Coping with Climate Change at a Wastewater Treatment Works.

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Climate Change

Climate change is predicted to provide more extremes in temperature and rainfall.

Typically, we expect:

1. Hotter and dryer summers
2. Colder winters
3. More sustained and longer periods of rainfall
4. Increased likelihood and frequency of catastrophic events such as floods and power outages

Uncle Tony, are you any good at probability?

50% of me says yes
50% of me says no

Amber, age 12

Tony, age 57

What is a 1 in 100 year event?

A. An event will occur once every 100 years (and won't happen again for another 100 years)

B. There is a 1% chance that the event will occur in any given year

Annual Exceedance Probability (AEP)

Example 1:

2% exceedance probability rainfall event:

A 2% chance of occurring in a year, so once in every 50 years

Example 2:

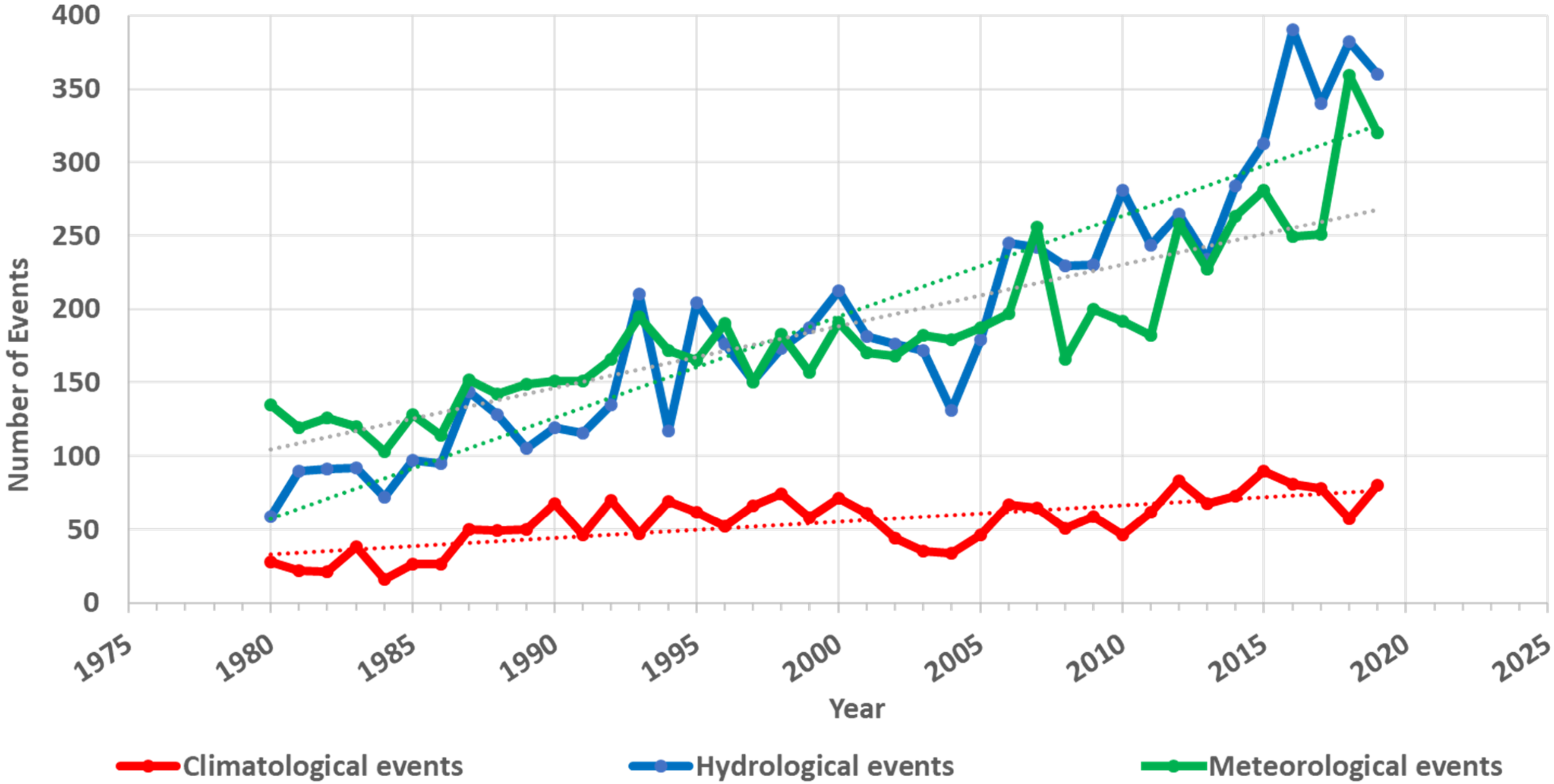
20% exceedance probability rainfall event:

A 20% chance of occurring in a year, so once in every 5 years

Exceedance Probability (AEP)	Potential Frequency	Flooding Event Size
1% AEP	1 in 100 Years	Greater Rainfall event
2% AEP	1 in 50 Years	↓
5% AEP	1 in 20 Years	
10% AEP	1 in 10 Years	
20% AEP	1 in 5 Years	
50% AEP	1 in 2 Years	
100% AEP	Happens Every Year	Lesser Rainfall Event

Number of Relevant Loss Events 1980–2019

Singapore International Water Week



Data source munichre.com

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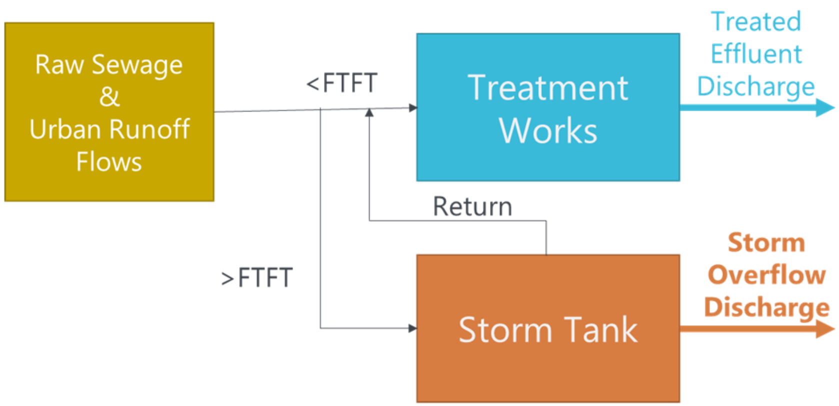
CASE STUDY 1 United Kingdom



- Change of approach in design treatment flow
- Storm tank design
- Storm overflows used in combined sewer systems
- Provide a 'release valve' that reduces the risk of overloaded sewers causing flooding during rainfall, especially in people's homes
- Overflows designed to operate infrequently typically discharging into inland rivers in England to 40, 20, 10, 5 and 0 as the annual average number of spills
- This forms the basis of permits

Sewage Flows & Infiltration

- **Dry Weather Flow (DWF)**

  Anticipated minimum flow after a period of dry weather

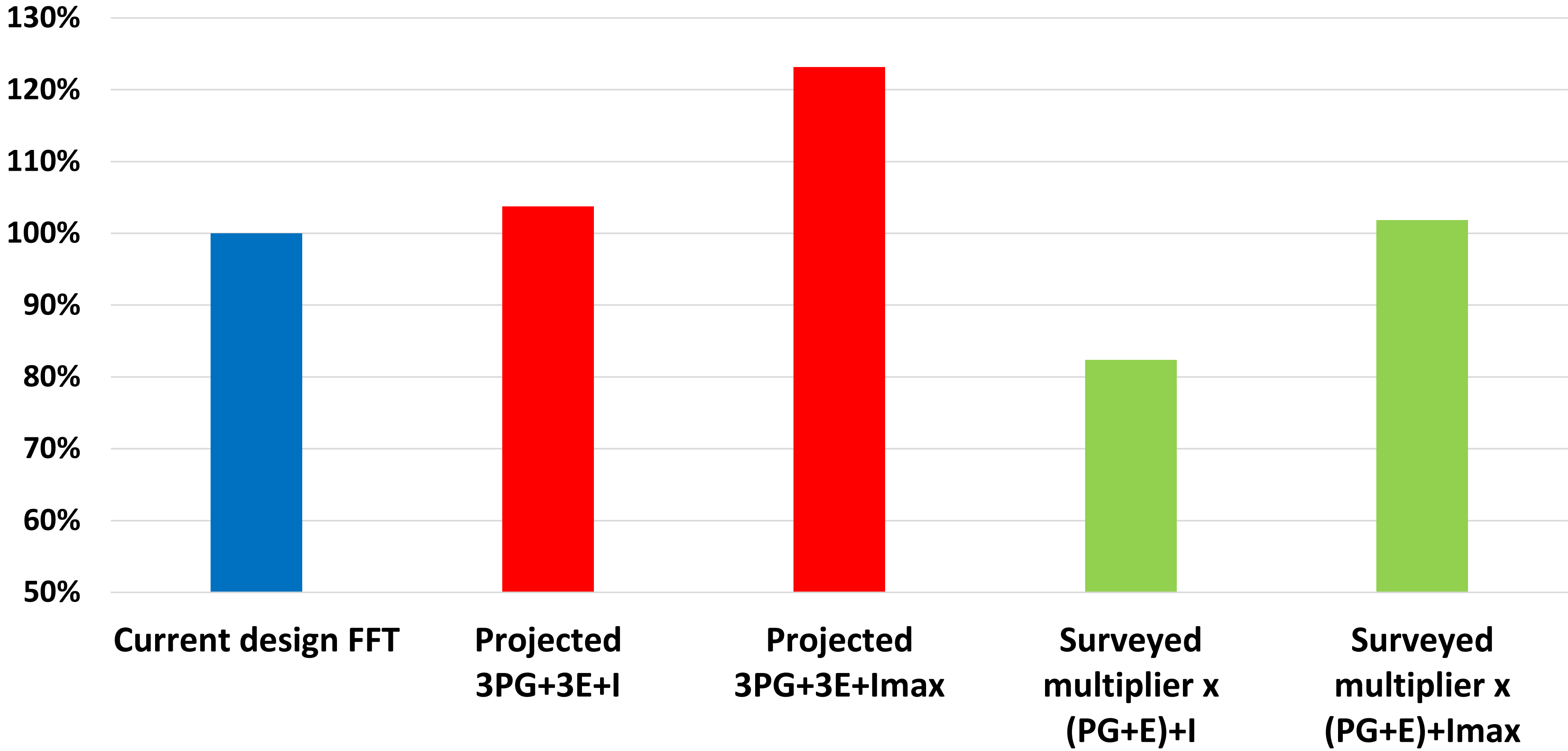
  (Population (P) × Flow per Capita (G)) + Infiltration (I) + Trade (E)

- **Infiltration**

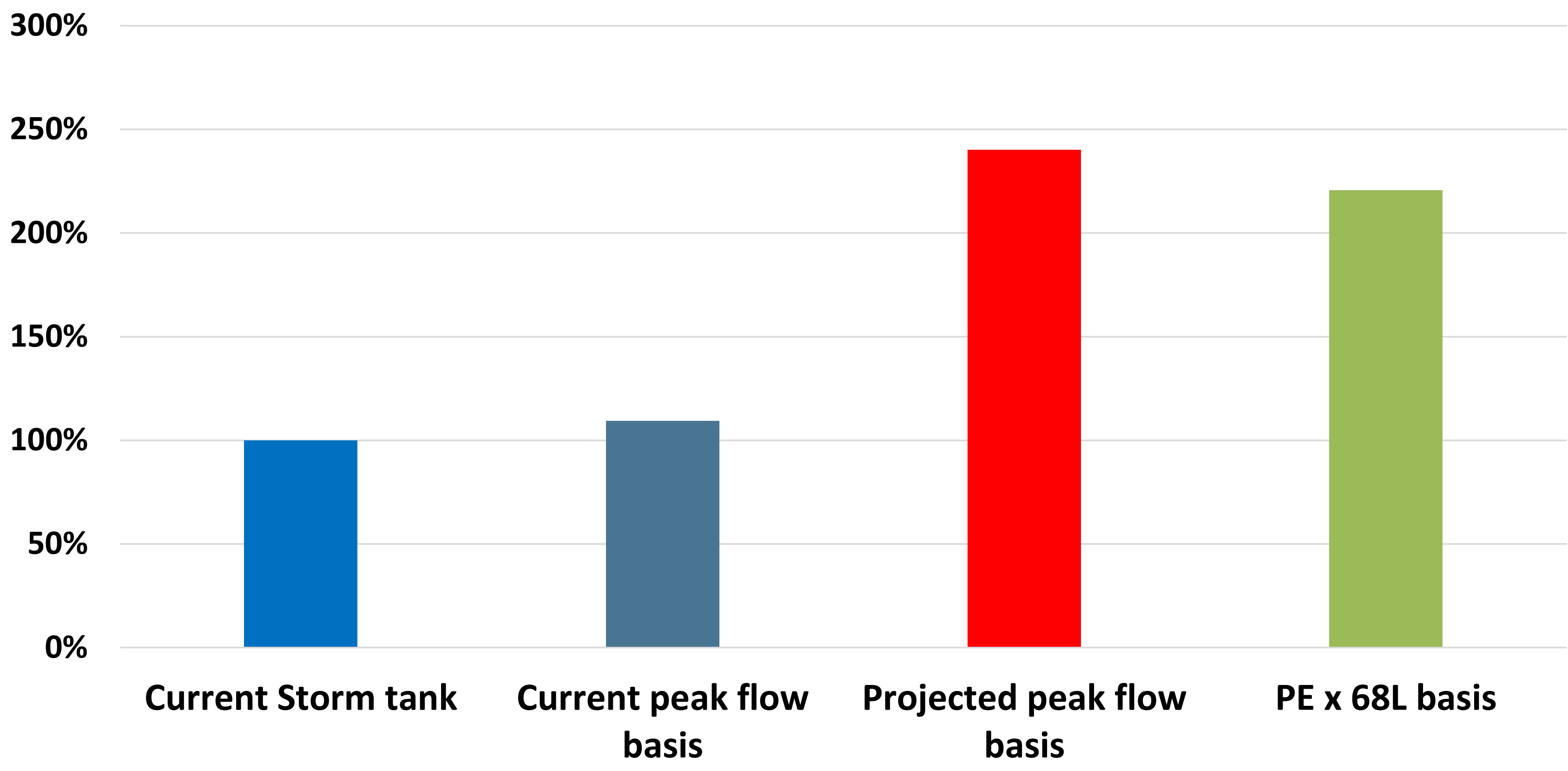
  The groundwater that seeps into the sewer system through cracks and leaks in the sewer pipes from the surrounding soil

  - Infiltration (average) – Conventional design
  - Infiltration (maximum) – Alternative design
    - Imax

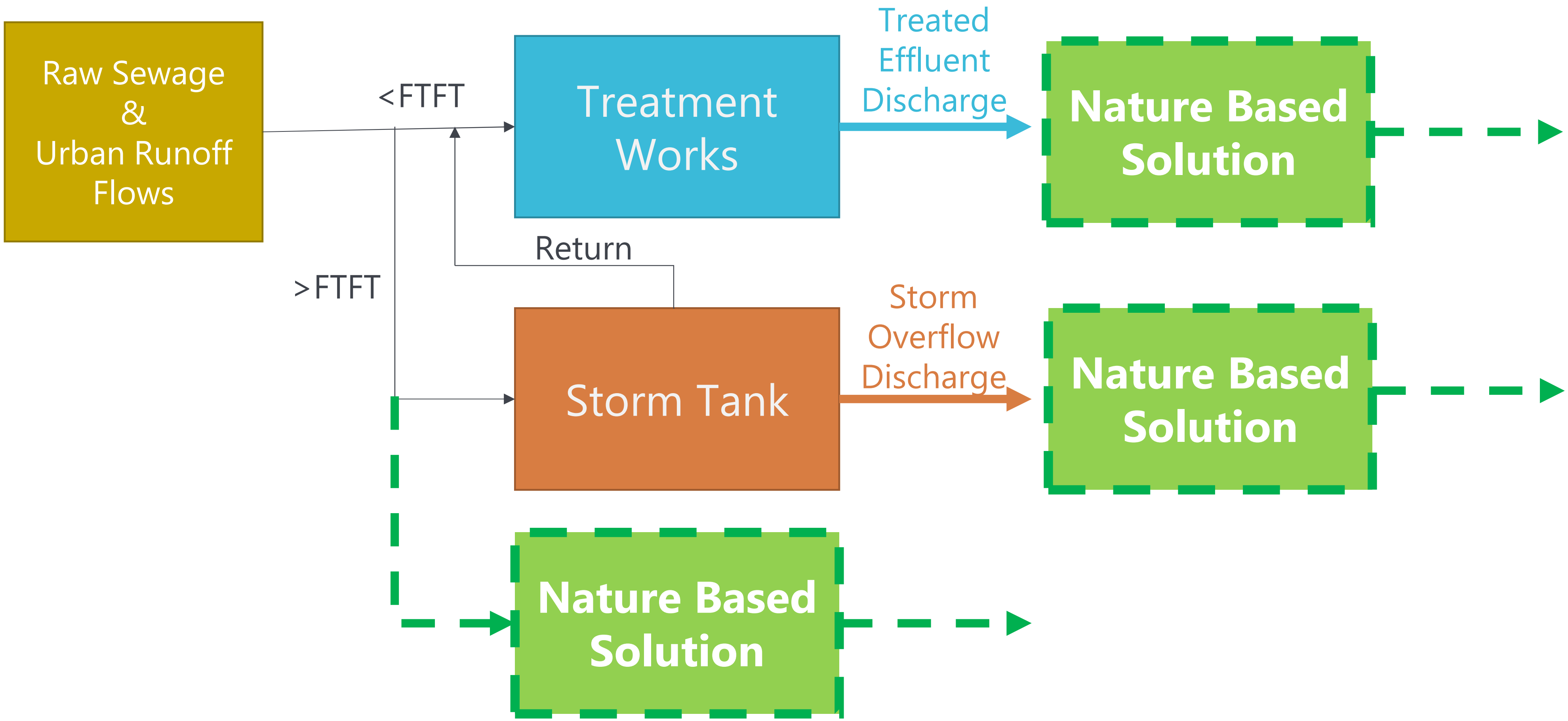
Effect of Imax on Hydraulic Capacity Requirement



Effect of Peak Flow on Storm Tank Capacity Requirement



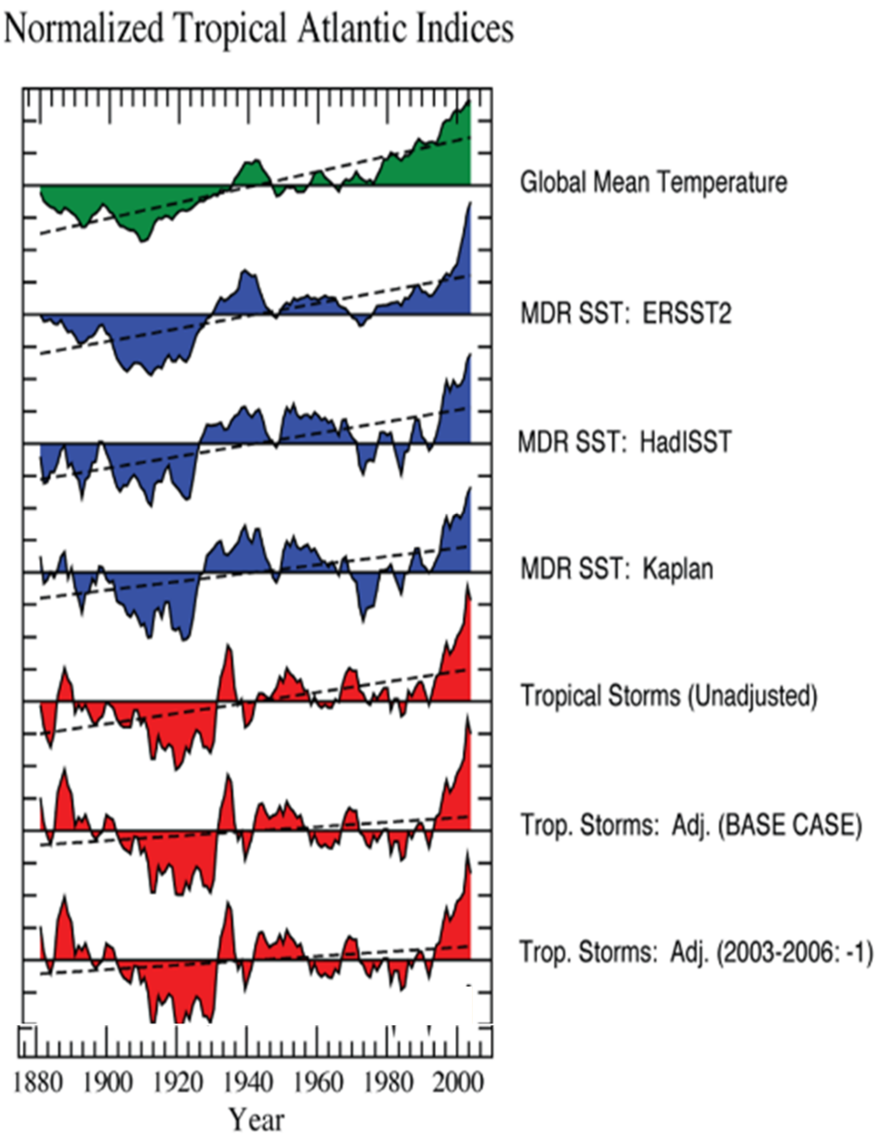
Sustainable Treatment Solutions



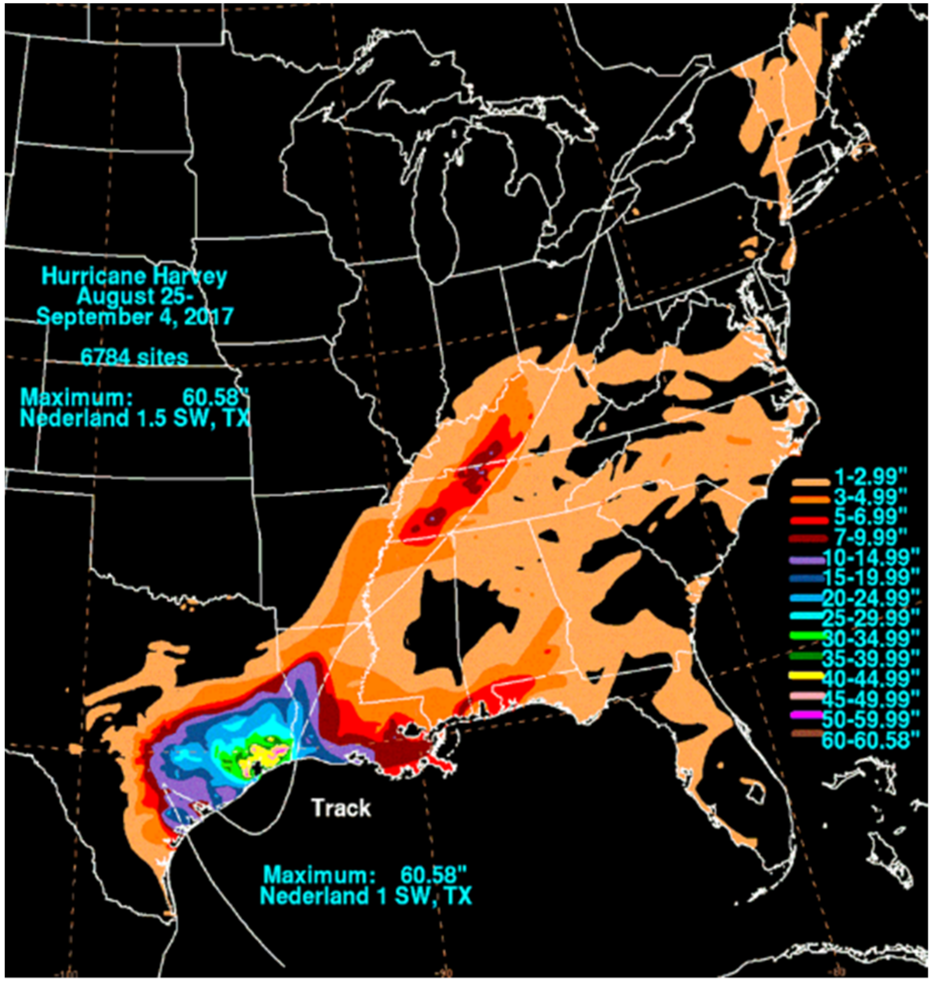
CASE STUDY 2 United States

- The City of Houston has 39 WWTPs and have a plan to consolidate them, eventually, to just 12 facilities
- First consolidation is at the “International Airport Houston” (IAH) facility.
- 3 other facilities will be shut down and the flows sent to IAH which must then be expanded.
- “Texas is a land of perennial drought, broken by the occasional devastating flood.”

An unnamed state meteorologist (1927)



Records – Geophysical Fluid Dynamics Laboratory (noaa.gov)



By NOAA - WPC Hurricane Harvey rainfall data, Public Domain, https://commons.wikimedia.org/w/index.php?curid=63865688

Historical Flow Analysis Summary

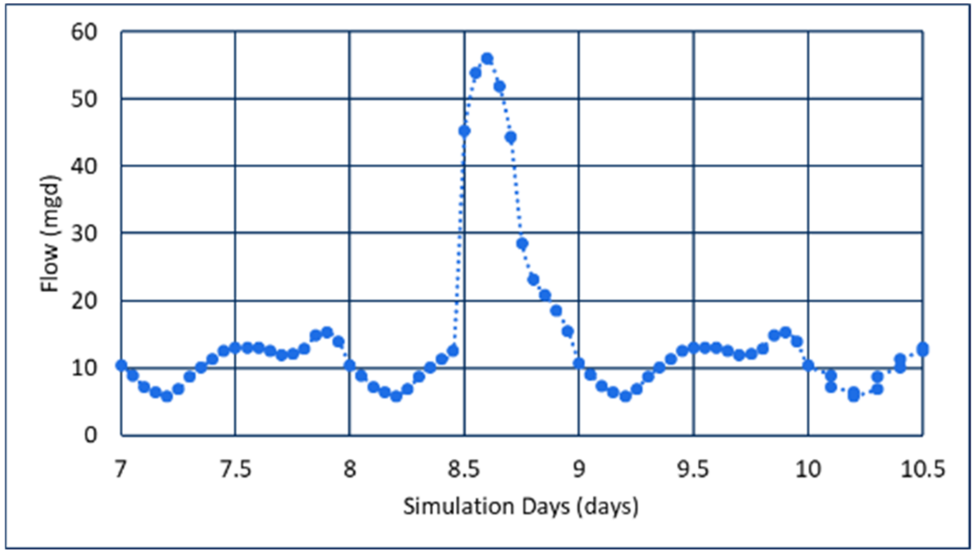
Very High Peaking Factors

WWTP	Historical Flow Data (MGD)		Peaking Factor (2HR)
	ADF	PEAK 2HR	
IAH	2.2	12.1	5.50
Northgate	2.5	7.7	3.08
Imperial Valley	1.6	11.6	7.25
MUD #203	0.4	3.3	8.25
Consolidated	**6.5**[1]	**32.2**[1]	**4.95**

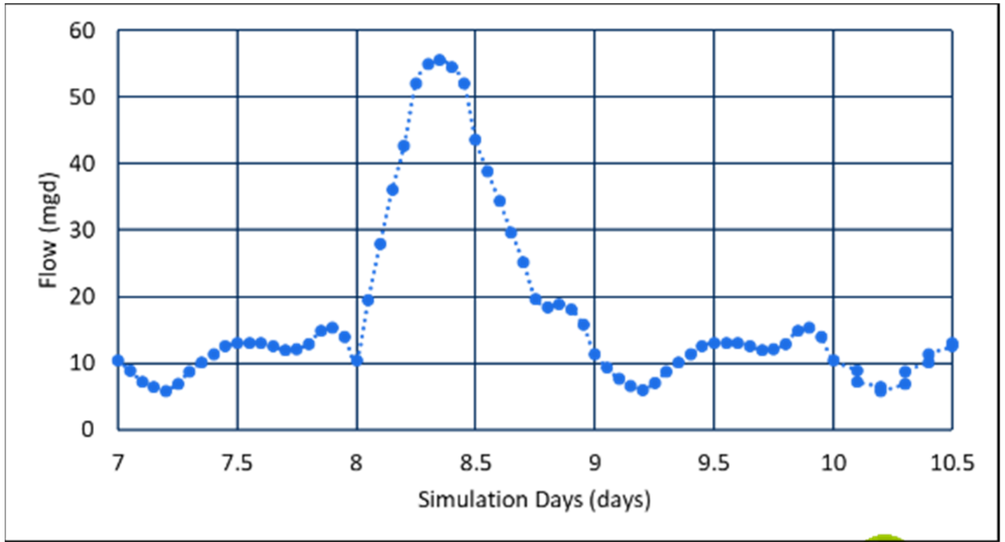
Note: 1 – Consolidated flow based on summation of individual days

Storm Analysis

Parameter	Units	Full Data Set	Data Set with > 2-Hour Storms
Total Storms	-	58	24
Approximate Frequency	Storms/year	15	6
Duration			
Average	Hours	3.6	7.8
Standard Deviation	Hours	5.4	6.5
Average + STDEV	Hours	8.9	14.3
Maximum	Hours	26.5	26.5



Average Storm Pattern



Maximum Storm Pattern

Singapore International Water Week

3 Options Analysed with Dynamic Modeling

1. Additional Influent EQ Basin
2. No EQ Basin
3. Extra Aeration Basin (AB)

- GPS-X Simulator by Hydromantis
  - Wastewater modeling and simulation software

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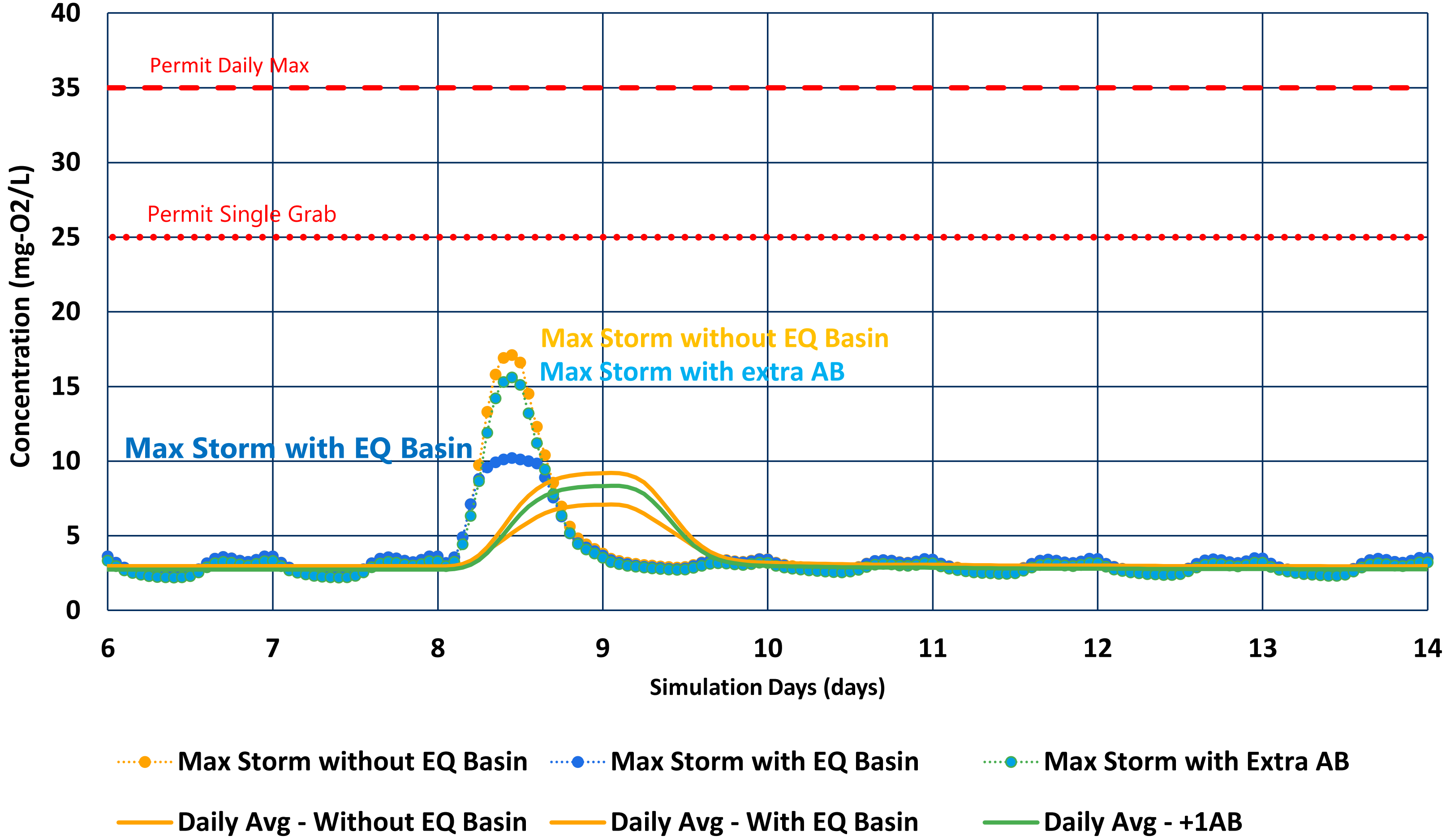
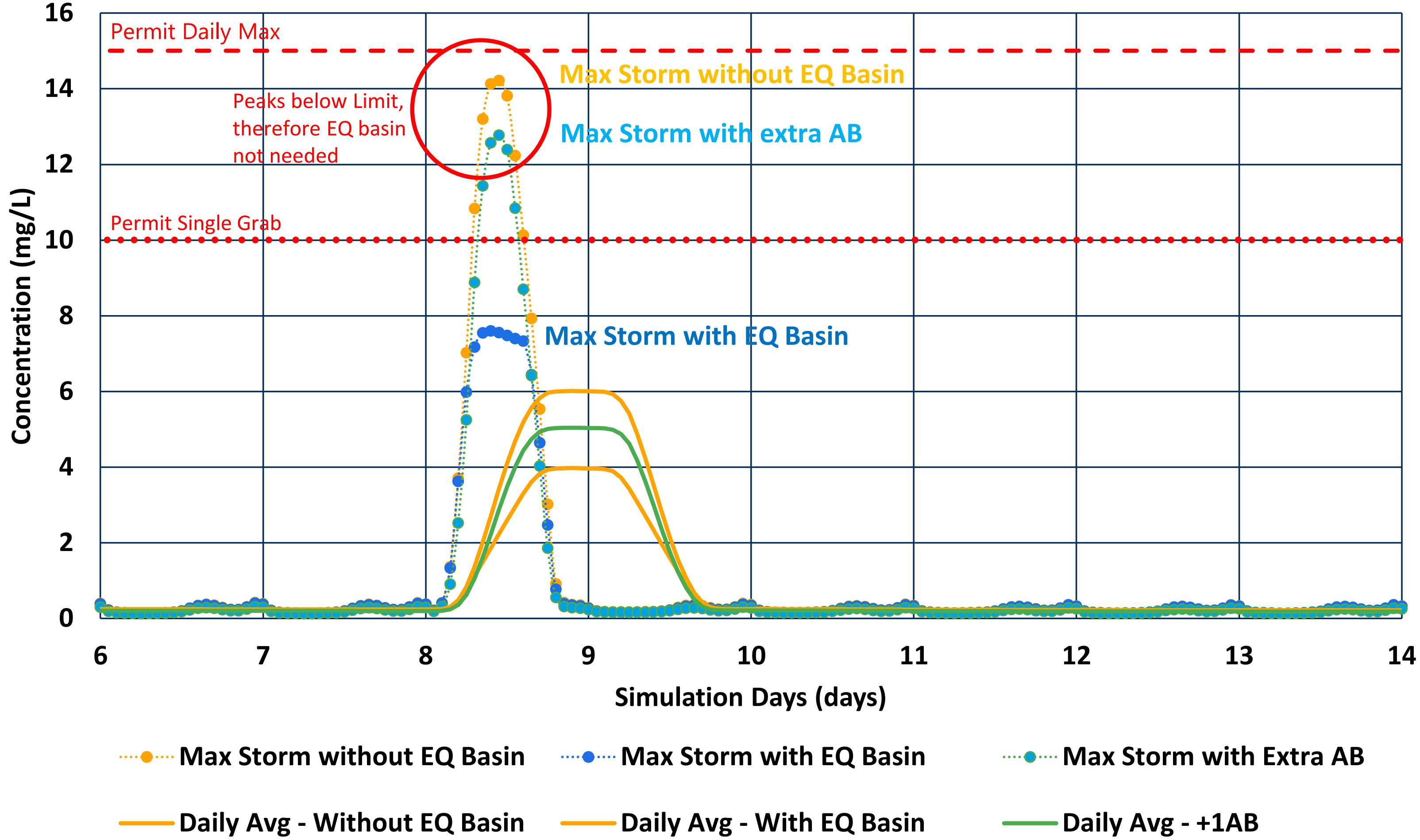
Simulations – Wet Weather Analysis
Effluent cBOD



Simulations – Wet Weather Analysis
Effluent Ammonia



Climate Change Impacts on Wastewater Treatment Process Design

	Design Parameter	Impacts
A	Flows and loads	• High flows • Low flows • Dilute influent • Concentrated Influent • Assessment of infiltration (Imax)
B	Preliminary Treatment	• Peaking factors for screening and grit production
C	Wet Weather Treatment	• Sizing of equalization or storm storage • Provision of excess flow treatment
D	Primary Treatment	• Peak hydraulic loading • Impact on peak sludge design
E	Secondary Treatment	• Robustness for turn down and turn up • Selection of peaking factors • Oxygen transfer at high temperatures
F	Tertiary Treatment	• Plant sizing at peak flows

Summary

- The design of wastewater treatment facilities needs to adapt to enable the plants to cope with the current and future issues of extreme weather conditions.
- A variety of initiatives have been implemented by water companies around the world
- If the industry is to cope with the imminent climate change impacts all stakeholders will need to engage in dialogue to ensure opportunities are captured and risks are mitigated.

THANK YOU

Costs and Considerations when Implementing Process Intensification Technologies at a Wastewater Treatment Facility.

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