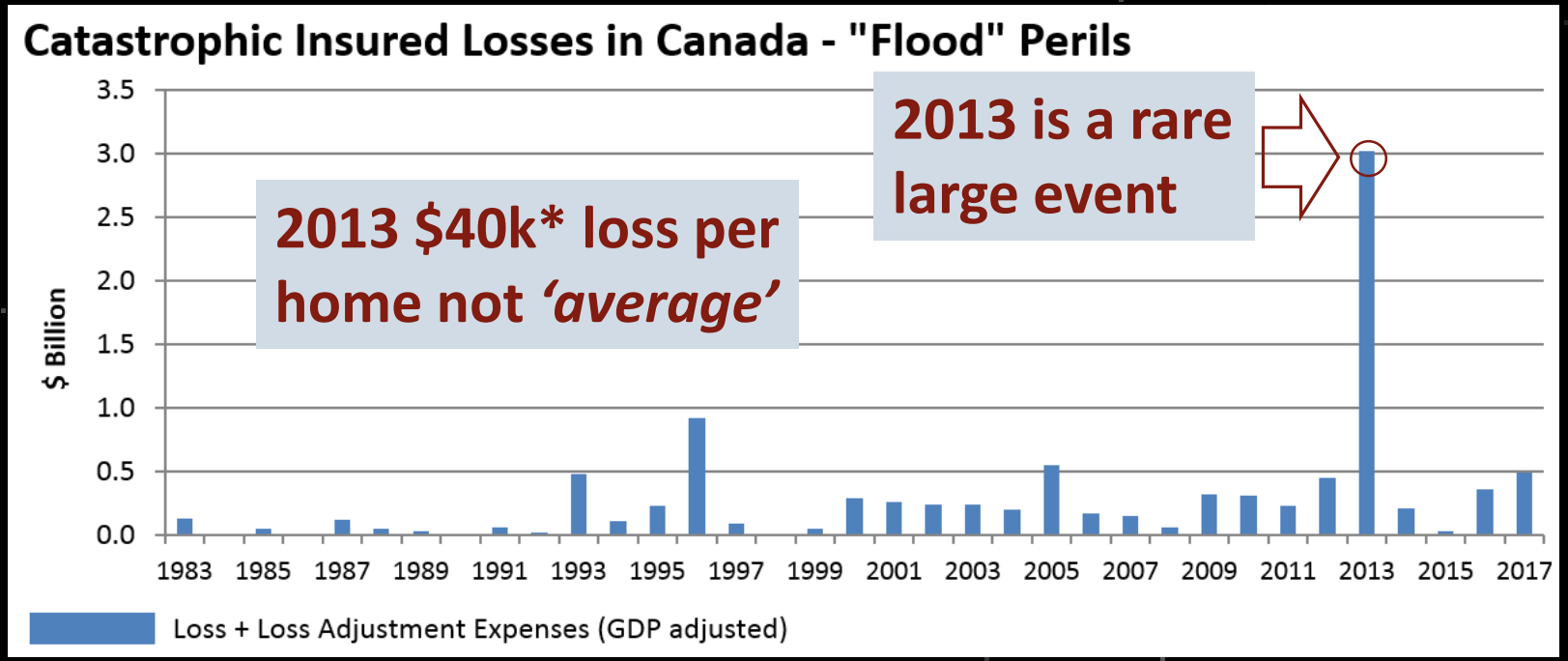
The Floods Awaken - A New Hope for Cost-Effective Investment in Flood Management Infrastructure

Have the floods “awakened” ?

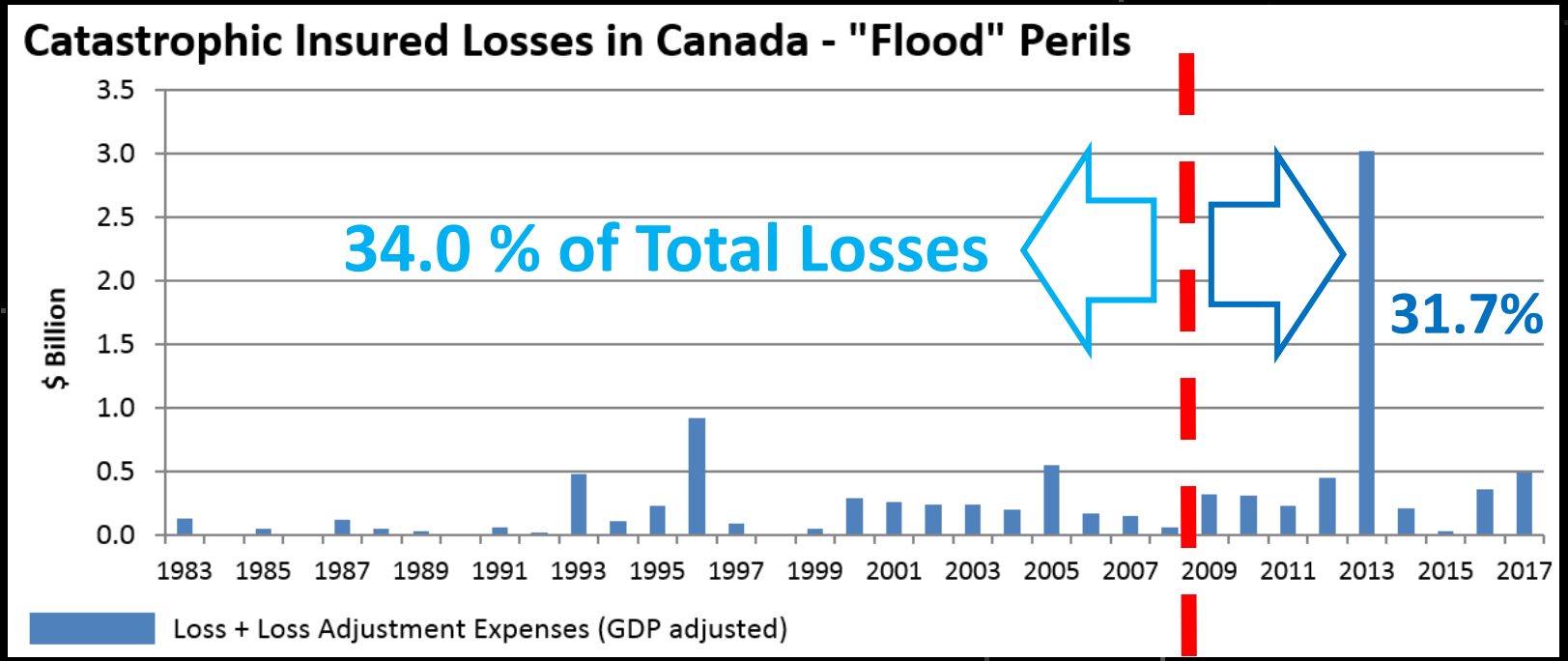
Look at some data we must



Flood, water, storm perils …



Water damage % is decreasing



“Fear is the path to the dark side.”

What's Going On? …..Thinking Fast

"People are not accustomed to thinking hard, and are often content to trust a plausible judgment that comes to mind."

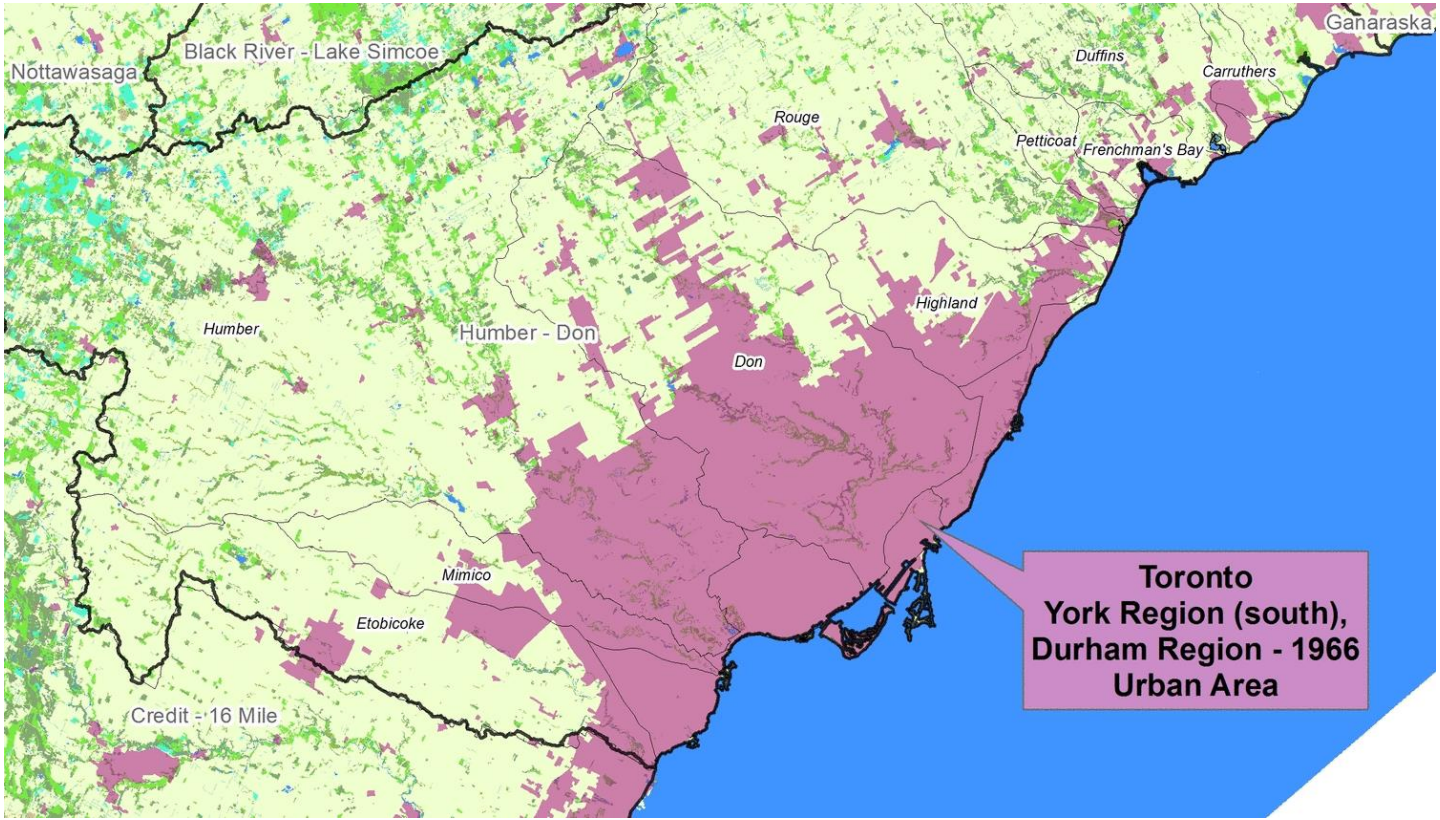
Daniel Kahneman, American Economic Review 93 (5) December 2003, p. 1450

Thinking Fast vs. Thinking Slow

- Weather events that happened every 40 years happening every 6 years.
- Water damage a key driver to increasing insured losses.
- **New normal.**

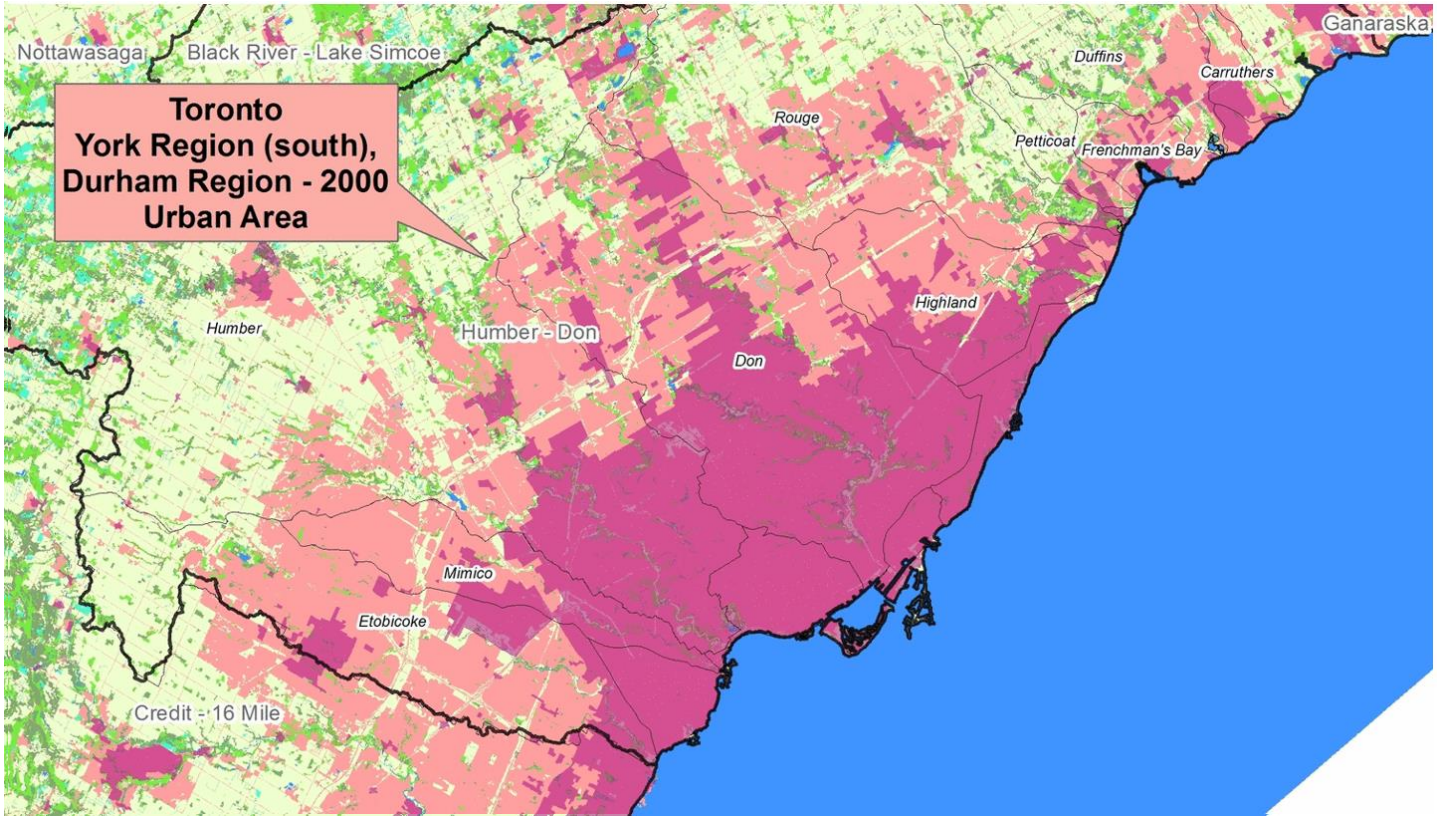
- Data shows lack of detectable trend signal in rainfall intensities.
- Data shows water damage only 1/3 of losses and is a decreasing percentage.
- **Same old extremes**.

What Is Causing More Flooding? Urbanization



http://www.cityfloodmap.com/2016/08/land-use-change-drives-urban-flood-risk.html

What Is Causing More Flooding? Urbanization



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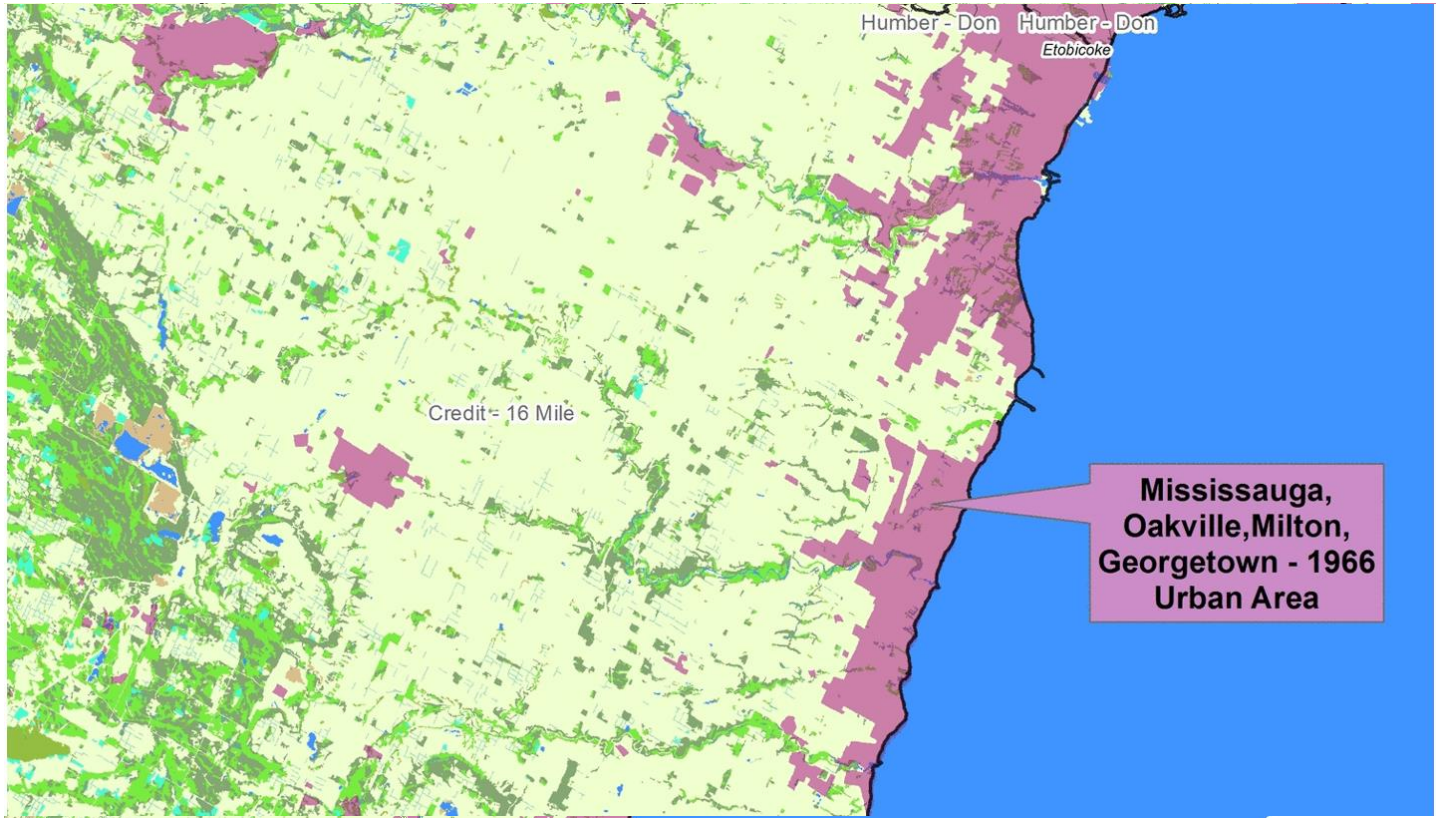

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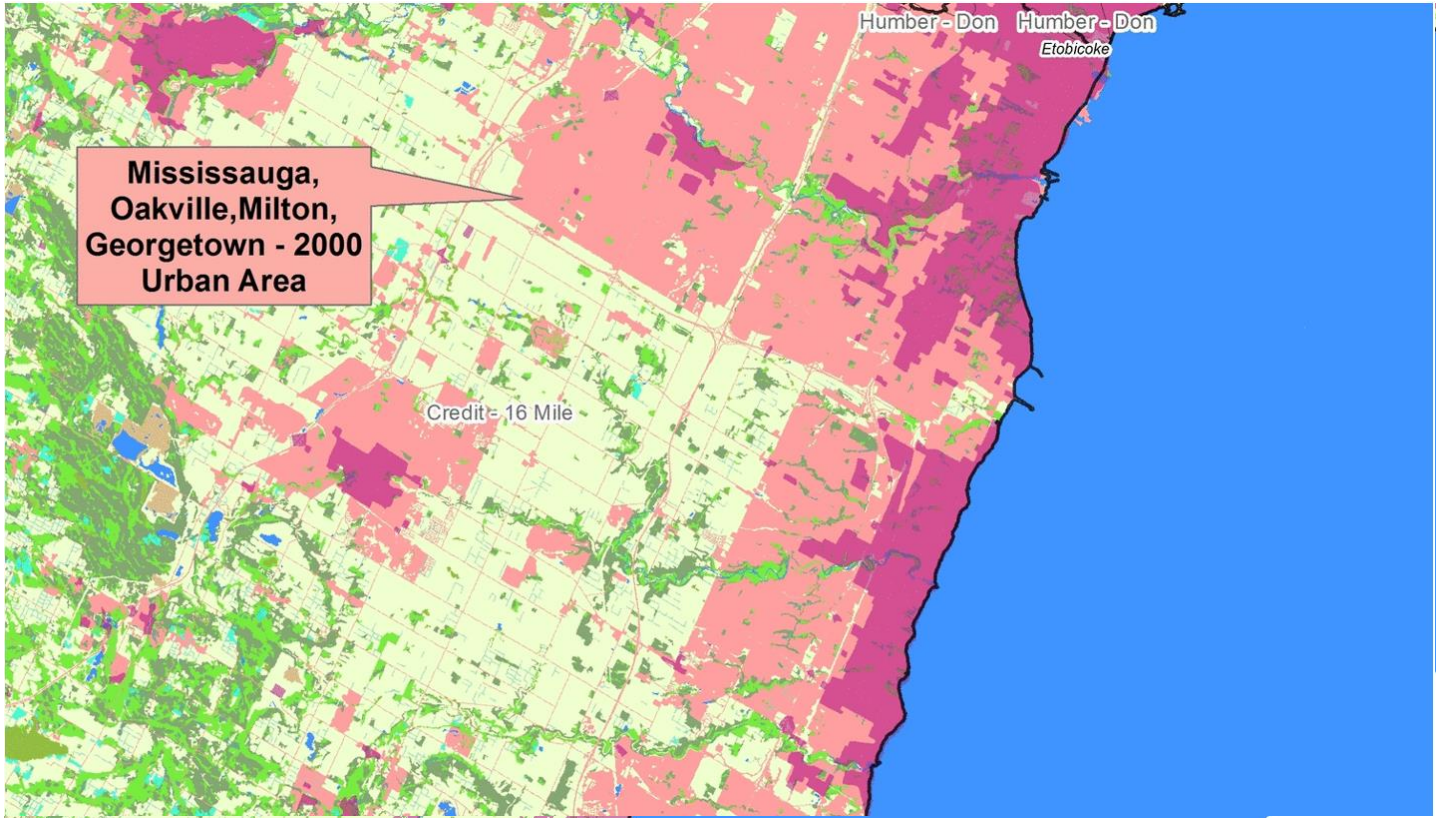
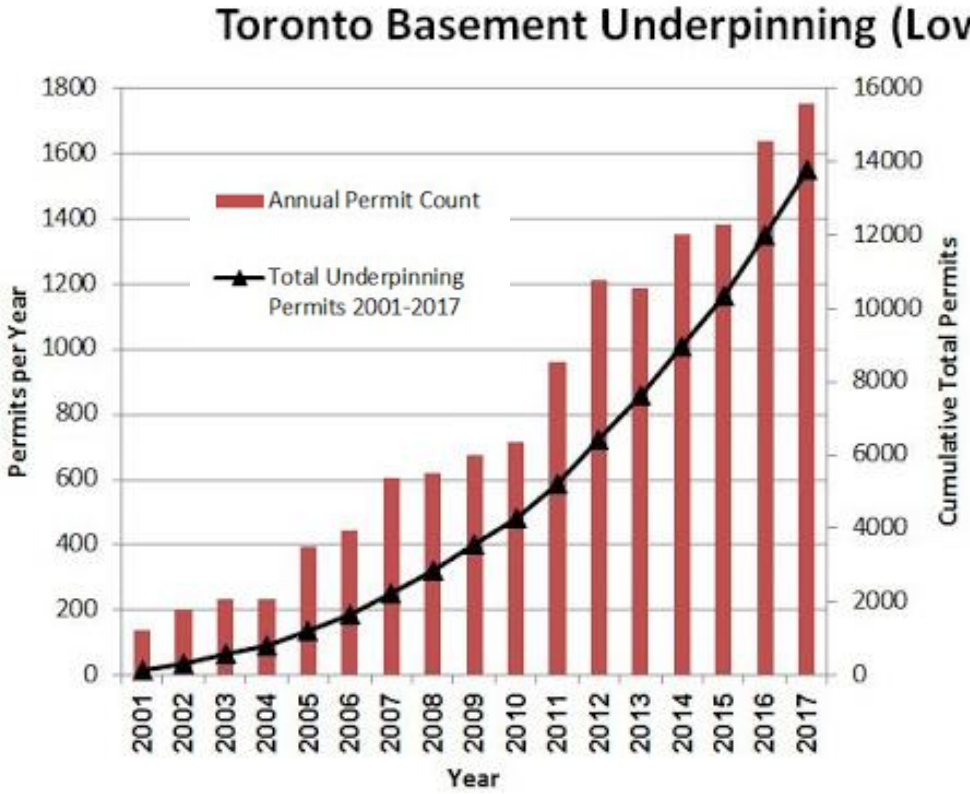


http://www.cityfloodmap.com/2016/08/land-use-change-drives-urban-flood-risk.html

What Else Is Causing More Flooding? Deeper Finished Basements.



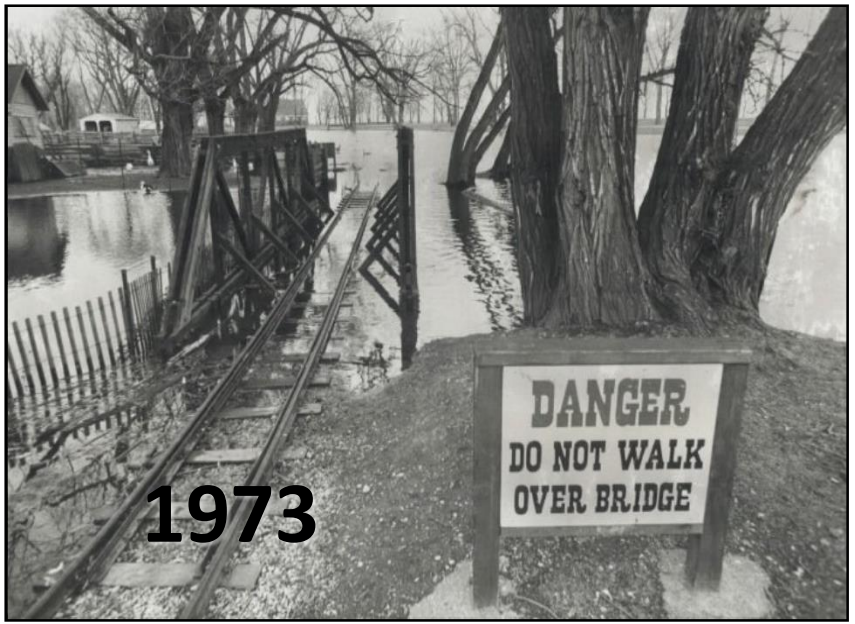
https://www.cityfloodmap.com/2018/07/basement-underpinning-and-sewer-back-up.html

But we have unprecedented flood events, Rob!

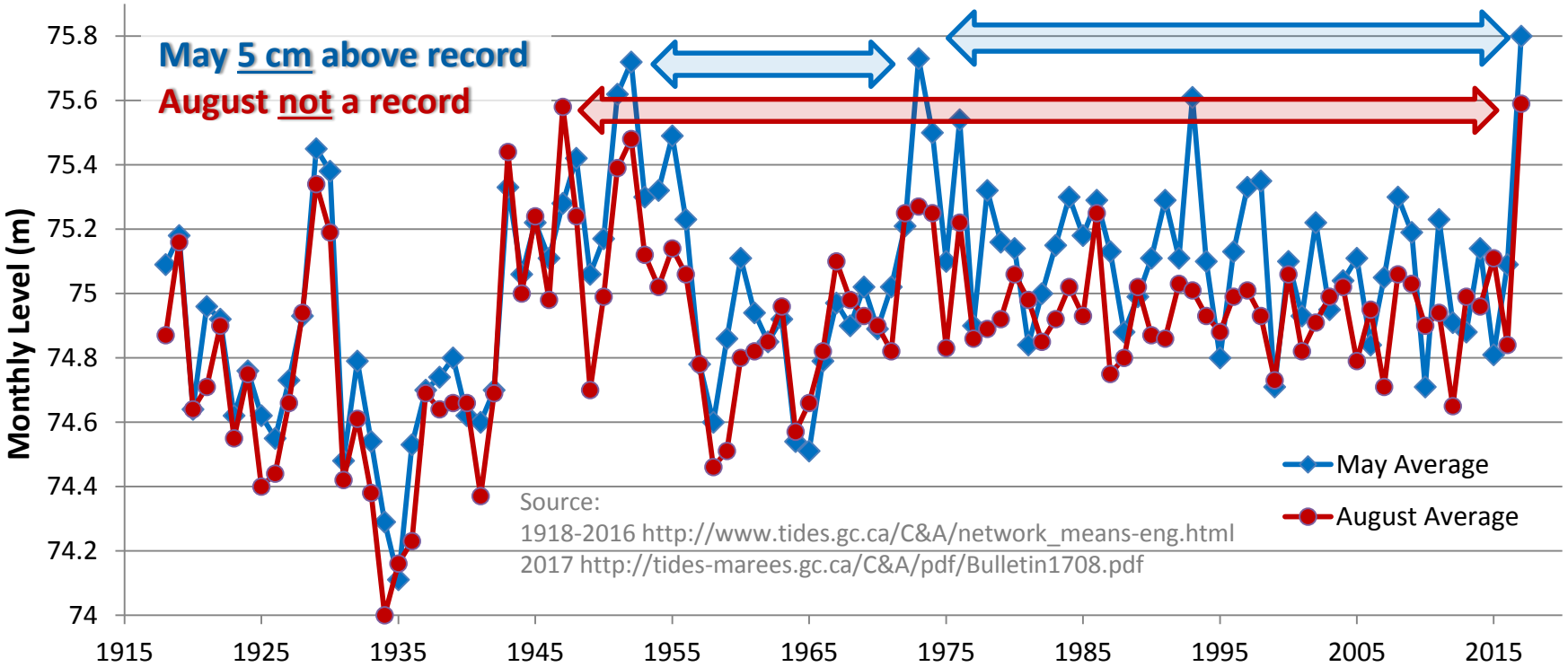
Metrolinx said this 2013 flood was unprecedented

http://http://www.cityfloodmap.com/2015/12/toronto-go-train-flood-avoidable-july-8.html

2017 Lake Ontario Levels Unprecedented?



Lake Ontario Historical May - August Levels



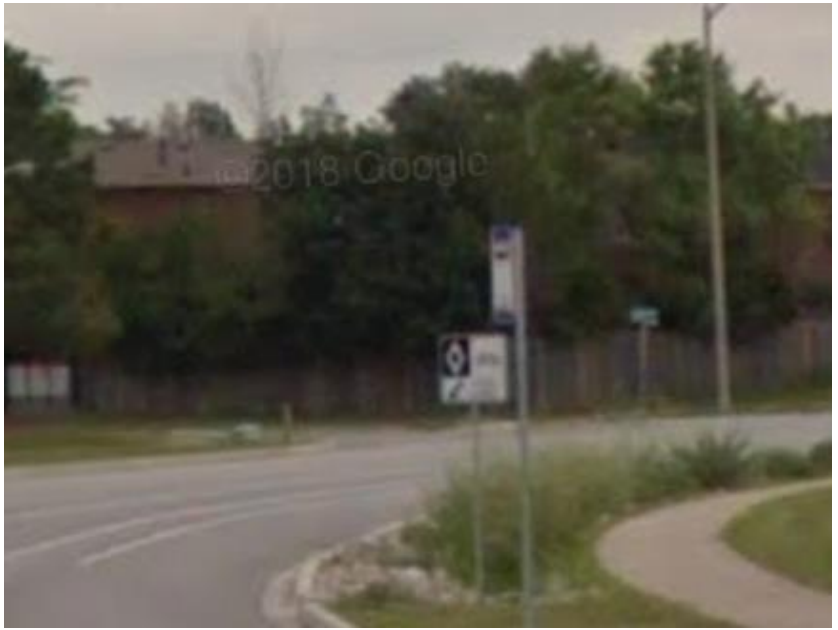
http://www.cityfloodmap.com/2017/09/toronto-island-flooding-2017-were-lake.html

We have always had flooding

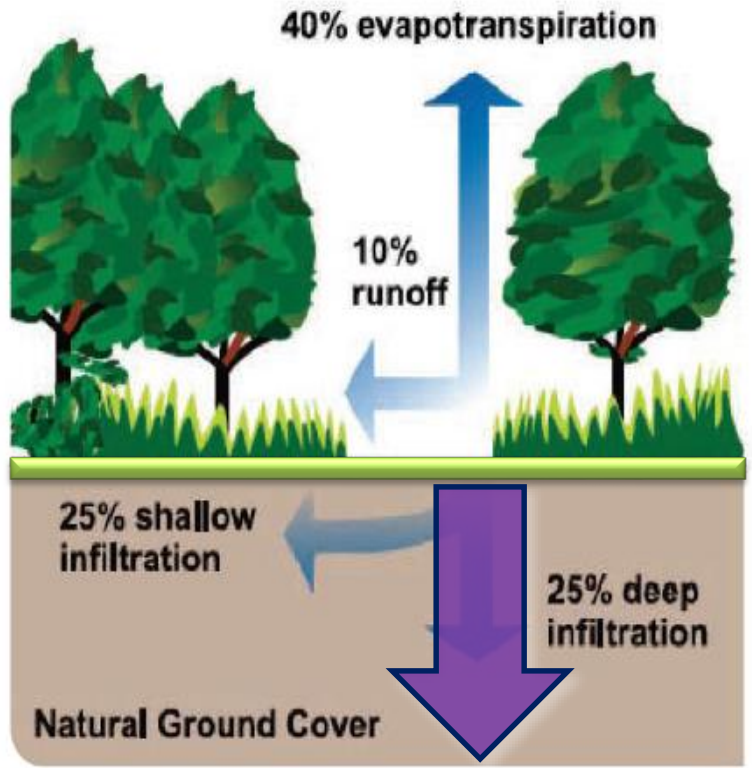
Engineers don't let that stop them in in their quests …

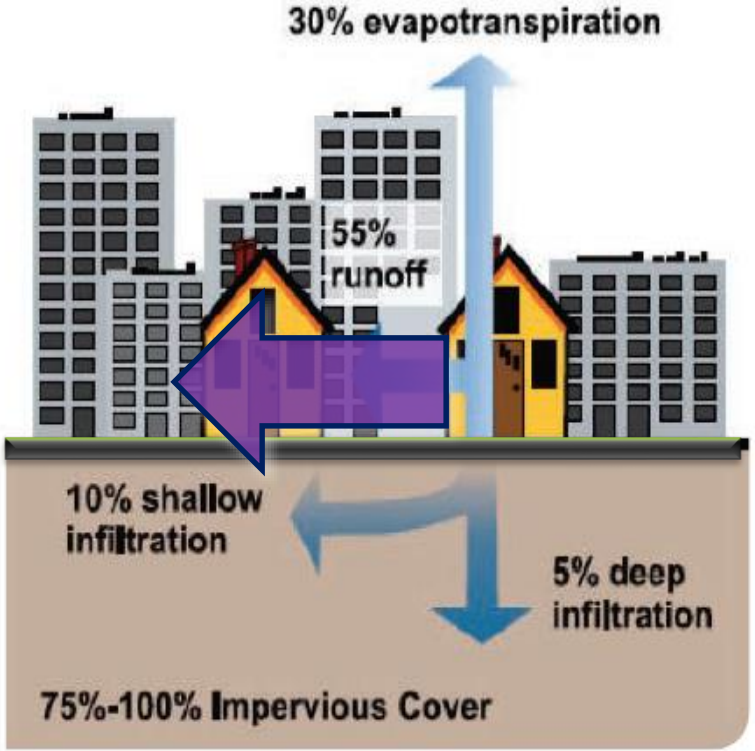
What about adding green infrastructure like bioswales into the right of way?

Bioswales may not look so nice in practice …



Green infrastructure needed to restore water balance





But creek baseflows have been going up for decades ?!?

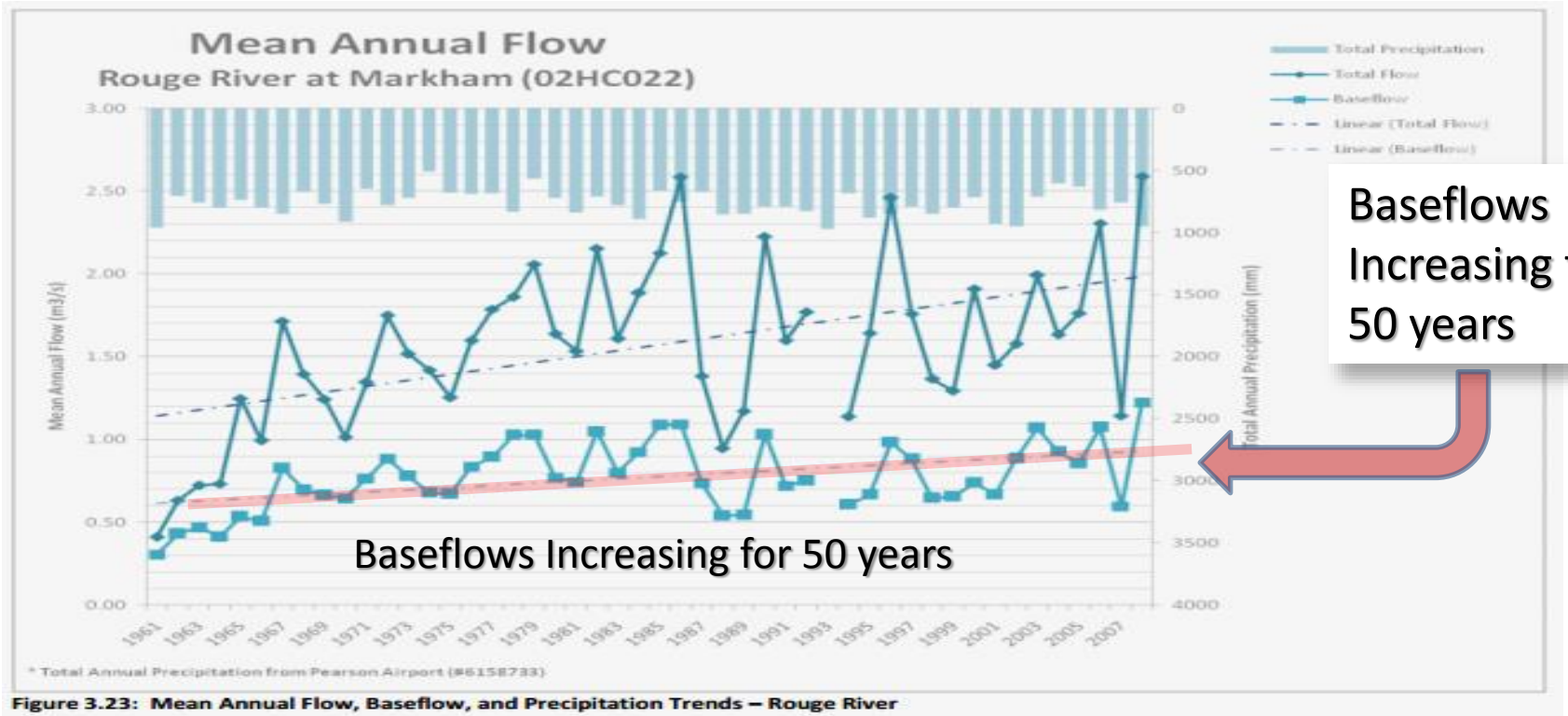
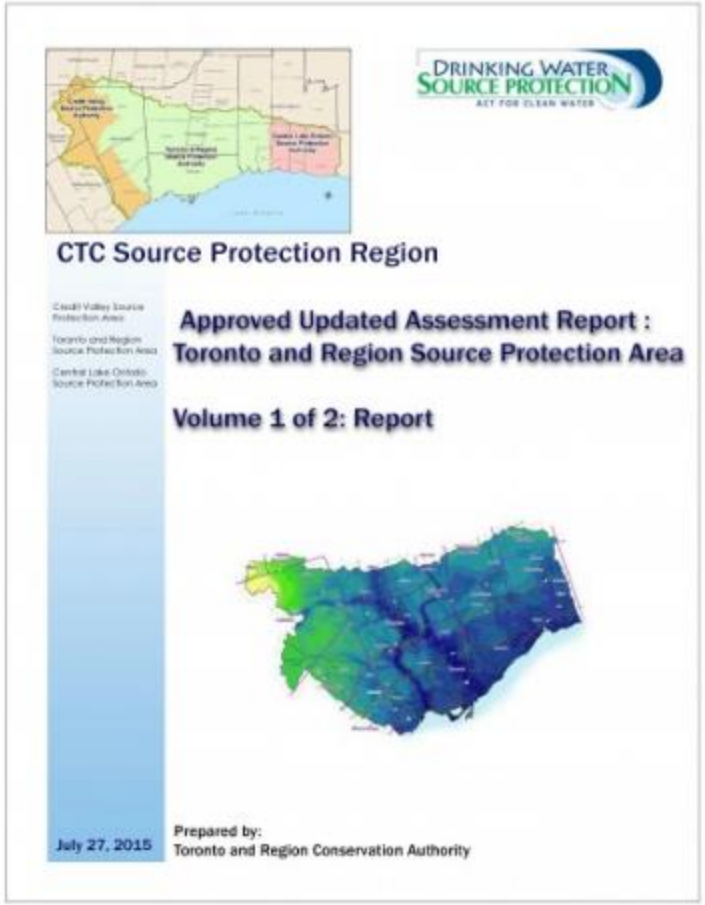


Figure 3.23: Mean Annual Flow, Baseflow, and Precipitation Trends – Rouge River

Conservation Authority Says "Common Thought" Is Inaccurate

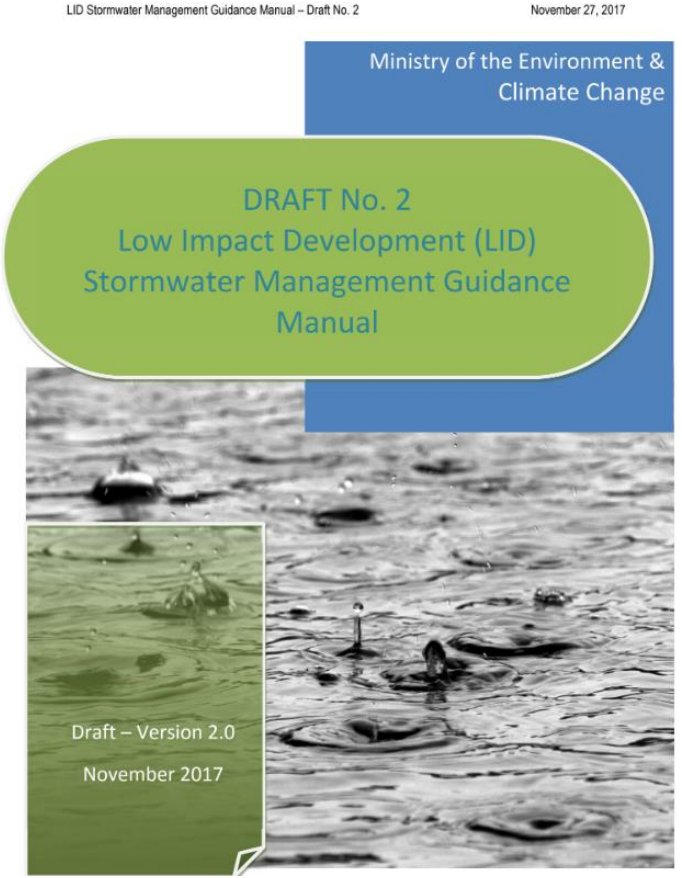
- "At all but two gauging stations, a positive or upward trend was observed. These upward trends vary depending on the watershed, ranging from 2% in the Don and Etobicoke watersheds and up to 45% in the Rouge. **These overall increases to baseflow volumes are contrary to the common thought that increased impervious cover leads to reduced baseflow**"



http://www.ctcswp.ca/wp-content/uploads/2015/07/RPT_20150723_Feb2015_TRSPA_PUAR_Chap3_HiRez.pdf

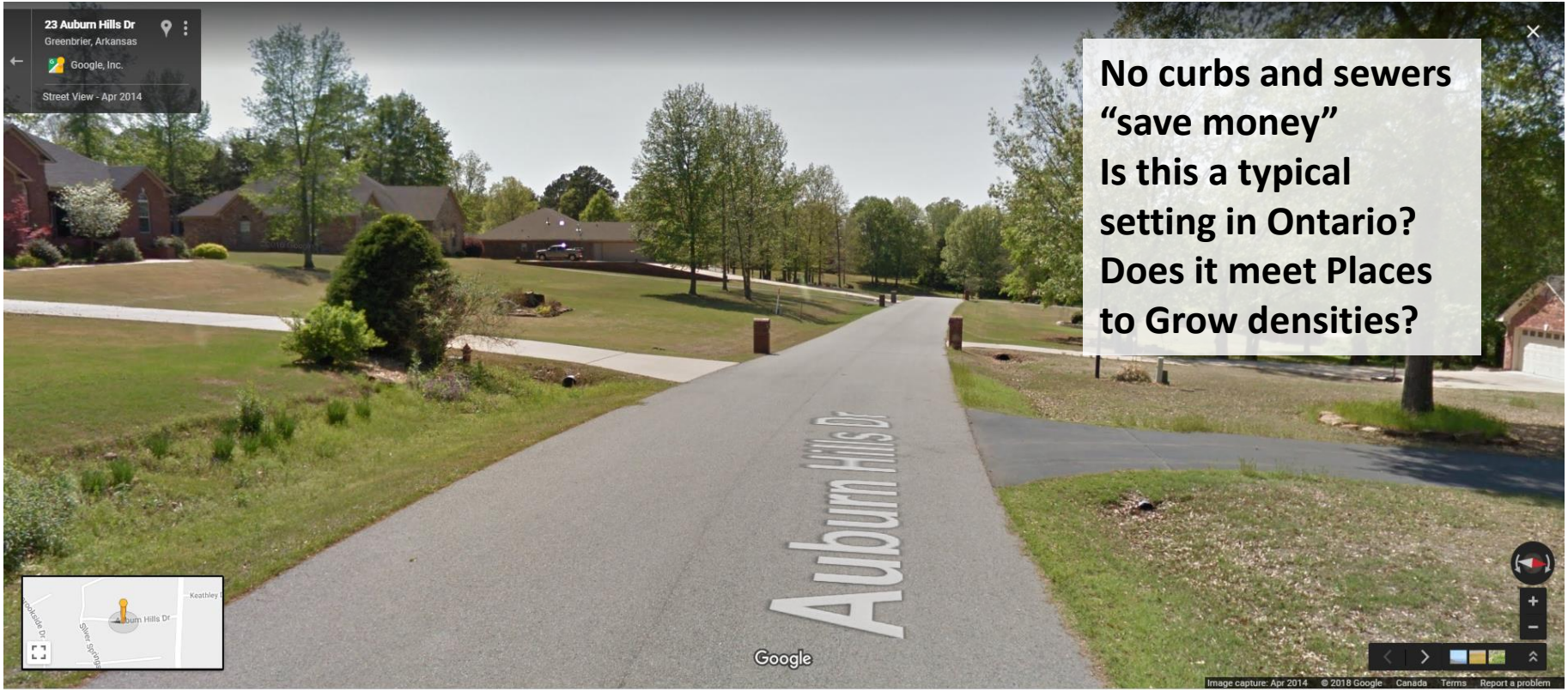
Green infrastructure saves money ?

"Excessive costs alone shall not be considered an acceptable constraint"



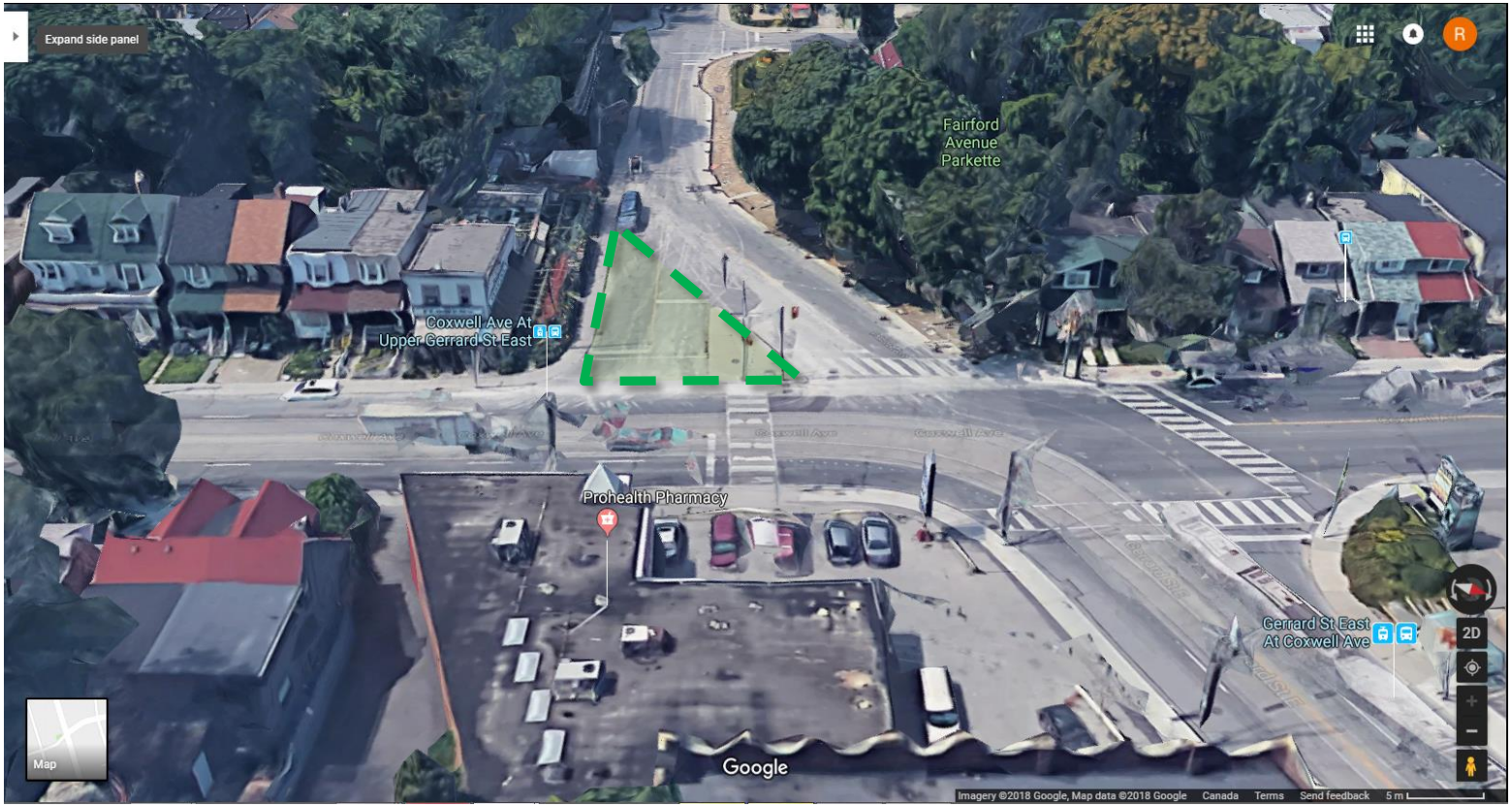
Then Why Say That?

Green infrastructure saves money ? .. in rural Arkansas



http://www.cityfloodmap.com/2017/09/toronto-island-flooding-2017-were-lake.html

What about here in the GTA ?



City of Toronto. Fairford and Coxwell.

Groups involved:

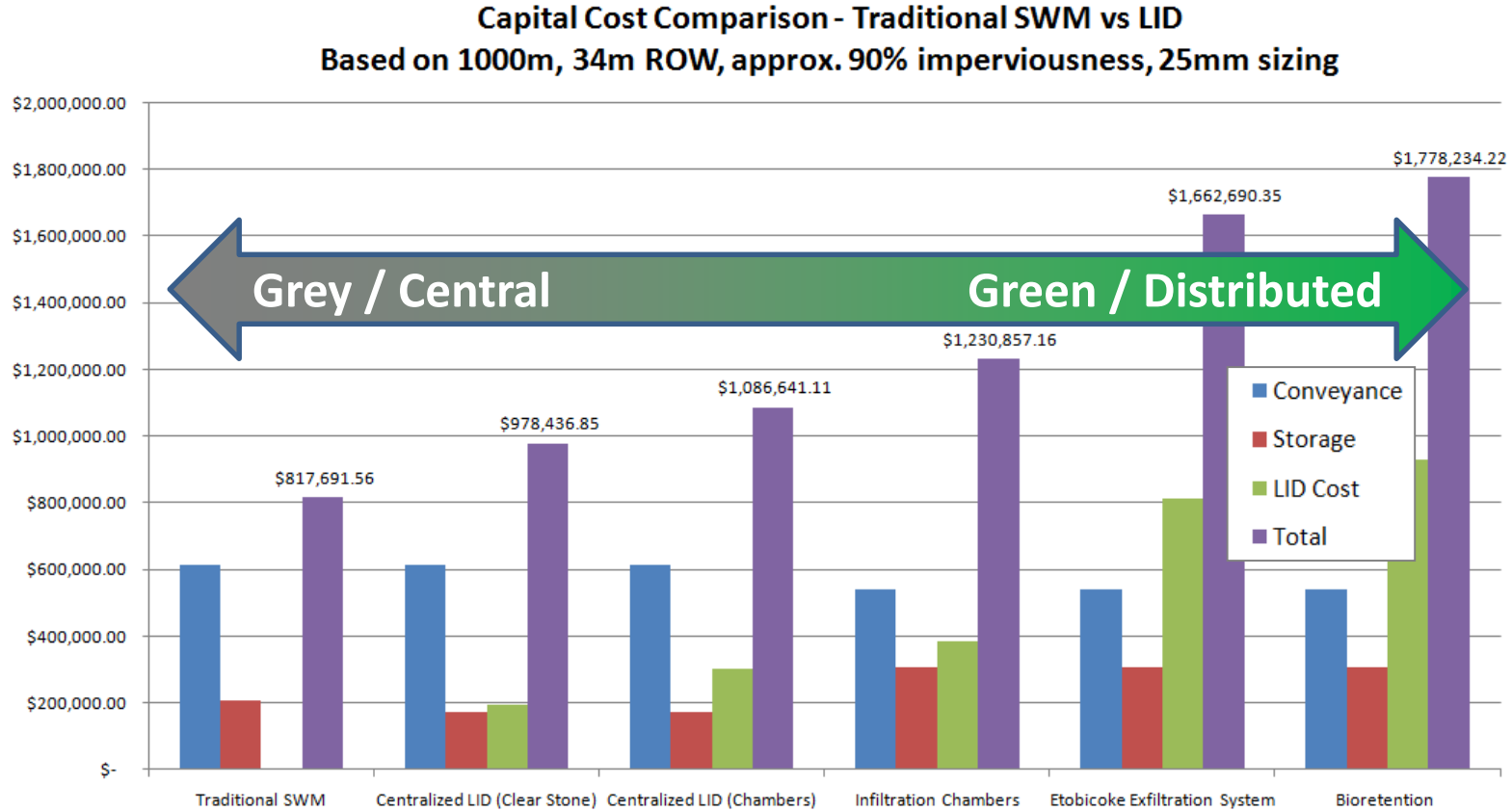
- Urban Design within City Planning
- Toronto Water
- Transportation Services
- Parks, Forestry and Recreation
- Parks, Capital and Operations and Maintenance
- Engineering and Construction Services

Budget:
$350,000
Actual: $320,000

Ontario and US Project Costs:
https://www.cityfloodmap.com/2018/07/green-infrastructure-capital-and.html

http://https://sustainabletechnologies.ca/app/uploads/2017/08/Fairford-Parkette-Case-Study_2017.pdf

Ontario Costs – Over $500,000 per Hectare (same as US)



Cost for LID higher than traditional centralized technol-ogies

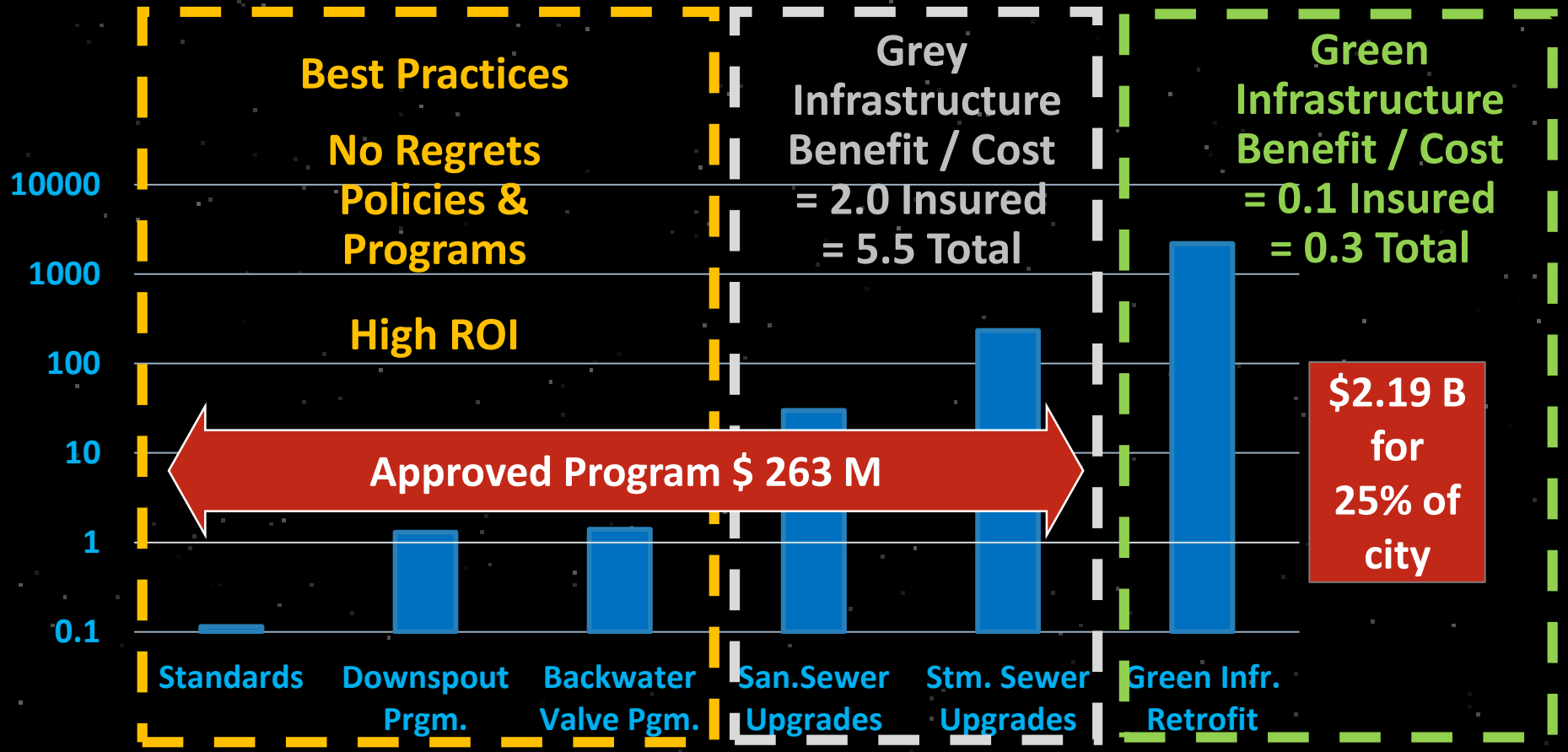
Flood Control Program - Markham

Cost ($M)

10000
1000
100
10
1
0.1

Standards
Downspout Prgm.
Backwater Valve Pgm.
San.Sewer Upgrades
Stm. Sewer Upgrades
Green Infr. Retrofit

Flood Control Program - Markham



Conclusions

- Crowded, the Right of Way it is
- To Identify necessary infrastructure improvements critical “Thinking Slow”, we must do
- On your Mission Possible Right of Way Strategy, may the force be with you
- The path to the dark side, “Thinking Fast” it is

STORM WARTS

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Twitter: @RobertMuir_PEng
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Questions ?

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