



# Inflow & Infiltration

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## **Impact Discovery Response**

Missouri Water & Wastewater Conference  
Cape Girardeau, Mo  
April 24, 2013

# OVERVIEW

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- **Impact of I&I Flows**
  - General Impacts
  - Specific Treatment Plant Impacts
- **Cape's I&I Flow Reduction Program**
  - **Discovery**
    - Field Studies
    - Findings
  - **Response**
    - Action Plan
      - 1990's
      - 2013-2018



# IMPACTS

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# General

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- Collection Systems
  - SSO's - DNR Action
  - Backups - Claims Costs
  - Call outs
    - Overtime Costs
    - Wear on Employees & Equipment
  - Lost Capacity
    - Economic Development Impacts
  - Equalization / Overflow Tanks
    - Cost
    - Sizing
    - Septic Issues
    - Cleaning & Maintenance Issues



# General

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- Treatment Facilities
  - Bypasses
  - Peak flow rates can shock process units
  - Non-compliance with permit limits
  - Increased power demand
    - Higher costs
    - Budget adjustments
  - Increased wear on pumps & equipment
    - Increased maintenance expense
    - Premature replacement
  - Lower Influent BOD
    - Can impact treatment efficiency

# IMPACTS - Specific

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- WWTP Processes
  - SBR
  - Trickling filter
  - Ox Ditch
  - Activated sludge
  - Lagoon
  - CSO system



# SBR Facility

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- Reduced contact time for biological reactions
- Reduced influent nutrient loading
- Turbulence from high flow rates can increase effluent TSS
- Wash out of solids can impact treatment efficiencies after rain event



# SBR Facility

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- Note: SBR's can absorb the shock of peak flows without bypasses



# Trickling Filter Facility

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- Grit passes into Process Units
  - Place grit removal system on hand
  - Place bar screen on hand
- Primary Clarifiers
  - Not much treatment impact
  - Must watch for turbulence and TSS over weirs



# Trickling Filter Facility

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- Trickling Filter Unit
  - Grit causes excessive wear on pumps
  - Nutrient loading can be reduced
  - Scour of media growth can occur
  - Must control flow rate (min and max)
- Final Clarifiers
  - Reduced detention time
- Digesters
  - Grit build up
  - Reduced heat transfer efficiency



# Oxidation Ditch Facility

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- Washout of micro-organisms (bugs)
  - Preventative measures
    - Turnoff rotors / aerators
- Turbulence through process train
- Excessive flow over weirs
- Bug washout can increase TSS
- Activate standby units
  - Use extra clarifier



# Activated Sludge Facility

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- Increased grit volume carries into clarifiers, aeration units, and digesters
  - increased maintenance required
- Washing out of solids from clarifiers
- Reduced contact time in aeration tanks
- Increased turbulence in process units



# Activated Sludge Facility

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- Increased TSS through treatment process
  - Can cause non-compliance in effluent
- Lower influent BOD can reduce treatment efficiencies
- More grit in digesters effects required contact time



# Lagoon Facility

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- Reduced influent nutrients
- Reduced influent BOD
- Reduced contact time for biological reactions
- Increased turbulence can cause higher effluent TSS
- Washout of solids will impact treatment after the rain event



# DISCOVERY

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Cape Girardeau  
Inflow & Infiltration  
Flow Reduction Efforts

# Cape Girardeau I&I Program

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- From January 2010 through August 2012 the Cape WWTP reported 67 bypasses. 57 of these were related to wet weather flows
- The current NPDES Permit for the Cape WWTP has requirements for treatment of bypass flows. *This is difficult and costly.*



# Cape Girardeau I&I Program

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- In 2010 the City contracted with RJN Group, Inc, to perform an I&I Study to perform flow monitoring on the City sewer collection system. This work was to quantify the flows and relate those flows to the various sub-basins of the system.
- Their scope of work was later expanded to include the field work to specifically identify the source defects, make recommendations for repairs, and provide cost estimates for those repairs.

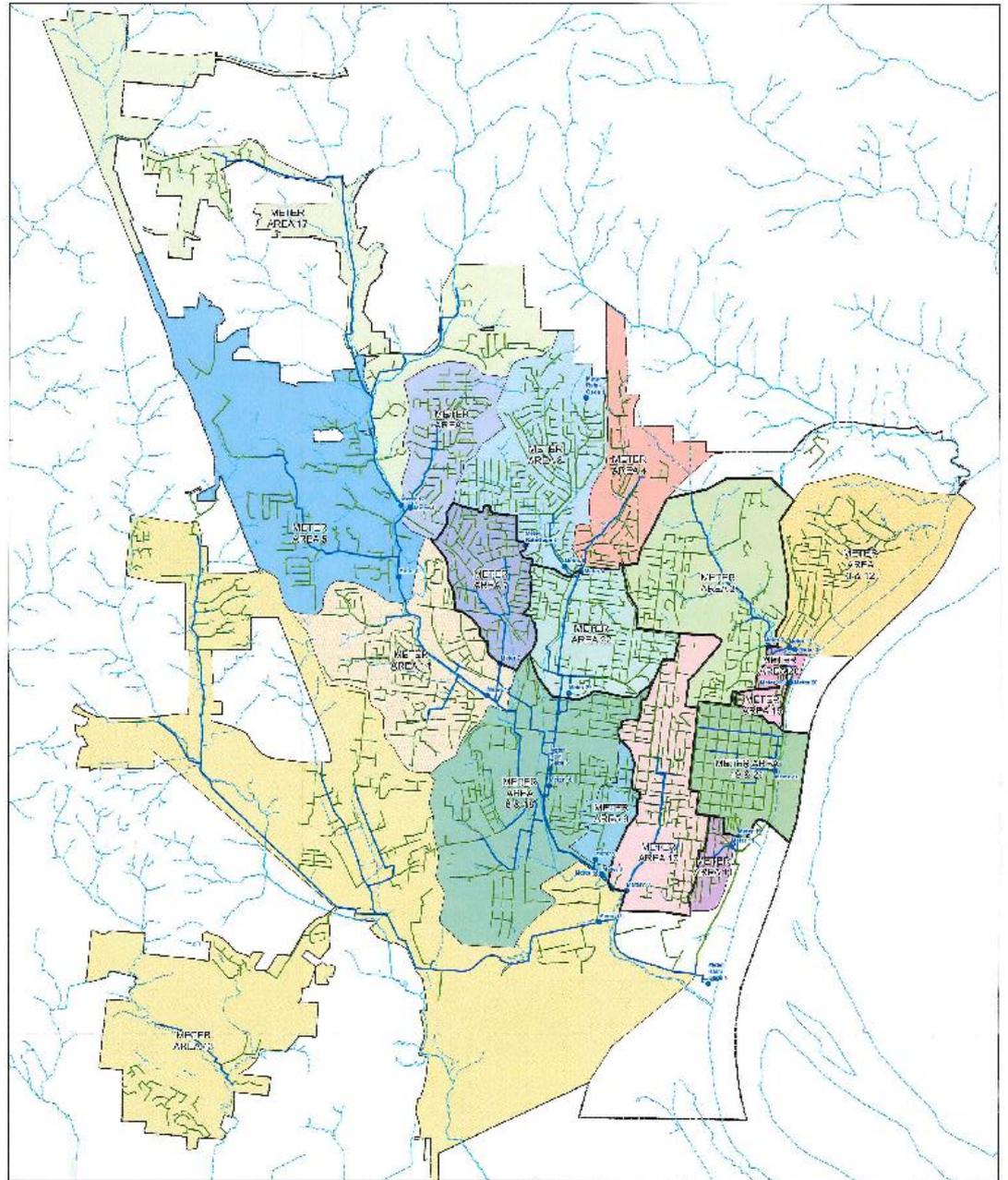


# Map of Flow Meter Locations

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These are the sewer sub-basins of the city collection system.

Each colored area is a sub-basin and has at least one flow meter.





# Cape Girardeau I&I Program

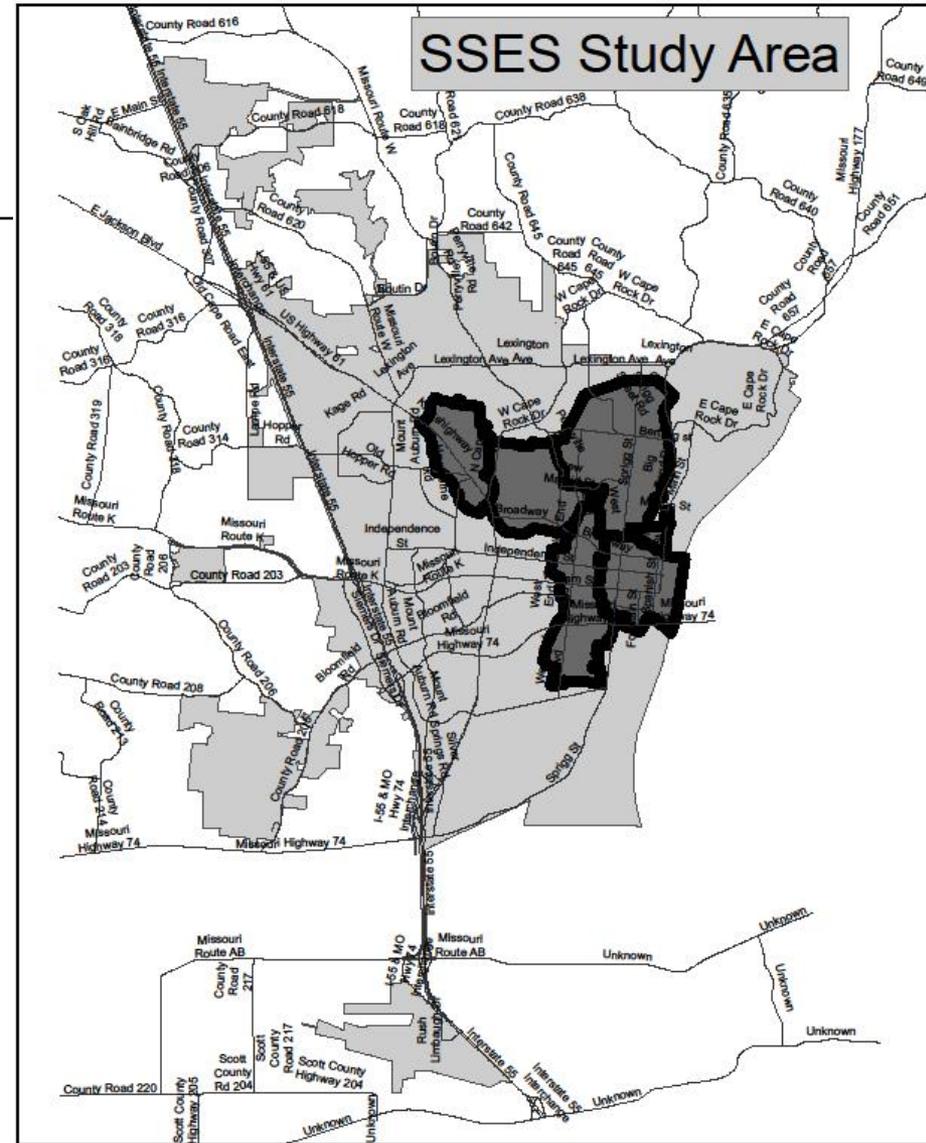
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- 22 flow meters were set up around the city to monitor the entire collection system flow
- The flow monitoring data showed that roughly 60% of I&I flow was from a central area of the system.
- This became the study area. It is about 30% of the total sewer collection system.

# I&I Project Study Area

The lighter grey area is the city collection system service area.

The dark grey area is the portion of the sewer collection system where we did the detailed field work to identify defects.





# Cape Girardeau I&I Program

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- Flow monitoring identified an estimated 7.5 million gpd of I&I flow coming from the study area in a moderate rain event, (2 yr event).
- The field evaluation of the study area documented 5,196 public sector defects and 789 private sector defects



# Cape Girardeau I&I Program

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- These 5,196 public sector defects were estimated to allow roughly 6 million gallons of rain water into the sewer system.
- The 798 private sector defects were estimated to allow roughly 1.5 million gallons of rain water into the sewer system.



# Cape Girardeau I&I Program

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- It is noteworthy that the great majority of the I&I flow comes from public sector defects
- It is more common for the majority of I&I flows to come from private sector defects
- This is evidence of effective work done in the Combined Sewer Separation work

# Cape Girardeau I&I Program

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- Defect Breakdown
  - 5,063 defects in 1588 manholes
    - 4 mgpd flow; that is 76% of the flow
  - 116 main line defects
    - 1 mgpd flow; that is 23% of the flow
  - 17 defects are cross connections
    - 1 mgpd flow; that is 1 % of the flow



# Cape Girardeau I&I Program

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- The estimated cost to repair the 5,196 public sector defects in the study area is \$7.7 million.
- The estimated cost to repair the 789 private sector defects in the study area is \$5.9 million.



# RESPONSE

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# Cape Girardeau I&I Program

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Let's jump back in history a bit...

In the 1980's and early 1990's the City WWTP would experience very high peak flow rates during rain events.

Flow rates as high as 40 million gal per day in the big rains.



# Cape Girardeau I&I Program

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In those days the city had some areas that were a combined sewer / storm system. This was a large part of the problem.

To address the problem of the extremely high flows a Combined Flow Separation Program was started in 1994.



# Cape Girardeau I&I Program

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- 1994-2002
- Separated Combined Sewers
- 12 Projects
  - 6 for Separation
  - 6 for Relief and Extension
- Removed about 8,000 I&I points
  - Estimate 20 million gal of I&I flow removed
- Costs
  - Staff man hours estimated at 20,000
  - Total expense estimated at over \$750,000



# Cape Girardeau I&I Program

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- In the '90's the City made quite an effort to remove I&I flow from the system
- Now, based on the findings of the 2010 RJN work we have more work to do.



# Cape Girardeau I&I Program

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- Based on the RJN findings the City has identified almost 6,000 defects that allow 7.5 million gallons of rainwater to enter the collection system from only 30% of the system.
- ..... Now what ???  
We stopped 20 million gallons before ...ain't that enough ?



# Cape Girardeau I&I Program

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- Unfortunately, no  
..... it ain't enough.
- There is still an I&I problem and it  
must be improved.



# Cape Girardeau I&I Program

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- So...the City reviewed the data, considered the facts, and determined to address only the public sector defects at this time.
- The City has developed a 5 year plan to address these defects.



# Cape Girardeau I&I Program

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- The cost for the proposed 5 year program is estimated at \$8.5 million.
- This is for the public sector defects identified in the study area. Private sector defects in the study area will be considered in the future.



# Cape Girardeau I&I Program

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- With a decision to address public sector defects, we needed to consider alternative methods to accomplish flow reduction.



# Alternatives Considered

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- Take No Action
- I&I Flow Reduction - Replace with New
- I&I Flow Reduction - Rehabilitation

# Alternatives Considered

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## **Take No Action**

- Single advantage
  - No monetary expenditure for repairs
- Disadvantages
  - Costs of claims for backups
  - Continued WWTP bypasses
  - Increased water pollution levels in area waterways
  - Probable penalties from MoDNR
  - Lost capacity in collection system

# Alternatives Considered

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## I&I Flow Reduction - Replace with New

### Advantages

- Defects get repaired
- Wet weather flows to WWTP reduced
- System would have 1588 new manholes
- Water pollution levels reduced

### Disadvantages

- Extended repair times
- Traffic control costs and detours
- Estimated cost is over \$10 million
- Possible Environmental Impacts

# Alternatives Considered

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## **I&I Flow Reduction - Rehabilitation**

### Advantages

- Defects get repaired
- Wet weather flows to WWTP reduced
- Water pollution levels reduced
- One day repair time
- Minimal traffic control costs & detours
- Estimated cost \$3 million less than “Replace with New”
- Can be funded through existing revenues and SRF funds

# Alternatives Considered

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## **I&I Flow Reduction - Rehabilitation**

### Disadvantages

- Has estimated \$8.5 million cost
- 1588 manholes rehabilitated, not replaced



# Selected Alternative

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## **I&I Flow Reduction - Rehabilitation**

- Reduction in number of bypasses at WWTP
- Reduces bypass treatment costs
- Most cost effective alternative
- Maintains compliance with City's NPDES Permit requirements
- Preserves capacity in collection system for users
- Minimal environmental impacts



# Selected Alternative Details

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- Proposed 5 Year program of I&I repairs
- Estimated cost is \$8.5 million
- Funded through existing revenues
- Includes follow-up flow monitoring
- Includes second round of system evaluation
  - Recall this round of work was focused on just 60% of the identified I&I flows.

# 5 Year Defect Repair Schedule

Program Year	<u>Manholes</u>		<u>Cross Connects</u>		<u>Main Lines</u>		<u>Annual</u>
	Number	Cost (\$)	Number	Cost (\$)	Number	Cost(\$)	Cost (\$)
Year 1 FY 2013-14	322	1183771	17	53,763	Eng Fees	221,861	1,459,395
Year 2 FY 2014-15	322	1183771	0	-	60	826,860	2,010,631
Year 3 FY 2015-16	300	1102892	0	-	56	771,736	1,874,628
Year 4 FY 2016-17	322	1183771	0	-	0	-	1,183,771
Year 5 FY 2017-18	<u>322</u>	<u>1183771</u>	<u>0</u>	<u>-</u>	<u>0</u>	<u>-</u>	<u>1,183,771</u>
<b>Totals</b>	<b>1588</b>	<b>5,837,975</b>	<b>17</b>	<b>53,763</b>	<b>116</b>	<b>1,820,457</b>	<b>7,712,195</b>

Note: All costs per the RJN Report

# 5 Yr I&I Program – Cost Breakdown

Program Year	Defect Repair Costs	Verification Flow Monitoring	SSES Work Remaining 40% I&I	Annual Total Costs
Year 1 FY 2013-14	\$ 1,459,395			\$ 1,459,395
Year 2 FY 2014-15	\$ 2,010,631			\$ 2,010,631
Year 3 FY 2015-16	\$ 1,874,628	\$ 200,000		\$ 2,074,628
Year 4 FY 2016-17	\$ 1,183,771		\$ 600,000	\$ 1,783,771
Year 5 FY 2017-18	\$ 1,183,771			\$ 1,183,771
Totals	\$ 7,712,195	\$ 200,000	\$ 600,000	\$ 8,512,195



# This 5 Year I&I Program will:

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- Effectively repair 1588 manholes, 17 cross connections, and 116 main line segments, implement verification flow monitoring, and perform a second SSES effort related to the remaining 40% of the I&I flows
- Successfully accomplish reduction of I&I flows in the sewer system
- Accomplish flow reduction in a cost effective manner and within established local budget limits.
- Accomplish the flow reduction in an acceptable time frame
- Result in true reduction of water pollution levels in area waterways from sewage overflows and bypasses
- Maximize the available transport / treatment capacity of the City's sewer system for future development



# Cape Girardeau I&I Program

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- So, the City will be expending between \$1.5 and \$2 million in each of the next 5 years to reduce I&I flows.
- Recall this is just for public sector defects in about 30% of the collection system.



# Cape Girardeau I&I Program

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- It is evident that I&I flow reduction is a considerable commitment of time, manpower, and money.
- If you are already engaged with this work you know that.
- If you are not already engaged in it, be advised it is lurking your future.



## Summary

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- I&I Flows have specific impacts at treatment facilities. Impacts are usually negative.
- A well planned approach to identifying I&I Flows is necessary to efficiently use limited resources (\$).
- I&I Flow reduction can be achieved with significant positive impacts.



# Summary

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- I&I Flow Reduction is a long term effort.
- Even a well planned I&I Flow Reduction Program can be costly.
  - Field work
  - Repair work
- Some I&I Flow Reduction can be achieved with staff as evidenced in the 1994 – 2002 work.



## Summary

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- Evidence leads to speculation that I&I Flow Reduction will be an unending effort
- Said differently – One 5 year program will likely lead to the next 5 year program.



# Summary

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OUCH !!!

Don't like the sound of that!

Why does it have to be like that ??



# Summary

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- Clean Water Act -  
after 40 years the goals still have not been accomplished.
- Regulations will likely get more strict.
- System components will age and deteriorate causing more defects.
- O & M budgets continue to get tighter.



## Summary

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- These realities have led to programs like CMOM.
- These realities have resulted in enforcement actions like Compliance Orders, Penalties, Letters of Agreement, etc.
- These realities have led to expansion of water pollution control efforts to include stormwater runoff.



## Conclusion

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- Owners / Operators of sanitary sewer collection systems and treatment facilities will continue to face increasing demands and requirements for improved operation and maintenance of their wastewater systems.



# Conclusion

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- I&I Flow Reduction will be one of several efforts used to accomplish compliance with the current and future NPDES permits.



# Questions / Comments

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