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EPA SSOAP Toolbox – Evolution and Applications

Srini Vallabhaneni
CDM Smith, USA

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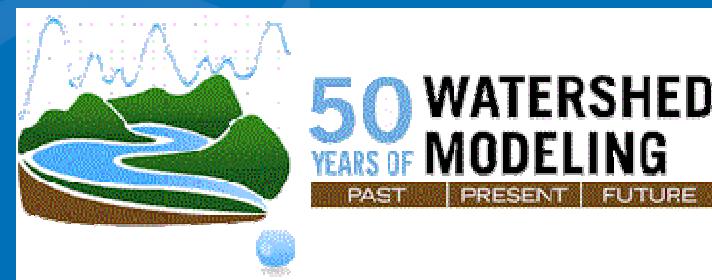


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EPA SSOAP Toolbox – Evolution and Applications

Presented by:

Srini Vallabhaneni, P.E., BCEE
CDM Smith Project Manager

EPA Project Officer:

Ari Selvakumar, Ph.D., P.E.

Office of Research and Development
National Risk Management Research Laboratory
Water Supply and Water Resources Division
Urban Watershed Management Branch, Edison, NJ

The National Center for Atmospheric Research

Boulder, Colorado, USA

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Office of Research and Development
National Risk Management Research Laboratory

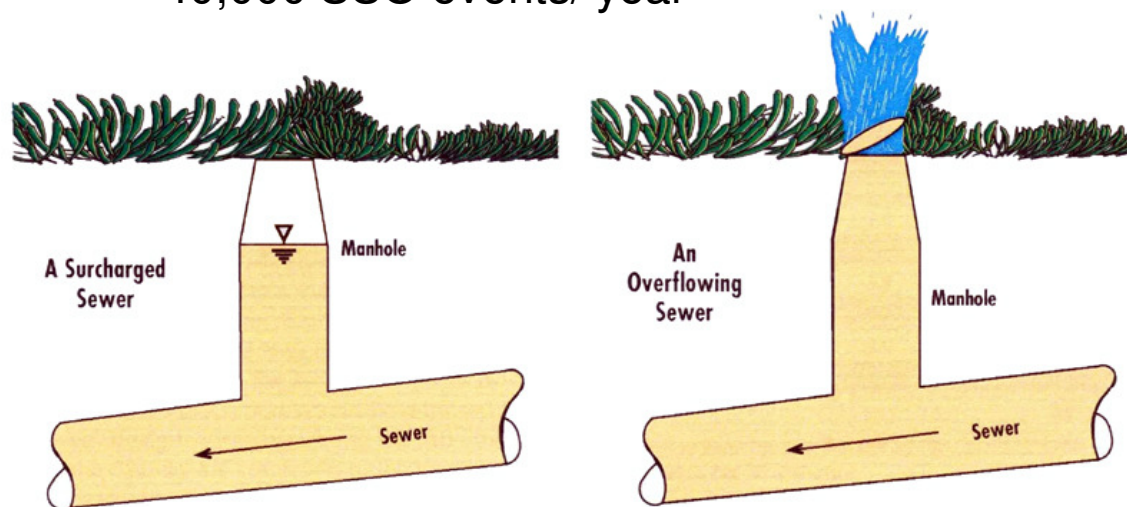


Presentation Outline

- Aging Infrastructure Challenges
- EPA Research and Development
- SSOAP Applications
- Current Status and On-going Efforts
- Contact Information

Aging Wastewater Infrastructure Challenges in the United States

- Aging sewers - risk of failure; performance problems - sanitary sewer overflows (SSOs)
 - some more than 100 years old
 - more than 19,500 sanitary sewer systems serving 150 million people
 - 50,000 sewer breaks/year
 - 500,000 stoppages/year
 - 75% of sewers operating at 50% capacity or less
 - 40,000 SSO events/ year

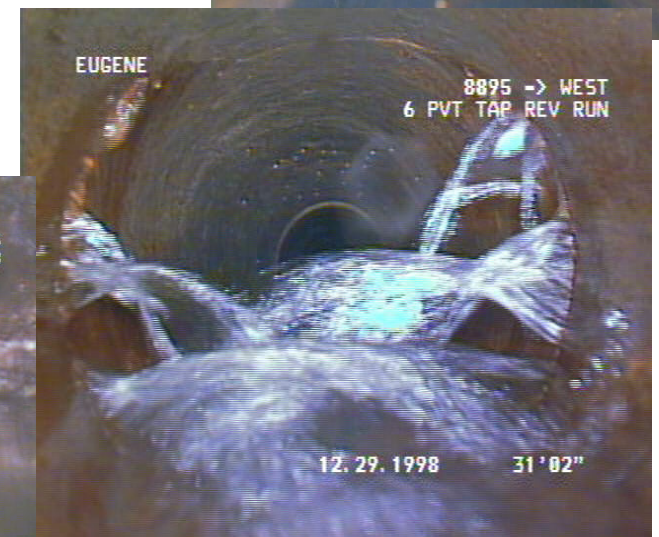
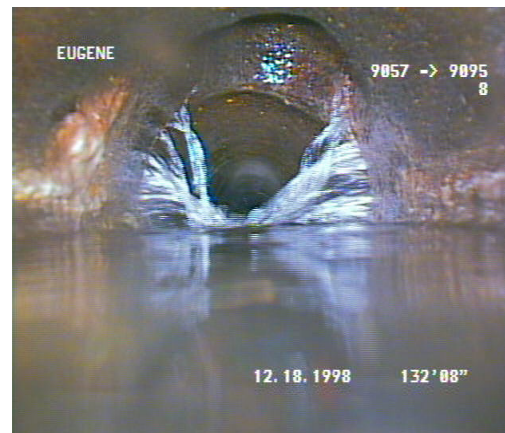


Sewer Capacity Can Be Exceeded During Wet Weather



Prime Culprit of SSO

- Rainfall Derived Infiltration and Inflow (RDII) that causes flows to exceed sewer capacity from:
 - **Poor sewer maintenance** - root intrusion, grease build up, debris
 - **Aging sewers** - defective joints, lines, manholes, missing manhole covers



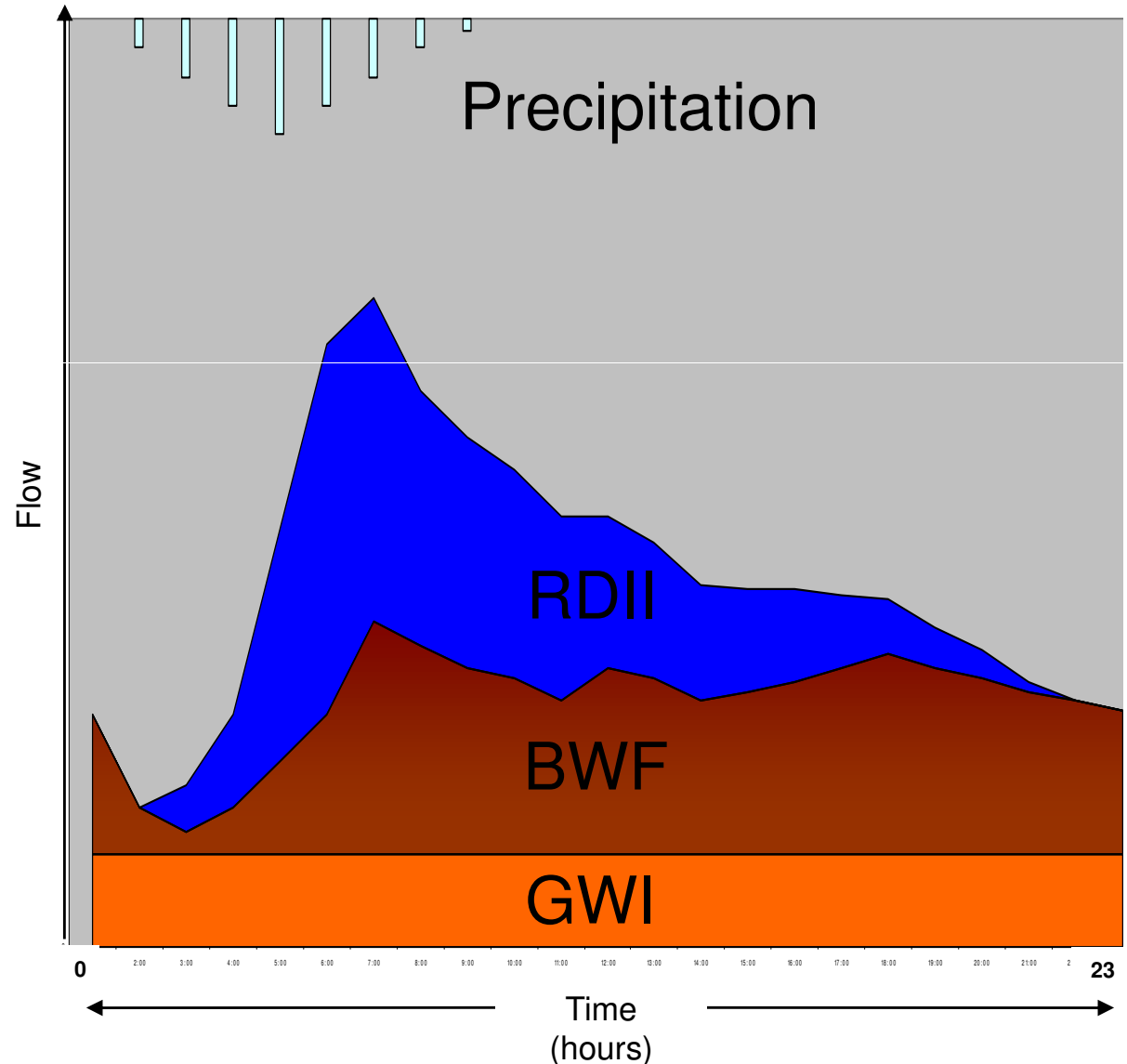
EPA Research and Development (2002 - 2008)

- R&D goal - develop guidance and tools:
 - methodology for assessing RDII
 - Sewer capacity and conditions assessment tools
 - SSO mitigation plans
- SSO CRADA (Cooperative Research and Development Agreement)

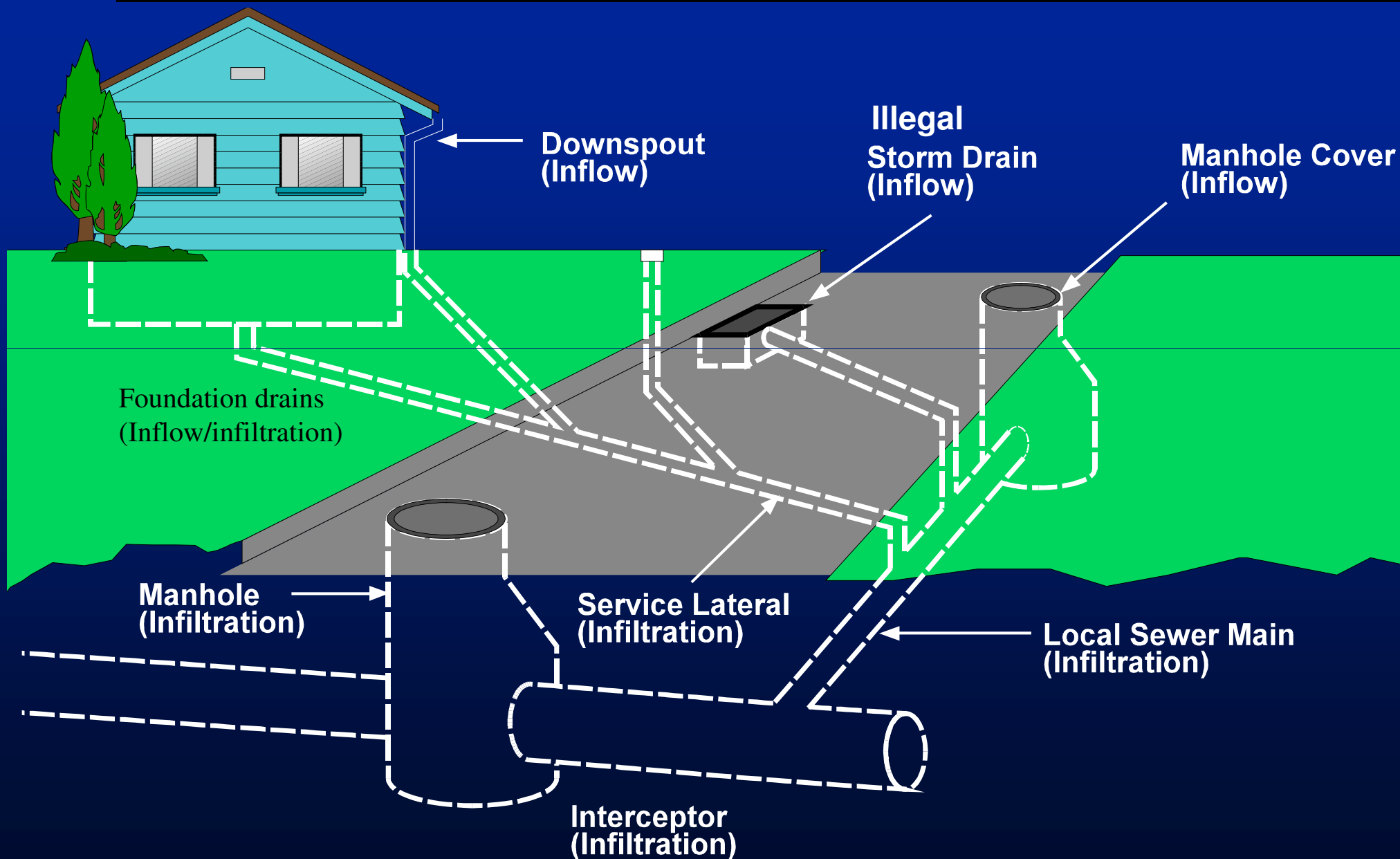


Components of Wet-weather Wastewater Flow

- **GWI – Ground Water Infiltration**
– f (season, river flow, tides)
- **BWF – Base Wastewater Flow**
– f (pop, land use)
- **RDII – Rainfall Derived Infiltration and inflow**
– f (rain, AMC)



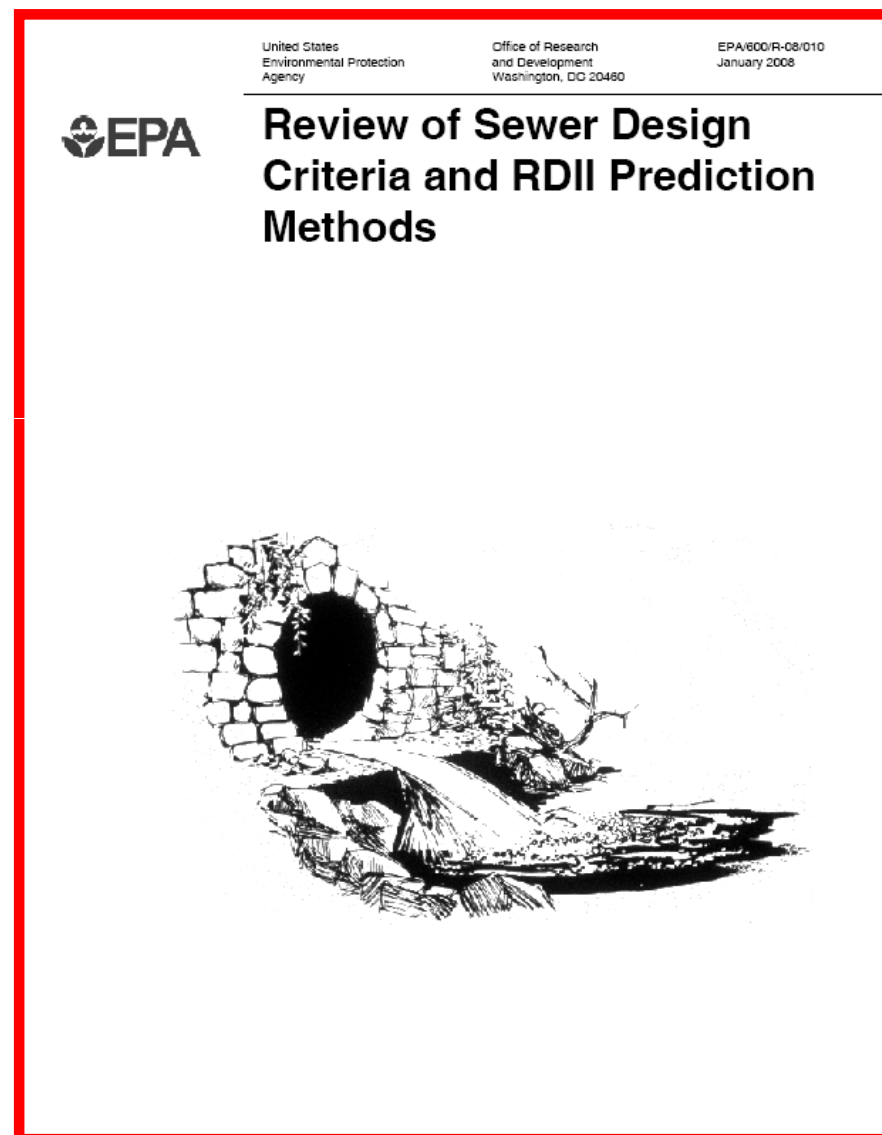
Collection System Components & Infiltration/Inflow Sources



CRADA Outcomes – Technical Report #1

- EPA Report,
EPA/600/R-08/010,
Jan 2008
- Website link:
<http://www.epa.gov/nrmrl/pubs/600r08010/600r08010.pdf>

Provide a literature review of RDII prediction methods and selection of the RDII method for SSOAP



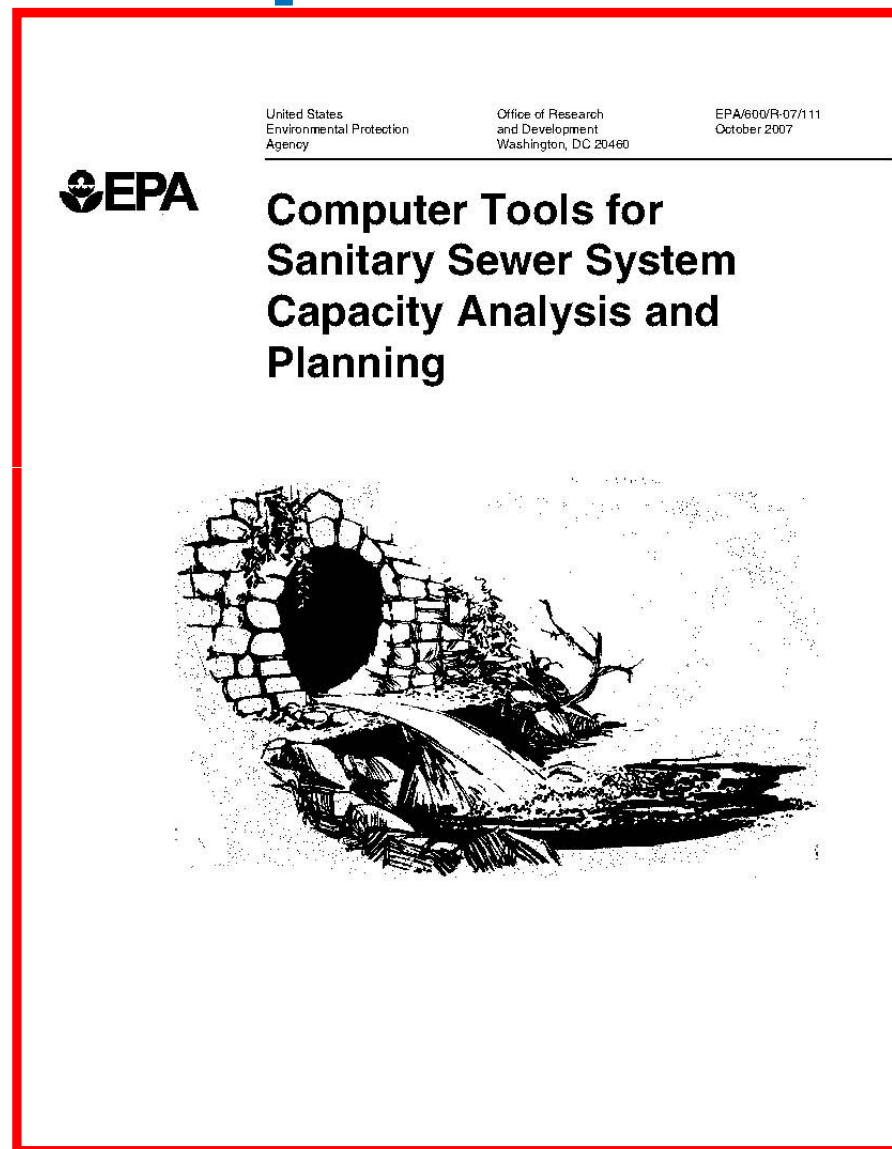


CRADA Outcomes – Technical Report #2

- EPA Report, EPA/600/R-07/111, Oct. 2007
- Website link:
<http://www.epa.gov/nrmrl/pubs/600r07111/600r07111.pdf>

A reference report for SSOAP users

An independent national technical panel provided critical review of the Toolbox and technical report



CRADA Outcomes – SSOAP Toolbox

Urban Watershed Management Research

U.S. ENVIRONMENTAL PROTECTION AGENCY

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Sanitary Sewer Overflow Analysis and Planning (SSOAP) Toolbox

- [Description](#)
- [Methodology](#)
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Description

Rainfall-derived infiltration and inflow (RDII) into sanitary sewer systems has long been recognized as a source of operating problems in sewerage systems. RDII is the main cause of sanitary sewer overflows (SSOs) to basements, streets, or nearby receiving waters and can also cause serious operating problems at wastewater treatment facilities. Thus, there is a need to develop proven methodologies and computer tools to assist SSO communities in developing an optimal capital improvement program that is in line with the projected annual capital budget and provides flexibility for future improvements. To assist municipalities in developing plans to mitigate SSO problems, the United States Environmental Protection Agency (USEPA) developed a public-domain Sanitary Sewer Overflow Analysis and Planning (SSOAP) toolbox. The SSOAP toolbox is a suite of computer software tools used for quantification of RDII and facilitating capacity analysis of sanitary sewer systems. The toolbox is currently interfaced with the USEPA Storm Water Management Model Version 5 (SWMM5) for performing dynamic routing of flows through the sanitary sewer systems.

The SSOAP toolbox was developed by the [Water Supply and Water Resources Division](#) of the USEPA's [National Risk Management Research Laboratory](#) from a cooperative research and development agreement (CRADA) with CDM Inc., a global consulting, engineering, construction, and operations firm.

⚡ Top of page

Methodology

SSOAP uses the synthetic unit hydrograph (SUH) approach for predicting RDII. Specifically, this approach employs the RTK method, as is used in SWMM5, to characterize the RDII response to a rainfall event. The selection of this method for quantifying RDII in the SSOAP toolbox is documented in the USEPA report "[Review of](#)

```

    graph TD
      RainfallData[Rainfall Data] --> DBTool[Database Management Tool]
      FlowMonitoring[Flow Monitoring Data] --> DBTool
      SewerbedData[Sewerbed Data] --> DBTool
      DBTool --> RDIIAnalysis[RDII Analysis Tool]
      DBTool --> HydrographGen[Hydrograph Generation Tool]
      DBTool --> SWMM5Int[SWMM5 Interfacing Tool]
      RDIIAnalysis --> SWMM5[SWMM5]
      HydrographGen --> SWMM5
      SWMM5Int --> SWMM5
      SWMM5 --> SSOAnalysis([SSO Analysis & Planning])
      OtherFCITools((Other FCI Tools)) --> SSOAnalysis
      OtherHydroModelEngines((Other Hydraulic Model Engines)) --> SSOAnalysis
  
```

This is a screen shot of the EPA SSOAP Toolbox Release 1.0. It contains five tools: 1) Database Management Tool, 2) RDII Analysis Tool, 3) RDII Hydrograph Generation Tool, 4) SWMM5 Interfacing Tool, and 5) SWMM5 Tool. These tools can help to analyze a sanitary sewer system.

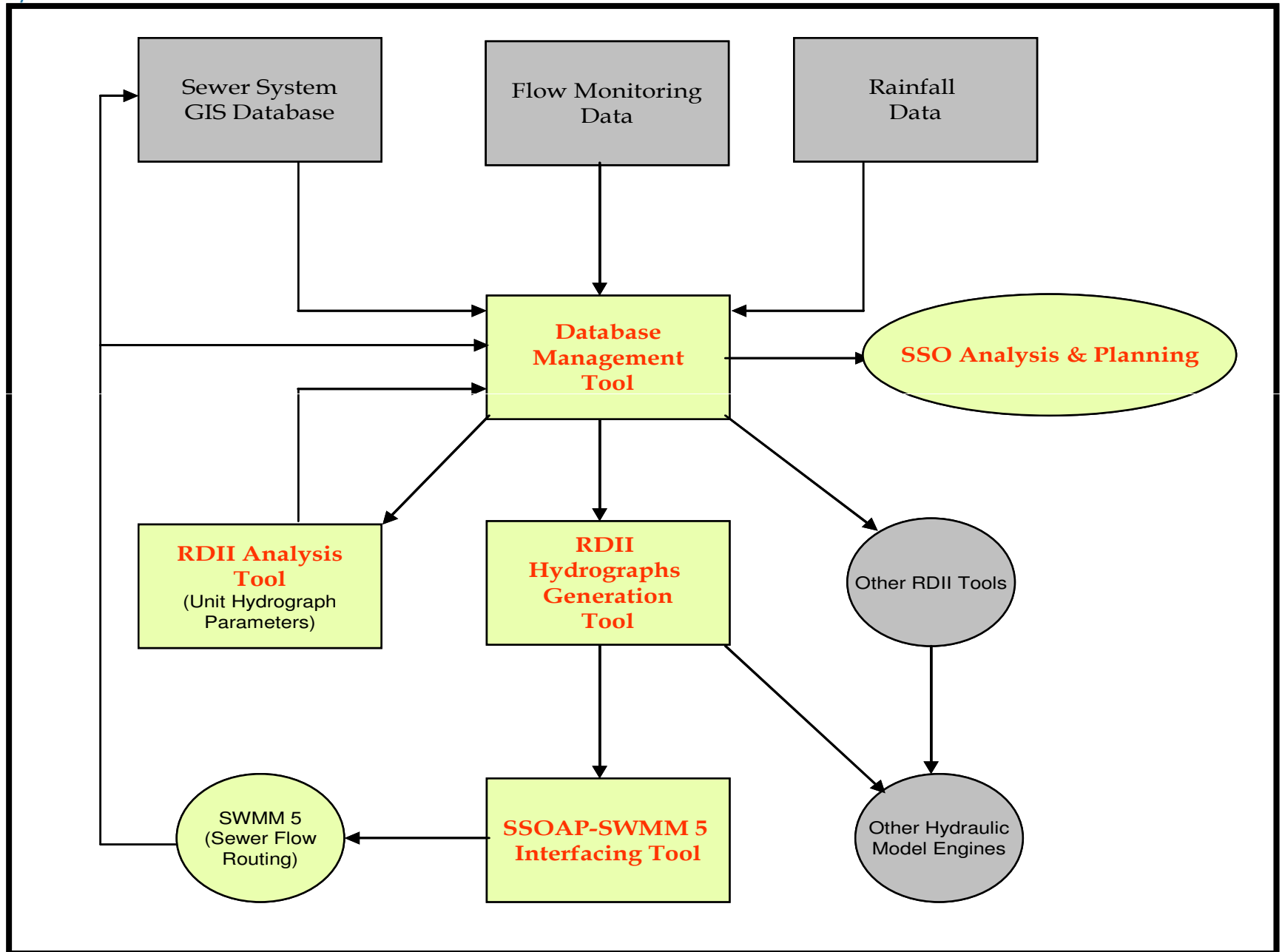
<http://www.epa.gov/nrmrl/wswrd/wq/models/ssoap/>

What is SSOAP Toolbox?

- The SSOAP Toolbox contains a suite of computer software tools
- It is designed to assist SSO communities to:
 - Assess sanitary sewer capacity problems, and develop mitigation solutions
 - Prioritization of subareas to perform field investigations for sewer condition assessment
 - Assess post-rehabilitation RDII



Overview of SSOAP Toolbox



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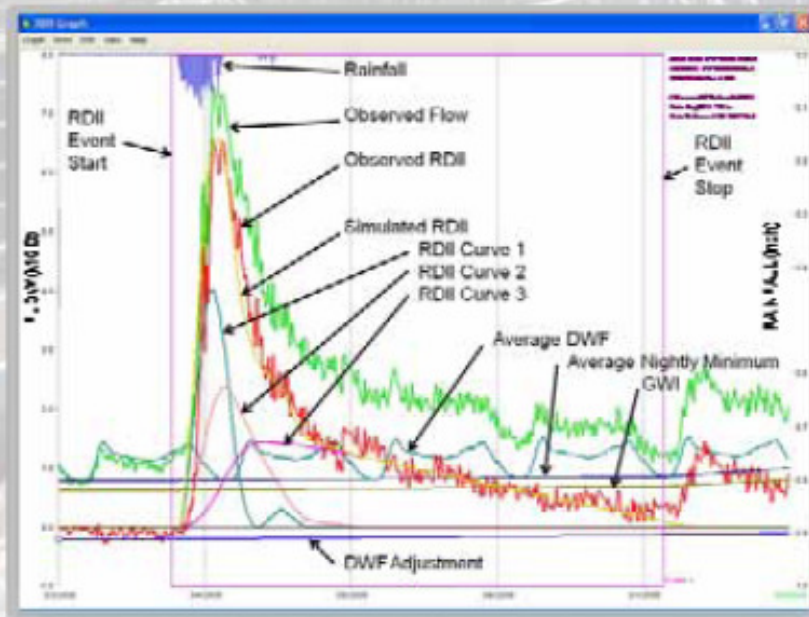
Research and Development (2009 – ongoing)



RESEARCH PROJECT

National Risk Management Research Laboratory
Water Supply and Water Resources Division
Urban Watershed Management Branch

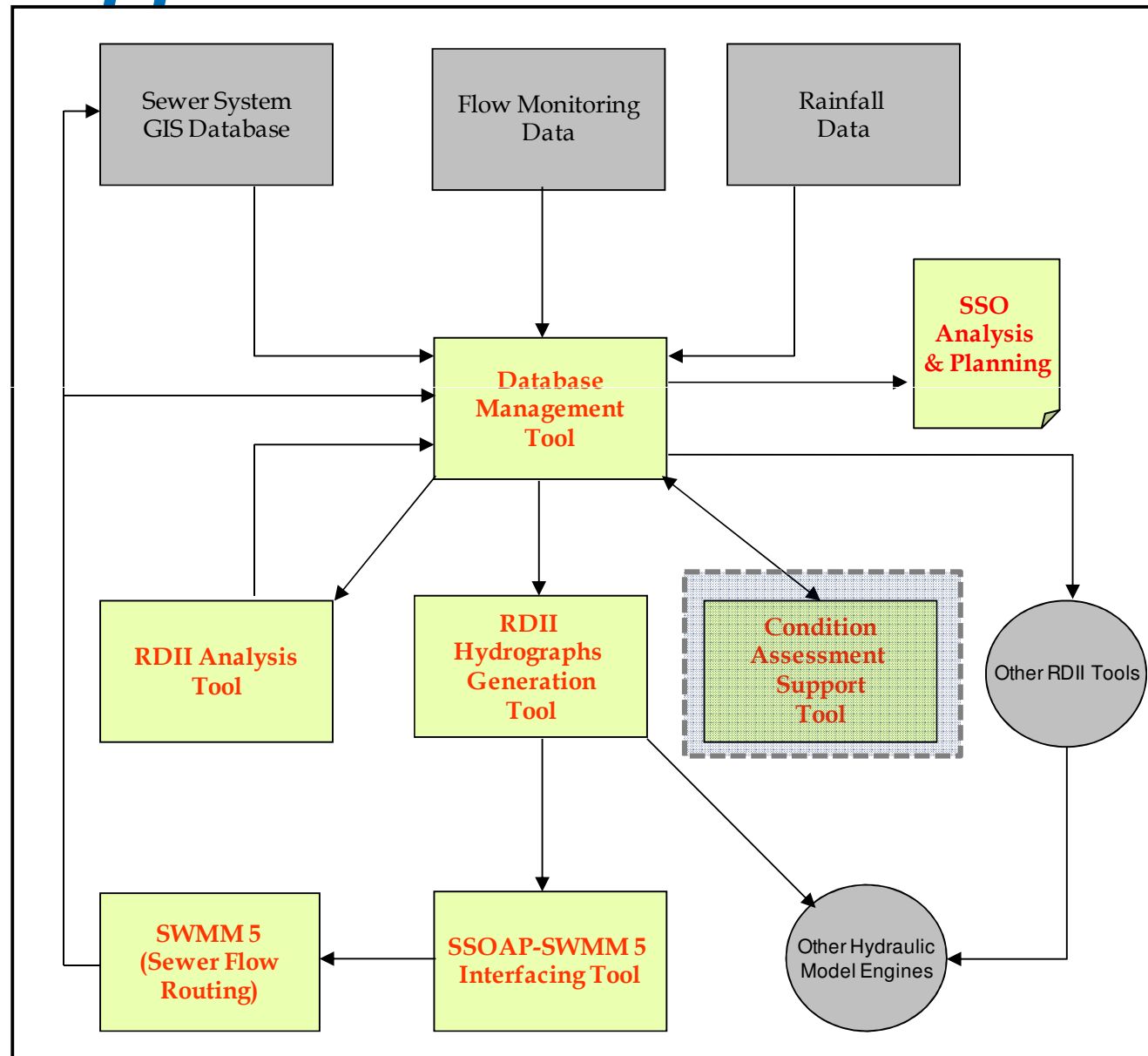
CONDITION ASSESSMENT OF WASTEWATER COLLECTION SYSTEMS USING THE SANITARY SEWER OVERFLOW ANALYSIS AND PLANNING (SSOAP) TOOLBOX



IMPACT STATEMENT

The Sanitary Sewer Overflow Analysis and Planning (SSOAP) Toolbox can serve as the foundation of wastewater collection system infrastructure research, among several applications, for analyzing monitored flow data to prioritize where to inspect, monitor, and to assess the performance of rehabilitation activities. In addition, it will support program offices in adding the conducting capacity, operation and maintenance requirements to the National Pollutant Discharge Elimination System (NPDES) permits and help municipalities identify sanitary sewer overflow problems and develop a sensible control plan to meet their NPDES permit requirements.

SSOAP Enhancements: Addition of *Condition Assessment Support Tool*



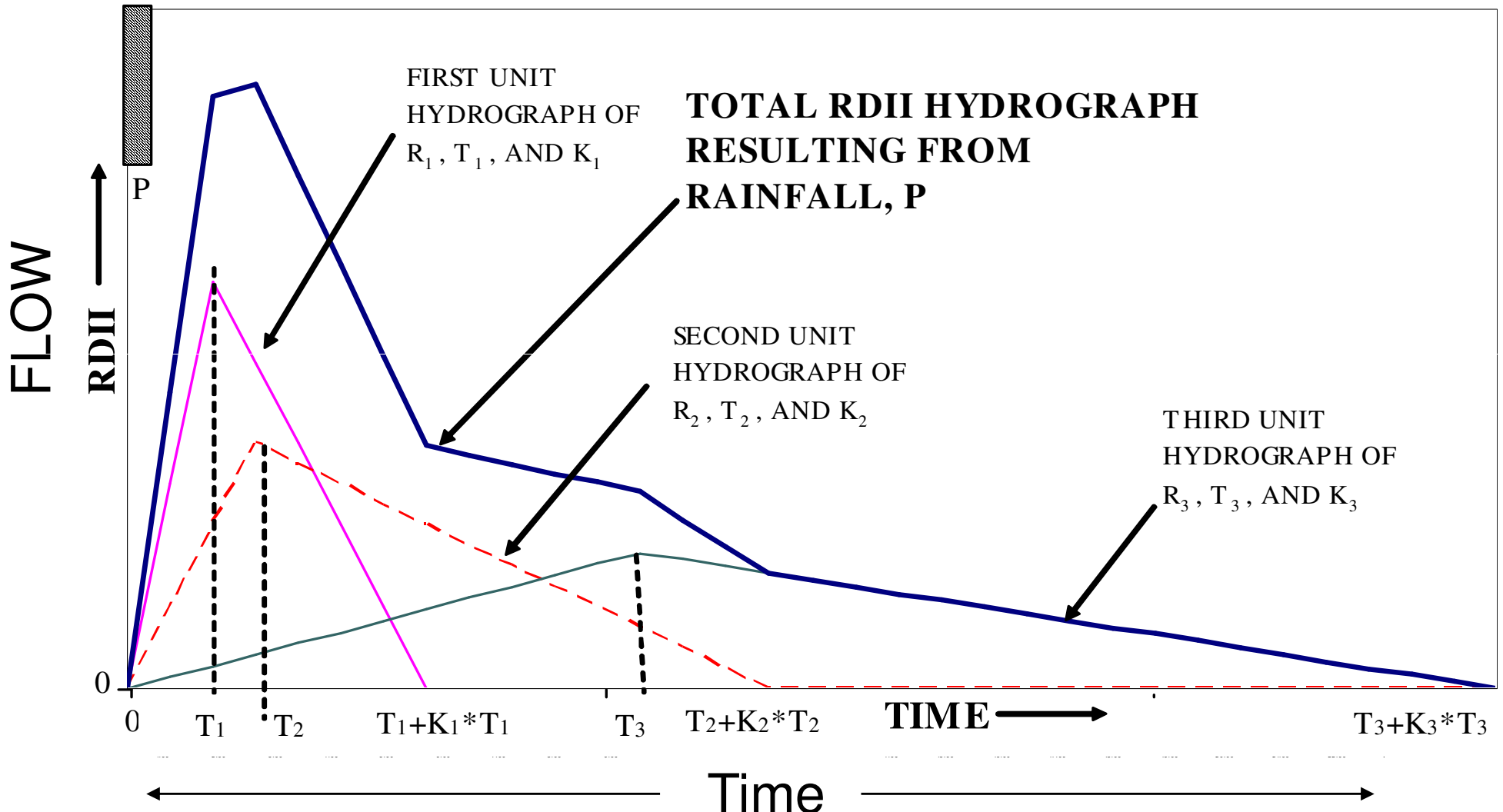


SSOAP Enhancements – Condition Assessment Support Tool

Objectives are to create a dedicated tool for:

- Developing priorities among different sewersheds and sub-sewersheds for designing a focused field investigation plan and subsequent sewer rehabilitation plan
- Assessing effectiveness of sewer rehabilitation programs using pre- and post-rehabilitation RDII correlations

SSOAP Synthetic Unit Hydrograph Method



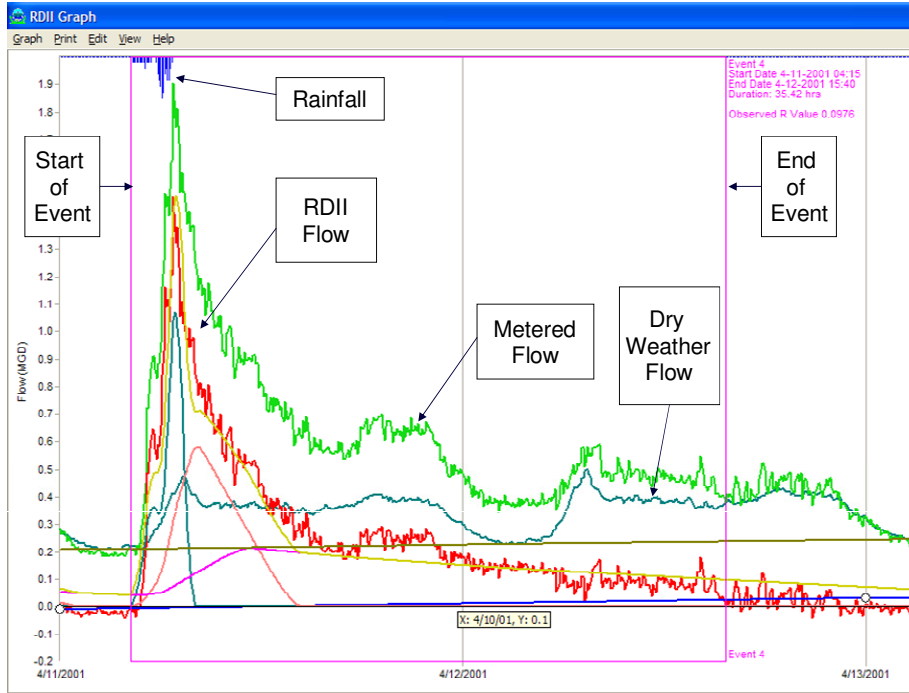
- R:** Percentage of rainfall that enters the sanitary sewer as RDII
- T:** Time to the peak flow
- K:** Ratio of the time to recession to the time to peak



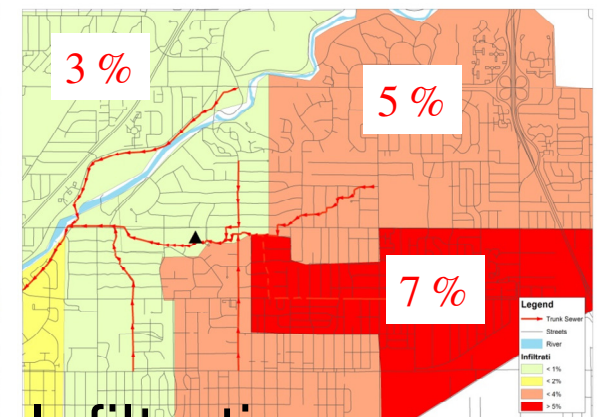
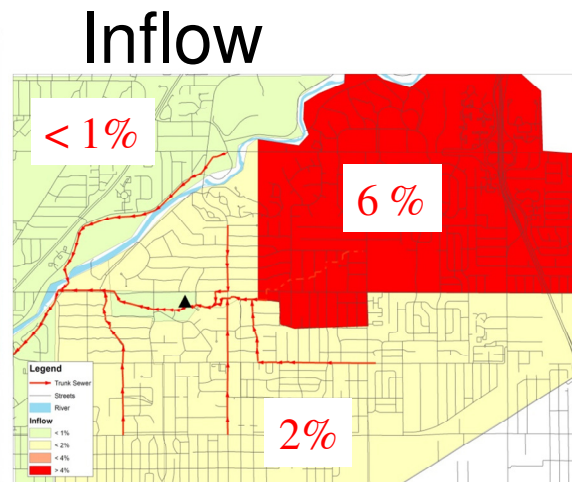
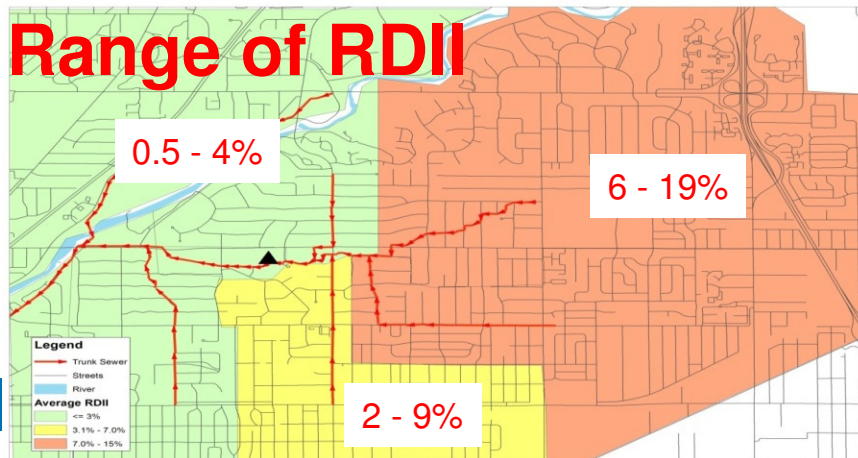
SSOAP Applications



RDII Assessment

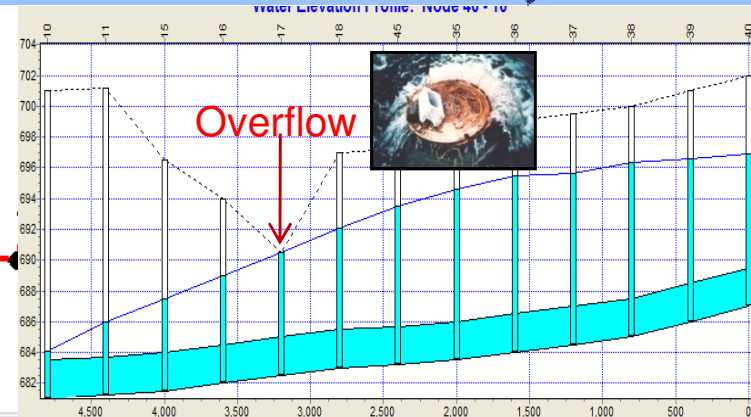
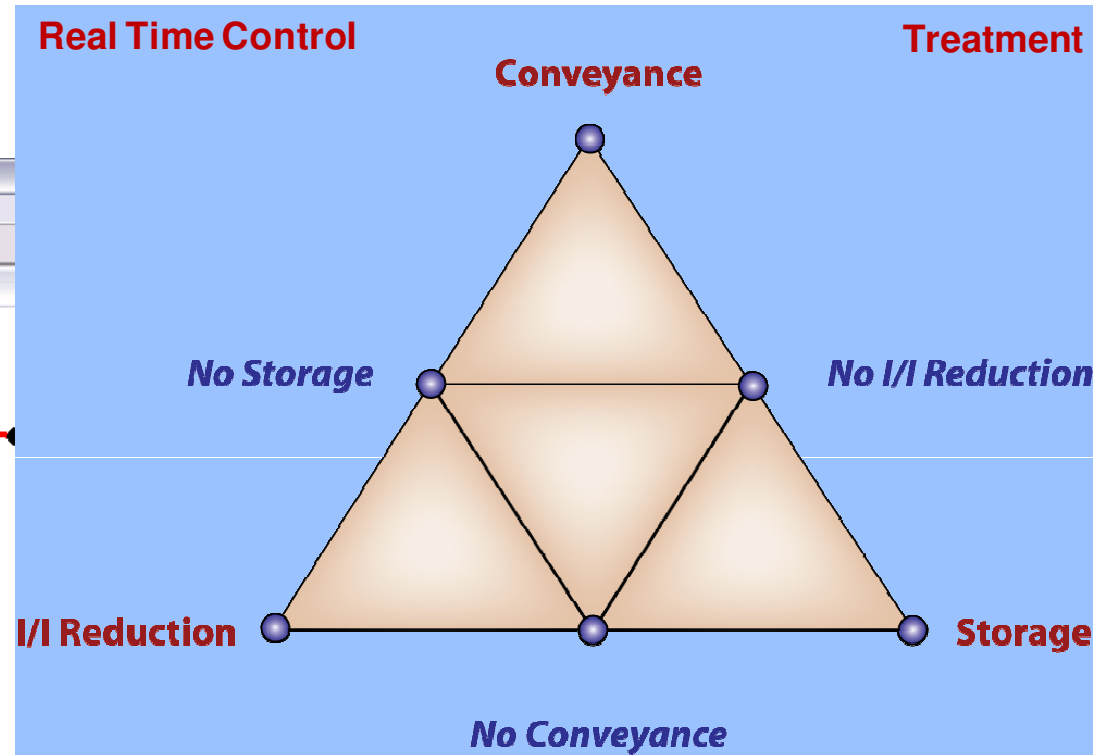
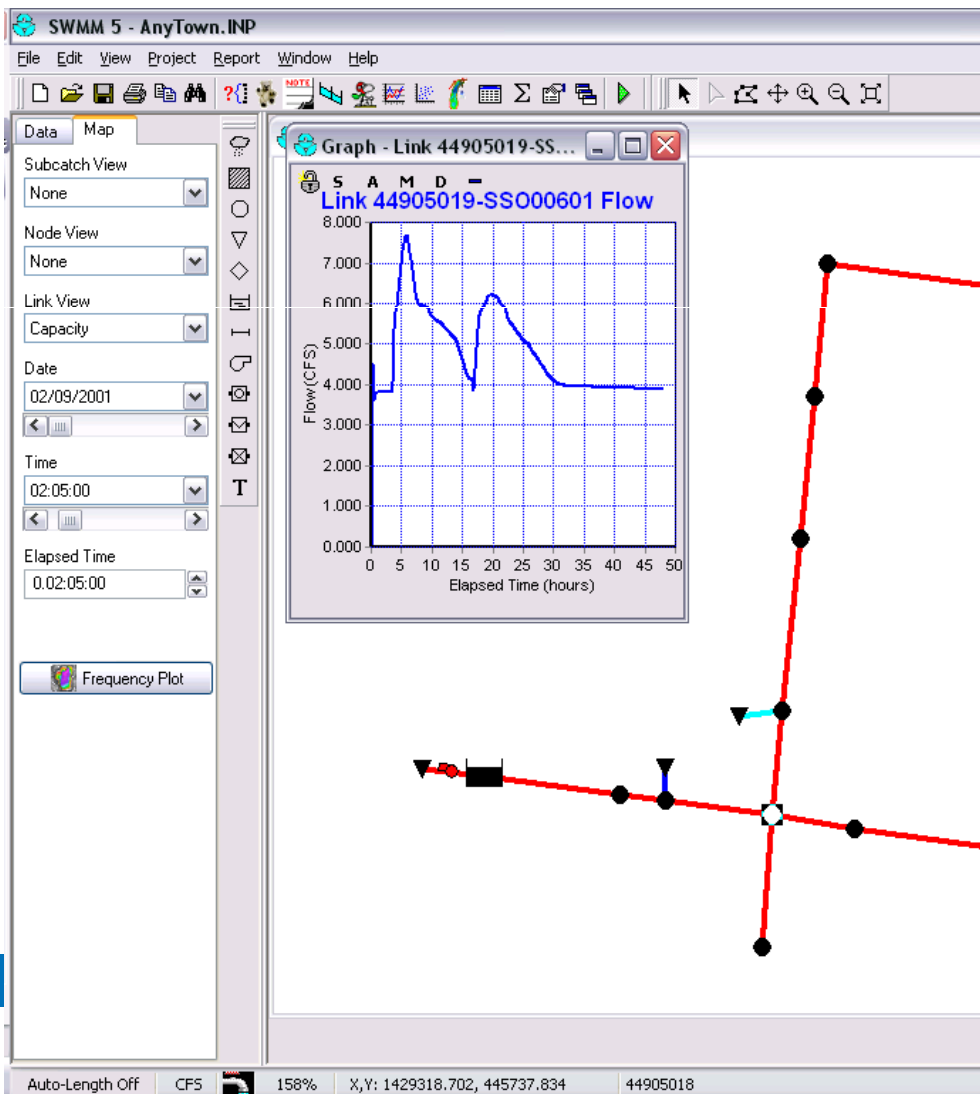


Event No.	Start Date/Time	Total Volume (in)	Duration (hr)	Peak Intensity (in/hr)	AMC (Days)	10-day Antecedent Rainfall volume (in)	Return Period (based on total volume)	Total R	R1	R2	R3	T1	T2	T3	K1	K2	K3
1	April 22, 2005	2.88	31	0.73	0.9	6.9	1-year	9.2%	1.0%	2.2%	6.0%	1	6	9	2	5	6
2	April 26, 2005	0.6	18	0.18	2.6	3.2	<2-month	5.0%	1.0%	1.0%	3.0%	1	5	8	2	5	5
3	May 11, 2005	0.13	9	0.05	12	0.0	<2-month	1.3%	0.2%	0.5%	0.6%	1	4	8	1.9	4	6
4	May 13, 2005	1.05	21	0.21	1.4	0.1	<2-month	3.0%	0.5%	1.2%	1.3%	1	5	9	2	4	5
5	May 19, 2005	0.21	8	0.07	4.8	1.2	<2-month	2.5%	0.5%	0.9%	1.1%	1.2	4	8	1.8	5	6
6	May 19, 2005	0.15	2	0.11	0.3	1.4	<2-month	2.9%	0.5%	1.0%	1.4%	1	4	7	1.8	5	5
7	June 11, 2005	0.97	75	0.09	22.1	0.0	<2-month	4.3%	0.7%	1.5%	2.1%	1.2	5	8	1.9	4	6
8	June 28, 2005	1.48	4	1.3	13.7	0.0	6-month	4.8%	1.0%	1.3%	2.5%	1	6	7	2	5	6
9	June 29, 2005	0.28	4	0.19	0.7	1.5	<2-month	2.8%	0.5%	1.1%	1.2%	1.2	5	8	2.1	4	5
10	July 16, 2005	0.36	2	0.34	2.9	0.4	<2-month	2.2%	0.4%	0.7%	1.1%	1	5	9	2.2	4	6
11	July 16, 2005	2.64	10	1.19	0.4	0.8	2-year	5.3%	1.5%	1.6%	2.2%	1	4	8	1.9	5	6
12	July 21, 2005	2.46	5	1.16	2.8	3.2	5-year	6.2%	1.5%	1.5%	3.2%	1	6	7	2	4	5

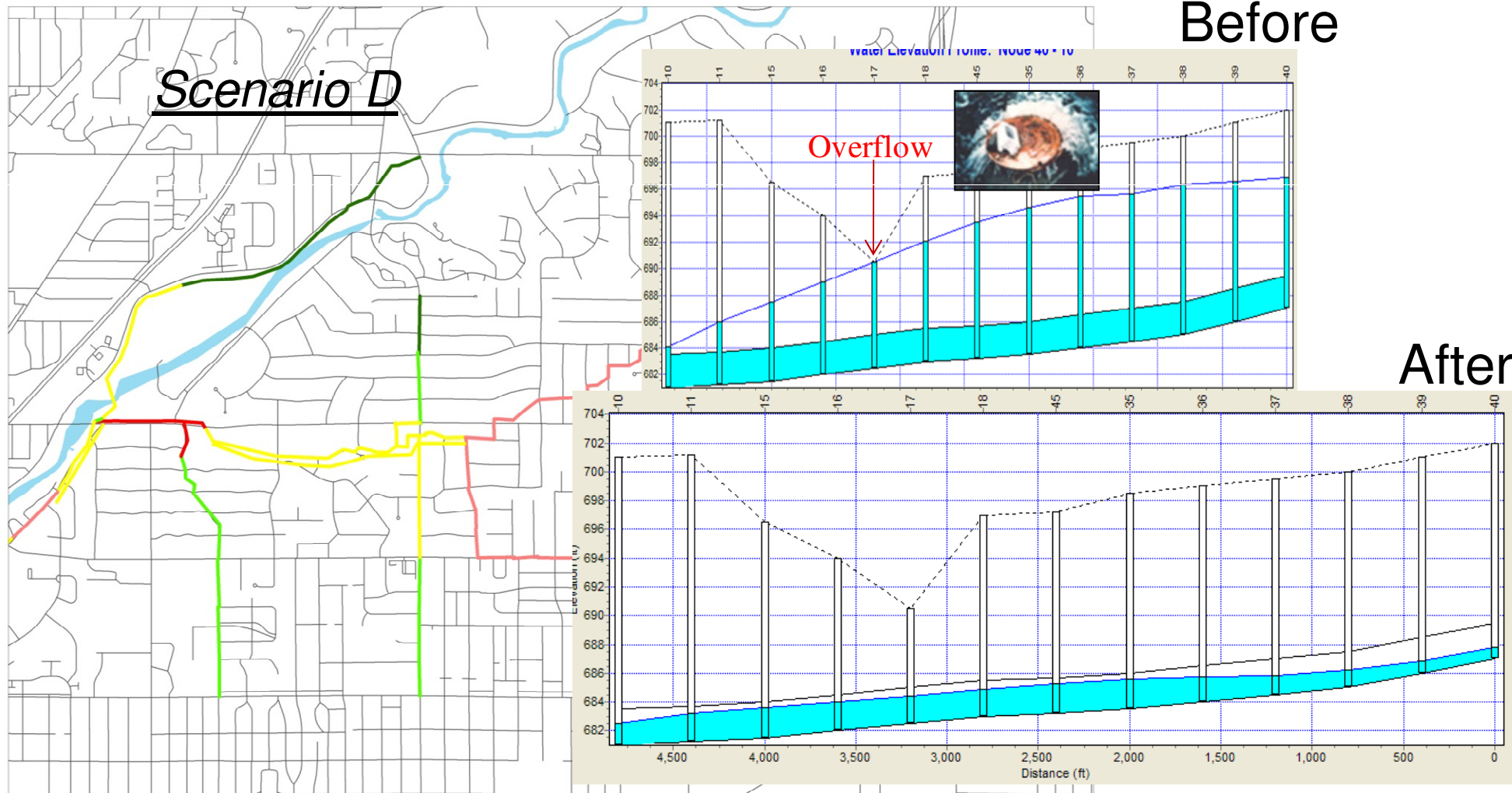


Infiltration

Sewer System Modeling - Alternative Improvement Analysis

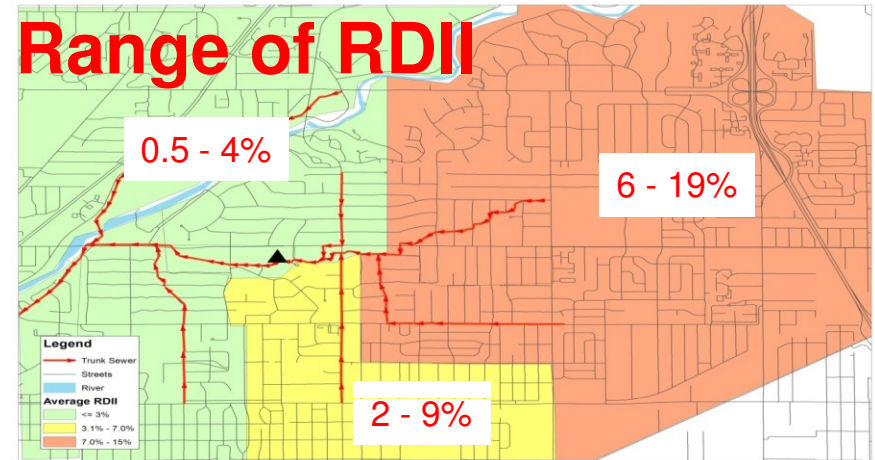


Capacity Assessment and Assurance

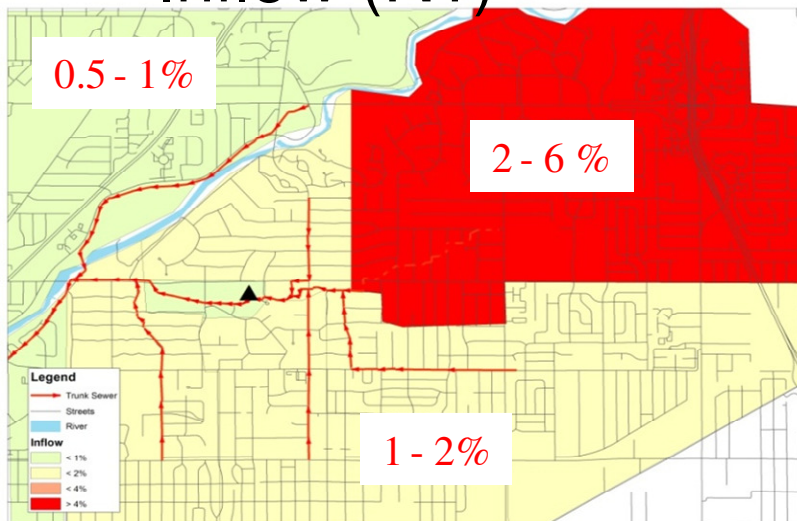


Sewer Condition Assessment and Rehabilitation Prioritization

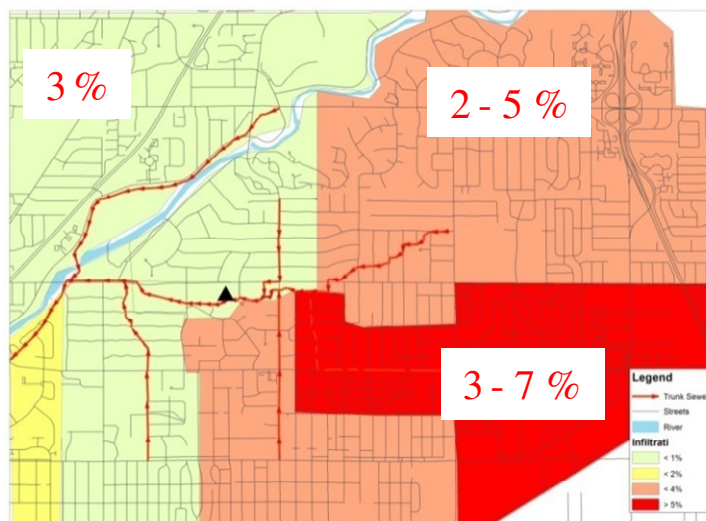
Prioritized subareas to perform field investigations to assess sewer condition and subsequent rehabilitation



Inflow (R1)

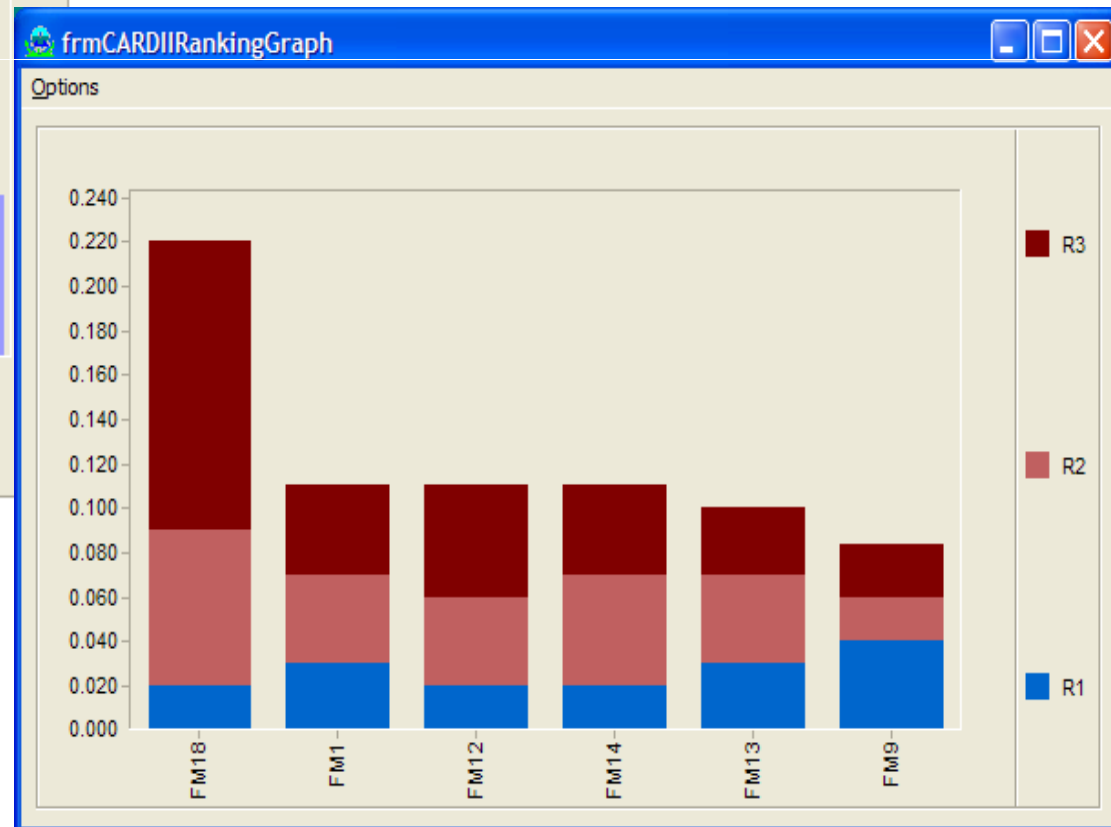
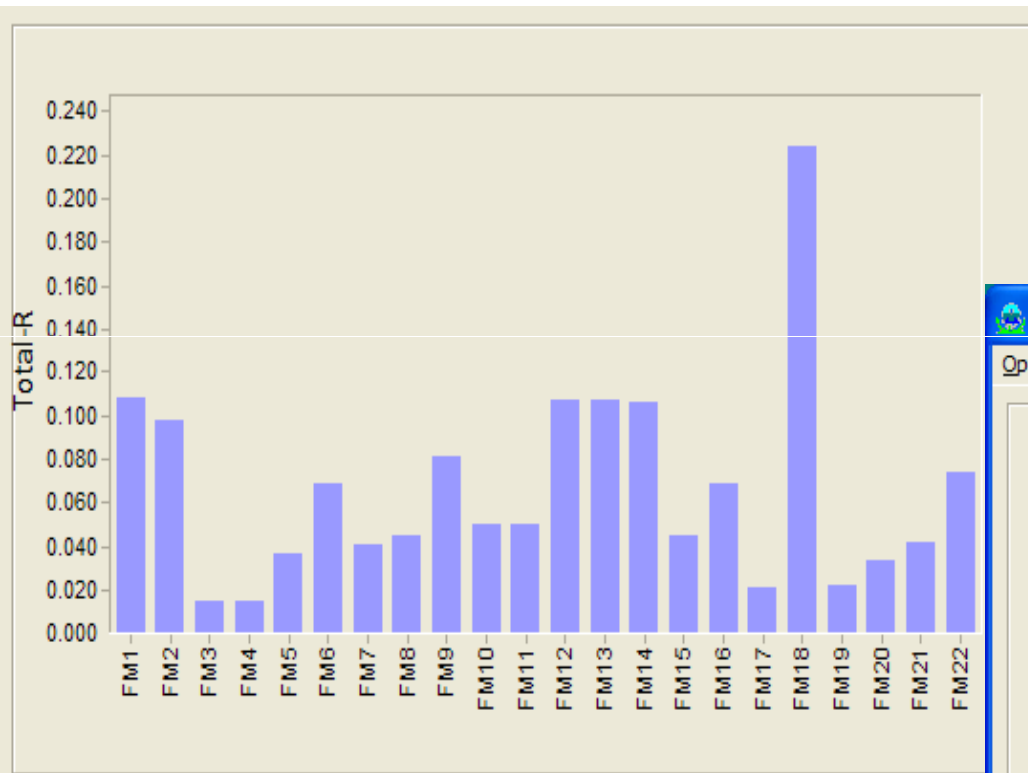


Infiltration (R3)



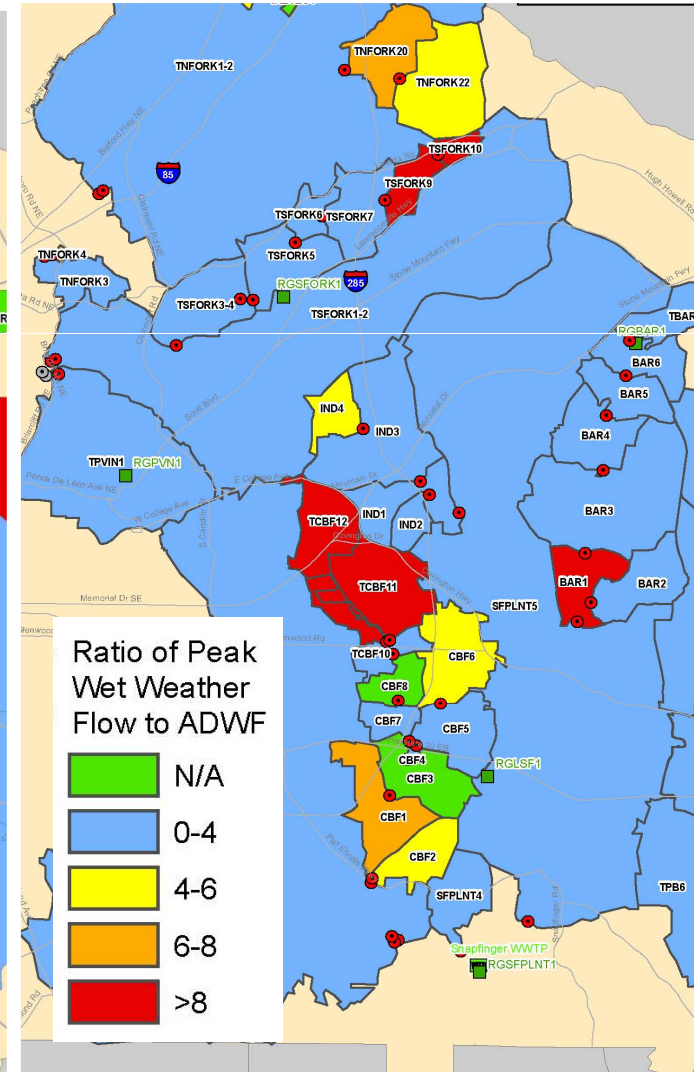
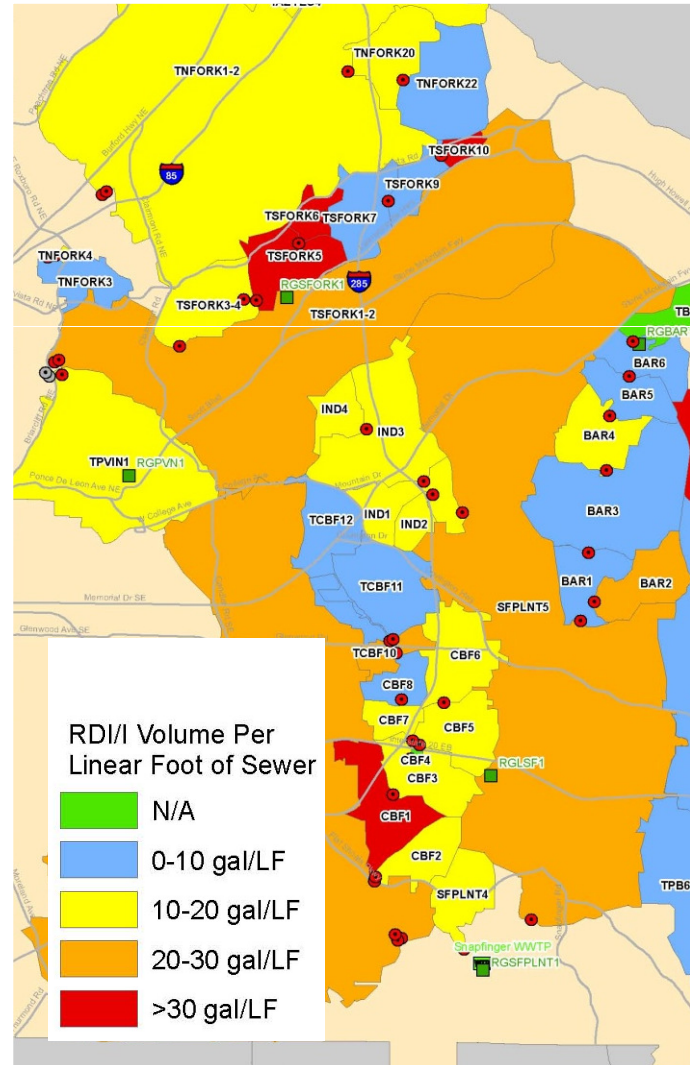
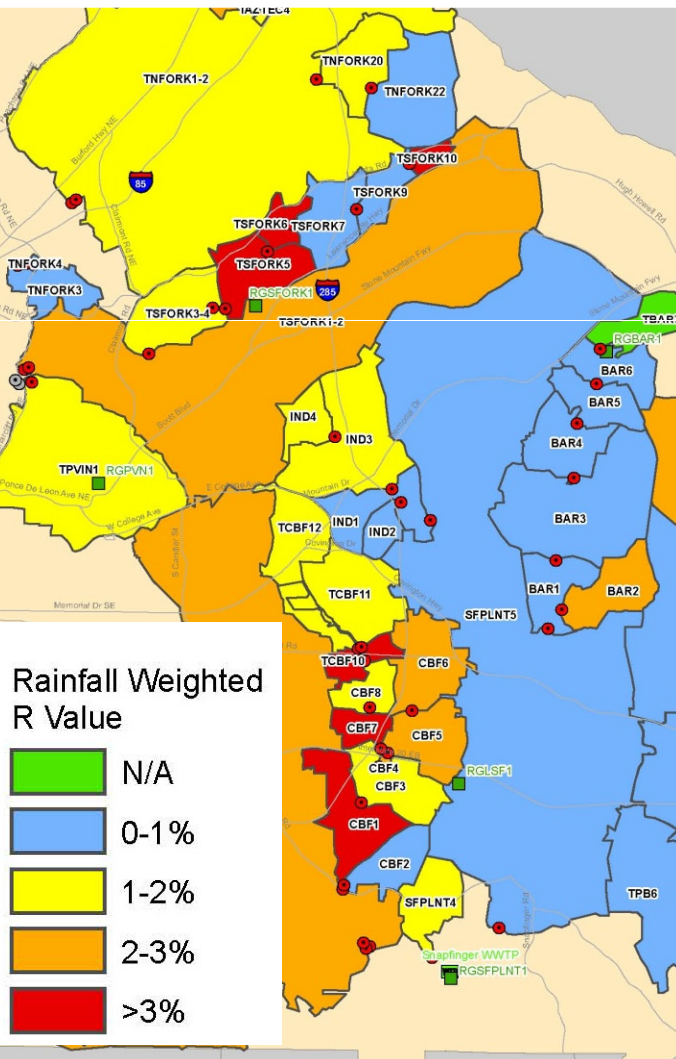
- Prioritization by:
 - Total RDII
 - Inflow
 - Infiltration

Sewershed Comparisons with Relative Inflow and Infiltration Contributions



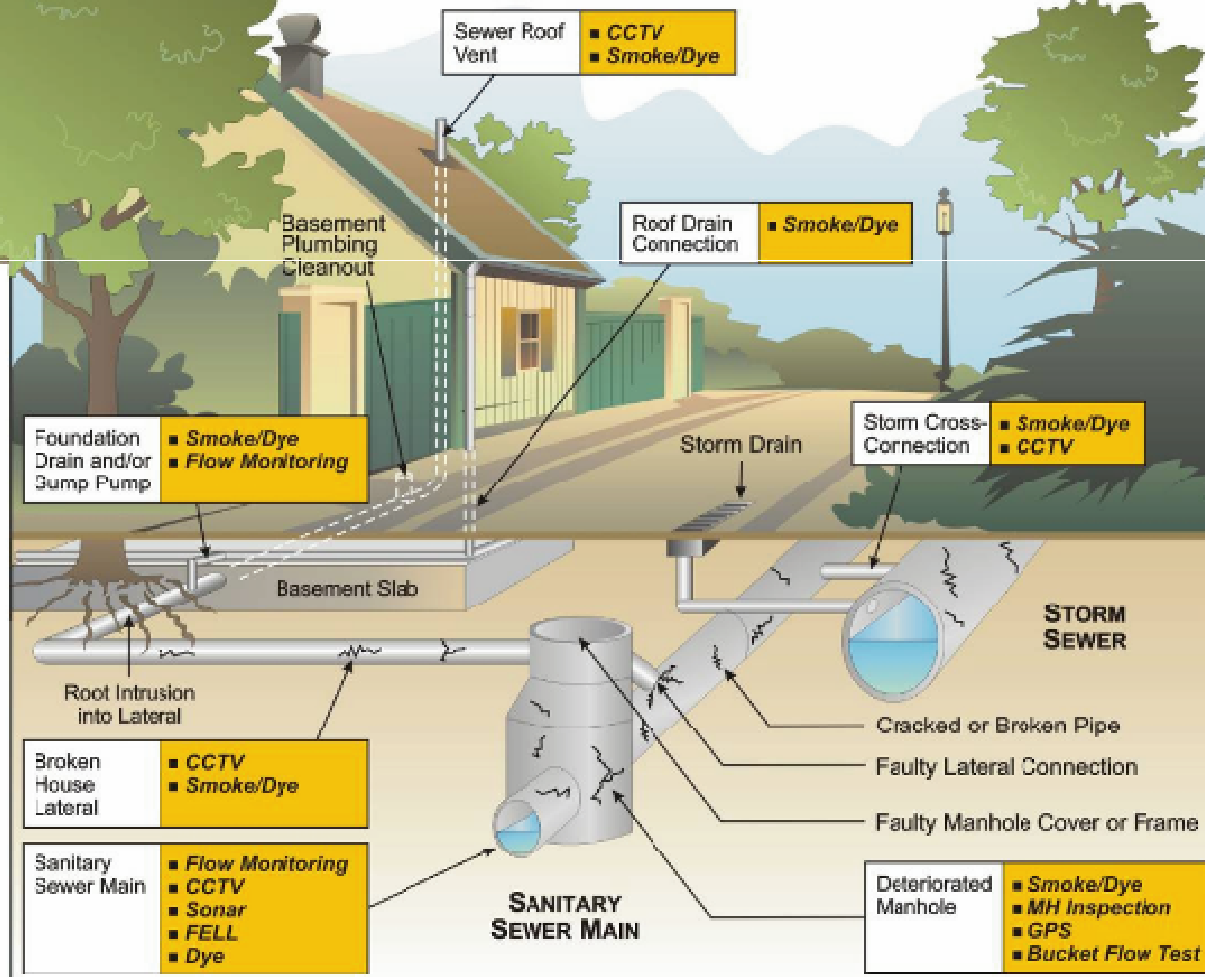
Field Investigation Priorities

– Varying Metrics



Focused Field Investigations

I/I INVESTIGATION TOOLS

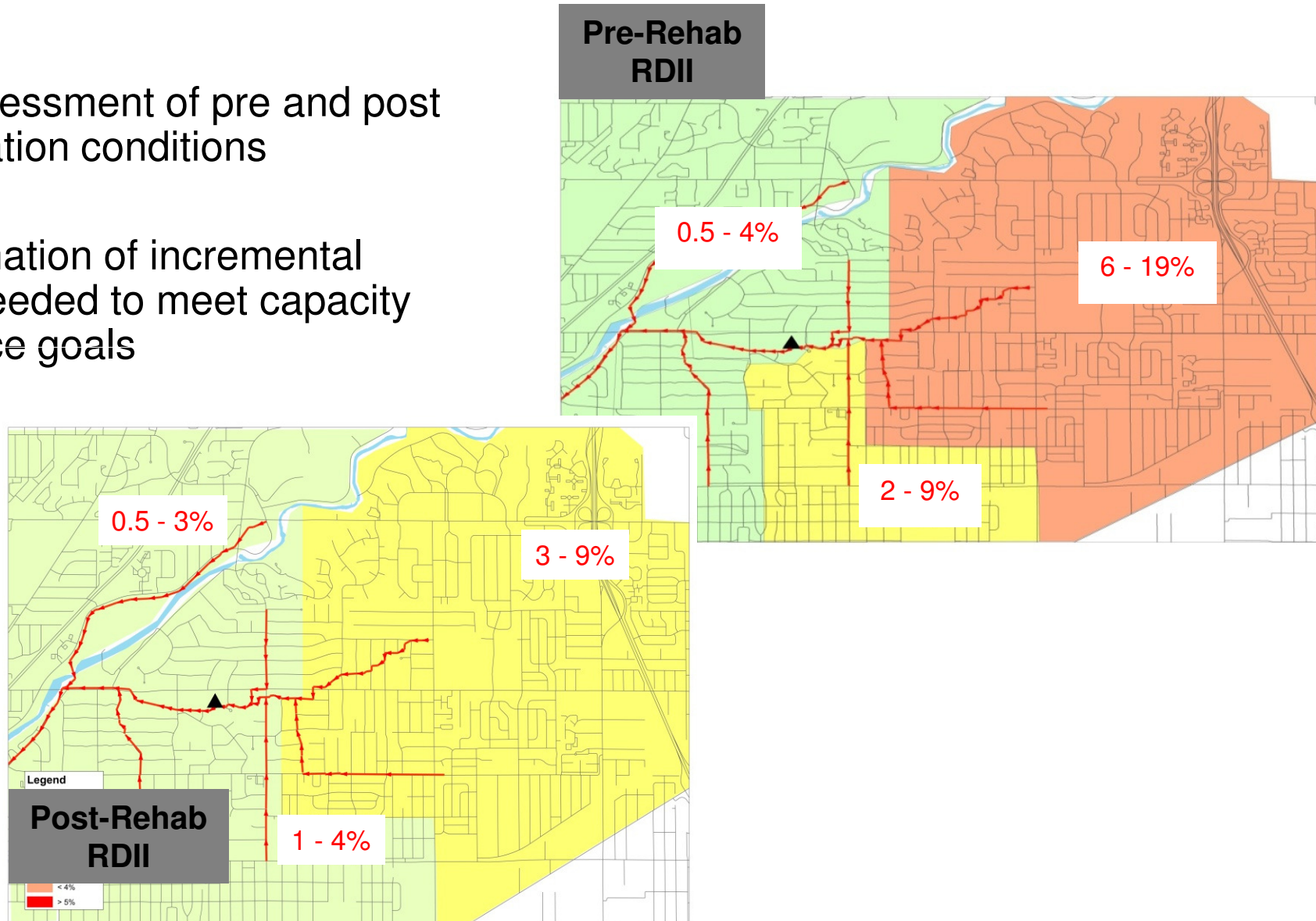


SSOAP Toolbox designed to assist prioritizing portions of the sewer systems and help select proper I/I investigation tools

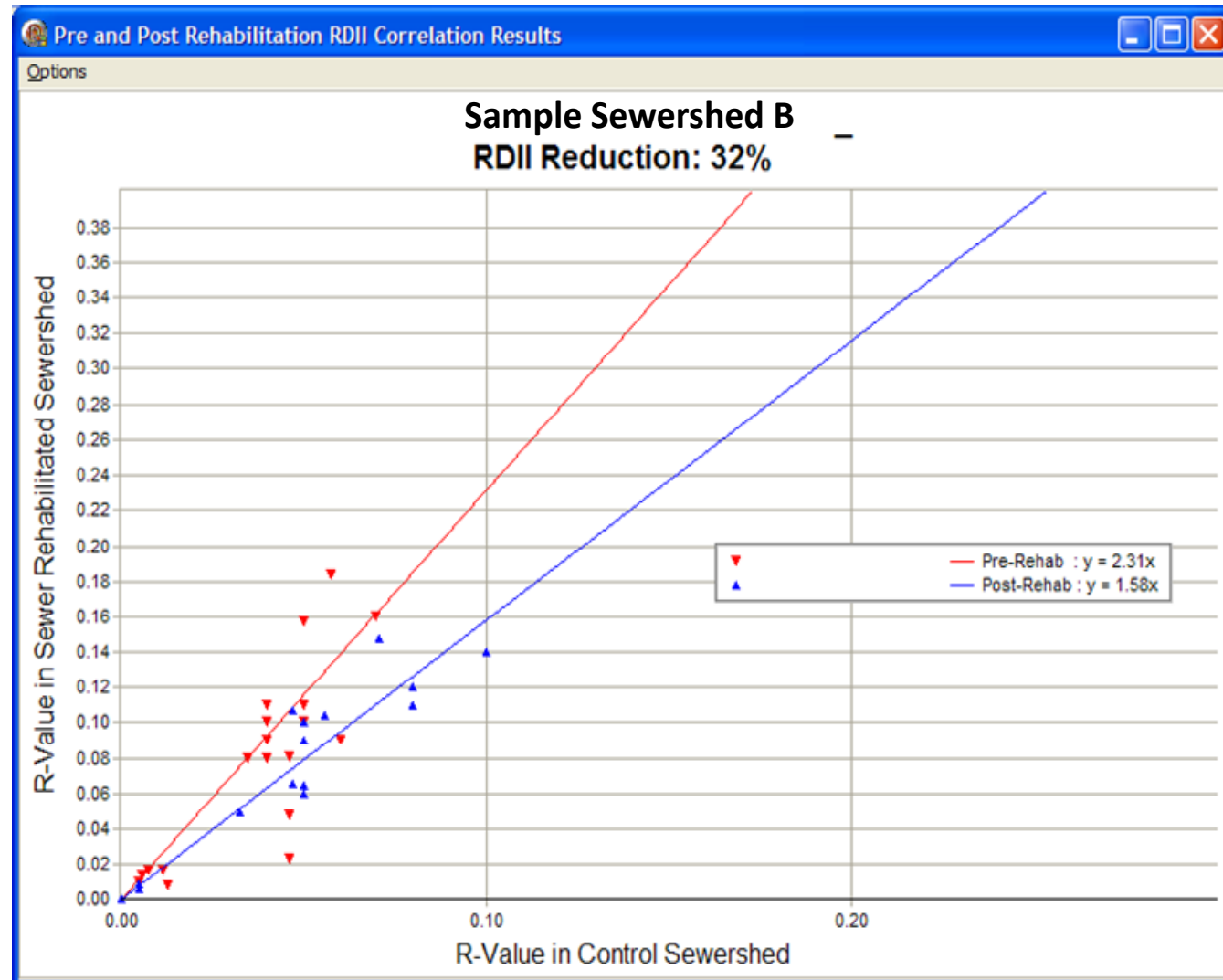
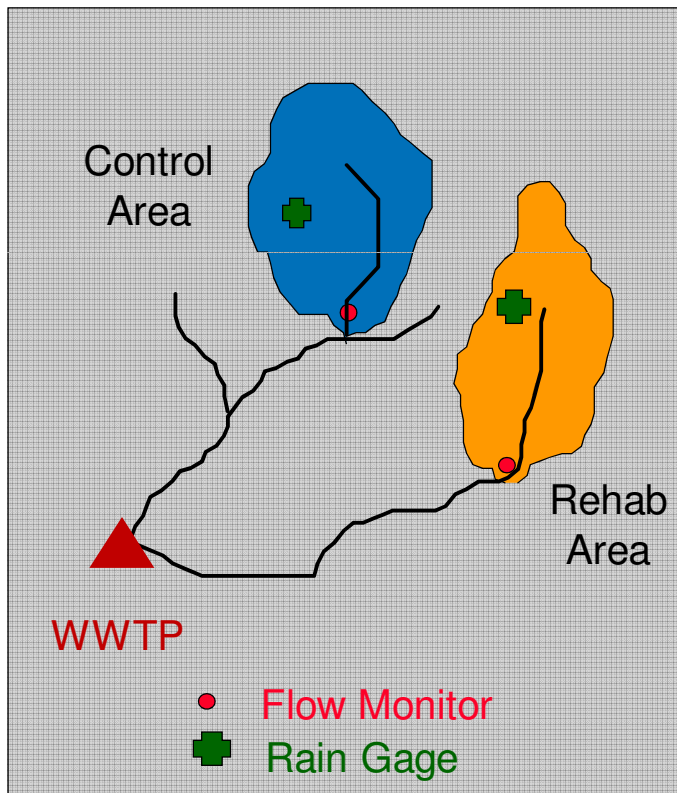
- Save program \$\$
- Collect meaningful data

Post-Rehabilitation RDII Assessment

- RDII Assessment of pre and post rehabilitation conditions
- Determination of incremental efforts needed to meet capacity assurance goals



Confirmation of Rehabilitation Effectiveness (Correlation of RDII Between Rehab and Control Sub-basins)





SSOAP R&D Status and Ongoing Efforts

- 2009-2012:
 - SSOAP training workshops
 - Provide users support
 - Enhance SSOAP to facilitate condition assessment applications – Condition Assessment Support Tool
 - Technical Report: SSOAP Enhancements and Case Study



For information on research and tools:

Dr. Ari Selvakumar, EPA
selvakumar.ariamalar@epa.gov

Srini Vallabhaneni, CDM Smith
VallabhaneniS@cdmsmith.com

Technical support team
SSOAP@cdmsmith.com

Thank You