

**Challenges and Effectiveness of I/I Reduction on
Private Property and in Component Agency Systems for 10
Pilot Projects**



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November 23, 2004

I/I in the Service Area

☁️ 75% of Peak Flows in King County System is I/I

☁️ 95% of I/I is from Local Agencies

☁️ 50% From Private Property



I/I Program Objectives

-  A Regional Consensus Program
-  Determine the Amount of I/I Received by King County from Entire Separated Sewer Area
-  Identify Major I/I Areas Within Collection Systems
-  Identify Specific Types of I/I Occurring Within These Areas
-  Forecast the Amount of I/I that can be Removed Cost-Effectively
-  Develop a Long-Term Regional Strategy for I/I Control in Partnership with Local Agencies

RWSP I/I Policies

-  “...pilot rehabilitation projects shall be used to demonstrate the effectiveness of I/I controls in the local sewer systems tributary to the regional system.”
-  A report identifying options and the associated costs of removing I/I and preventing future increases should be “informed by the results of the pilot rehabilitation projects...”

Purpose of Pilot Projects

-  To Provide Information That Will Assist in Determining if I/I Removal is Cost-Effective
-  To Demonstrate & Test the Effectiveness of Different Techniques for I/I Removal
-  To Provide Models for Successful Future Projects
-  To Test Standards, Policies & Procedures

Pilot Project Selection Criteria

- #1 – Geographic Balance
- #2 – Meet constructability time frames for the I/I program, including permitting needs
- #3 – Consider differing geologic conditions/do no harm
- #4 – Provide environmental/public health benefits
- #5 – Address private sewer issues
- #6 – Provides a regional impact
- #7 – Useful as a model for future I/I projects
- #8 – Demonstrate variety of proven technologies and rehabilitation techniques
- #9 – Representative of typical I/I problems in the region
- #10 – The “Wild Card” criteria – project contributes to program goals but conditions were not anticipated during criteria development

Pilot Project Overview



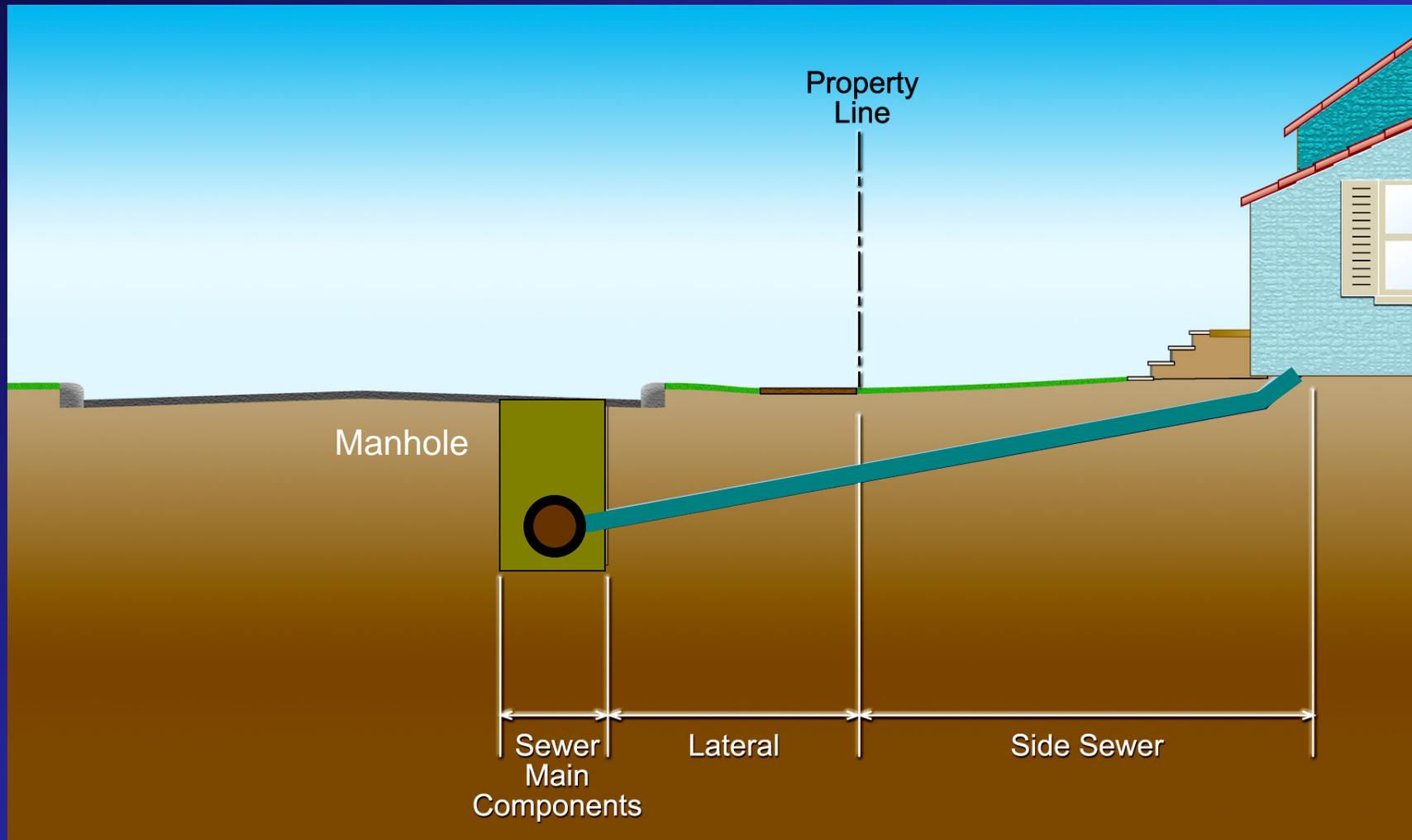
- ☁️ Auburn
- ☁️ Brier
- ☁️ Kent
- ☁️ Kirkland
- ☁️ Lake Forest Park
- ☁️ Manhole Project (Coal Creek, Northshore, Val Vue)
- ☁️ Mercer Island
- ☁️ Redmond
- ☁️ Ronald
- ☁️ Skyway

● Pilot Basin
King County Wastewater Service Area

 **King County**
Department of Natural Resources and Parks
Wastewater Treatment Division
Regional 1/I Control Program

Pilot Project Overview

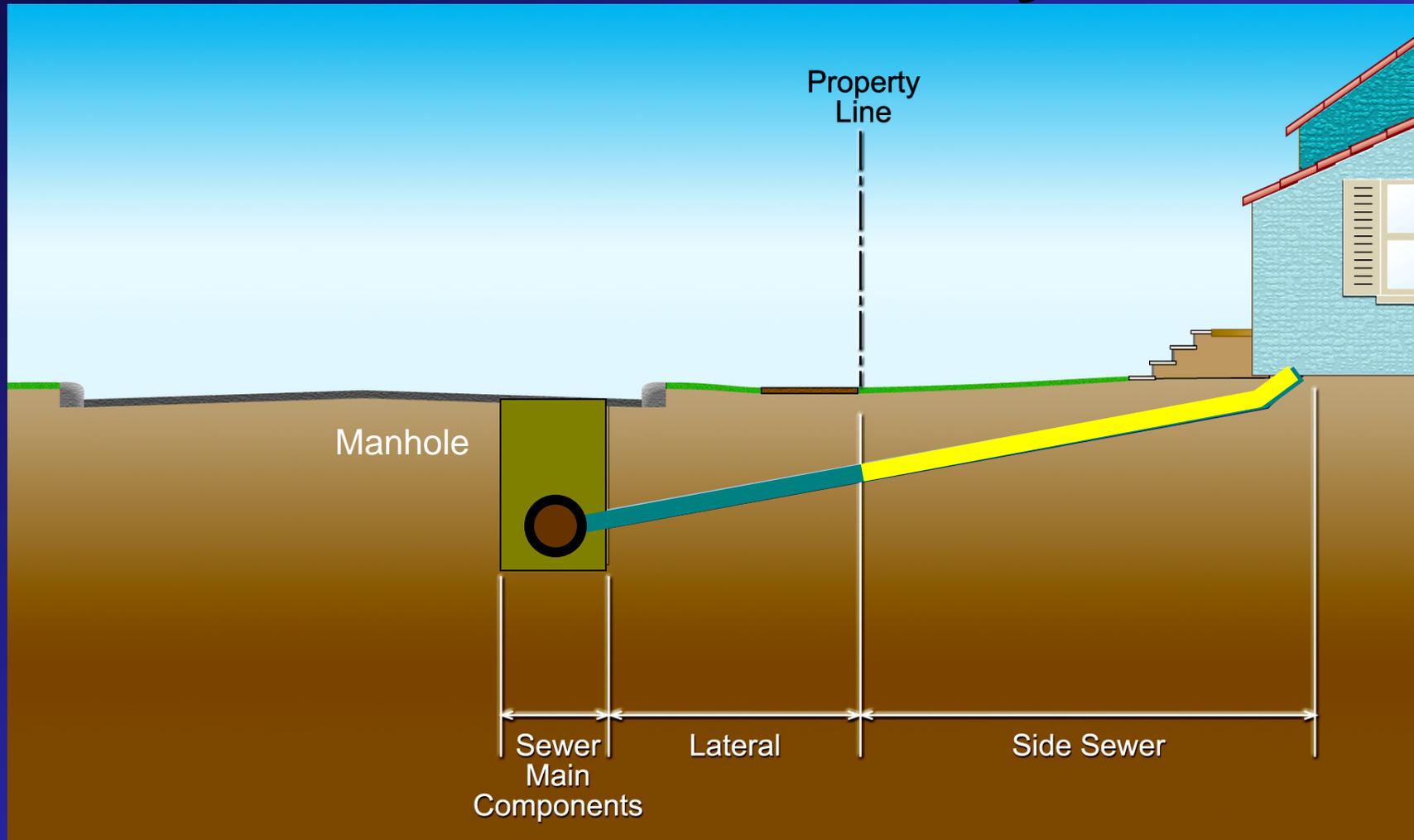
Collection System Components



Pilot Project Overview

Ronald

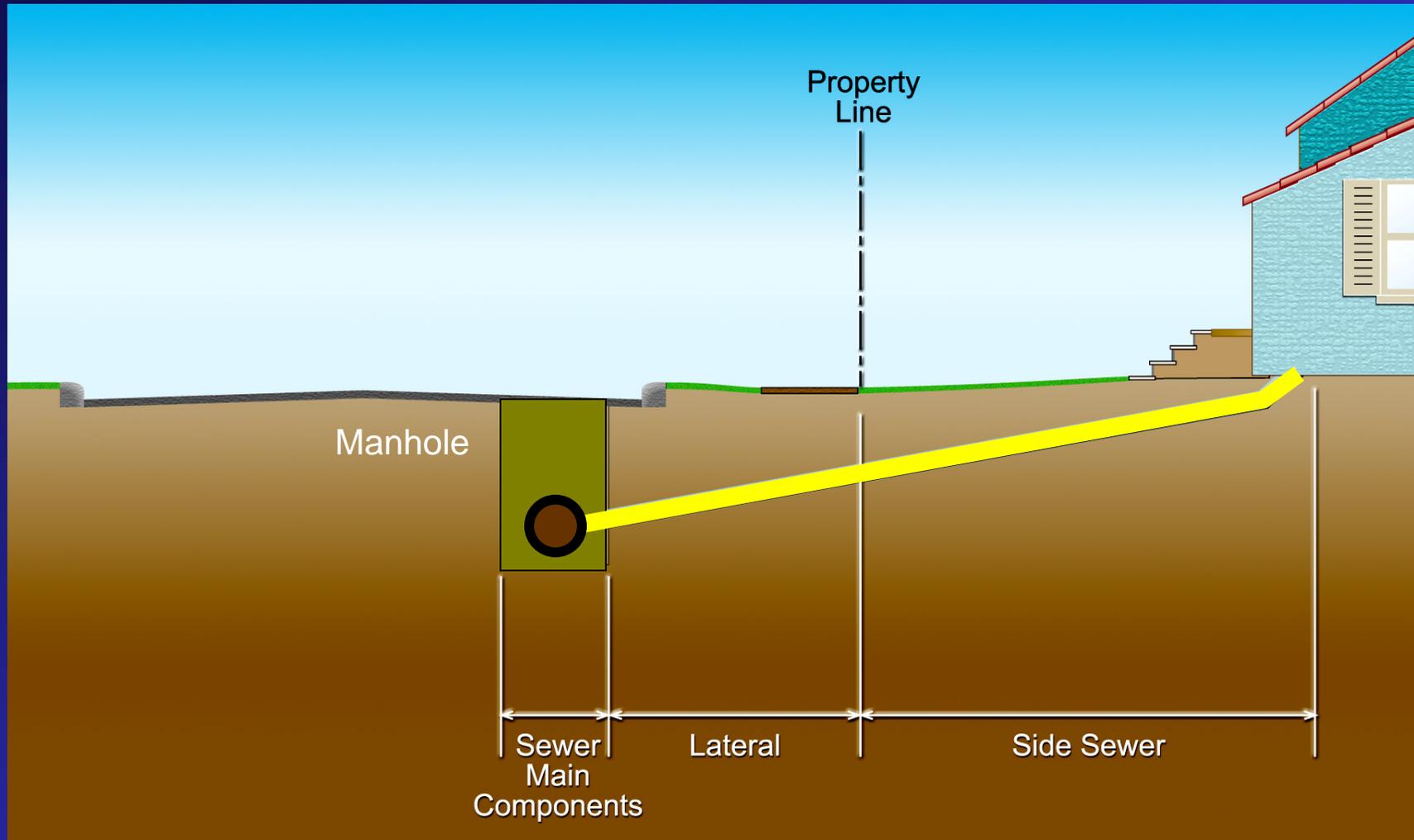
Side Sewers Only



Pilot Project Overview

Kent

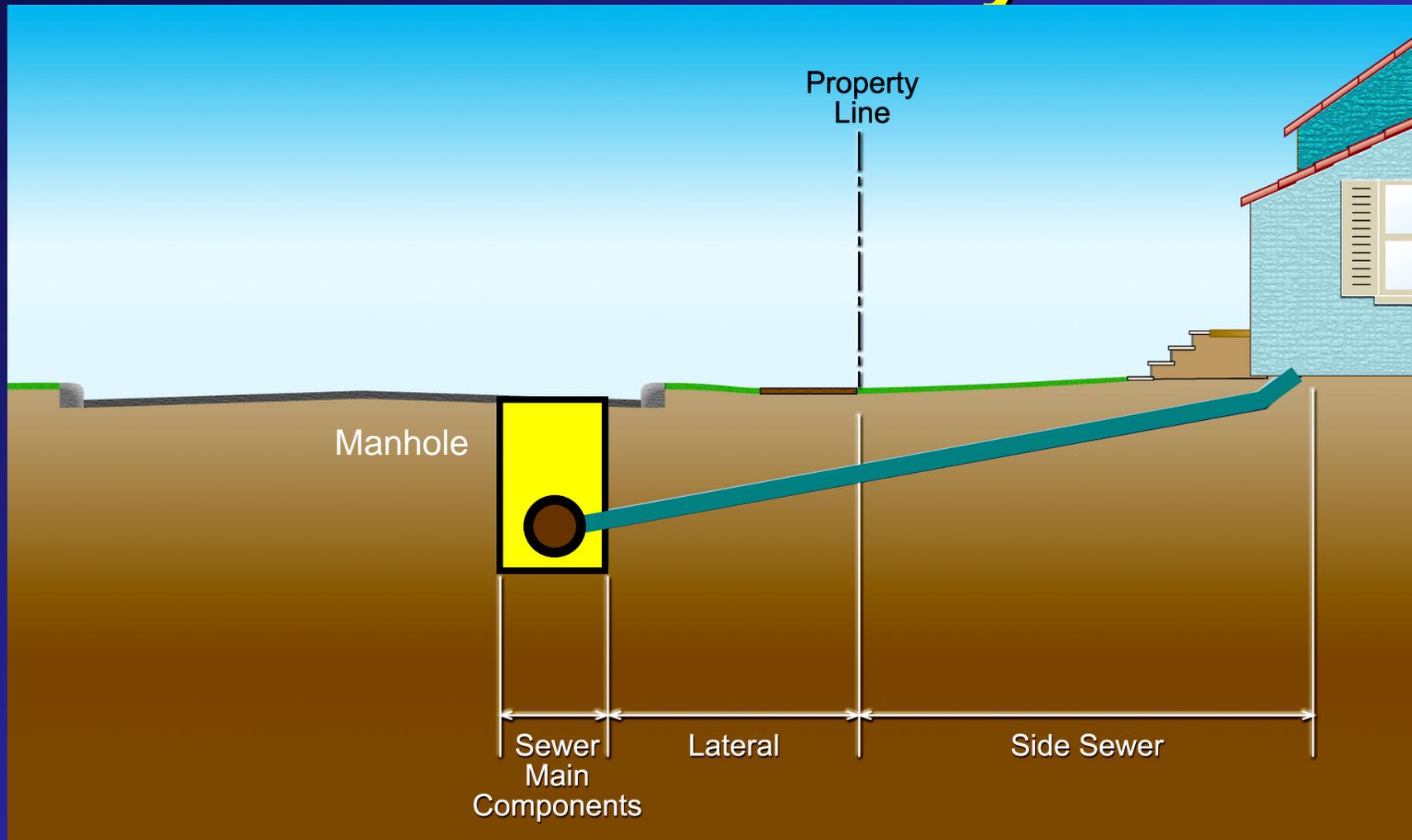
Laterals and Side Sewers



Pilot Project Overview

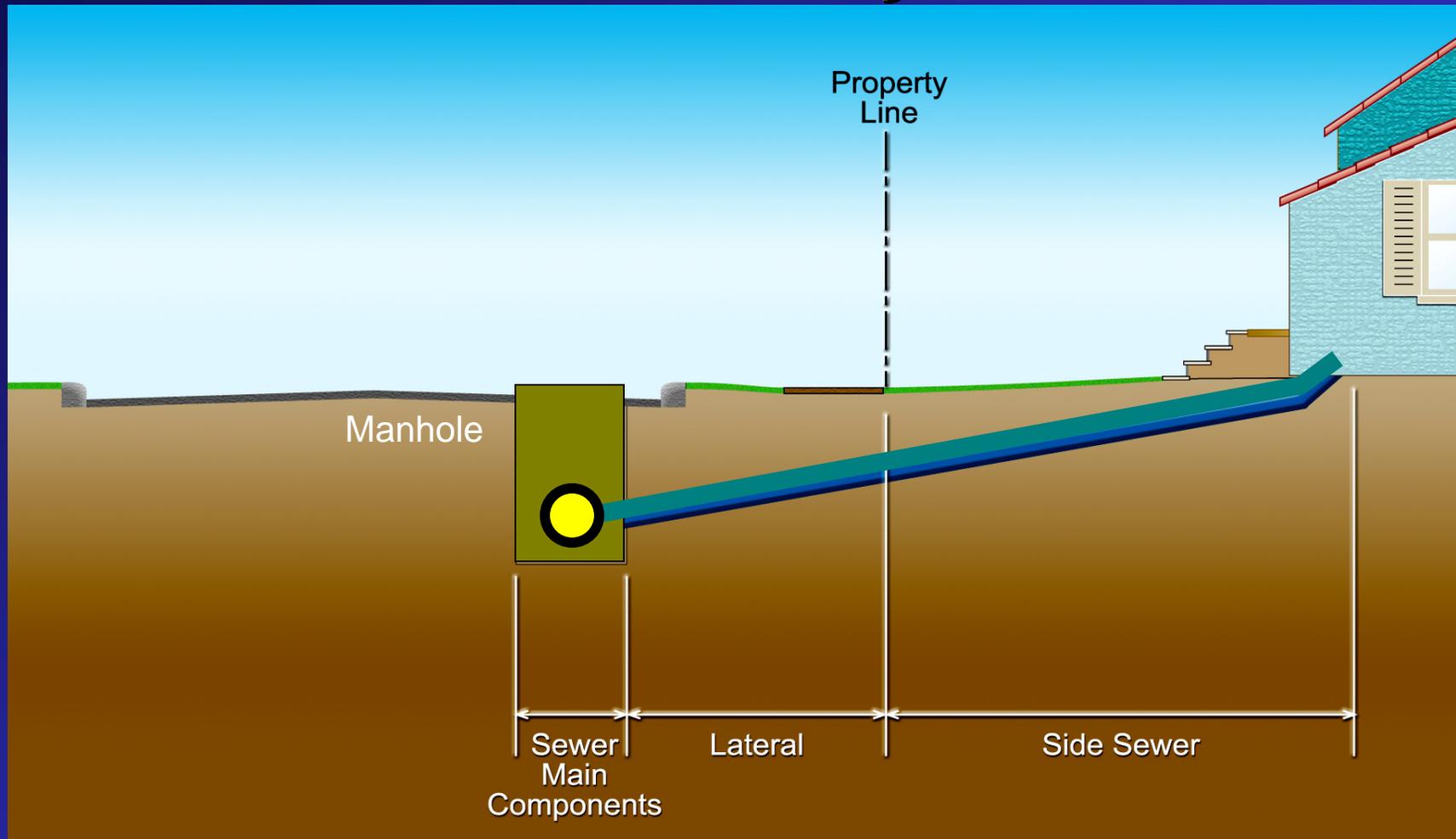
Coal Creek, Northshore, Val Vue

Manholes Only



Pilot Project Overview

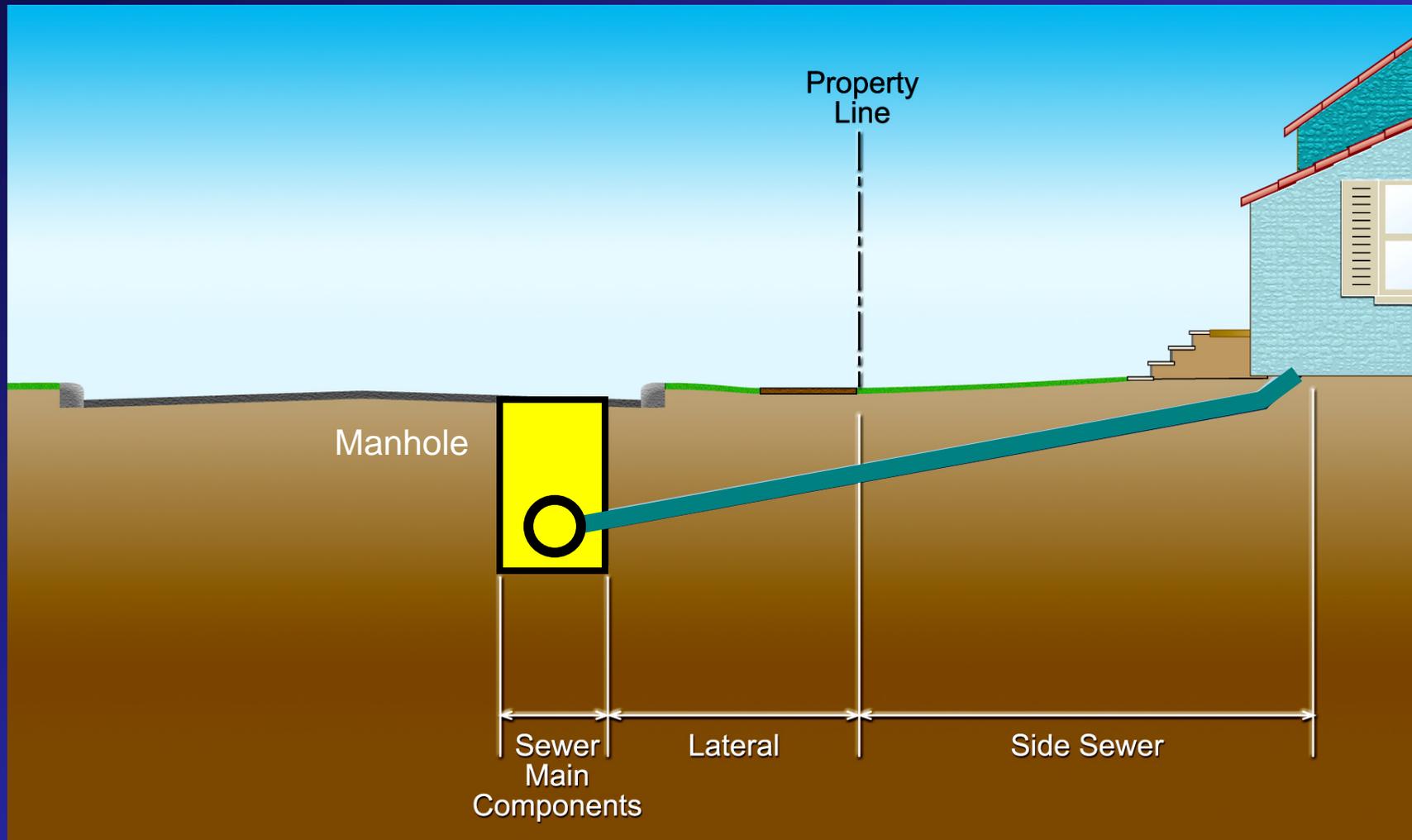
Mercer Island and Redmond Mains Only



Pilot Project Overview

Brier and Lake Forest Park

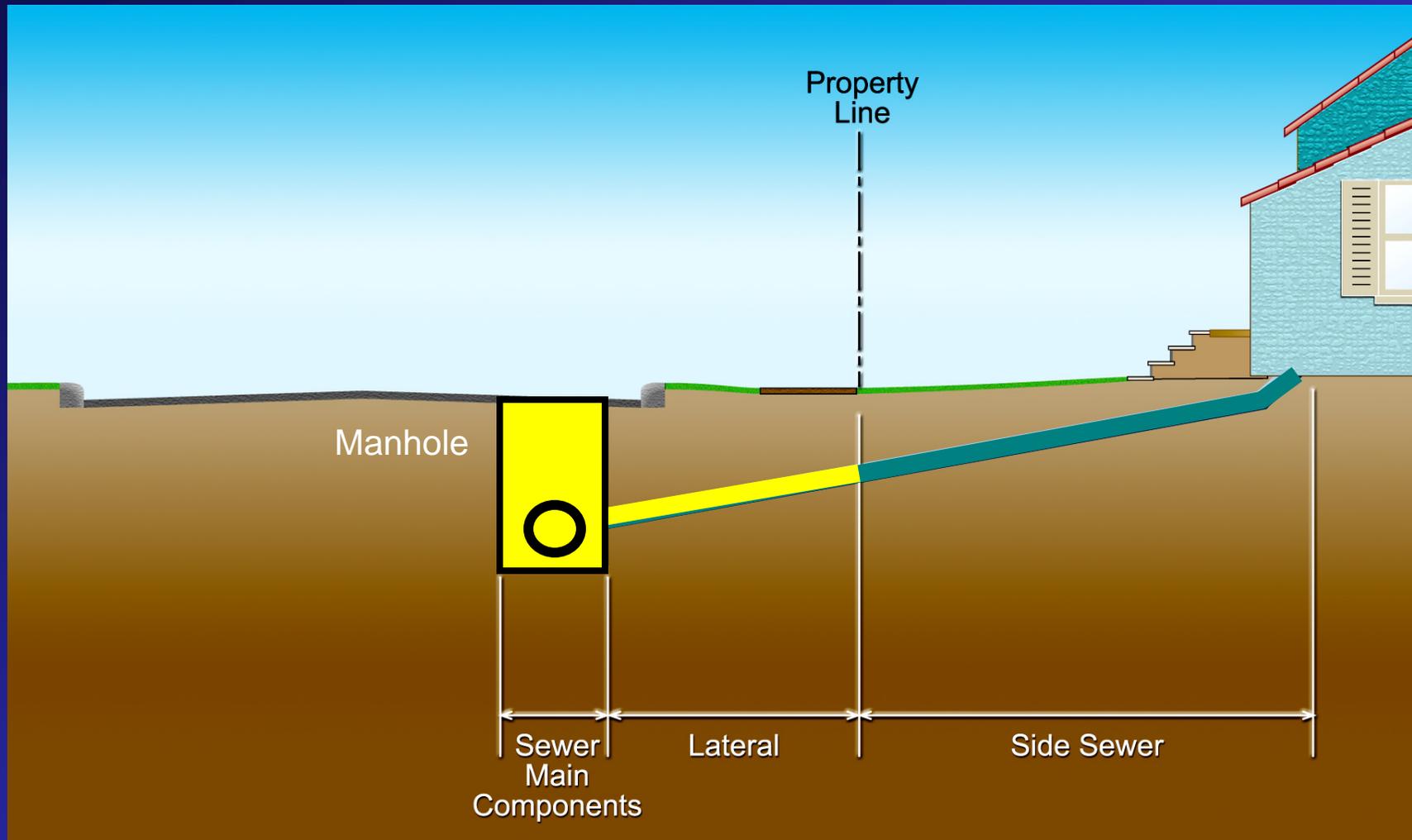
Manholes and Mains



Pilot Project Overview

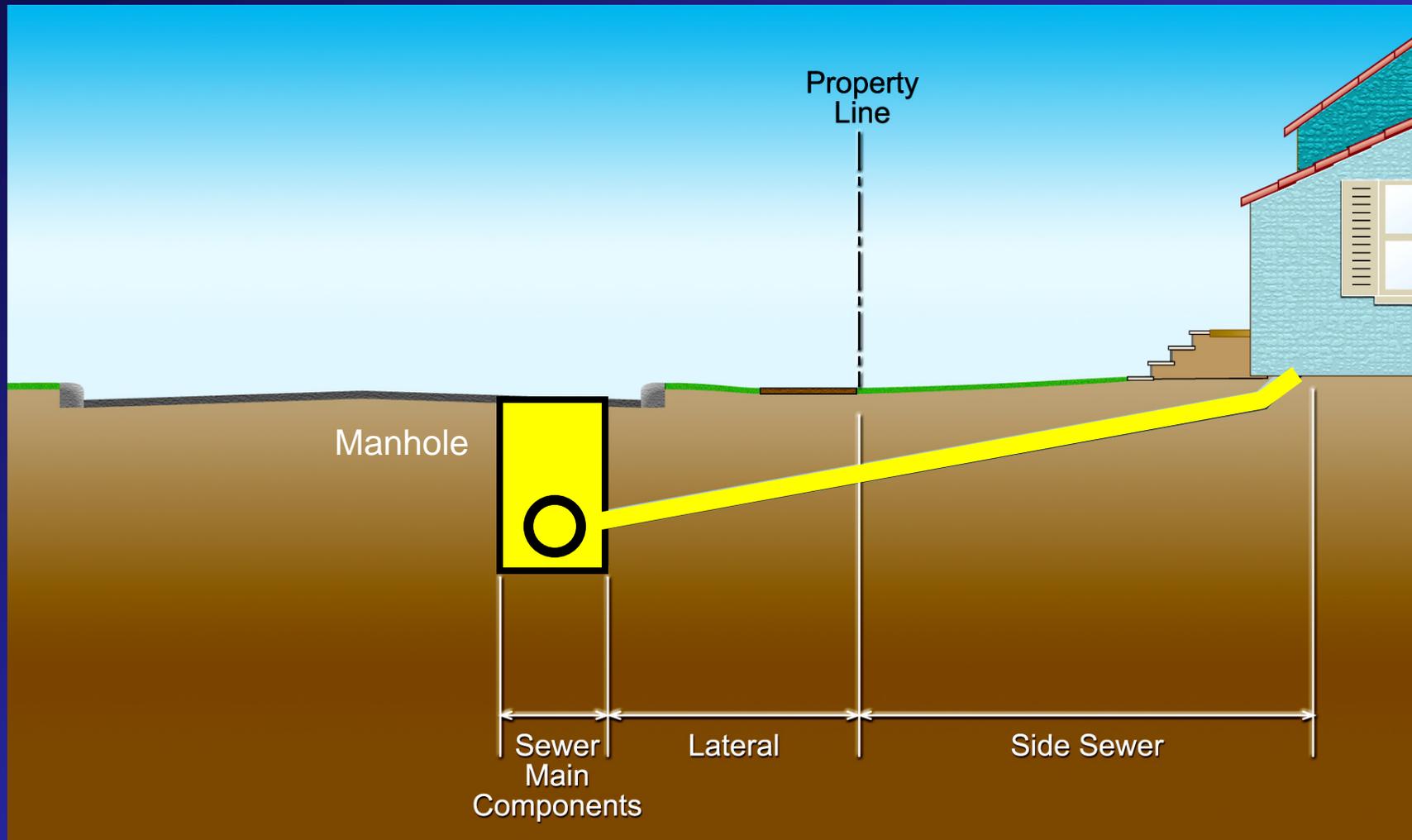
Kirkland

Manholes, Mains, and Laterals



Pilot Project Overview Skyway

Manholes, Mains, Laterals and SS



Rehabilitation Technologies

Manholes:

Grouting, Manhole Pans, Replacement, CIP Liners, Grade Adjustments

Mains:

Pipe Bursting, CIP Pipe, Spot Repairs

Laterals and Side Sewers:

Pipe Bursting, Dig and Replace, CIP Pipe

Rehabilitation Technologies

Pipe Bursting - Side Sewers



Definition:

I/I Reduction & Control



I/I Reduction:

- Cost Effective Projects Implemented to Reduce, Delay, or Eliminate Planned Improvements to the King County Conveyance and Treatment Systems



I/I Control:

- Measures Needed to Achieve Long-Term I/I Reduction and to Limit Future I/I Increases from System Degradation

Private Property I/I Reduction Issues

 Ownership – Side Sewer, Lateral

 Access/Right of Entry

 SSES Requirements

 Stormwater Drainage

 Property Restoration

 Financial Responsibility

Private Property Legal Issues

-  Use of Public Funds on Private Property
-  Liability
-  Implied Warranty
-  Enforcement of New/Existing Requirements

What We've Learned

- ☁️ Significant I/I reduction can be achieved through rehabilitation of side sewers on private property
- ☁️ Risk exposure minimized through contracts, IGA's and Right of Entry agreements
- ☁️ Overall very positive experience working with private property owners and local agencies on all pilot projects

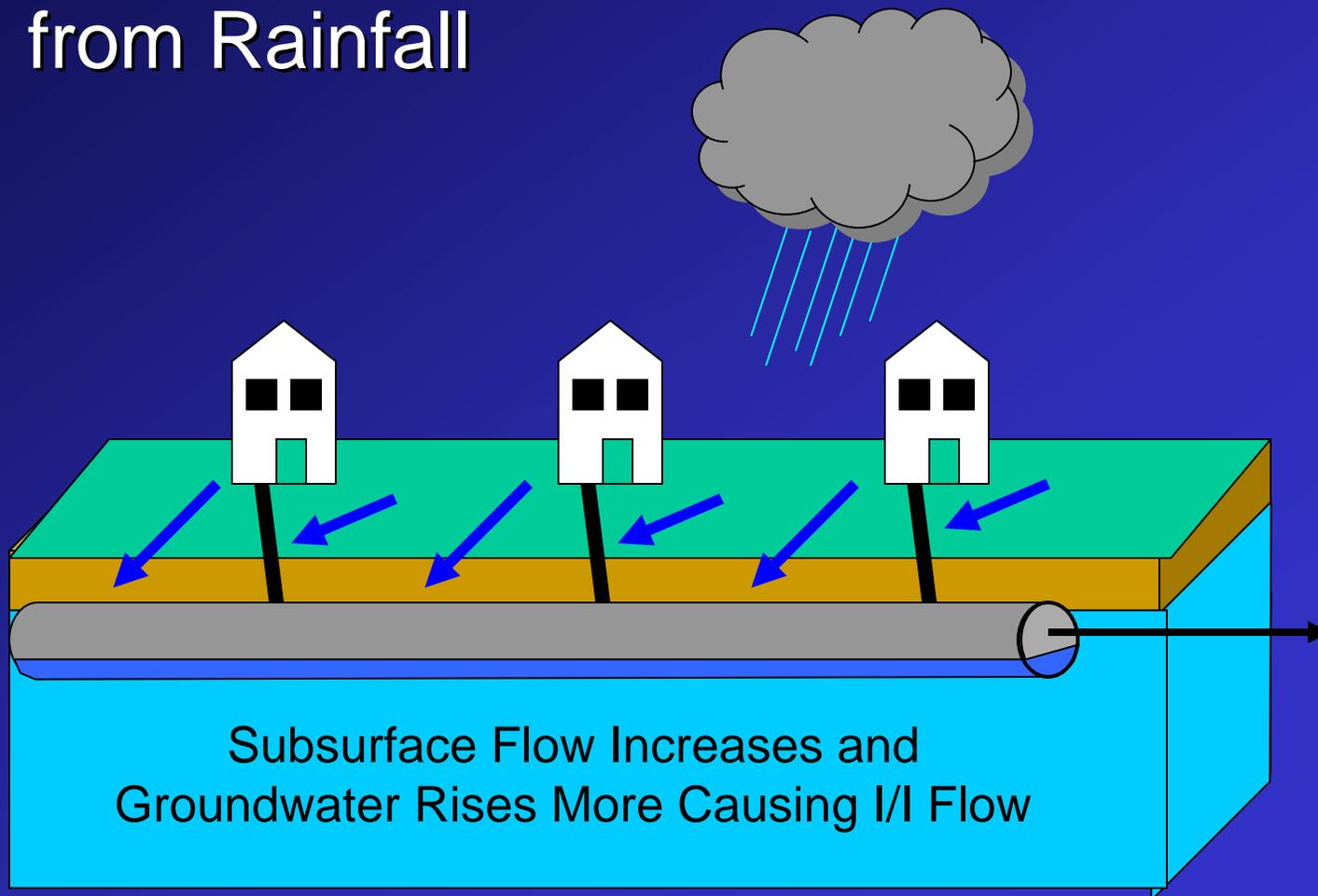
Pilot Project

I/I Reduction Effectiveness



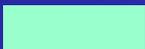
Where does I/I come from?

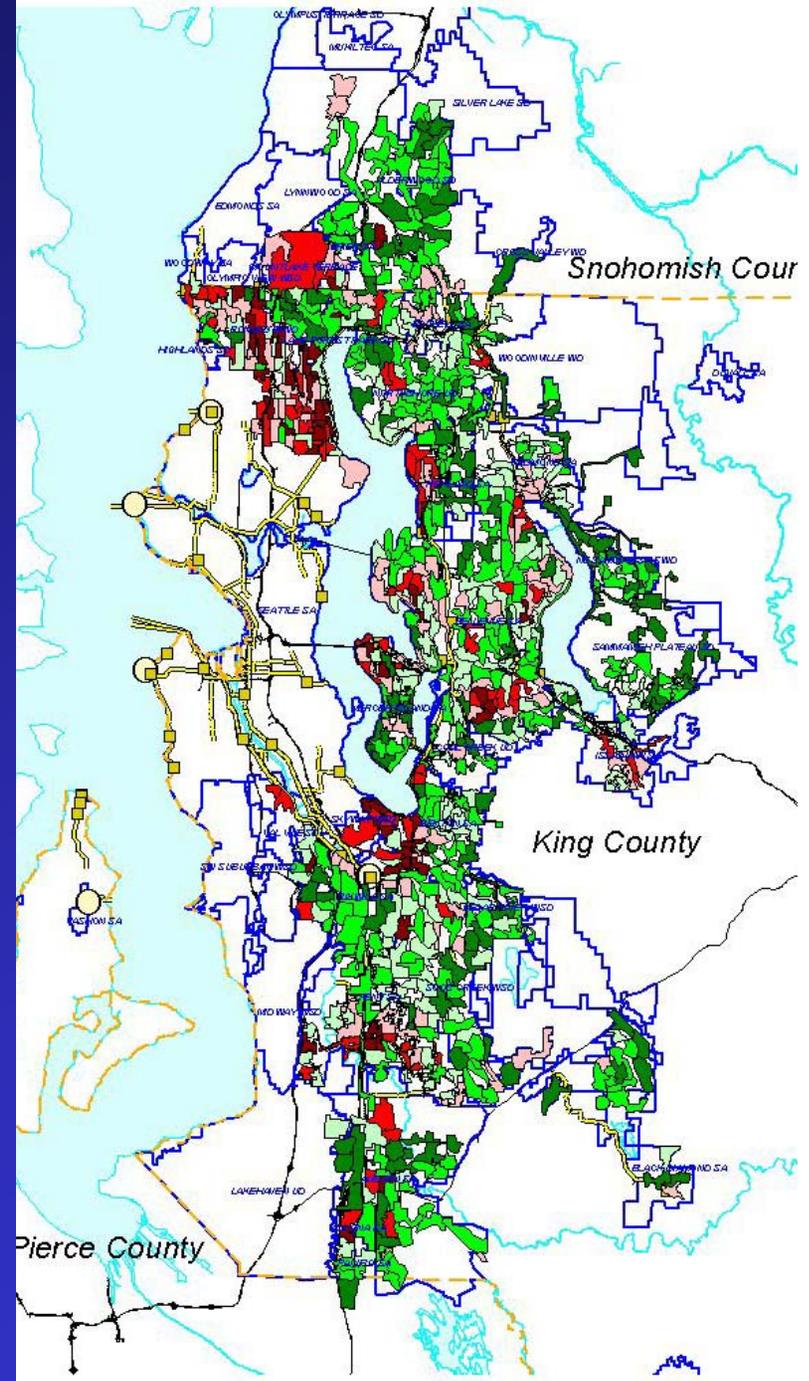
- ☁️ Dependent on Soil Saturation Resulting from Rainfall



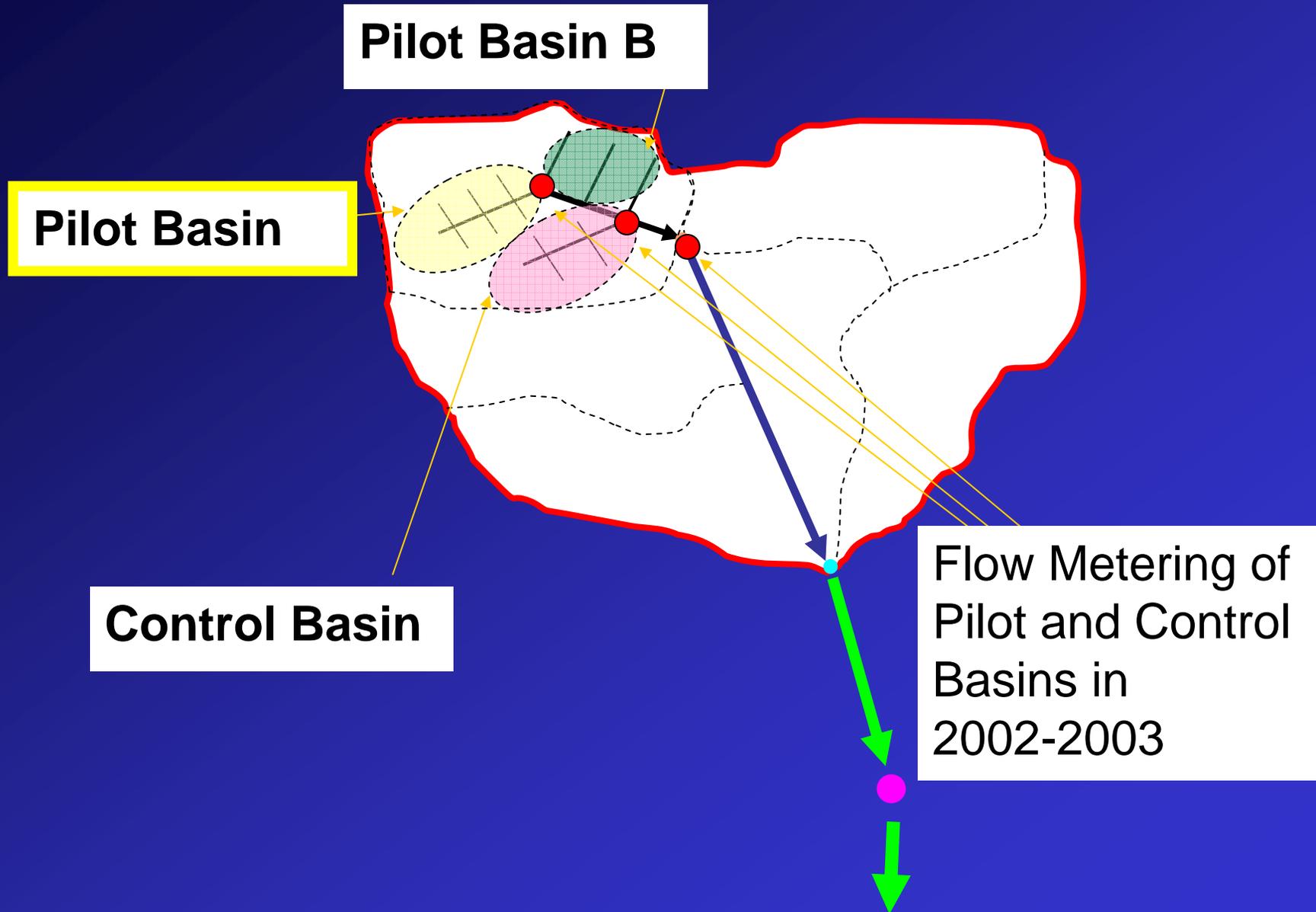
Peak I/I in the Service Area

By Mini-Basin (GPAD)

GPAD	No. Mini-Basins	Increment % of I/I	
0 - 1100	133	3.6	
1100 - 2500	224	16.4	
2500 - 4350	172	~20	
4350 - 6250	106	~20	
6250 - 9000	69	~20	
9000 - 65000	51	~20	

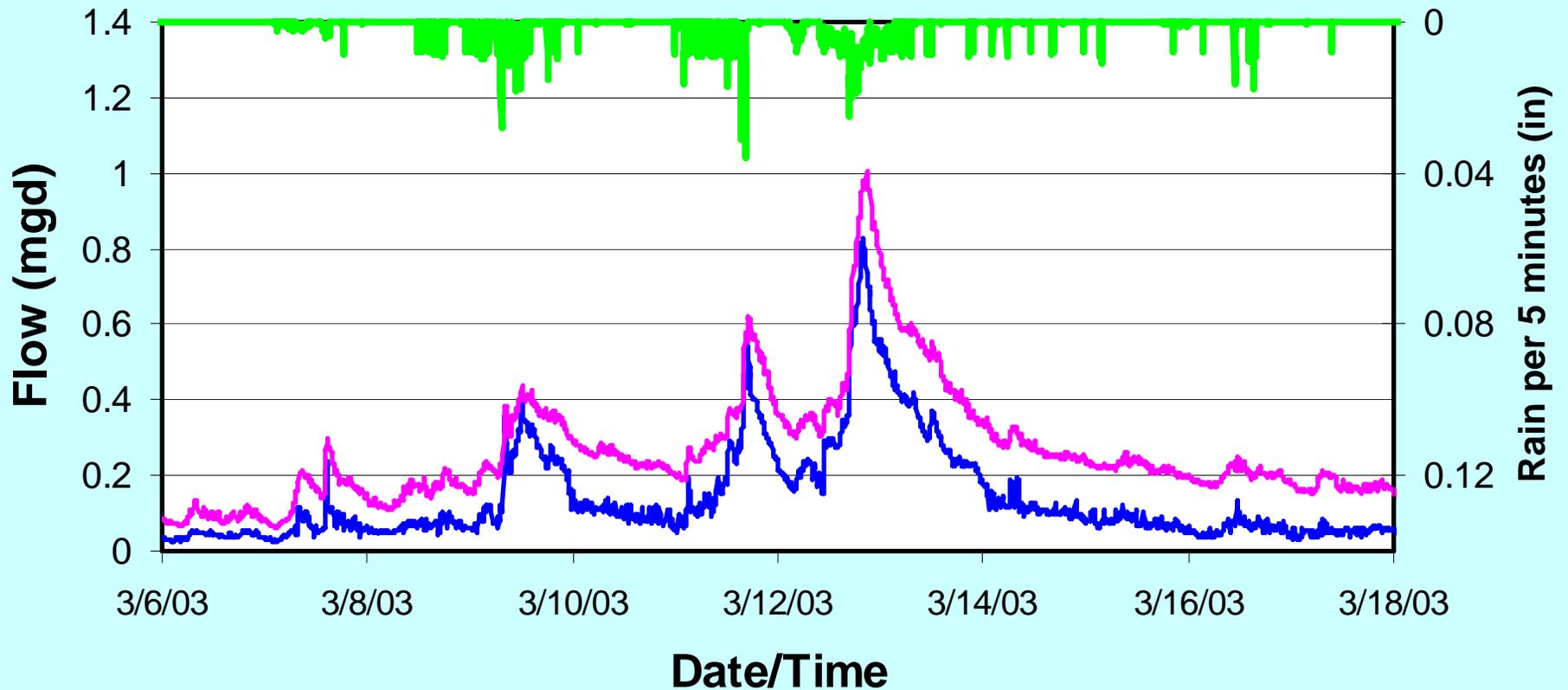


Pilot and Control Basins



Pre-rehab (3/9 - 3/12/03)

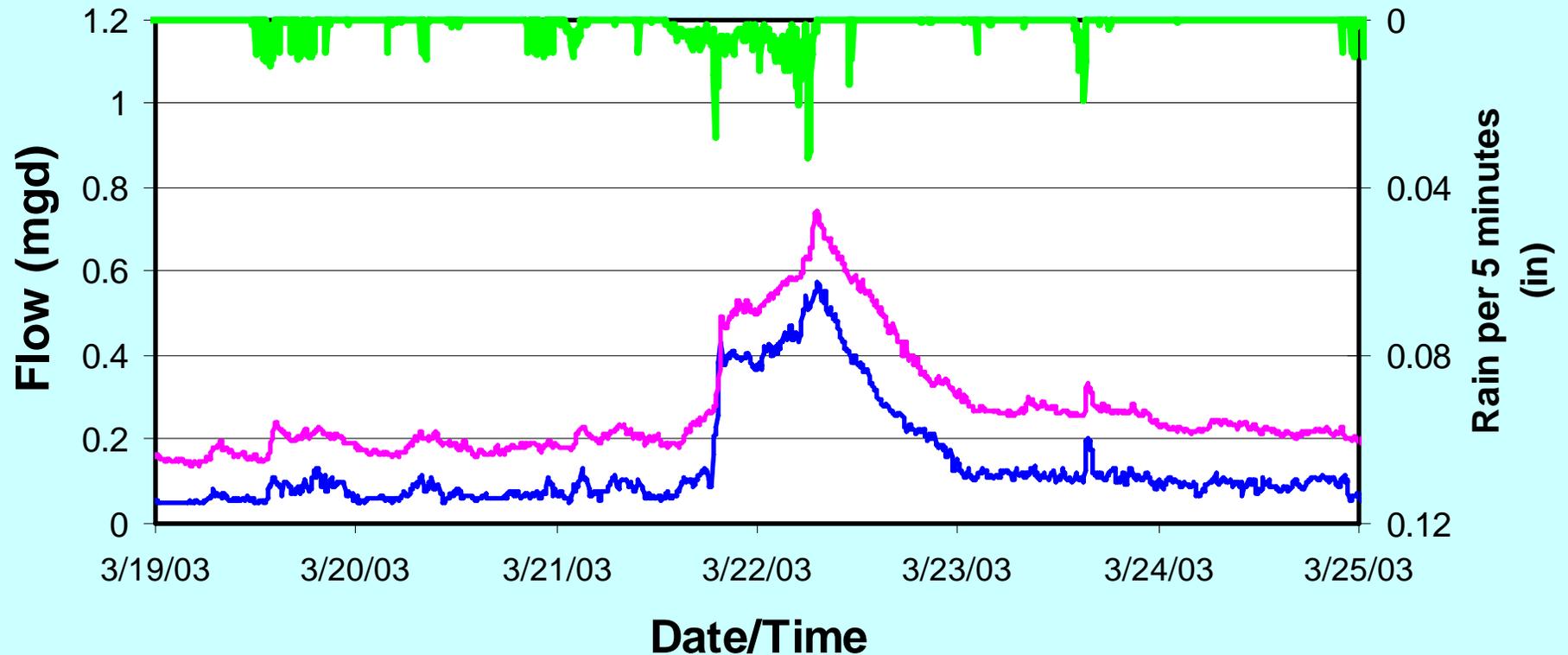
Skyway Pre-rehab Control and Pilot basins response comparison
(3/9 to 3/12/03 rain events)



— Skyway Control-Prerehab — Skyway Pilot-Prerehab — Calamar Rain

Pre-rehab (3/19 - 3/24/03)

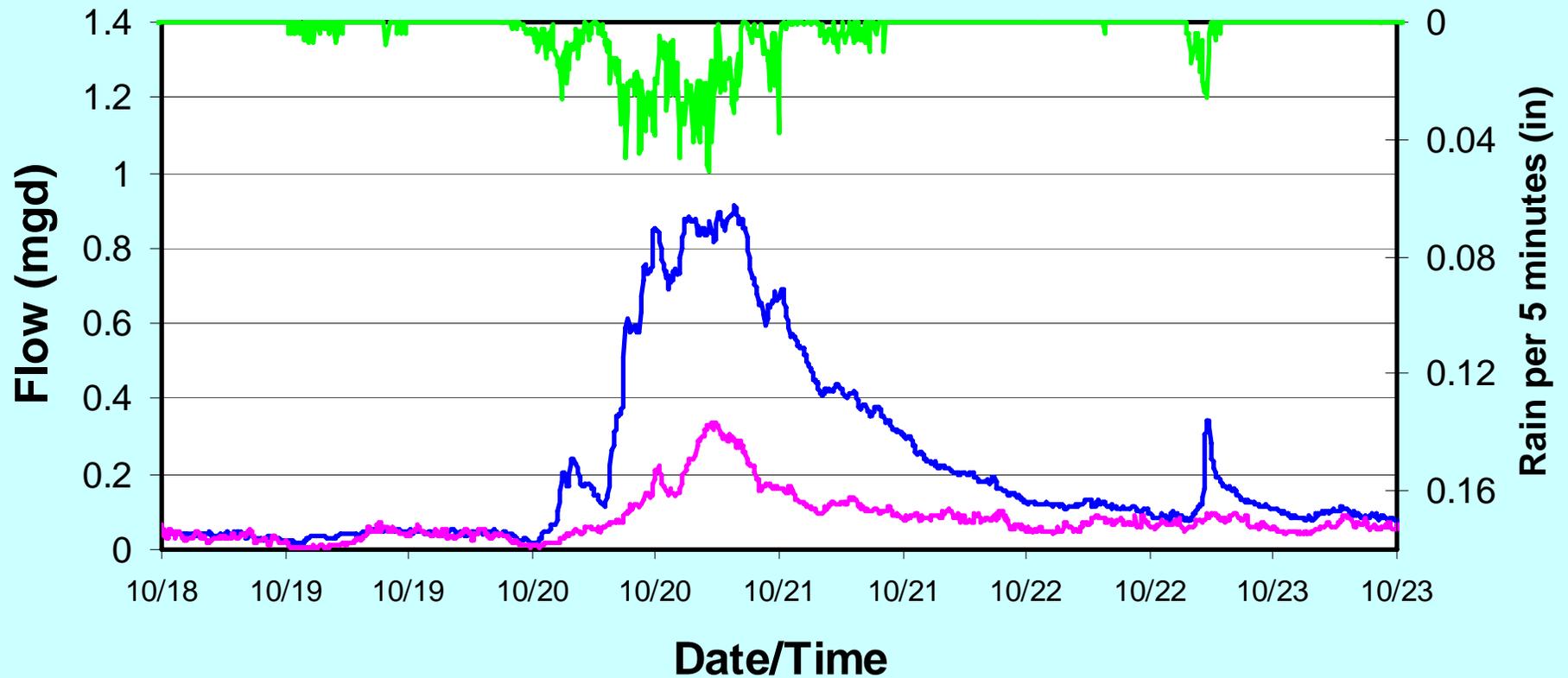
Skyway Pre-rehab Control and Pilot basins response comparison
(3/21 to 3/23/03 rain events)



— Skyway Control-Prerehab — Skyway Pilot-Prerehab — Calamar Rain

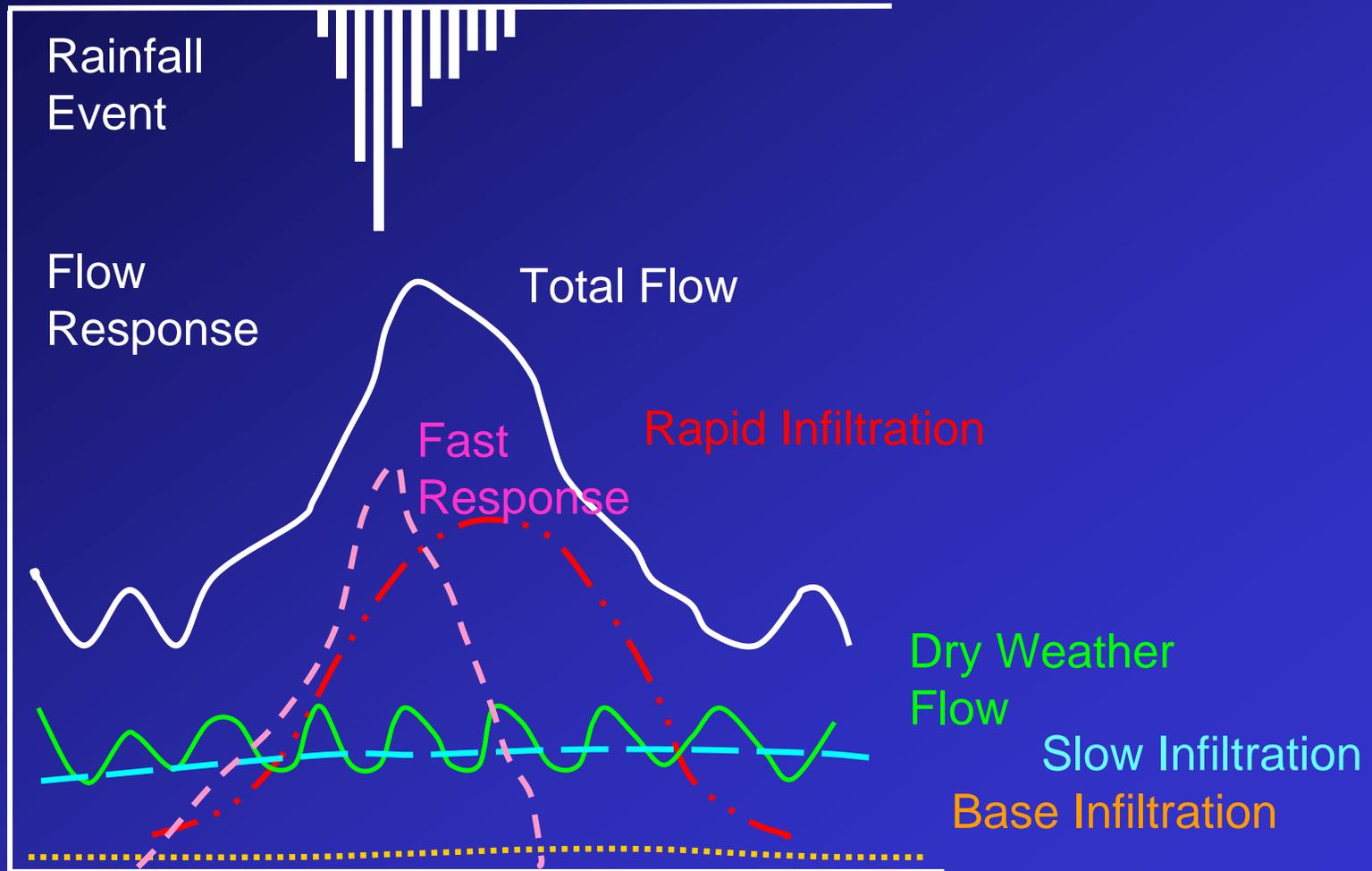
Post-rehab (10/20/03)

Skyway Post-rehab Control and Pilot basins response comparison
(10/20/03 rain event)



— Skyway Control-Post — Skyway Pilot-Post — Calamar Rain

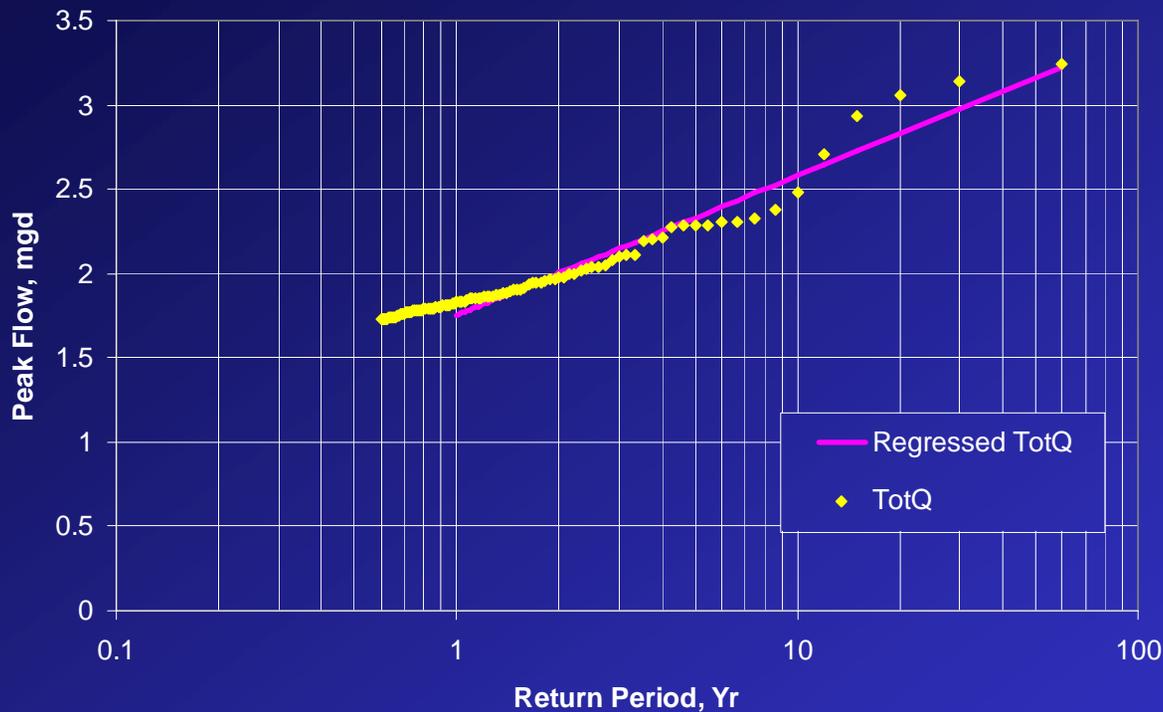
Components of Flow



How We Estimate I/I Reduction?

-  Use MOUSE -- a Computer Model That Simulates Flow Contributions
 - How Rain Becomes I/I in the Wastewater Collection System
-  Calibrate I/I Response to Rainfall from 2 Different Wet Seasons
-  Run Model with 60 Years of Rain Data and Estimate I/I Reduction for 20-year Peak Flow Conditions

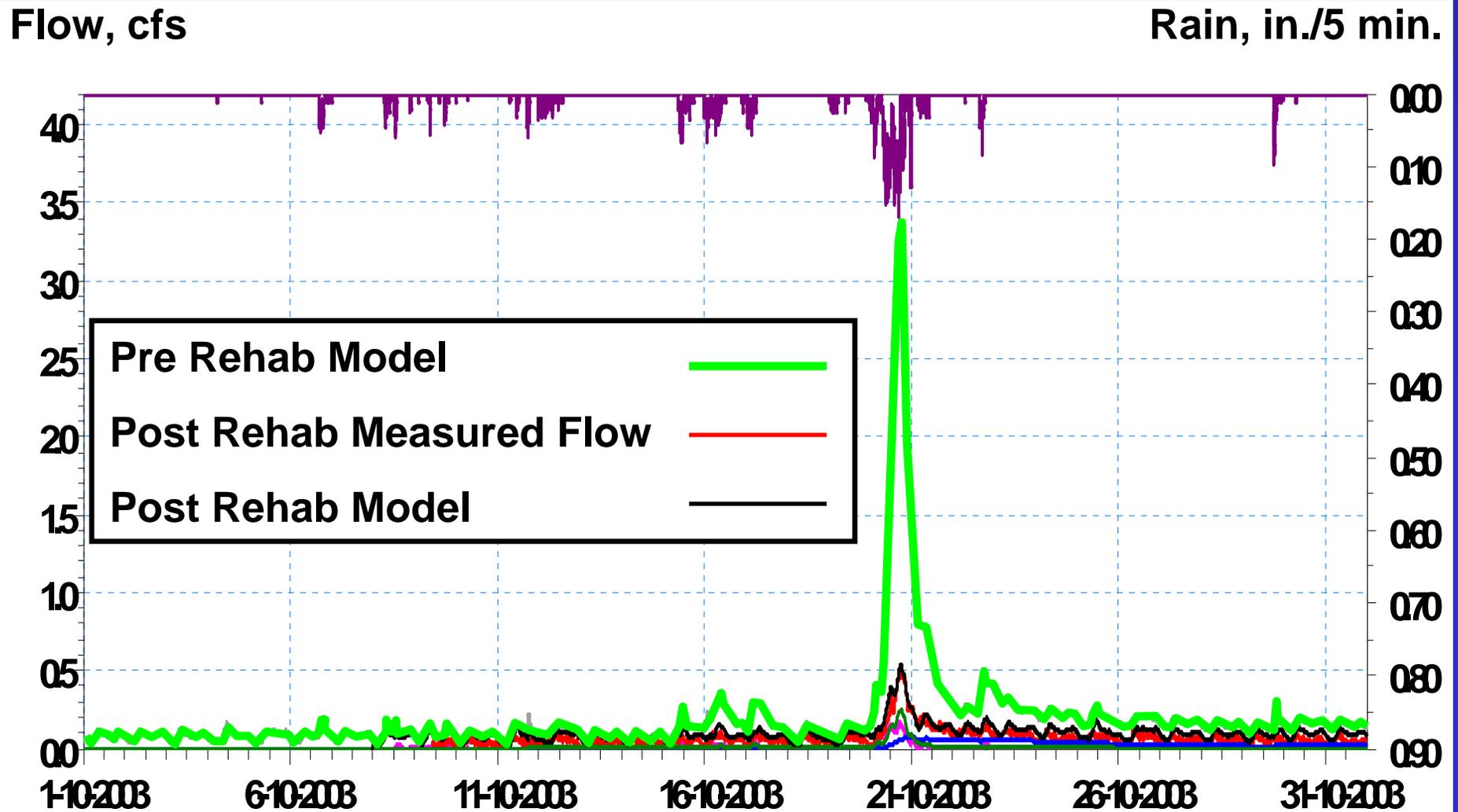
Model Results - Flow Frequency



Basis:

- Flow Frequency Developed from 60-Year Model Simulation
- Essential to Consider Antecedent Conditions
- Statistical Method Relies on Fit to Many Points
- Frequency Analysis Results Rely on Many Data Points, Not Just One Storm

Post Rehab w/ Pre Rehab Model



I/I Removal Effectiveness Summary

Pilot Basin	Mains	Manholes	Laterals	Side Sewers	% of Basin Improved	% Reduction
Auburn Pilot A	●	●	●	●		
Skyway	●	●	●	●		
Redmond Pilot A/B	●	●	●			
Kirkland	●	●	●			
Brier	●	●				
Lake Forest Park	●	●				
Mercer Island	●					
Auburn Pilot B		●				
Coal Creek		●				
Northshore		●				
Val Vue		●				
Kent			●	●		
Ronald				●		

I/I Removal Effectiveness Summary

Pilot Basin	Mains	Manholes	Laterals	Side Sewers	% of Basin Improved	% Reduction
Auburn Pilot A	●	●	●	●	11	NAR
Skyway	●	●	●	●	100	87
Redmond Pilot A/B	●	●	●			
Kirkland	●	●	●			
Brier	●	●				
Lake Forest Park	●	●				
Mercer Island	●					
Auburn Pilot B		●				
Coal Creek		●				
Northshore		●				
Val Vue		●				
Kent			●	●		
Ronald				●		

I/I Removal Effectiveness Summary

Pilot Basin	Mains	Manholes	Laterals	Side Sewers	% of Basin Improved	% Reduction
Auburn Pilot A	●	●	●	●	11	NAR
Skyway	●	●	●	●	100	87
Redmond Pilot A/B	●	●	●		38	NAR
Kirkland	●	●	●		25	28
Brier	●	●				
Lake Forest Park	●	●				
Mercer Island	●					
Auburn Pilot B		●				
Coal Creek		●				
Northshore		●				
Val Vue		●				
Kent			●	●		
Ronald				●		

I/I Removal Effectiveness Summary

Pilot Basin	Mains	Manholes	Laterals	Side Sewers	% of Basin Improved	% Reduction
Auburn Pilot A	●	●	●	●	11	NAR
Skyway	●	●	●	●	100	87
Redmond Pilot A/B	●	●	●		38	NAR
Kirkland	●	●	●		25	28
Brier	●	●			23	54
Lake Forest Park	●	●			35	69
Mercer Island	●					
Auburn Pilot B		●				
Coal Creek		●				
Northshore		●				
Val Vue		●				
Kent			●	●		
Ronald				●		

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Auburn Pilot A	●	●	●	●	11	NAR
Skyway	●	●	●	●	100	87
Redmond Pilot A/B	●	●	●		38	NAR
Kirkland	●	●	●		25	28
Brier	●	●			23	54
Lake Forest Park	●	●			35	69
Mercer Island	●				70	32
Auburn Pilot B		●				
Coal Creek		●				
Northshore		●				
Val Vue		●				
Kent			●	●		
Ronald				●		

I/I Removal Effectiveness Summary

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Auburn Pilot A	●	●	●	●	11	NAR
Skyway	●	●	●	●	100	87
Redmond Pilot A/B	●	●	●		38	NAR
Kirkland	●	●	●		25	28
Brier	●	●			23	54
Lake Forest Park	●	●			35	69
Mercer Island	●				70	32
Auburn Pilot B		●			19	NAR
Coal Creek		●			52	NAR
Northshore		●			64	23
Val Vue		●			45	NAR
Kent			●	●		
Ronald				●		

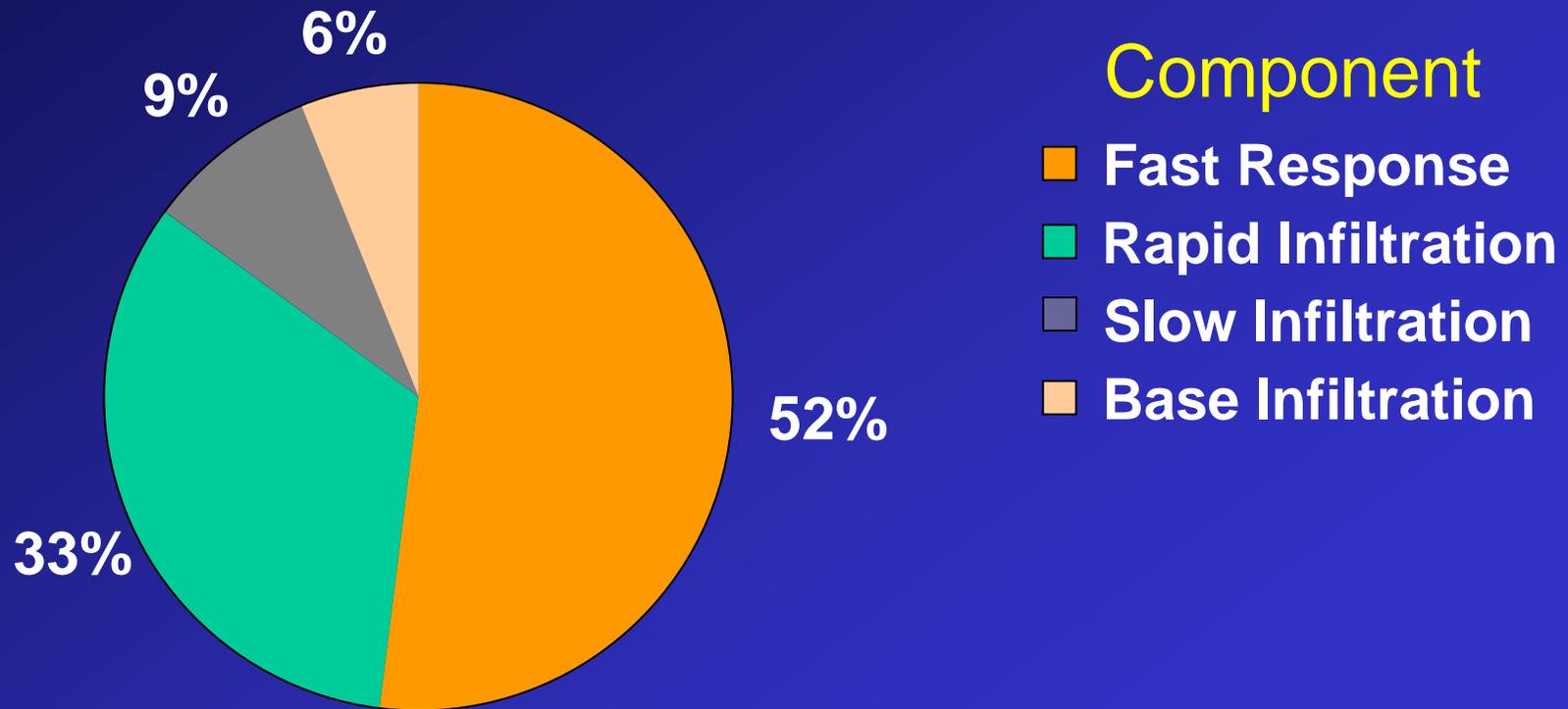
I/I Removal Effectiveness Summary

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Skyway	●	●	●	●	100	87
Redmond Pilot A/B	●	●	●		38	NAR
Kirkland	●	●	●		25	28
Brier	●	●			23	54
Lake Forest Park	●	●			35	69
Mercer Island	●				70	32
Auburn Pilot B		●			19	NAR
Coal Creek		●			52	NAR
Northshore		●			64	23
Val Vue		●			45	NAR
Kent			●	●	100	73
Ronald				●	72	74

% Reduction in Pilot Projects

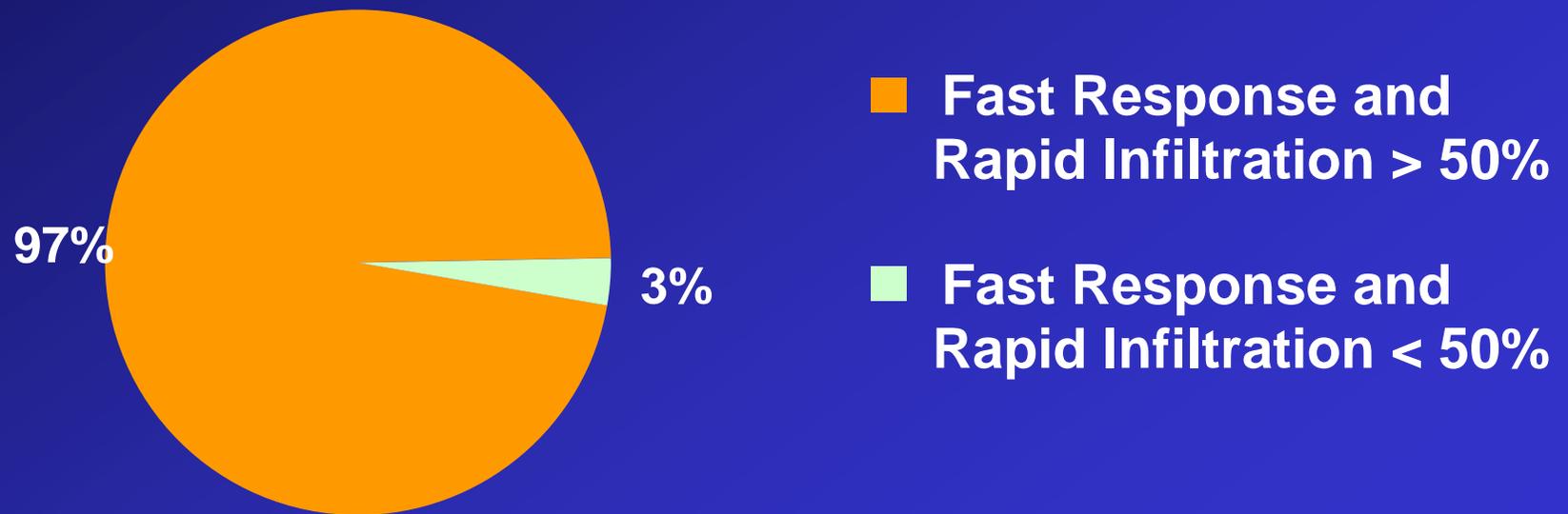
Area of System	Pilot Project	% Rehab. in Pilot Projects	% Reduction	Pre- I/I gpad	Post-I/I gpad
Total System	Skyway	100	87	57,500	7,500
Public	Kirkland	25	28	11,000	7,900
	Brier	23	54	10,000	4,600
	Lake Forest Park	35	69	22,900	6,900
	Mercer Island	70	32	10,300	7,000
Private	Kent	100	73	12,400	3,400
	Ronald	72	74	18,000	4,600
Direct Connections	Various	0-7	--		

Regional I/I Components



Mini-Basin I/I Components

☁️ Fast Response and Rapid Infiltration Dominate 97% of the Mini-Basins



Pre-Rehab I/I Type

Pilot Basin	System Components Rehabilitated				I/I Flow Component as % of Peak I/I			
	MN	MH	L	SS	Fast Response	Rapid Infiltration	Slow Infiltration	Base Infiltration
Skyway	●	●	●	●	4	87	8	1
Kirkland	●	●	●		32	62	6	0
Brier	●	●			3	93	4	0
Lake Forest Park	●	●			21	71	7	1
Mercer Island	●				32	46	22	0
Kent			●	●	3	88	6	3
Ronald				●	9	75	15	1

I/I Components Expressed as % of Pre-Rehab 20-Year Peak I/I

System Components: MN=Mains, MH=Manholes, L=Laterals, SS = Side Sewers

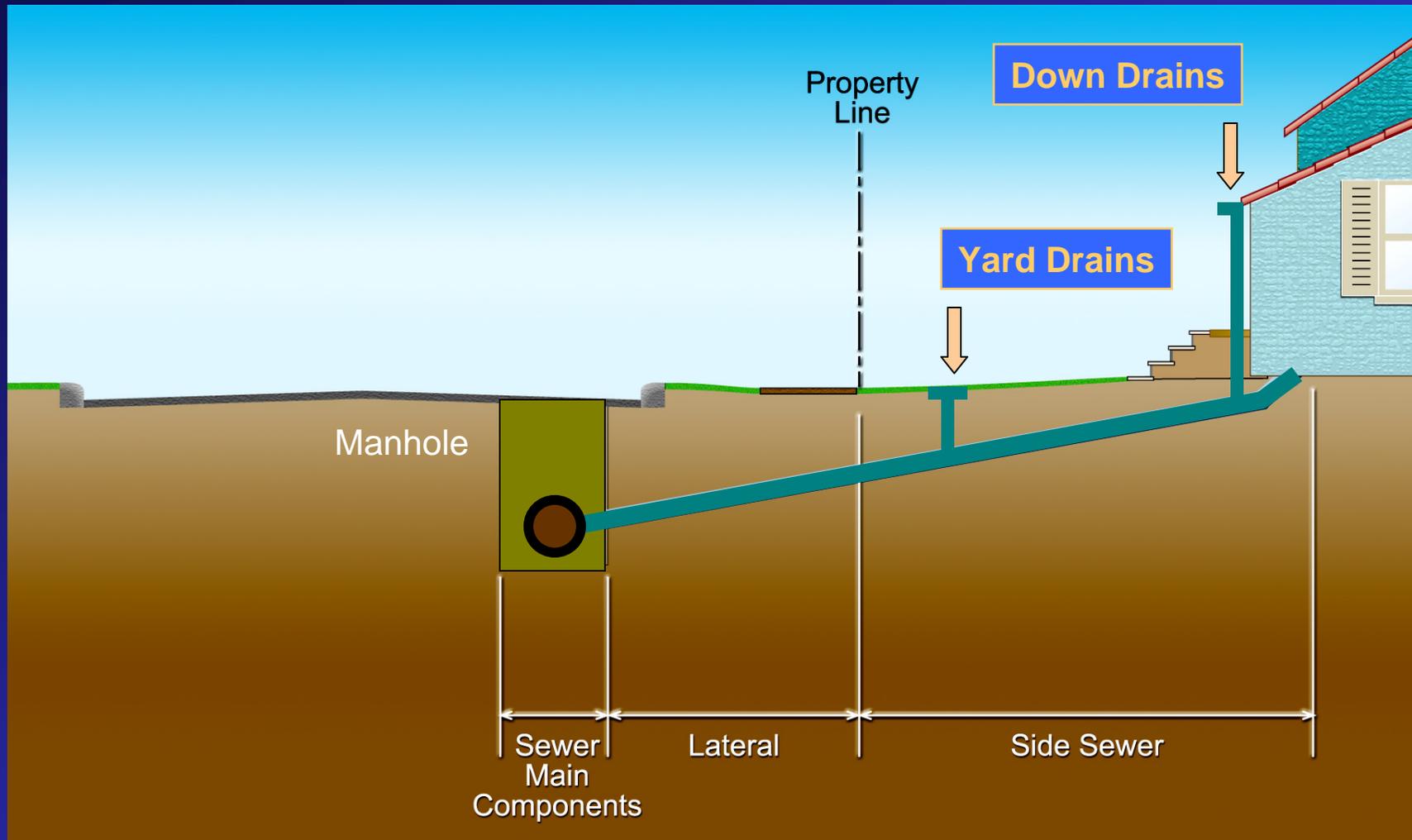
Importance of Private Property I/I



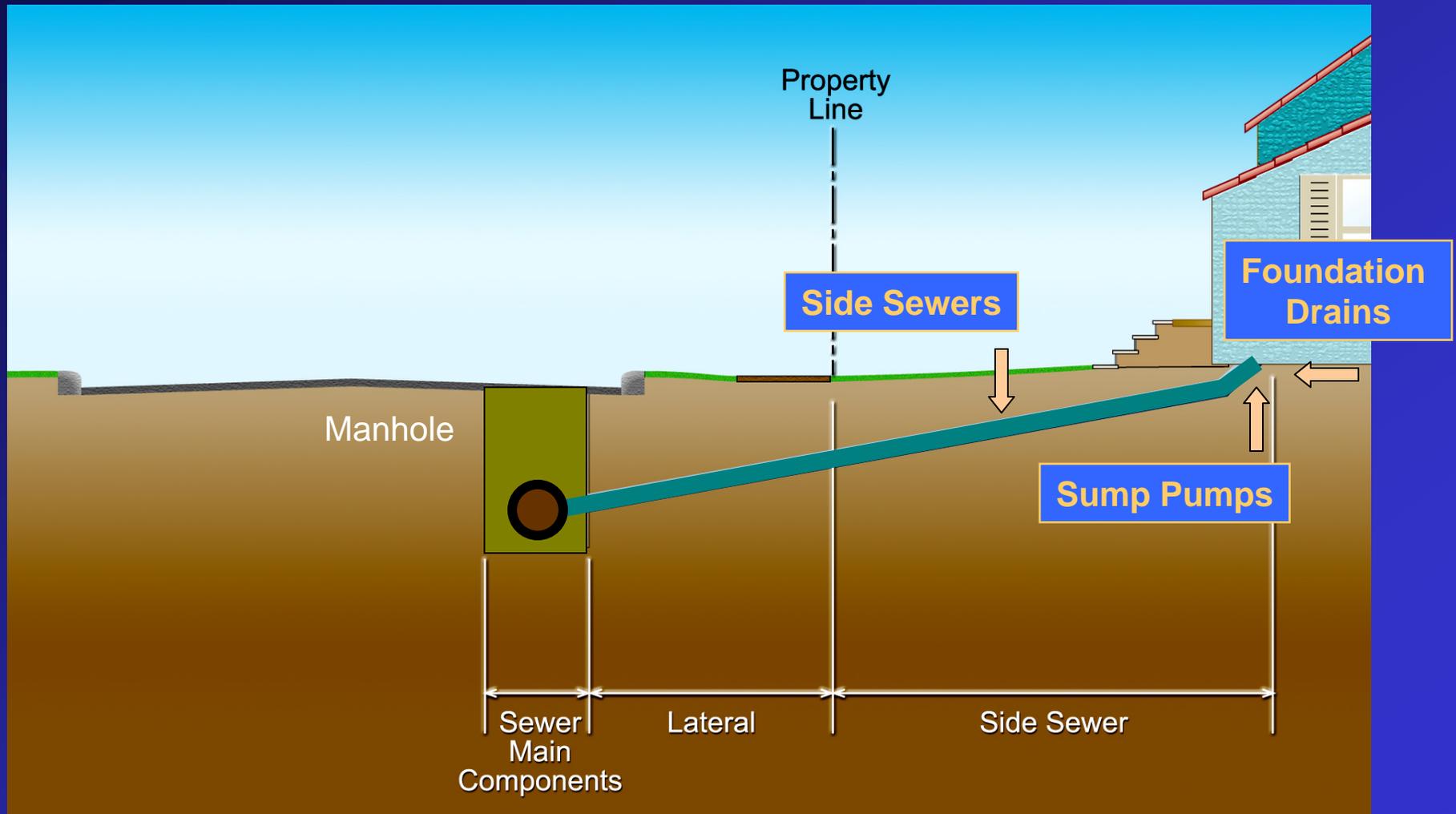
I/I Originating from Private Property is Associated with Fast Response and Rapid Infiltration I/I Components

Area of System	I/I Flow Component	System Component Contributing I/I to Flow Component
Private	Fast Response	Direct Connections (Down Drains, Yard Drains) <i>(Also MH Lids, Catch Basins, Public Storm Drain)</i>
	Rapid Infiltration	Side Sewer, Sump Pumps, Foundation Drains Shallow Mains, MH Chimney, Storm Drains
Public	Slow Infiltration	Mains, Manholes, Laterals
	Base Infiltration	Mains, Manhole Bases

Private Property I/I – Fast Response



Private Property I/I – Rapid Infiltration



Private Property Pilot Project I/I Reductions



Rehabilitation of Pilot Project Side Sewers Found to be Effective in Reducing I/I

– Kent Pilot Project

- 154 Side Sewers (100%) Rehabilitated
- 134 Laterals Rehabilitated
- 78% Reduction in Total I/I

– Ronald Pilot Project

- 208 Side Sewers (72%) Rehabilitated
- 53 Laterals Rehabilitated
- 74% Reduction in Total I/I

What Have We Gained?

- ☁️ Project Costs (\$/lateral/SS, \$/lineal foot, \$/MH)
- ☁️ Where I/I Originates Relative to Model Indicators
- ☁️ Process for Targeting Components and Estimating I/I Reduction Costs
- ☁️ % Removal Effectiveness and Remaining I/I

What Do We Do from Here?

- ☁️ Compare the Cost of I/I Reduction to the Cost of Expanding Facilities.

End of Show