Using Duration Curves in TMDL Development & Implementation Planning

ASIWPCA *"States Helping States"* Conference Call
July 1, 2003

Discussion Panelists:

Tom Stiles *(Kansas Dept. of Health & Environment)*
Bruce Cleland *(America's Clean Water Foundation)*

Duration Curves

Conference Call Overview

- ***Background & Basics*** ***(Tom)***
- ***Update on Kansas Applications*** ***(Tom)***
- ***Extended Uses*** ***(Bruce)***
- ***Linking to Implementation*** ***(Bruce)***

Duration Curves

Call Objectives

- **Create an awareness of efforts in this area**
- **Initiate an exchange of ideas among States**
  - ***Use several examples to frame the problem***
  - ***Highlight issues encountered***
  - ***Approaches to work through challenges***
  - ***Expand network of contacts***

Duration Curves

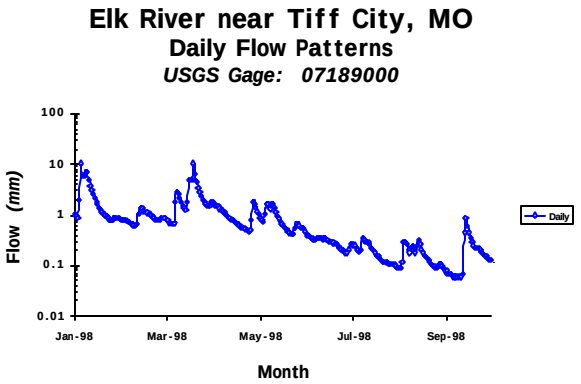
Background

- **One of the perpetual TMDL questions - - - How to address design flow conditions …**
  - ***Proper "design" storms or recurrence intervals***
  - ***Higher flows and NPS issues***
  - ***Continually looking at workable approaches***
  - ***Growing interest in use of "Load Duration Curves"***

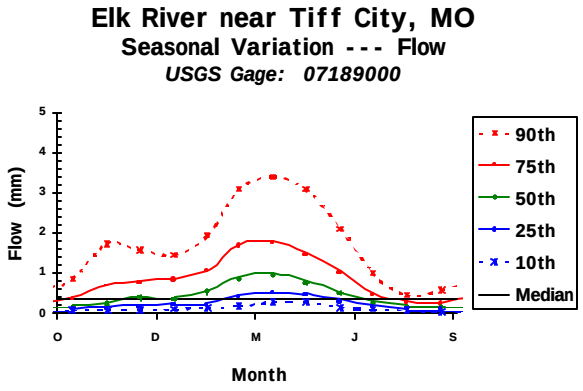
Duration Curves

Some Basic Concepts

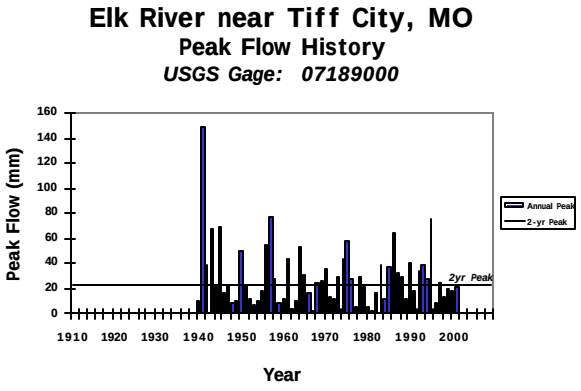
- ***Daily Average Flows***
- ***Seasonal Patterns***
- ***Annual Variation***
- ***Frequency Distributions***



USGS Flow Data



USGS Flow Data



USGS Flow Data

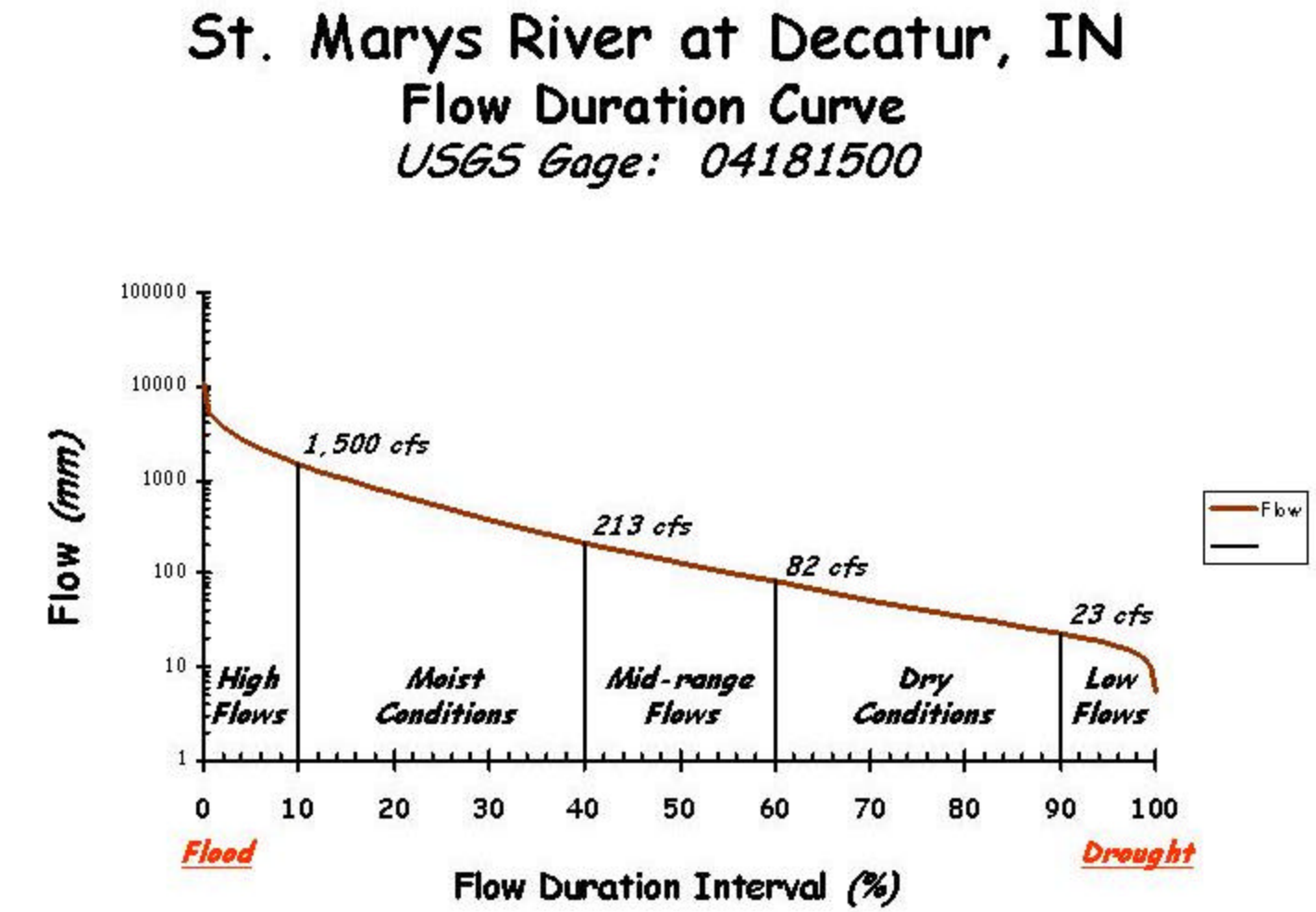
Duration Curves

Basics -- Flow Duration

- **Based on Cumulative Frequency Distribution**
  - ***Historic hydrologic record -- daily average flows***
    [e.g. download from USGS NWIS-Web]
  - ***Developed with statistical software or spreadsheet***
    [e.g. =PERCENTILE(a1:a3650,0.5) in Excel]
  - ***Can also look at other key recurrence intervals***
    [e.g. median flow, 2-year peak, 7Q10]

Duration Curves

Basics -- Flow Duration



USGS Flow Data

621 square miles

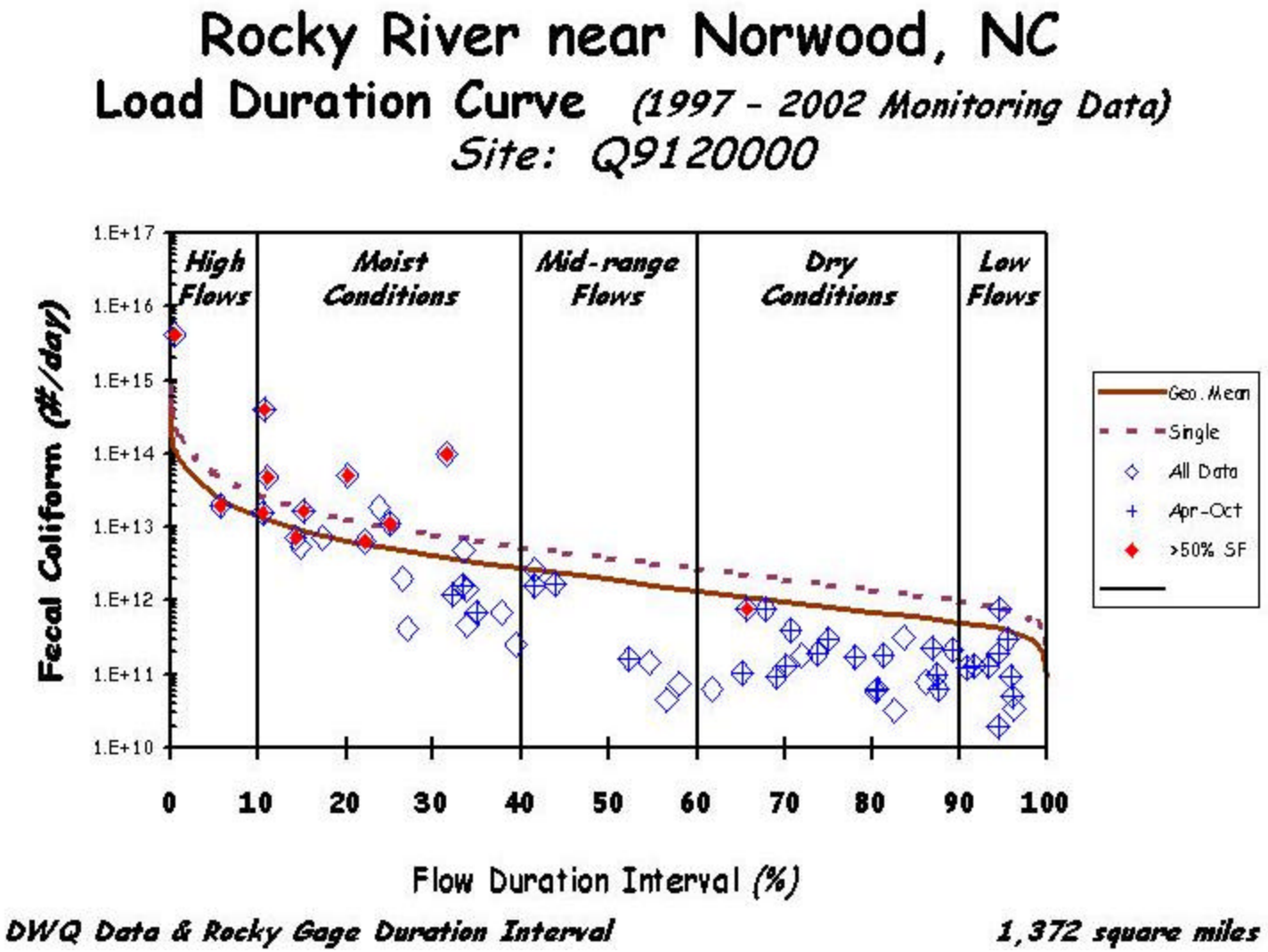
Duration Curves

Basics -- Load Duration

- **Again, use Cumulative Frequency Distribution**
  - ***Y-axis becomes water quality parameter value***
    [e.g. load or concentration]
  - ***X-axis position matches flow recurrence interval***
  - ***Curve determined by target concentration and flow associated with recurrence interval***

Duration Curves

Basics -- Load Duration



Duration Curves

Basics

- **Method offers a number of advantages**
  - ***Moves away from single point estimate***
  - ***Easier to explain – fairly simple graphic display***
  - ***Context for looking at monitoring / modeling data***
  - ***Targeting focus – framework to evaluate options***
  - ***Being evaluated as a tool in more & more States***

Duration Curves

Advantages

- **Context to interpret monitoring & modeling data**
- **Help guide implementation**
  - *Targeted* ***Participants***
  - *Targeted* ***Programs***
  - *Targeted* ***Activities***
  - *Targeted* ***Areas***

Duration Curves

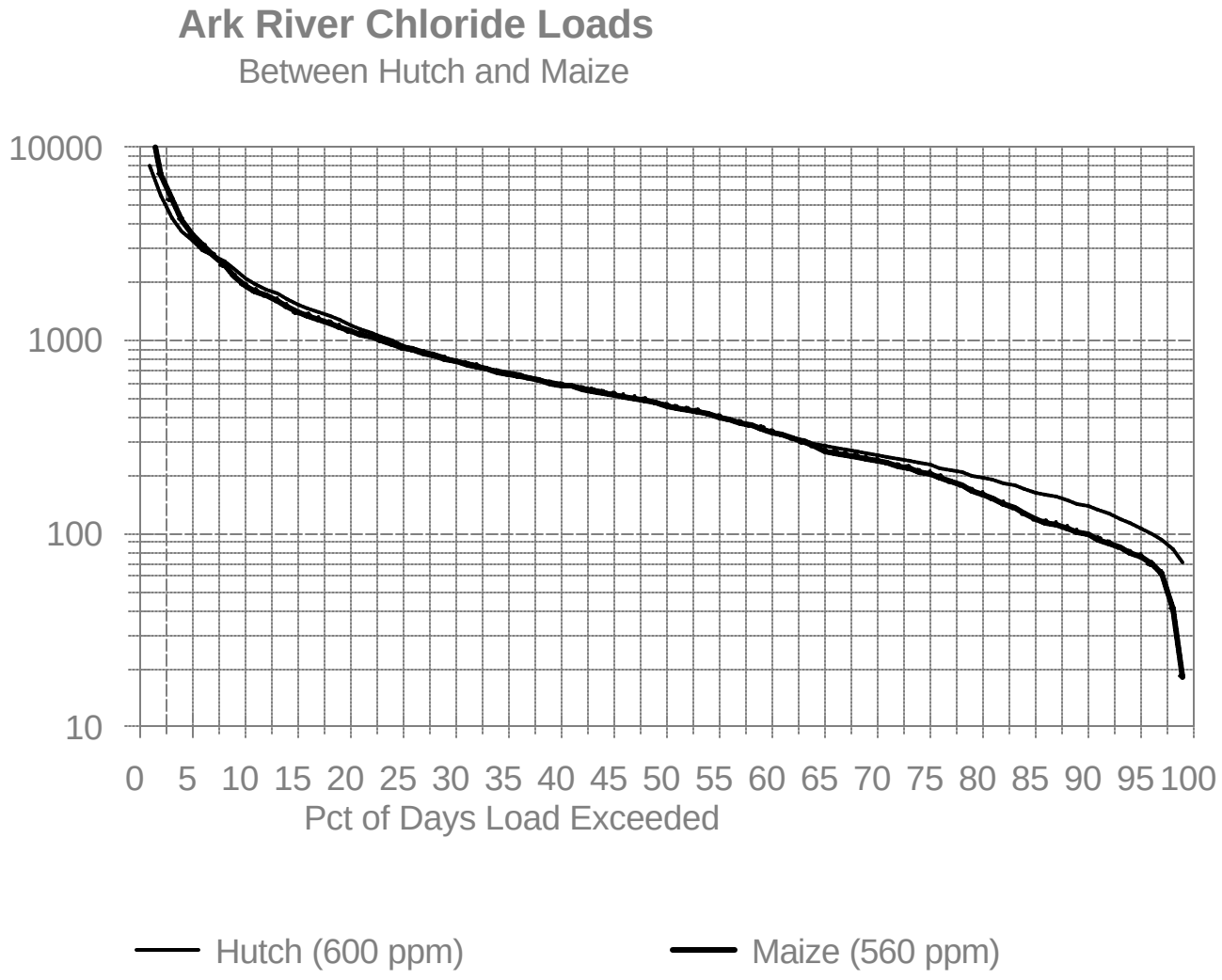
Latest Kansas Applications

Arkansas River Chlorides

- ***Hutchinson - Upstream Site, Salt Plants***
- ***Maize - Downstream Site, Historic Loss of Flow at Lower Flows***
- ***No Significant Difference in Chlorides***
- ***Significant Loss of Water and Chloride Load into Freshwater Aquifer***
- ***TMDL to set Cap on Upstream Load to Reduce Load Lost to Aquifer***

Load Duration Curves

Arkansas River Chlorides



Duration Curves

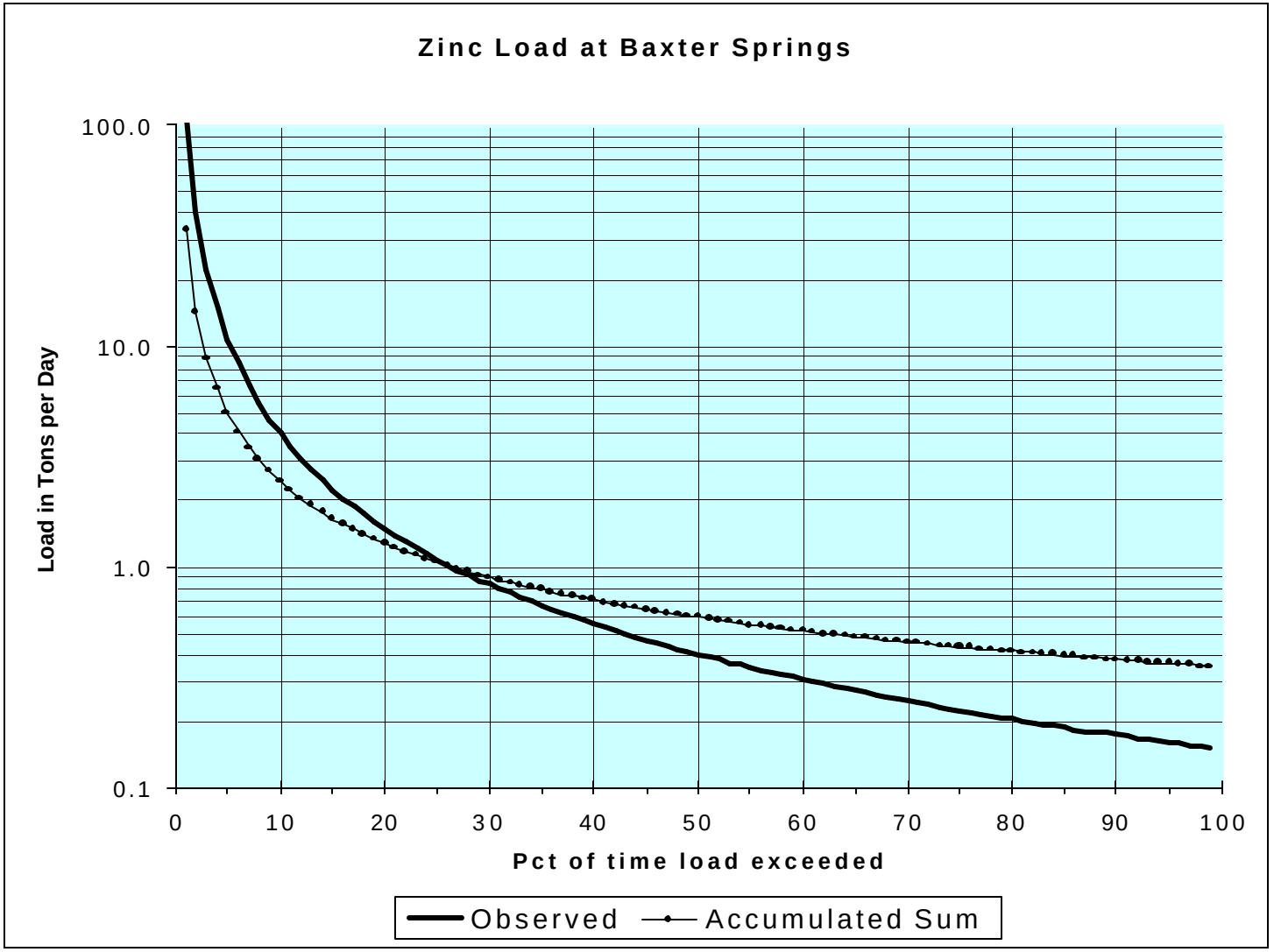
Latest Kansas Applications

Spring River Zinc

- ***Historic Mining Area in Tri-State Region***
- ***Baxter Springs Represents the Total Contribution from Drainage***
- ***Accumulations from Upstream Tribs Greater Than Observed Zinc Loads at Lower Flows***
- ***Observed Loads Exceed Accumulated Sum of Loads at Higher Flows***
- ***Hints at Deposition of Load at Lower Flows, Resuspension of Zinc Load at Higher Flows***
- ***In-Stream Impoundment Located above Baxter Springs on the River; Silt Trap***

Load Duration Curves

Spring River Zinc



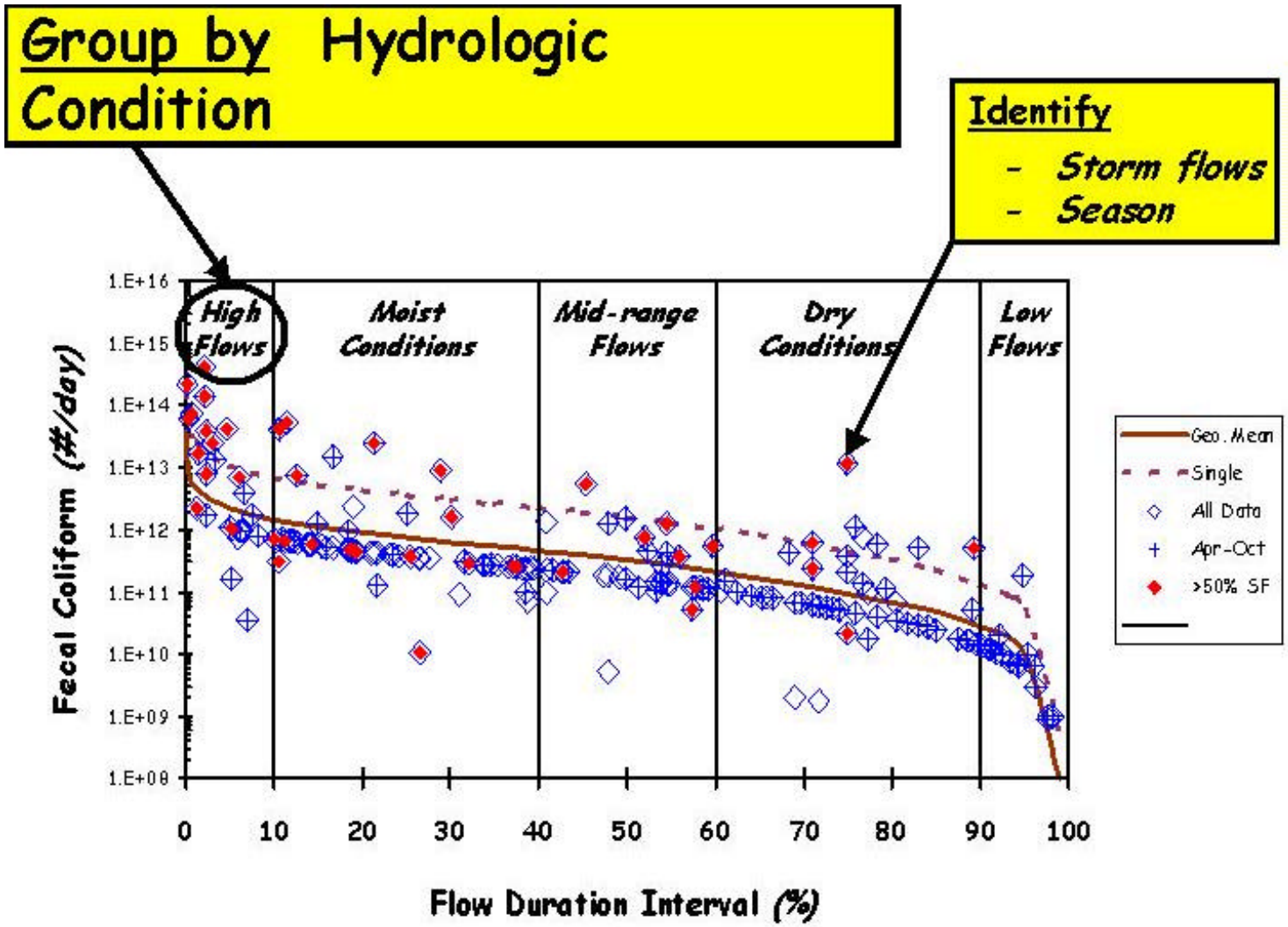
Duration Curves

Extended Uses

- **Support watershed planning by …**
  - ***Enhanced description of water quality concerns***
  - ***Improved basic understanding of key processes***
  - ***Focus on solution development***

Duration Curves

Enhanced Assessment



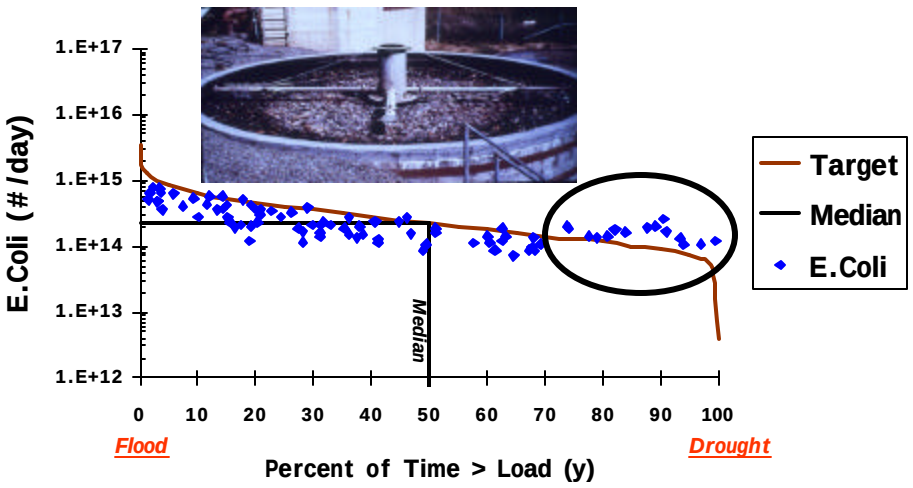
Load Duration Curves

Enhanced Assessment

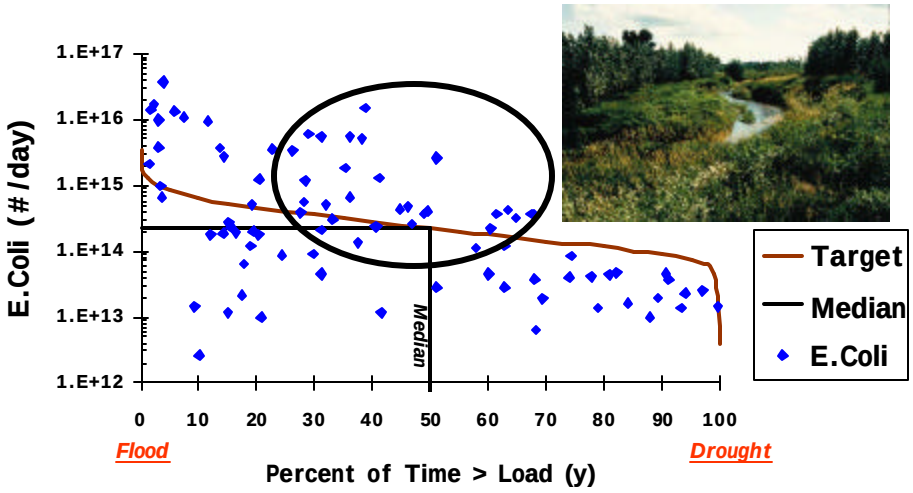
Connect WQ concerns to potential solutions …

Watershed Condition -- Hydrologic

Pipe Creek below Elfton
Sample Load Duration Curve



Willow Creek near Turkey Gap
Sample Load Duration Curve



TARGETED Participants: *Point Sources*

TARGETED Programs: *Riparian Buffers (e.g. CRP, CREP)*

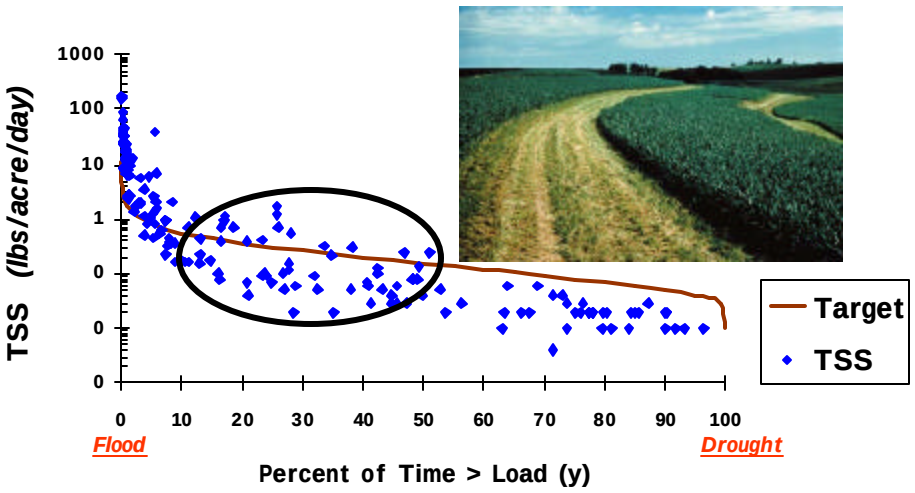
Load Duration Curves

Enhanced Assessment

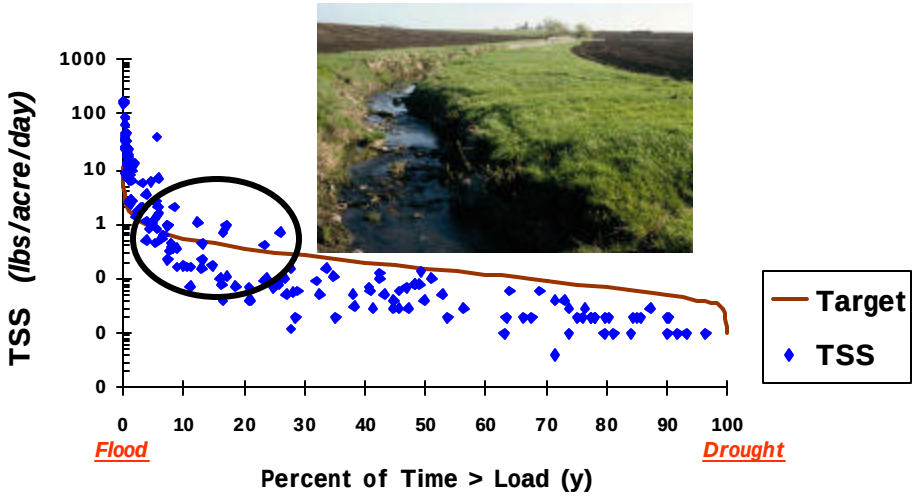
Connect WQ concerns to potential solutions …

Contributing Areas

Chicken Run above Mt. Pleasant
Sample Yield Duration Curve



Rock Creek near Moose Junction
Sample Yield Duration Curve



TARGETED Activities: ***Contour Strips, Conservation Tillage*** **TARGETED Areas:** ***Streambank Erosion, Bank Stability***

Duration Curves

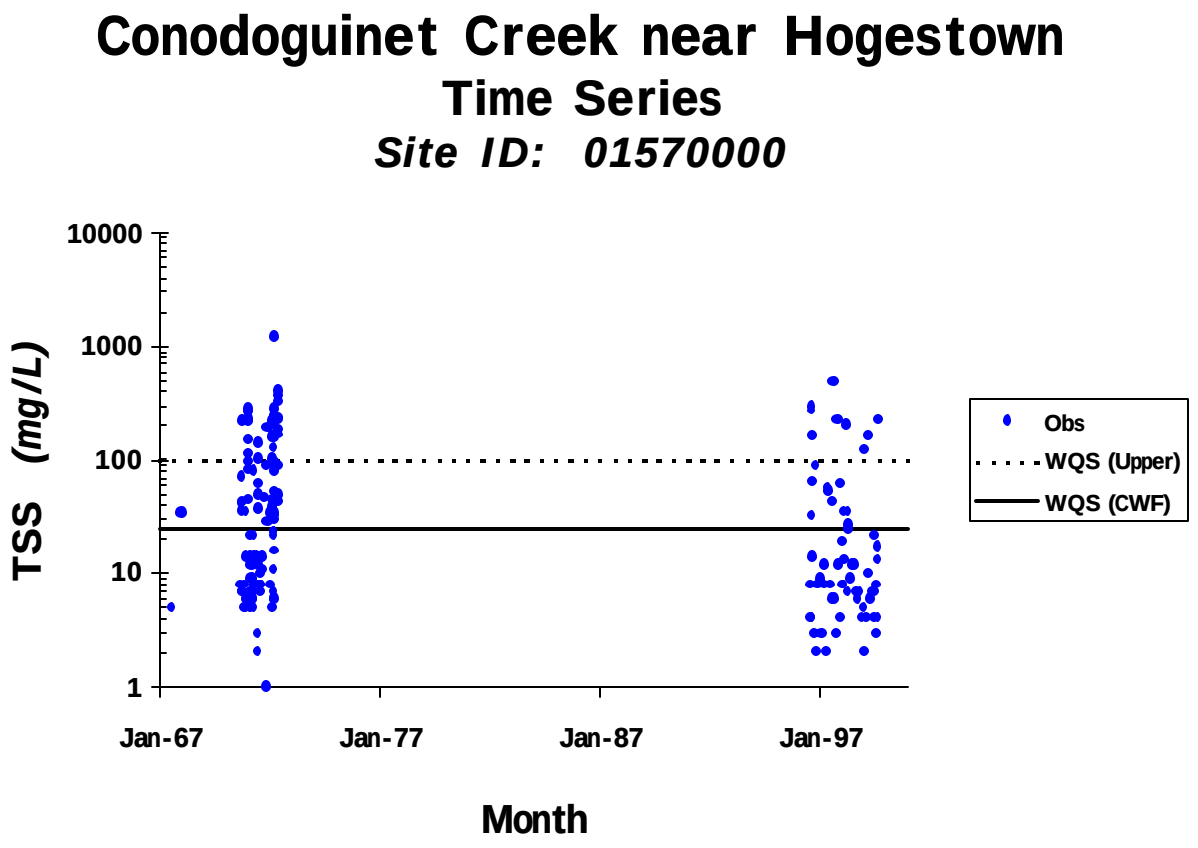
Enhanced Assessment

- **Other potential opportunities …**
  - ***Provides view beyond "Status & Trends"***
  - ***Expanded watershed characterization***
  - ***Use with volunteer monitoring efforts***
  - ***Linkage to other analytical methods (e.g. models, Bacteria Source Tracking)***

Duration Curves

Beyond "Status & Trends"

- **At first glance, a large gap …**

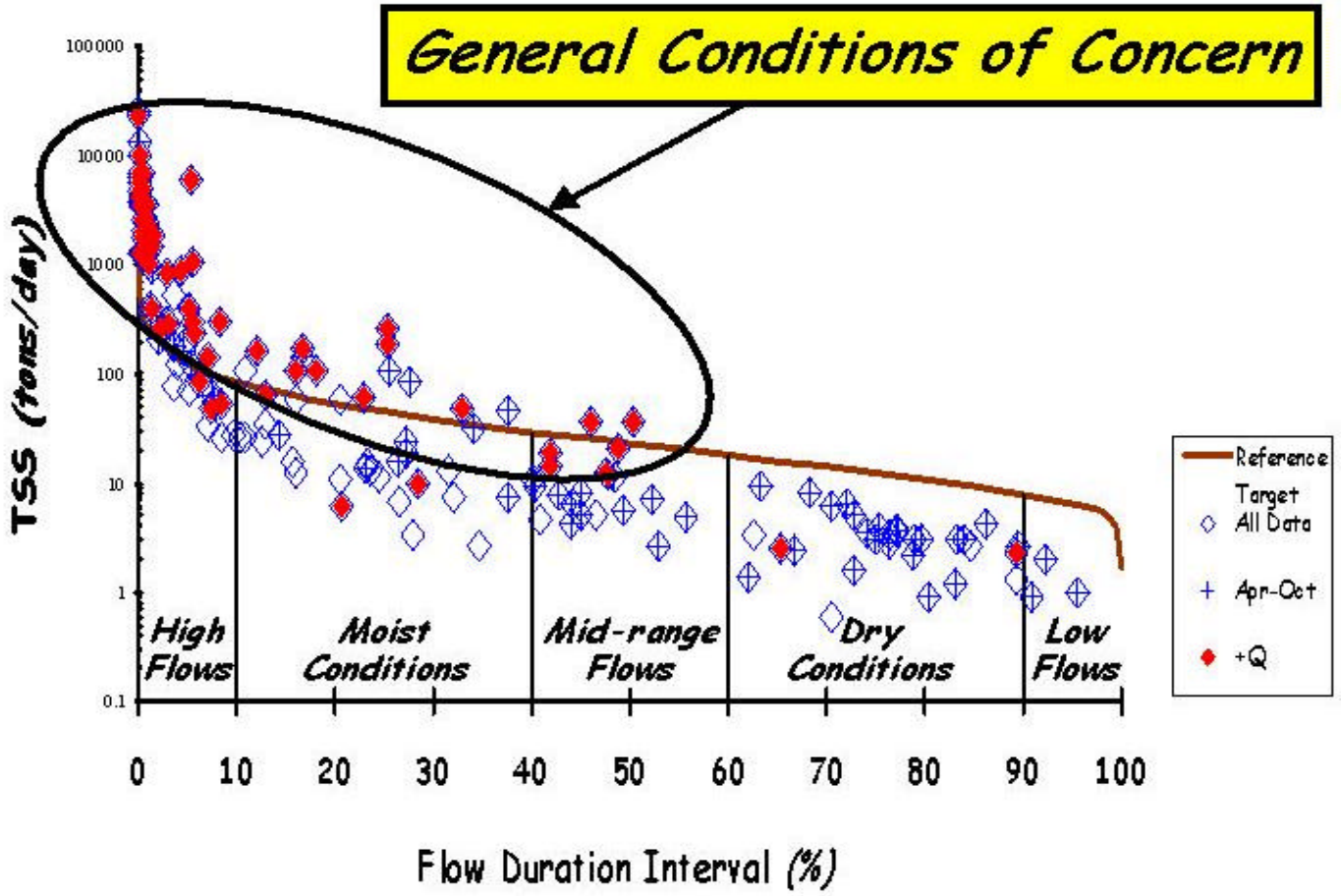


USGS Water Quality Data

Duration Curves

Beyond "Status & Trends"

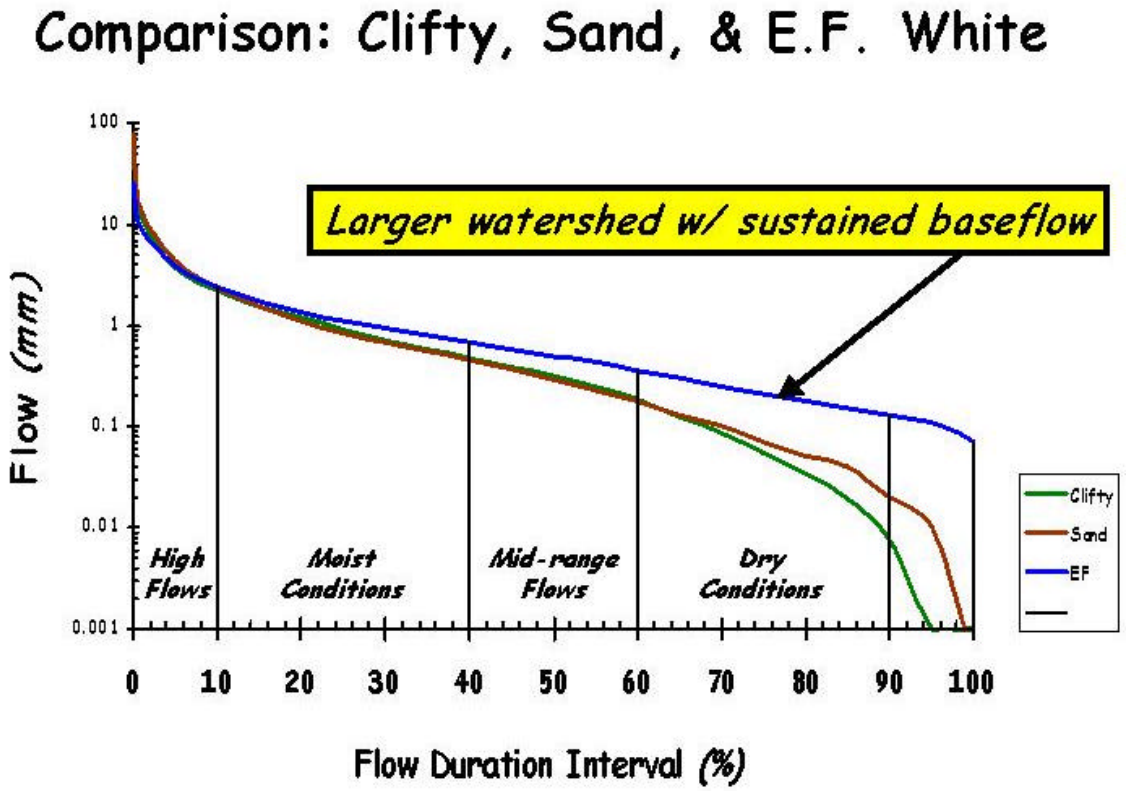
- **LDCs put focus on continuum of flows …**



Duration Curves

Expanded Characterization

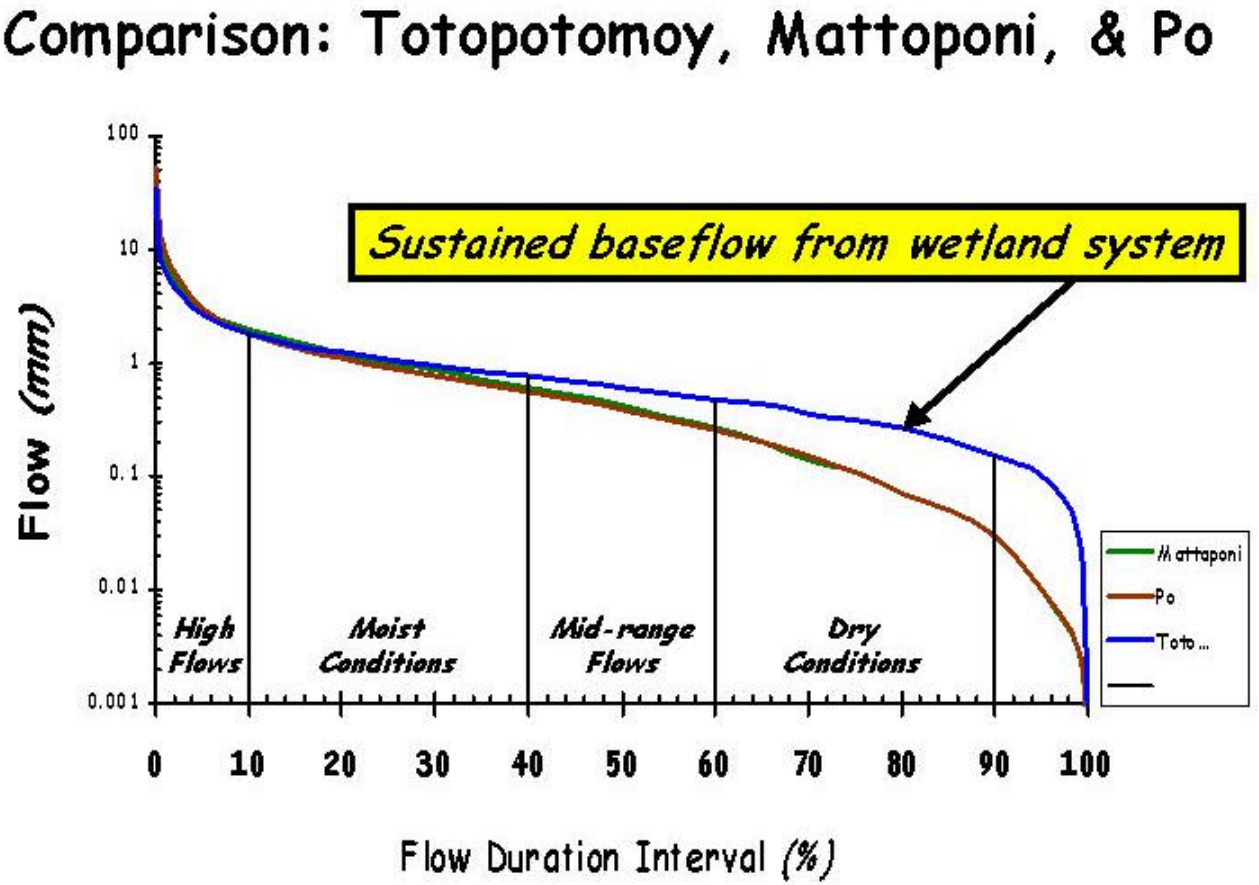
- **Importance of watershed size …**
  - ***Smaller ==> flashier at high flows; drier at low flows***



Duration Curves

Expanded Characterization

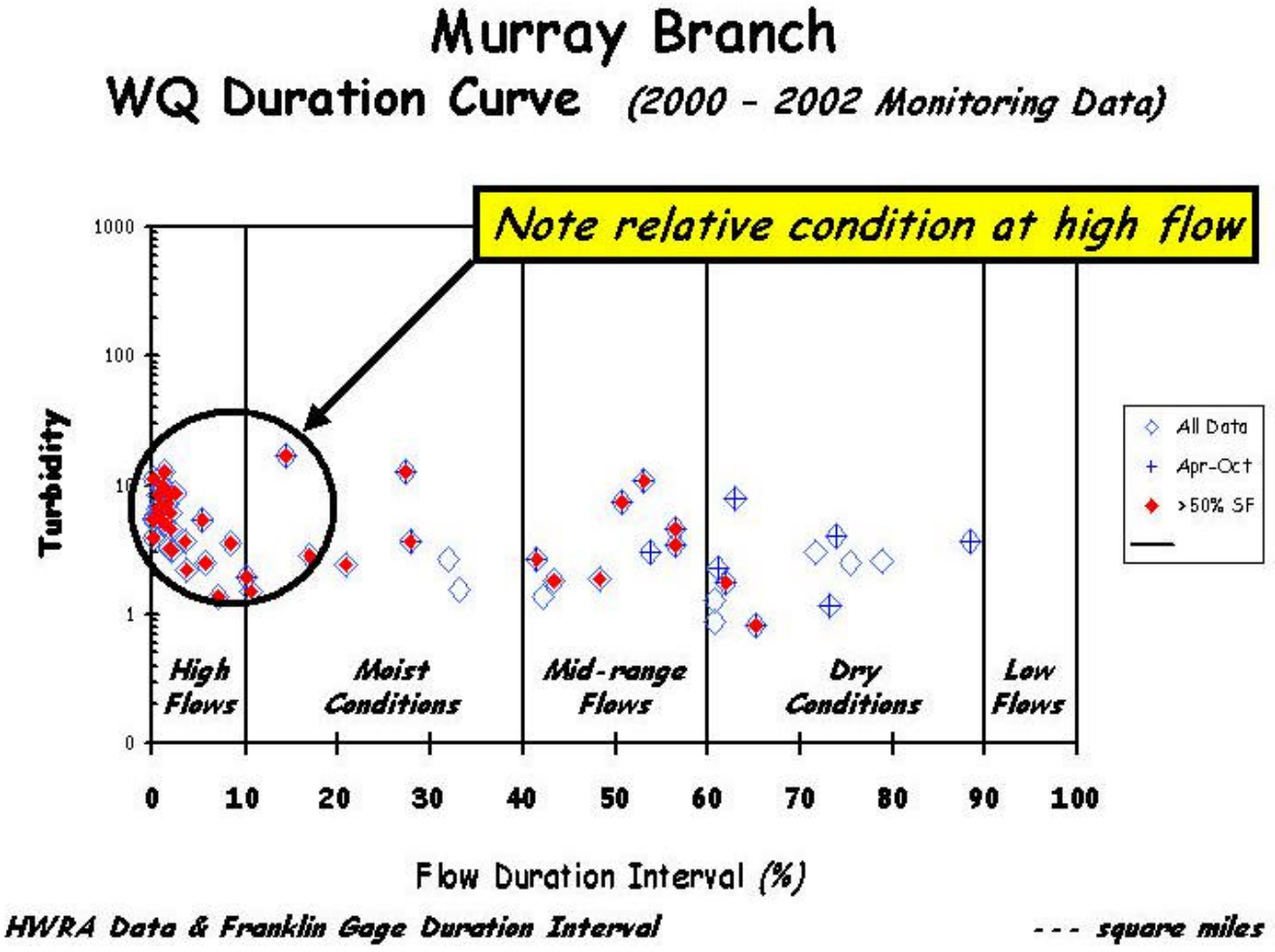
- **Importance of wetlands & lakes …**



Duration Curves

Use with Volunteer Monitoring Data

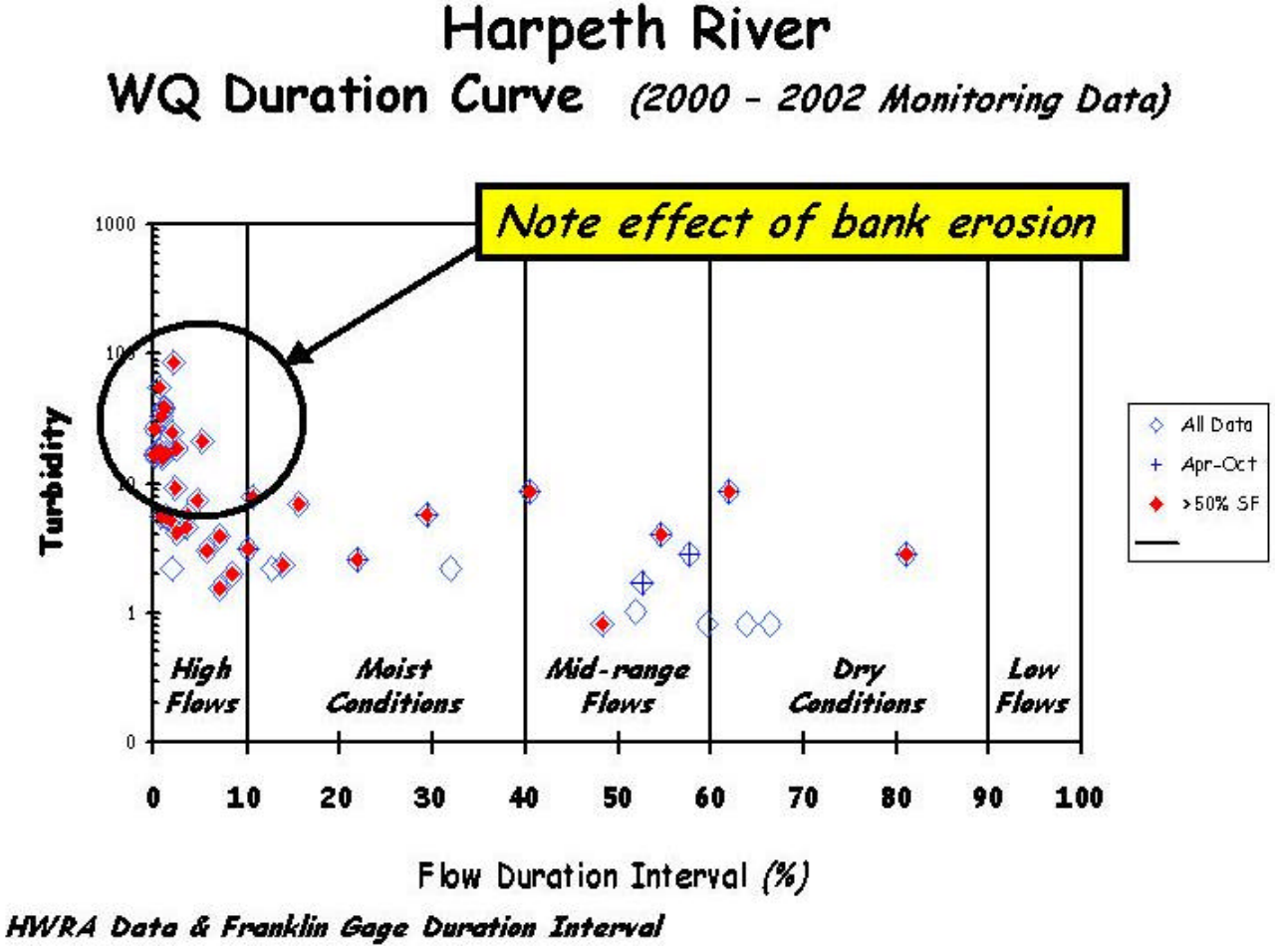
- **Reference watershed**



Duration Curves

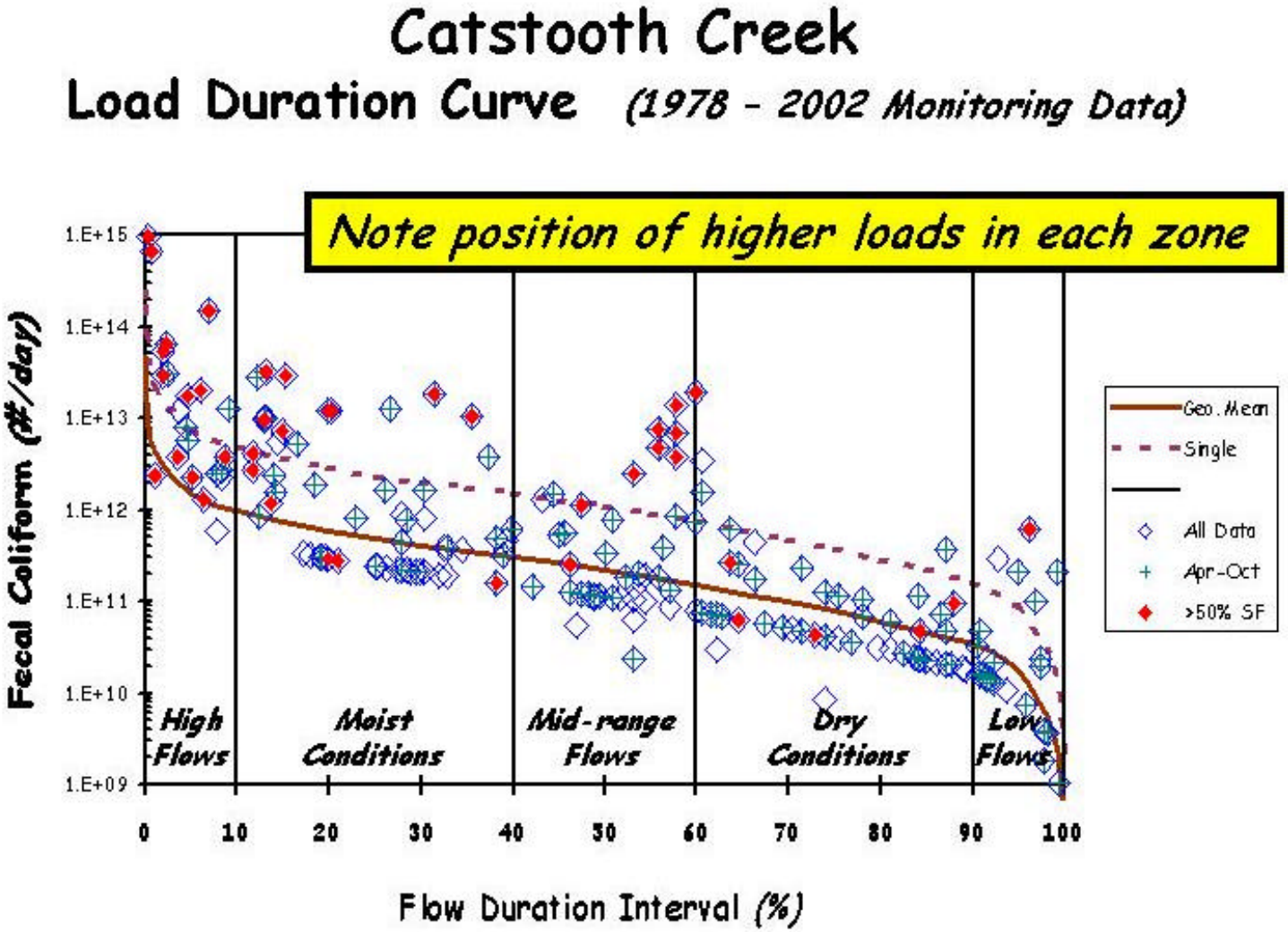
Use with Volunteer Monitoring Data

- **Provides feedback opportunities …**



Duration Curves

Comparing WQ Data to Model Output



Duration Curves

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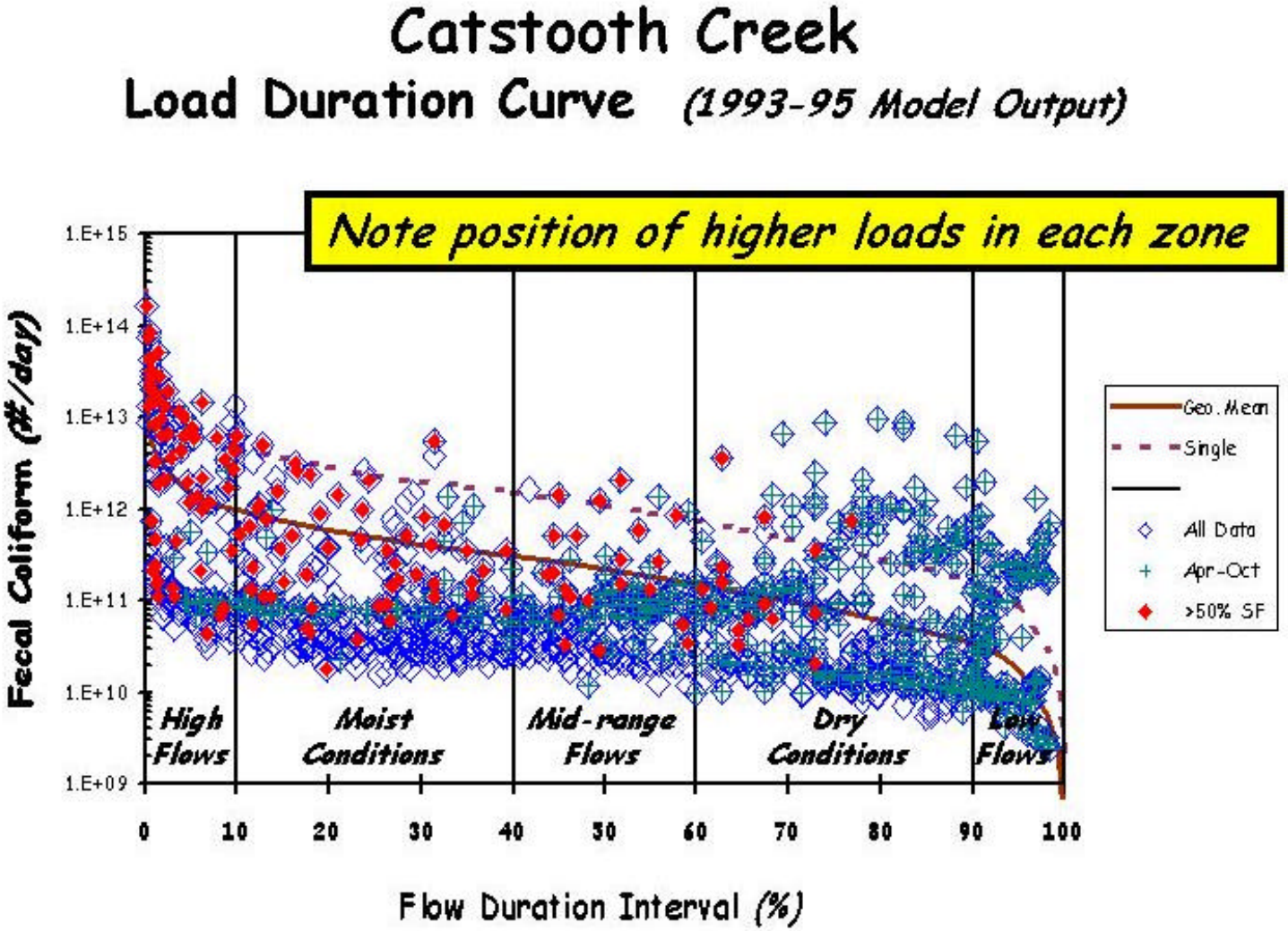
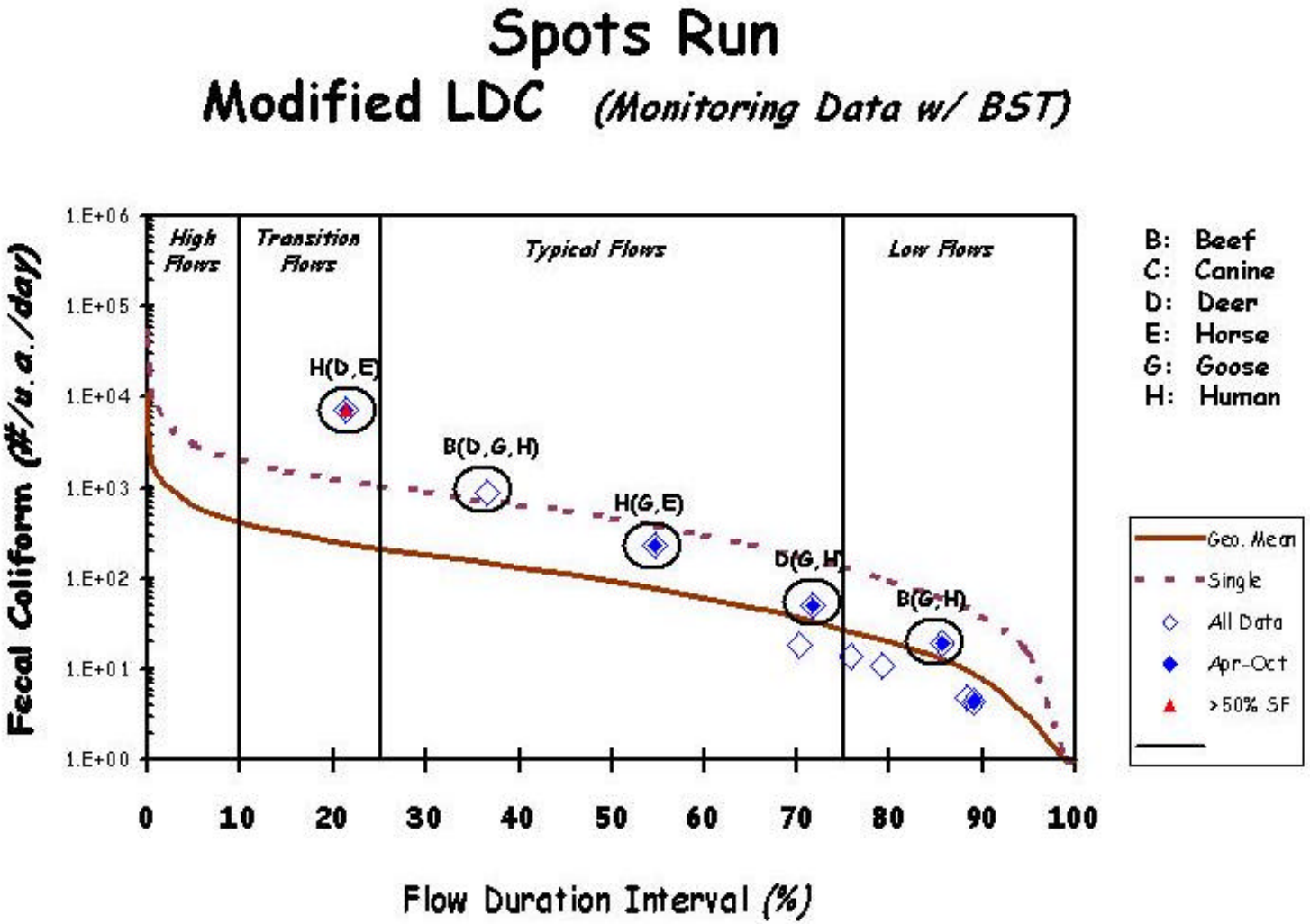


Duration Curves

Look at Bacteria Source Tracking Data



Load Duration Curves

Linking to Implementation Efforts

Focus: ***Source Areas & Delivery Mechanisms***

EXAMPLE		**Duration Curve Zone**				
	Source Area	**High**	**Moist**	**Mid-Range**	**Dry**	**Low**
	Point source				M	H
	Septic systems			M	H	
	Riparian areas		H	H	M	
	Stormwater: Impervious		H	H	H	
	CSO's	H	H	M		
	Stormwater: Upland	H	H	M		
		Potential for source area contribution under given hydrologic condition				

Load Duration Curves

Linking to Implementation Efforts

Focus: *Potential Management Practices*

EXAMPLE		Duration Curve Zone				
	Source Area	**High**	**Moist**	**Mid-Range**	**Dry**	**Low**
	Point source controls	L	L	M	H	H
	Septic system inspection	L	M	H	H	M
	CSO repair / abatement	H	H	H		
	SSO repair / abatement			M	H	H
	Riparian buffers		H	H	H	
	Pasture management	H	H	M		
	Pet waste education & ordinances		M	H	H	
	Hobby farm livestock education & ordinances		H	H	M	
		Potential for effective load reductions under given hydrologic condition				

Load Duration Curves

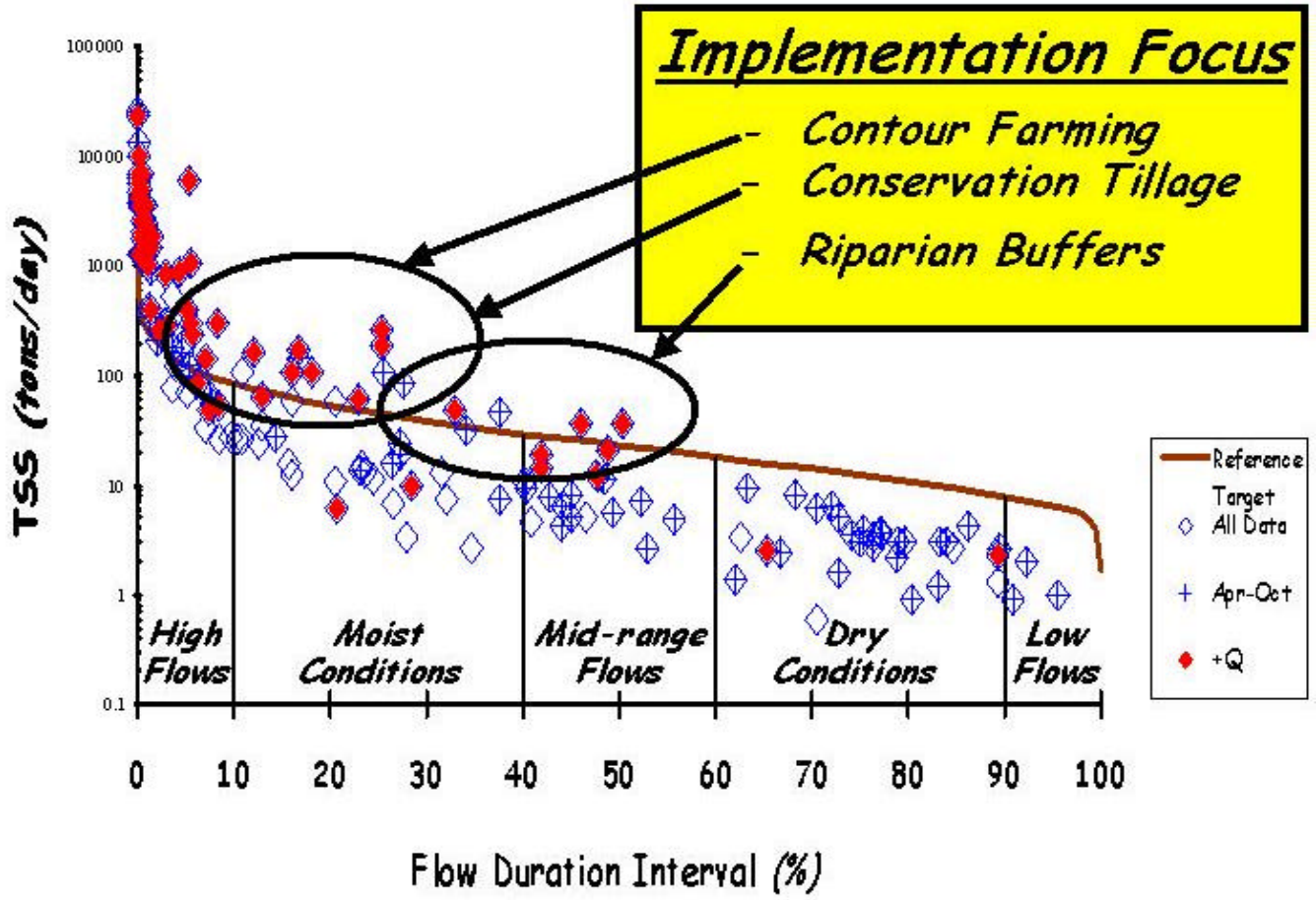
Linking to Implementation Efforts

- **Focus:** ***Source Areas & Delivery Mechanisms***
- **Example:** ***Agricultural Erosion Control***
  - ***Gully Stabilization*** ***(e.g. grade stabilization, grassed waterways)***
  - ***Bank Stabilization*** ***(e.g. channel stabilization, bank protection)***
  - ***Agricultural Fields*** ***(e.g. residue management, contour cropping)***
  - ***Filter Strips***

Duration Curves

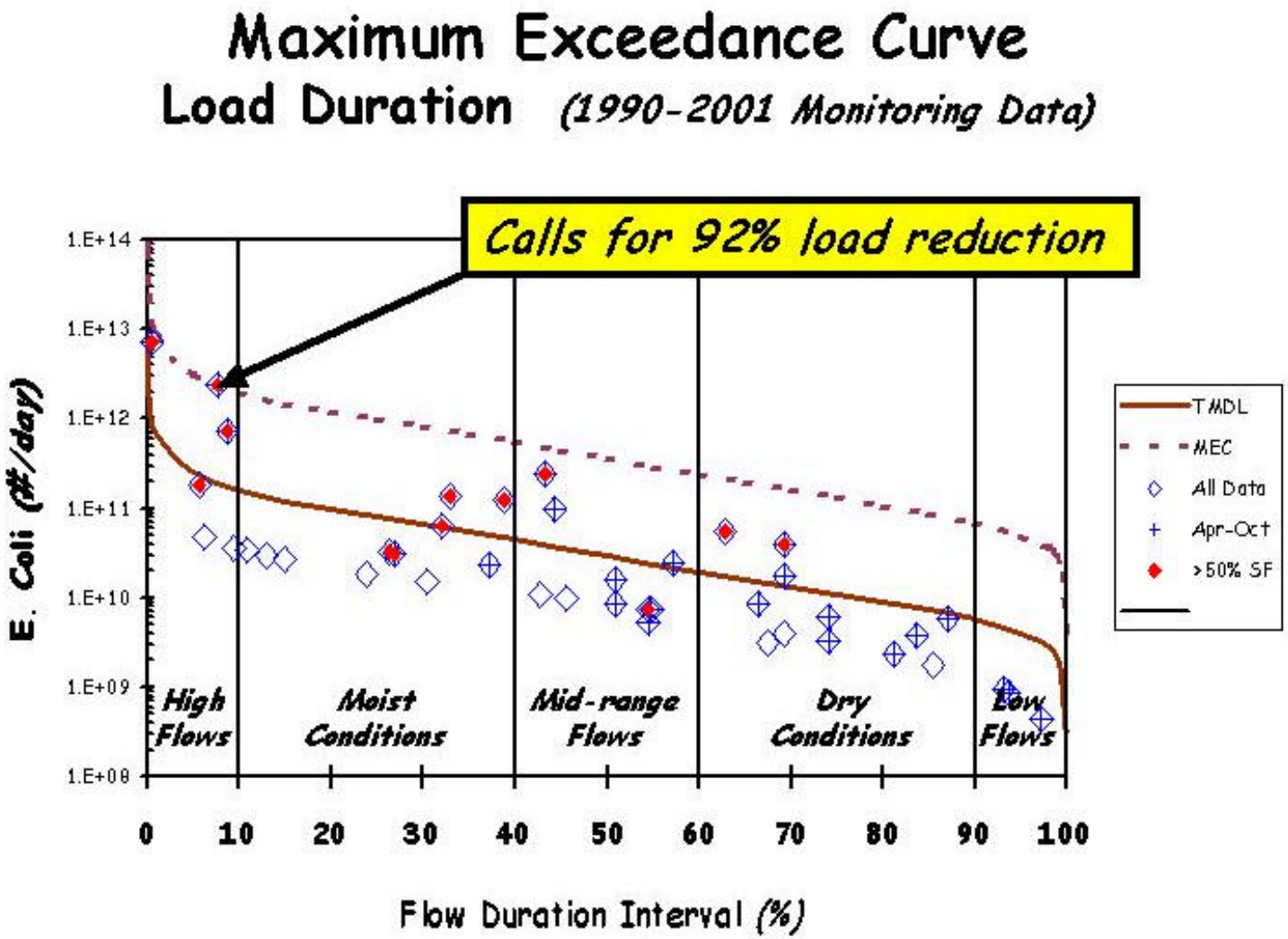
Linking to Implementation Efforts

Example: Agricultural erosion control …



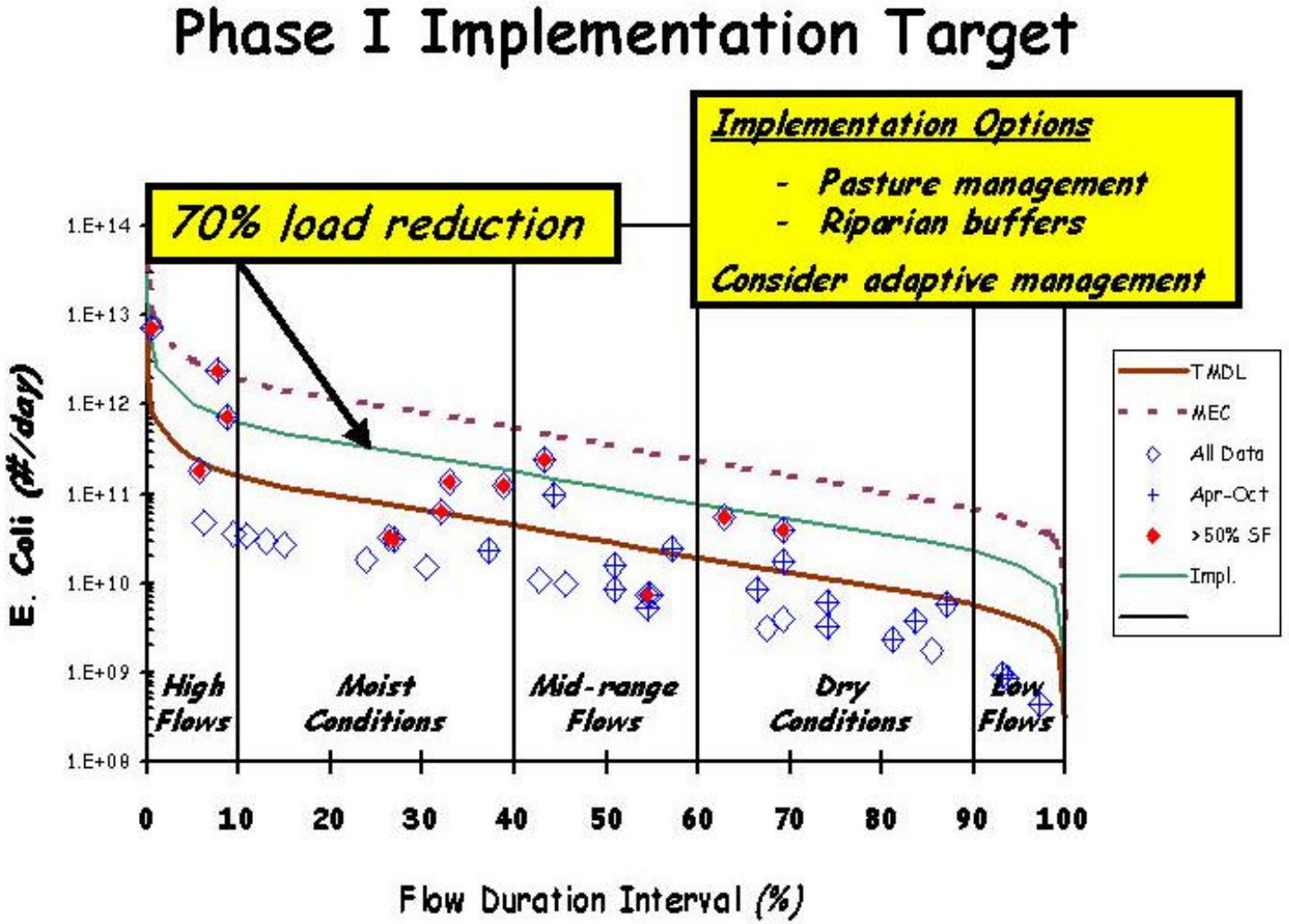
Duration Curves

Virginia & Bacteria TMDLs



Duration Curves

Virginia & Bacteria TMDLs



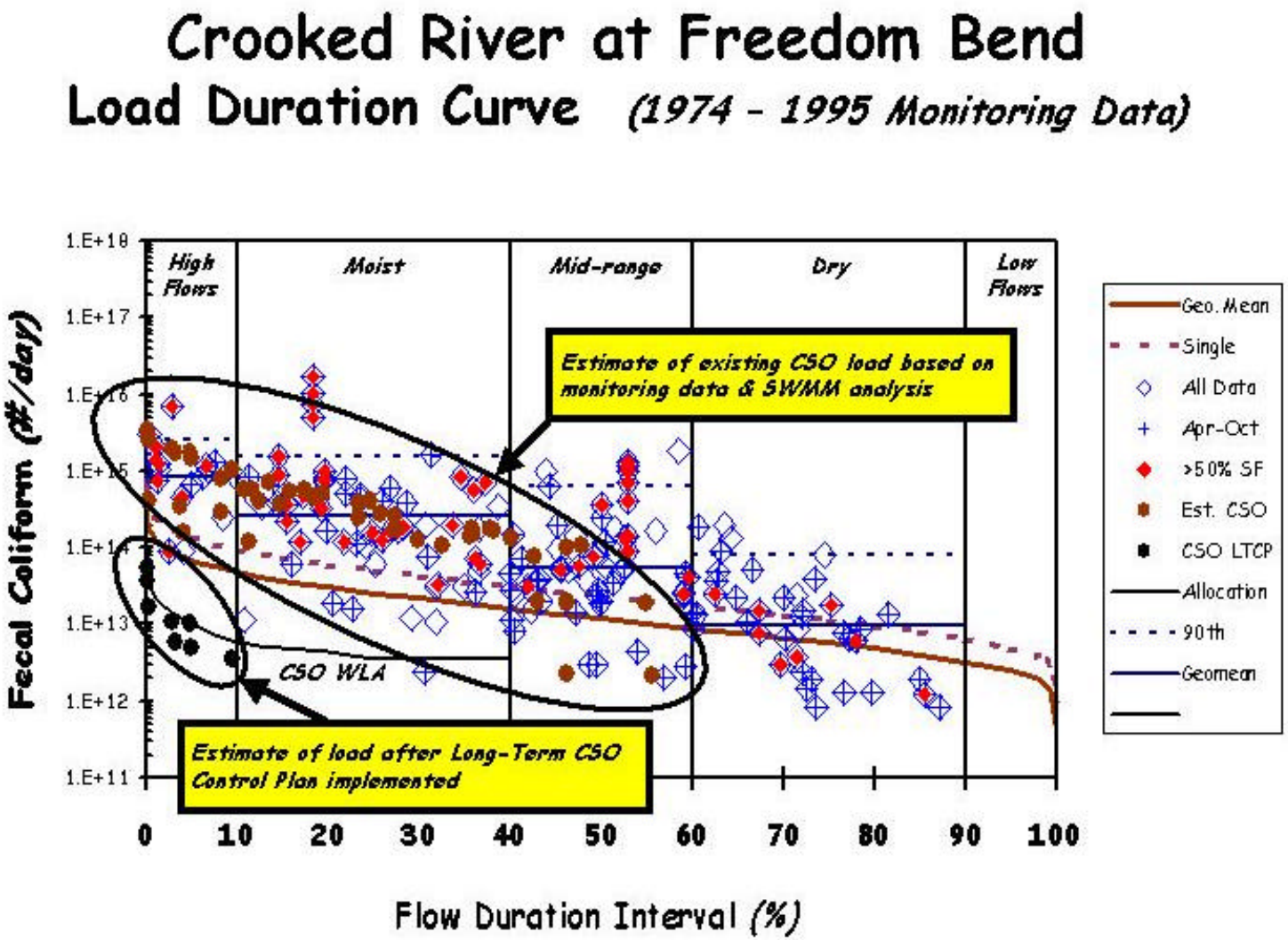
Connecting the Pieces

Combined Sewer Overflows

- **Targeted Activities**
  - ***Separation***
  - ***Storage Basins***
  - ***Tunnels***
  - ***Treatment Basins***
- **Calculation**
  - ***SWMM Modeling***

Connecting the Pieces

CSOs – One Approach



TMDL Summary

Crooked River

★ **Components *plus* Opportunities**

TMDL SUMMARY		Loads expressed as *(cfu/day)*				
		High	Moist	Mid-Range	Dry	Low
	Reduction	92%	90%	79%	41%	0%
	TMDL	1.39E+14	5.09E+13	2.37E+13	1.15E+13	5.09E+12
	Load Allocations	9.32E+12	2.73E+12	2.26E+13	1.05E+13	4.22E+12
	Wasteload Allocations	4.68E+11	4.68E+11	4.68E+11	4.68E+11	4.68E+11
	CSO	1.25E+14	4.58E+13	0.00E+00	0.00E+00	0.00E+00
	Margin of Safety	4.11E+12	1.89E+12	6.20E+11	4.99E+11	4.06E+11
	Implementation	Long Term CSO Plan			Municipal NPDES	
	Opportunities			Riparian Protection		
				Pet Waste Ordinance		
				Stormwater Mgt.		

Load Duration Curves

Contacts

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