



# **Project Area 2**

## **River Basin Groups D and E**

### **Bacteria Impairments**

#### **TMDL**

**Texas Commission on Environmental Quality**  
**James Miertschin & Associates, Inc.**



# Purpose of Today's Meeting

- Background: Review historical *E. coli*/Fecal Coliform data for San Antonio River and Salado Creek
- Model Development: Review modeling approach
- TMDL Loading Allocations
- Bacterial Source Tracking Results
- Implementation



# Introduction

- Section 303 (d) of the Clean Water Act requires states to identify water bodies that do not meet applicable water quality standards. This is known as the 303 (d) list.
- Pursuant to the Clean Water Act, and development of the 303 (d) list, the TCEQ is responsible for development of TMDL's.
- Due to elevated bacteria indicators, specifically fecal coliform or E. coli., Segments 1901 & 1911 of the San Antonio River as well as segments 1910A & 1910 of Waltzem and Salado Creeks (respectively) were selected for assessment in an area known as Project Area 2 – Basin Groups D and E.



# What is a TMDL (Total Maximum Daily Load)?

- Establishes the maximum amount of an impairing substance, or stressor, that a waterbody can assimilate and still meet Water Quality Standards
- allocate that load among pollutant contributors
- are a tool for implementing State water quality standards and are based on the relationship between pollution sources and in-stream water quality conditions



Salado Creek Segment 1910

Walzem Creek Segment 1910A

Upper San Antonio River Segment 1911

Lower San Antonio River Segment 1901

- Placed on the 2000 §303(d) list because bacteria exceeded the segment specific criteria of 126 colonies per 100 ml (geometric mean) and 394 colonies per 100 ml (single grab).
- Designated Uses
  - Contact Recreation



# TMDL Development

- Segment is listed on the federal Clean Water Act Section 303 (d) list
- Selection of Pollutant for TMDL
- Initiate TMDL Project
- Data Collection – Compile data about current water quality conditions, collect additional data
- Data Assessment – Quantify impacts and sources (point, non-point, natural background, atmospheric deposition)



# TMDL Development, continued

- TMDL Allocation – Identify a quantifiable water quality target for each constituent
- Implementation Plan – Comprehensive strategy for restoring the beneficial uses of the water body
- Draft TMDL Report
- TCEQ Review / Public Comment
- TCEQ Approval / EPA Approval
- Implementation



# Stakeholder Involvement

- Improve the quality and quantity of contributions to TMDL projects
- Ensure that state government considers the local perspective in its decisions
- Lead to consensus-based solutions
- Encourage open dialogue on water quality issues



# Project Background

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# Salado Creek Assessment

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- 1996-2001 record for *E. coli* , 9 of 16 stations indicated nonsupport
- 1996-2001 record for Fecal Coliform , 12 of 16 stations indicated nonsupport
- Upper portion and lower portion of Segment 1910 not supporting

# Salado Creek *E. coli* Data (1996-2001)



STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100	STATUS	COVERAGE
12877	NE Loop 410	7	2	94	no concern	1 mi
15643	SH 368	58	13	225	not supporting	<1 mi
12876	SH 368	5	5	2962	primary concern	<1 mi
12875	Eisenhaur	59	11	131	not supporting	1 mi
12874	Rittiman	4	0	129	primary concern	<1 mi
15642	Holbrook	56	16	212	not supporting	1 mi
12872	Pershing	65	10	113	fully supporting	1 mi
12871	IH 35	57	9	108	fully supporting	<1 mi



# Salado Creek *E. Coli* Data - Cont'd (1996-2001)

STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100	STATUS	COVERAGE
15644	Pletz Pk	59	12	143	not supporting	<1 mi
12870	Gembler	25	4	125	fully supporting	1 mi
15645	Commerce	59	11	169	not supporting	1 mi
15646	MLK Pk	99	31	220	not supporting	1.5 mi
12868	Rigsby	63	21	203	not supporting	2 mi
15647	E. Southcross	58	9	159	not supporting	1.5 mi
12864	Loop 13	69	14	184	not supporting	2.5 mi
12862	Goliad	120	17	114	fully supporting	1.5 mi



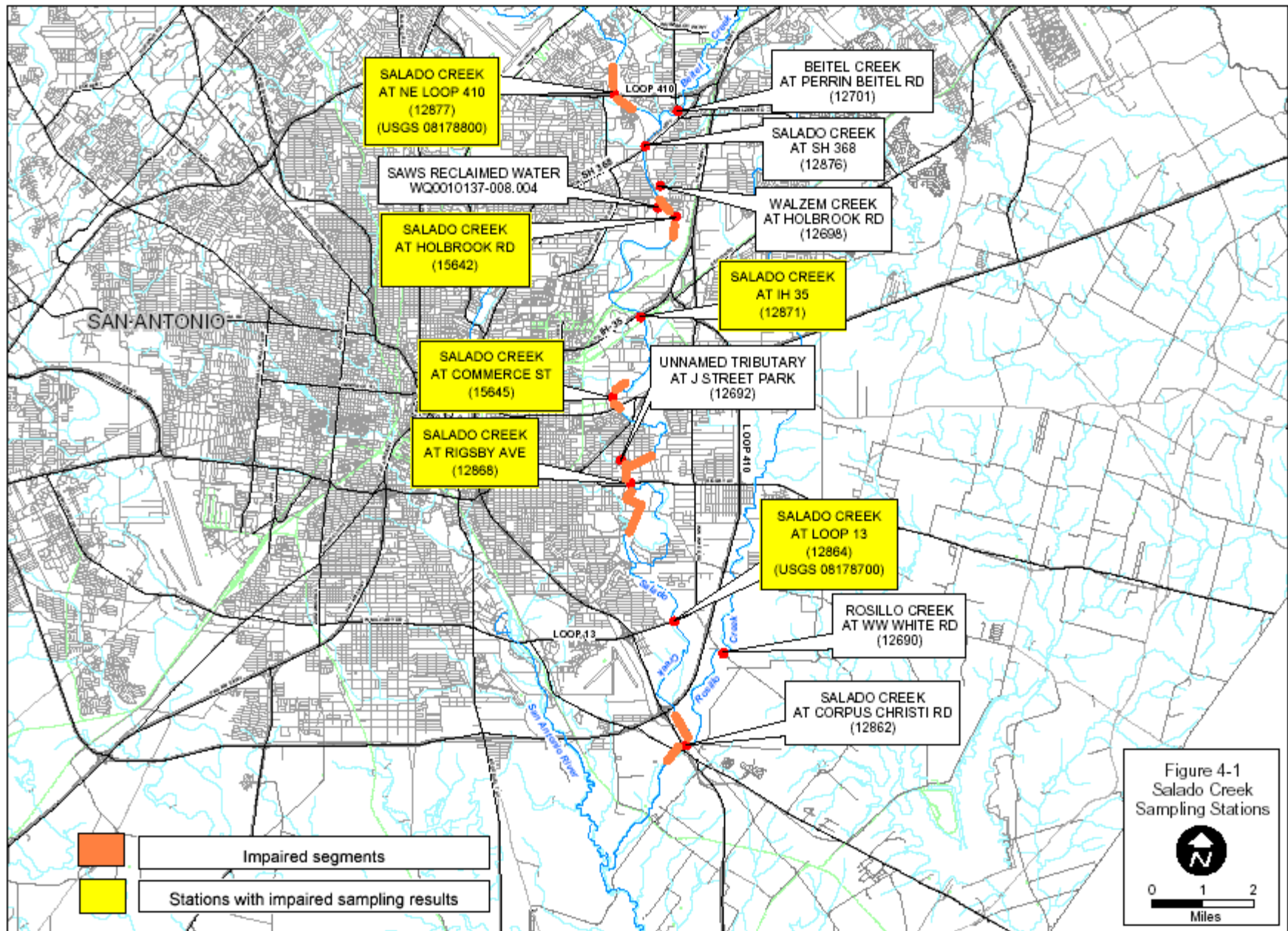
# Salado Creek Fecal Coliform Data (1996-2001)

STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100 ML	STATUS	COVERAGE
12878	Los Patios	1	0	320	not asses	<1 mi
12877	NE Loop 410	17	13	2124	not supporting	1 mi
15643	SH 368	60	29	439	not supporting	<1 mi
12876	SH 368	5	5	8226	primary concern	<1 mi
12875	Eisenhauer	61	24	260	not supporting	1 mi
12874	Rittiman	4	1	263	primary concern	<1 mi
15642	Holbrook	58	30	543	not supporting	1 mi
12872	Pershing	71	15	176	fully supporting	1 mi
12871	IH 35	59	14	208	not supporting	<1 mi



# Salado Creek Fecal Coliform Data - Cont'd (1996-2001)

STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN	STATUS	COVERAGE
15644	Pletz Pk	60	22	269	not supporting	<1 mi
12870	Gembler	26	7	248	not supporting	<1 mi
15645	Commerce	61	30	415	not supporting	1.5 mi
15646	MLK Pk	104	52	449	not supporting	2 mi
12868	Rigsby	67	30	462	not supporting	<1 mi
15733	Commanche Pk	2	0	215	not asses	1 mi
15647	E Southcross	60	19	311	not supporting	1.5 mi
12864	Loop 13	73	27	347	not supporting	2.5 mi
12862	Goliad	127	26	180	fully supporting	1.5 mi
12861	Southton	1	0	40	not asses	





# USAR Assessment

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- 1996-2001 record for *E. coli* , 1 of 9 stations indicated nonsupport
- 1996-2001 record for Fecal Coliform , 9 of 20 stations indicated nonsupport
- Upper portion and lower portion of Segment 1911 not supporting

# Upper San Antonio River *E. coli* Data (1996-2001)



STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100 ML	STATUS	COVERAGE
12912	Hildebrand	8	3	227	primary concern	<1 mi
12904	Alamo St	5	1	266	primary concern	1 mi
14256	Mitchell St	26	9	263	not supporting	<1 mi
12897	Loop 410	5	0	37	no concern	<1 mi
12894	Blue Wing	5	2	199	primary concern	1 mi
16731	Medina confl	19	0	63	fully supporting	<1 mi
12889	IH 37	6	0	45	no concern	1 mi
12883	Dietz Rd	5	0	123	no concern	1 mi
12879	FM 791	12	0	76	fully supporting	<1 mi



# Upper San Antonio River Fecal Coliform Data (1996-2001)

STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100 ML	STATUS	COVERAGE
12912	Hildebrand	26	14	469	not supporting	2 mi
12904	Alamo St	33	19	865	not supporting	2.5 mi
14220	Lone Star	4	4	779	primary concern	1 mi
14256	Mitchell St	48	39	1720	not supporting	2.5 mi
15308	700 m d/s Loop 13	8	2	332	primary concern	2.5 mi
15310	1.2 km d/s Loop 13	5	0	93	no concern	1 mi
12902	Mission Dam	5	1	171	no concern	1 mi
12899	Padre Rd	16	7	67	not supporting	4 mi
12897	Loop 410	27	10	261	not supporting	2 mi
12894	Blue Wing	21	13	452	not supporting	3 mi



# USAR Fecal Coliform Data – Cont'd

STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100 ML	STATUS	COVERAGE
12894	Blue Wing	21	13	452	not supporting	3 mi
16731	Medina confl	19	2	131	fully supporting	2 mi
12890	Medina	6	4	446	primary concern	0.75 mi
12889	IH 37	20	3	146	not supporting	2.5 mi
12886	FM 1604	15	5	327	not supporting	6 mi
12885	Calaveras	15	3	180	fully supporting	6.5 mi
12884	Labatt Rd	21	2	128	fully supporting	1.5 mi
12883	Dietz Rd	20	3	181	fully supporting	2.5 mi
12882	FM 536	14	2	124	fully supporting	5.5 mi
12880	FM 541	15	4	259	not supporting	8 mi
12879	FM 791	30	5	147	fully supporting	4 mi

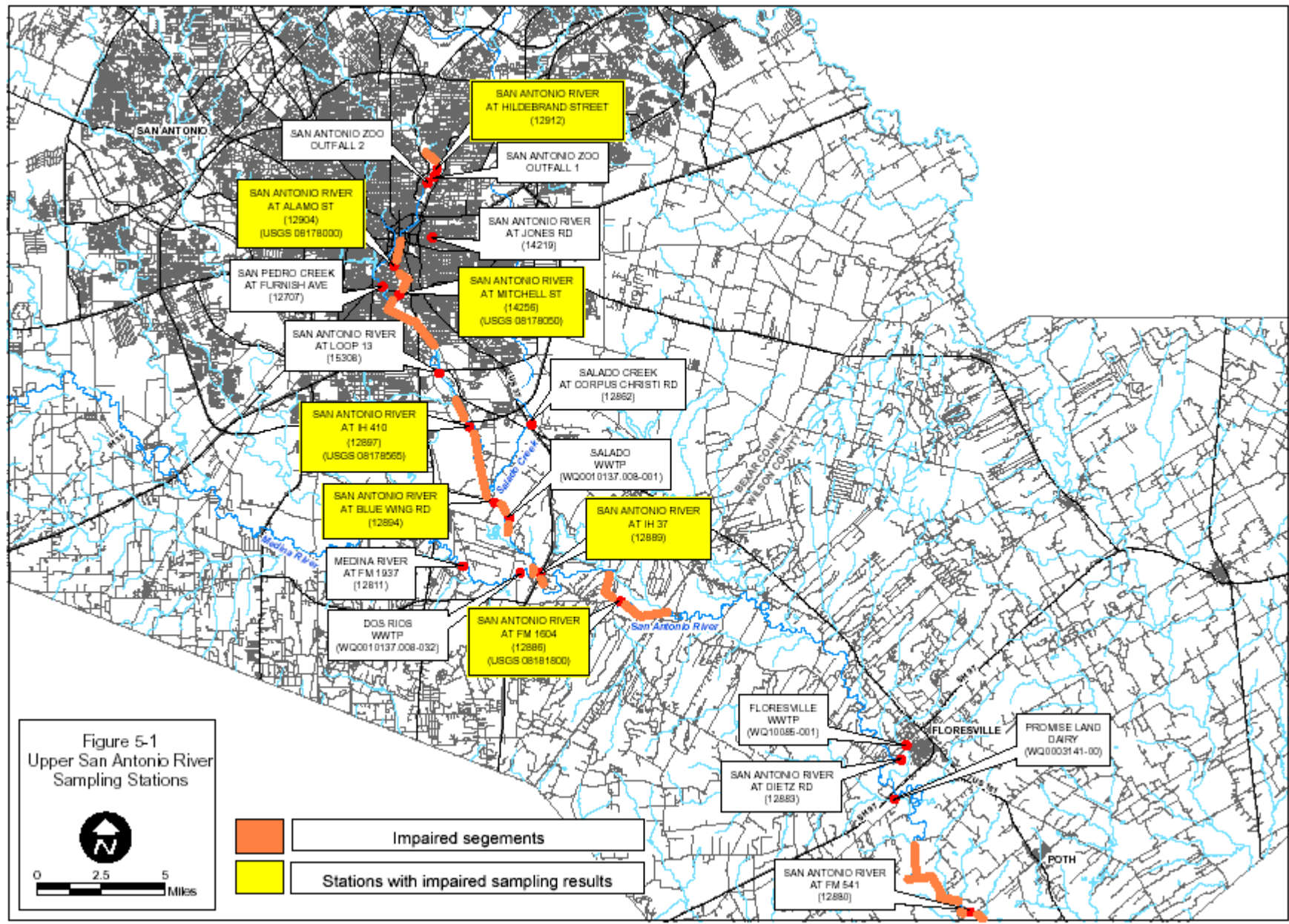


Figure 5-1  
Upper San Antonio River  
Sampling Stations



# LSAR Assessment

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- 1996-2001 record for *E. coli* , 3 of 5 stations indicated nonsupport
- 1996-2001 record for Fecal Coliform , 3 of 5 stations indicated nonsupport
- Upper portion and lower portion of Segment 1901 not supporting

# Lower San Antonio River E. coli Data (1996-2001)

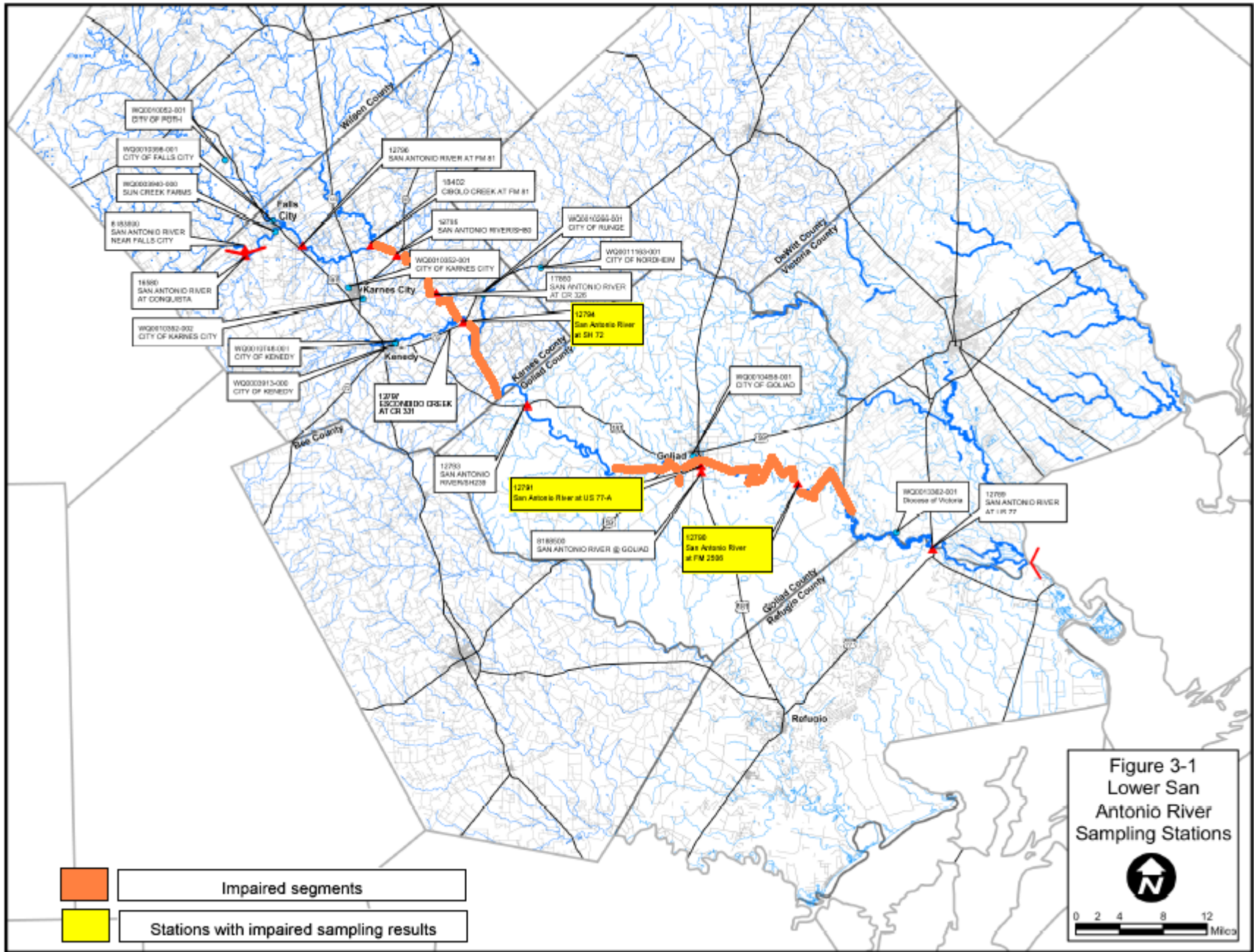


STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100ML	STATUS	COVERAGE
16580	at Conquista	4	0	94	no concern	FM 791 to Cibolo Ck, 19 mi
12794	at SH 72	13	2	153	not supporting	Cibolo Ck to 2 mi N of Hondo Ck, 25 mi
12793	at SH 239	4	0	107	no concern	2 mi N of Hondo Ck to unnamed trib near Lott Cem., 25 mi
12791	at US 77-A and 183	17	3	198	not supporting	unnamed trib near Lott Cem. To Manahuilla Ck, 25 mi
12790	at FM 2506	22	5	133	not supporting	Manahuilla Ck to Goliad/Refugio Cty line, 25 mi



# Lower San Antonio River Fecal Coliform Data (1996-2001)

STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100ML	STATUS	COVERAGE
16580	at Conquista	4	0	129	no concern	FM 791 to Cibolo Ck, 19 mi
12794	at SH 72	14	4	224	not supporting	Cibolo Ck to 2 mi N of Hondo Ck, 25 mi
12793	at SH 239	4	0	144	no concern	2 mi N of Hondo Ck to unnamed trib near Lott Cem., 25 mi
12791	at US 77-A and 183	18	6	268	not supporting	unnamed trib near Lott Cem. To Manahuilla Ck, 25 mi
12790	at FM 2506	26	10	268	not supporting	Manahuilla Ck to Goliad/Refugio Cty line, 25 mi





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# Part I: Model Development

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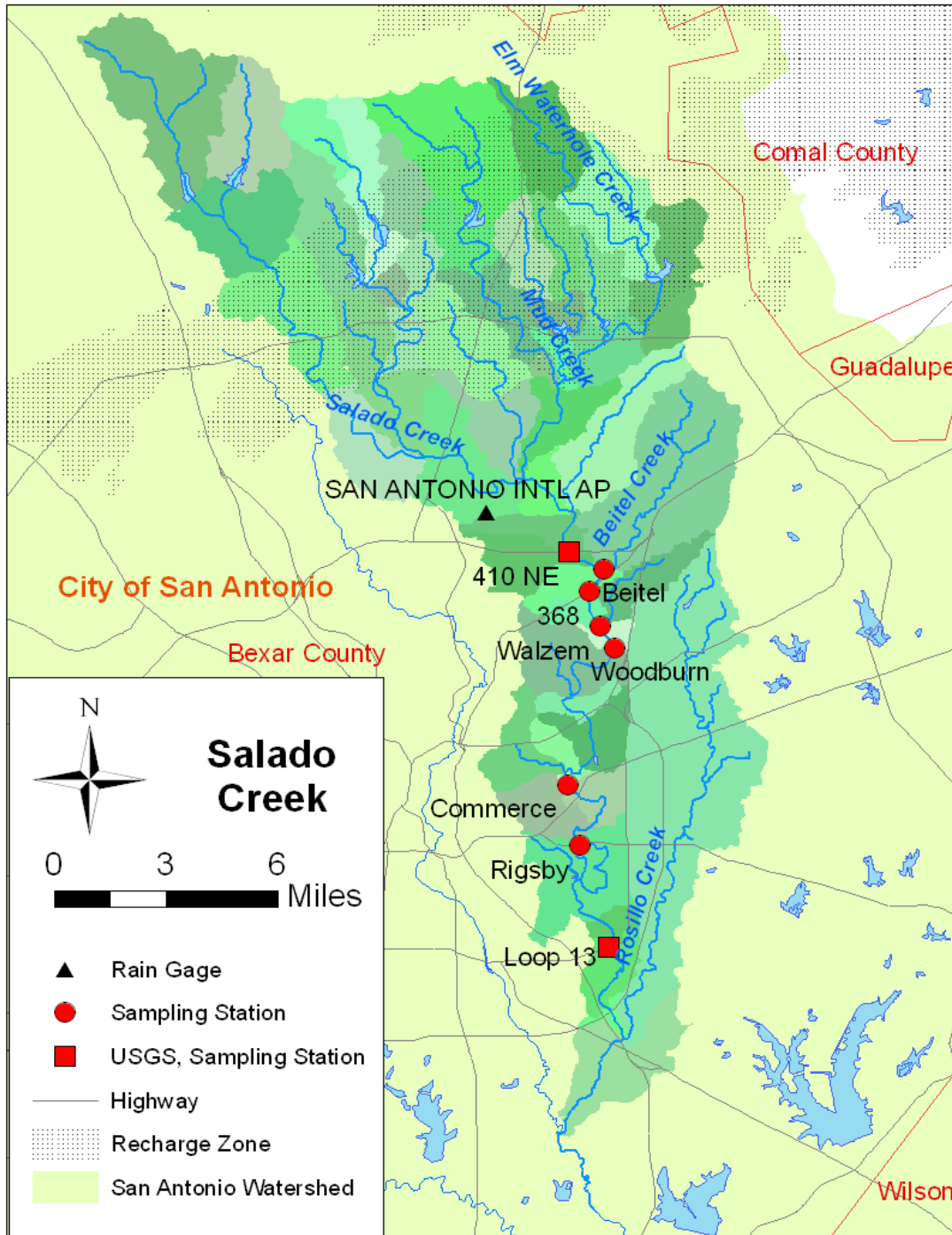


# HSPF

- Watershed Modeling System
- Simulation of Hydrology
- Simulation of Point Source Loadings
- Simulation of Nonpoint Source Loadings
- Simulation of Receiving Water Quality

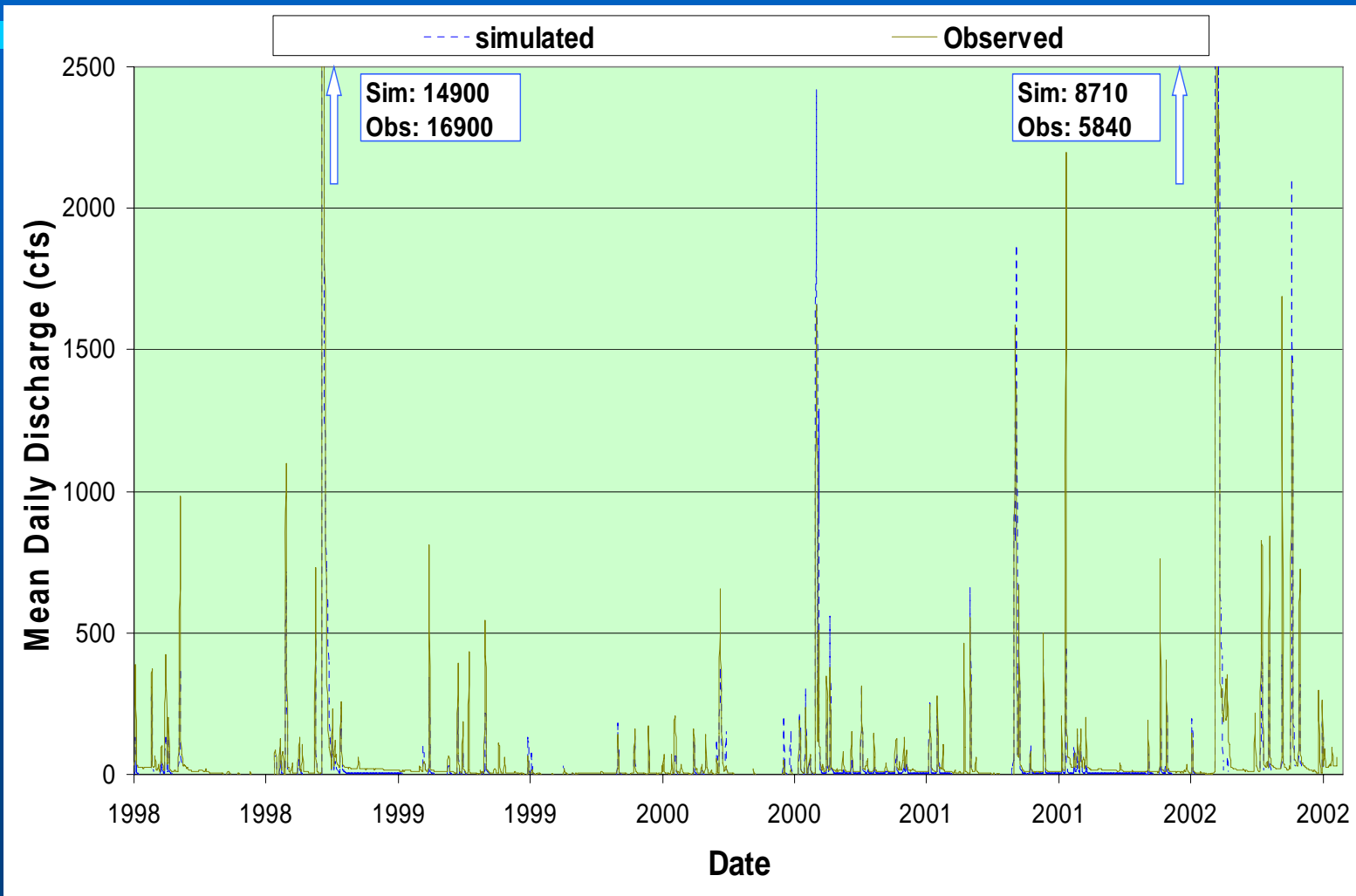


# Salado Creek Watersheds

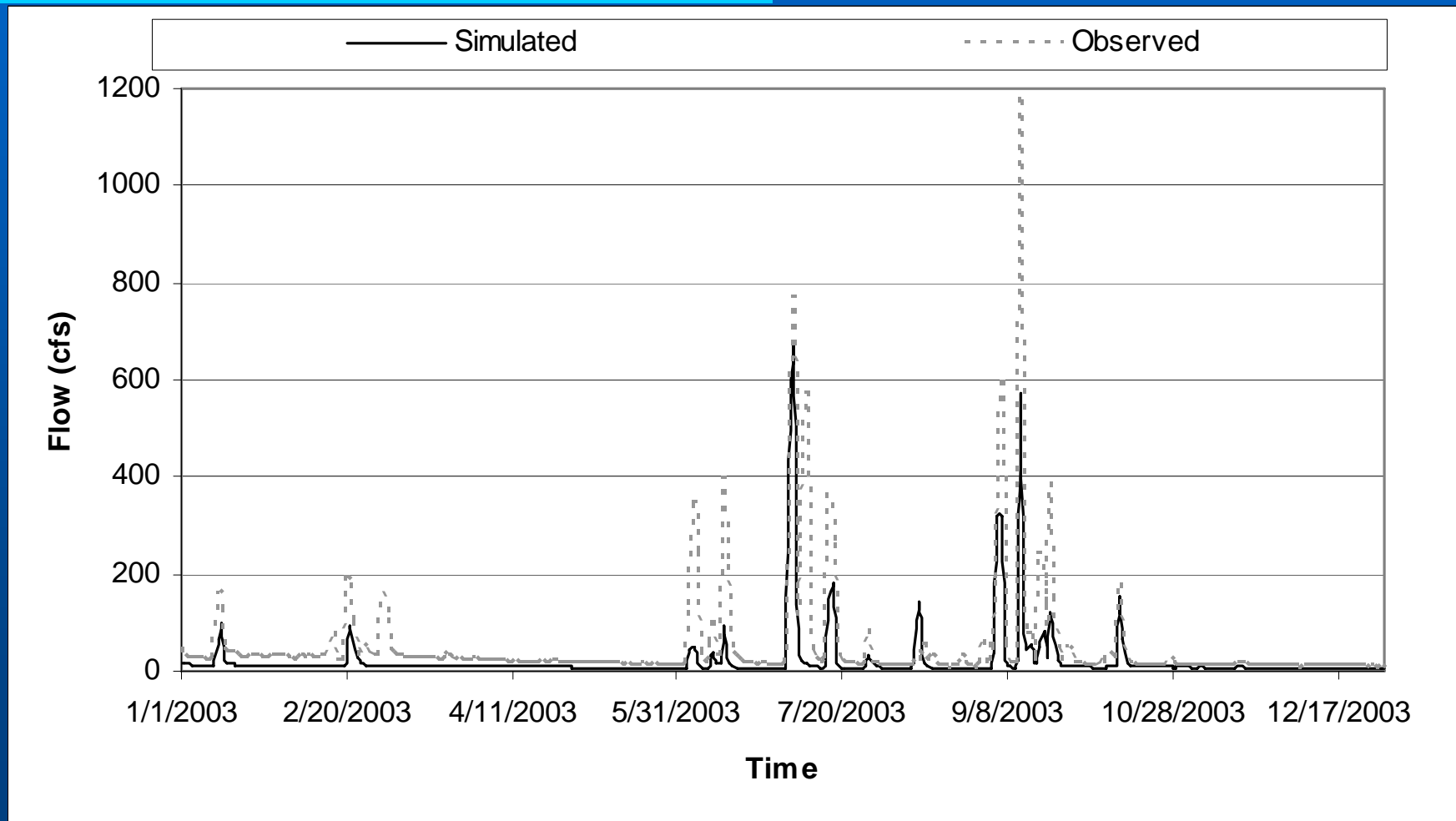




# Mean Daily Discharge for Calibration Years 1998-2002 - Salado Creek at Loop 13



# Mean Daily Discharge for Verification Year 2003 – Salado Creek at Loop 13



# HSPF Calibration Output

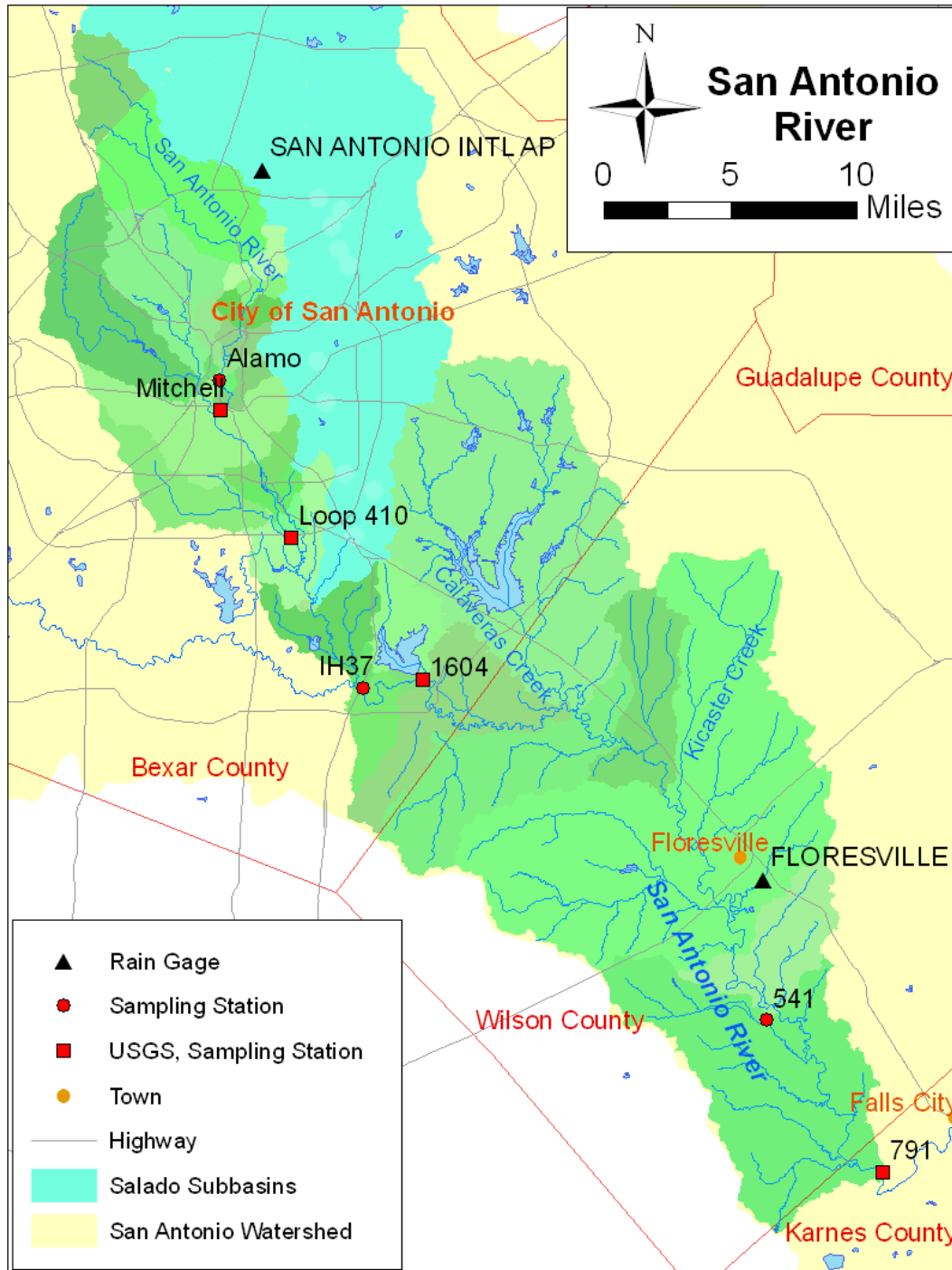
## Salado Creek at Loop 13



	<b>Simulated</b>	<b>Observed</b>
Total Runoff (in)	26.600	24.431
Total of Highest 10% Flows	21.390	20.323
Total of Lowest 50% Flows	0.840	0.855
Evapotranspiration	30.030	80.490
Total Storm Volume	9.790	9.119
Average of Storm Peaks (cfs)	606.087	633.429
Baseflow Recession Rate	0.980	0.910
Total Interflow	0.060	
Total Surface Runoff	10.430	
Summer Flow Volume	7.910	6.635
Winter Flow Volume	2.720	2.433
Summer Storm Volume	6.600	5.065
Error in total volume	8.900	
Error in low flow recession	-0.070	
Error in 50% lowest flows	-1.800	
Error in 10% highest peaks	5.300	
Error in storm peaks	-4.300	
Seasonal volume error	7.400	
summer storm volume error	22.900	

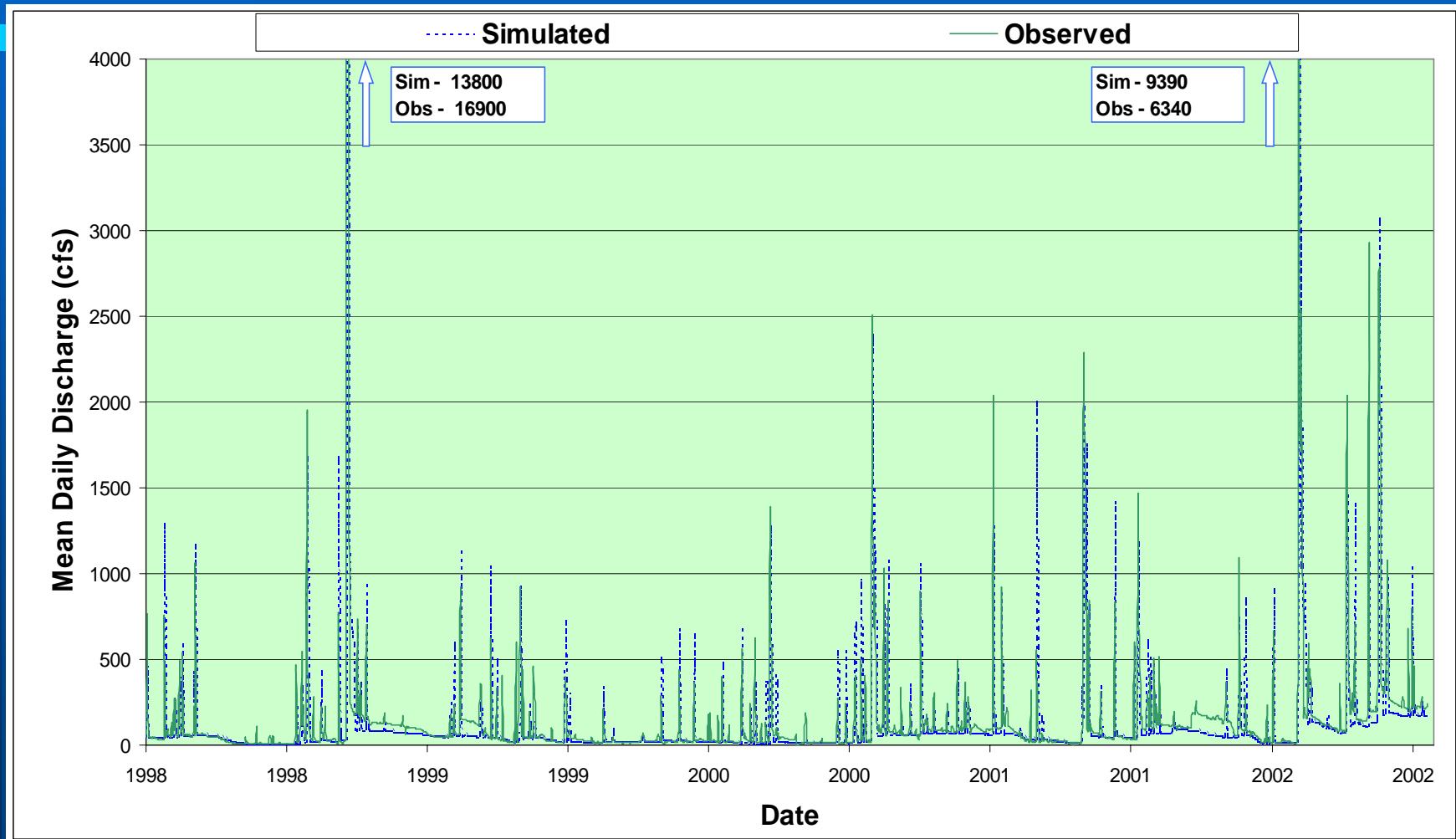


# San Antonio River Watersheds

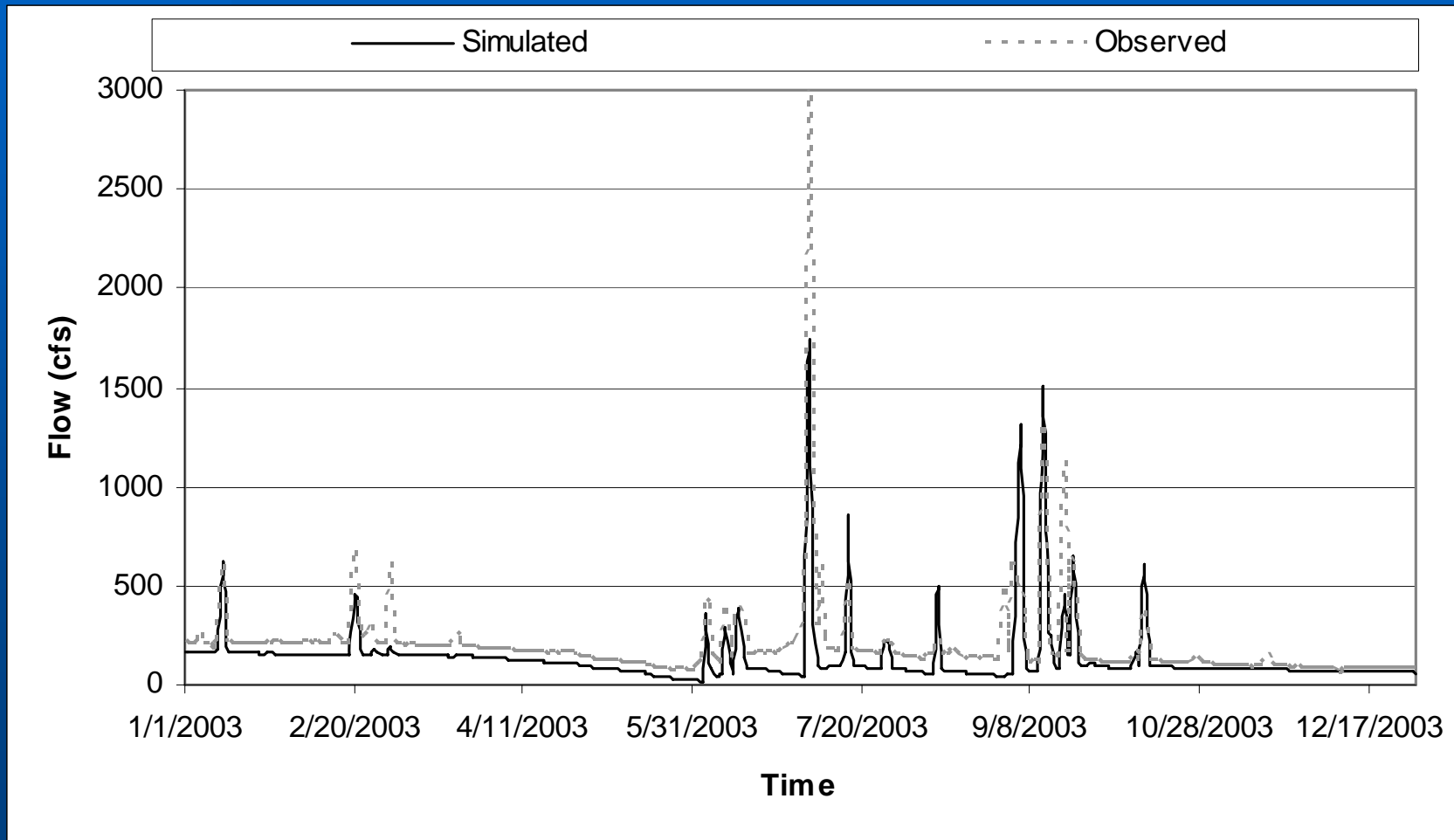




# Mean Daily Discharge for Calibration Years 1998-2002 - USAR at Loop 410



# Mean Daily Discharge for Verification Year 2003 – USAR at Loop 410



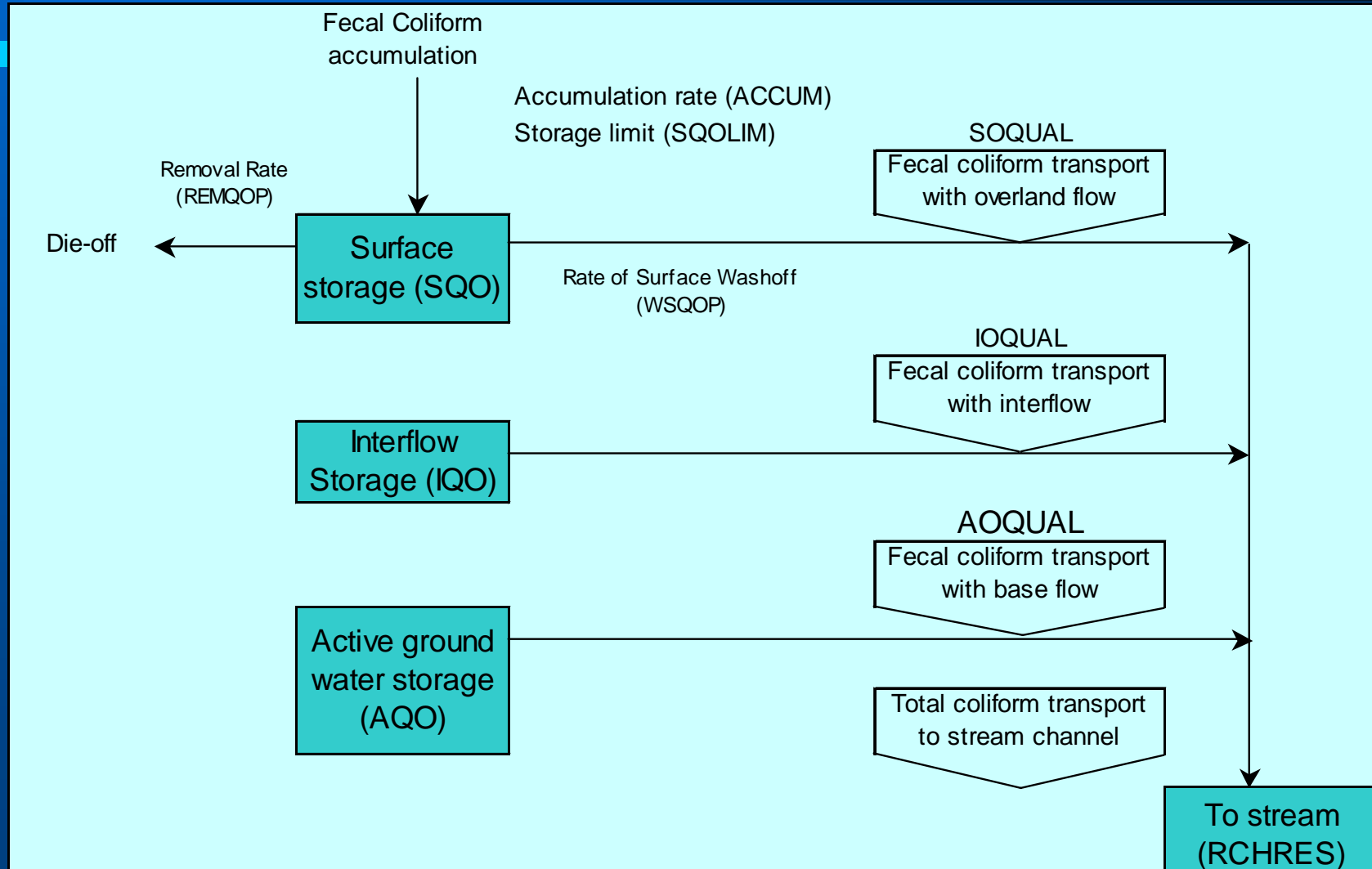
# HSPF Calibration Output

## USAR at Loop 410



	<b>Simulated</b>	<b>Observed</b>
Total Runoff (in)	74.520	76.539
Total of Highest 10% Flows	48.200	43.551
Total of Lowest 50% Flows	7.150	7.188
Evapotranspiration	106.700	293.500
Total Storm Volume	25.810	22.450
Average of Storm Peaks (cfs)	1149.855	1006.000
Baseflow Recession Rate	0.990	0.960
Total Interflow	0.480	
Total Surface Runoff	38.840	
Summer Flow Volume	19.270	16.643
Winter Flow Volume	12.660	14.799
Summer Storm Volume	12.570	9.660
Error in total volume	-2.600	
Error in low flow recession	-0.030	
Error in 50% lowest flows	-0.500	
Error in 10% highest peaks	10.700	
Error in storm peaks	14.300	
Seasonal volume error	30.300	
summer storm volume error	15.100	

# HSPF Bacteria Simulation



# Fecal Sources Considered in Modeling Analysis

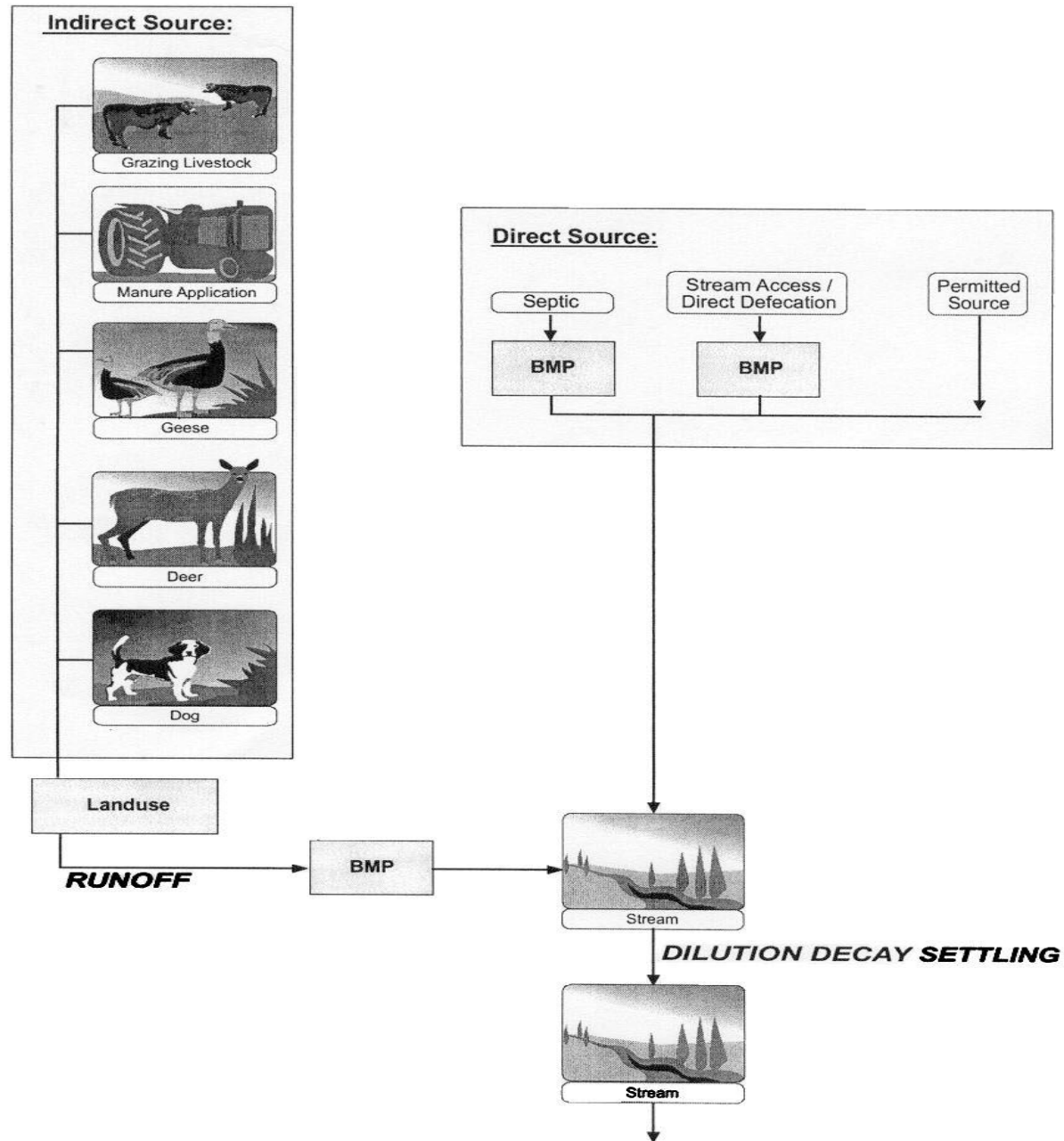


- **Direct Sources**
  - Failing septics
  - Direct wildlife contributions
  - Direct livestock contributions
  - Leaking sewer lines (implicit)
- **Rangeland, Forestland**
  - Wildlife (deer, raccoon, opossum, ducks, feral hogs)
  - Livestock (cattle, horses/donkeys, sheep/goats, hogs)
- **Cropland**
  - Wildlife (deer, raccoon, opossum, ducks, feral hogs)
- **Urban (residential, commercial/industrial)**
  - General urban sources and loading factors



# Fecal Coliform Accumulation Rate Development

## Summary of Fecal Coliform Sources

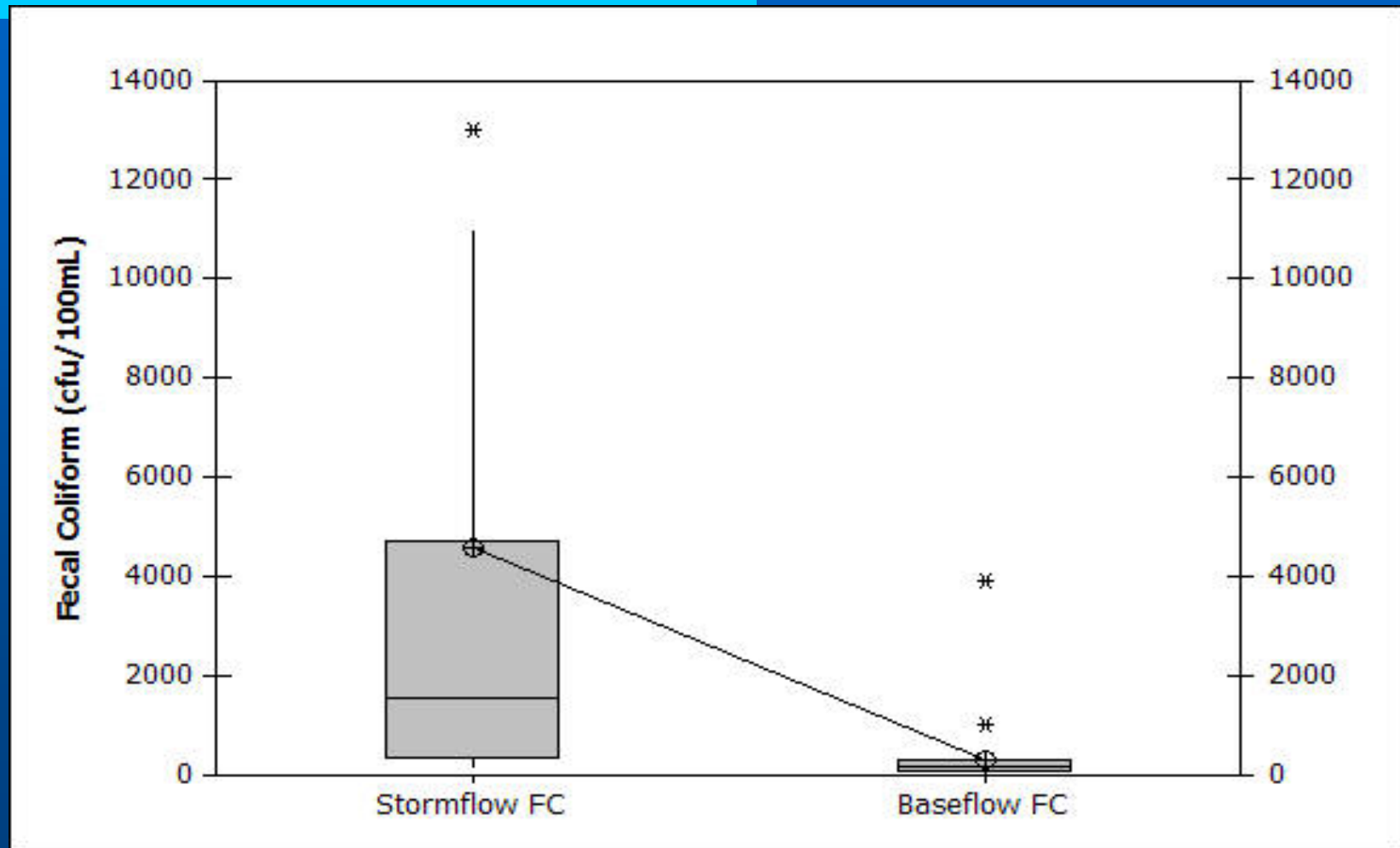




# Salado Creek at Loop 13

## Boxplot of Runoff vs. Baseflow

Note: a value of 38,000 cfu/100mL omitted to preserve plot scale



# Salado Creek Model Calibration for Fecal Coliform Runoff Events



<b>Station Location</b>	<b>Model Location</b>	<b>Observed Data Median Values (Col/100 mL)</b>	<b>Simulated Data Median Values (Col/100 mL)</b>
Loop 410NE	RCH 49	7682	1880
Hwy 368	RCH 52	1100	1410
Woodburn	RCH 53	2180	1775
Commerce	RCH 57	1380	1320
Rigsby	RCH 72	1400	1340
Loop 13	RCH 74	1030	1370
Walzem Creek at Holbrook	RCH 15	2675	2650



# Salado Creek Model Calibration for Fecal Coliform Baseflow Conditions

<b>Station Location</b>	<b>Model Location</b>	<b>Observed Data Median Values (org/100 mL)</b>	<b>Simulated Data Median Values (org/100 mL)</b>
Loop 410 NE	RCH 49	50	91.7
Hwy 368	RCH 52	185	182
Woodburn	RCH 53	248	245
Commerce	RCH 57	170	172
Rigsby	RCH 72	200	200
Loop 13	RCH 74	180	185
Walzem Creek at Holbrook	RCH 15	519	525

# Salado Creek Watershed Direct Sources By Reach



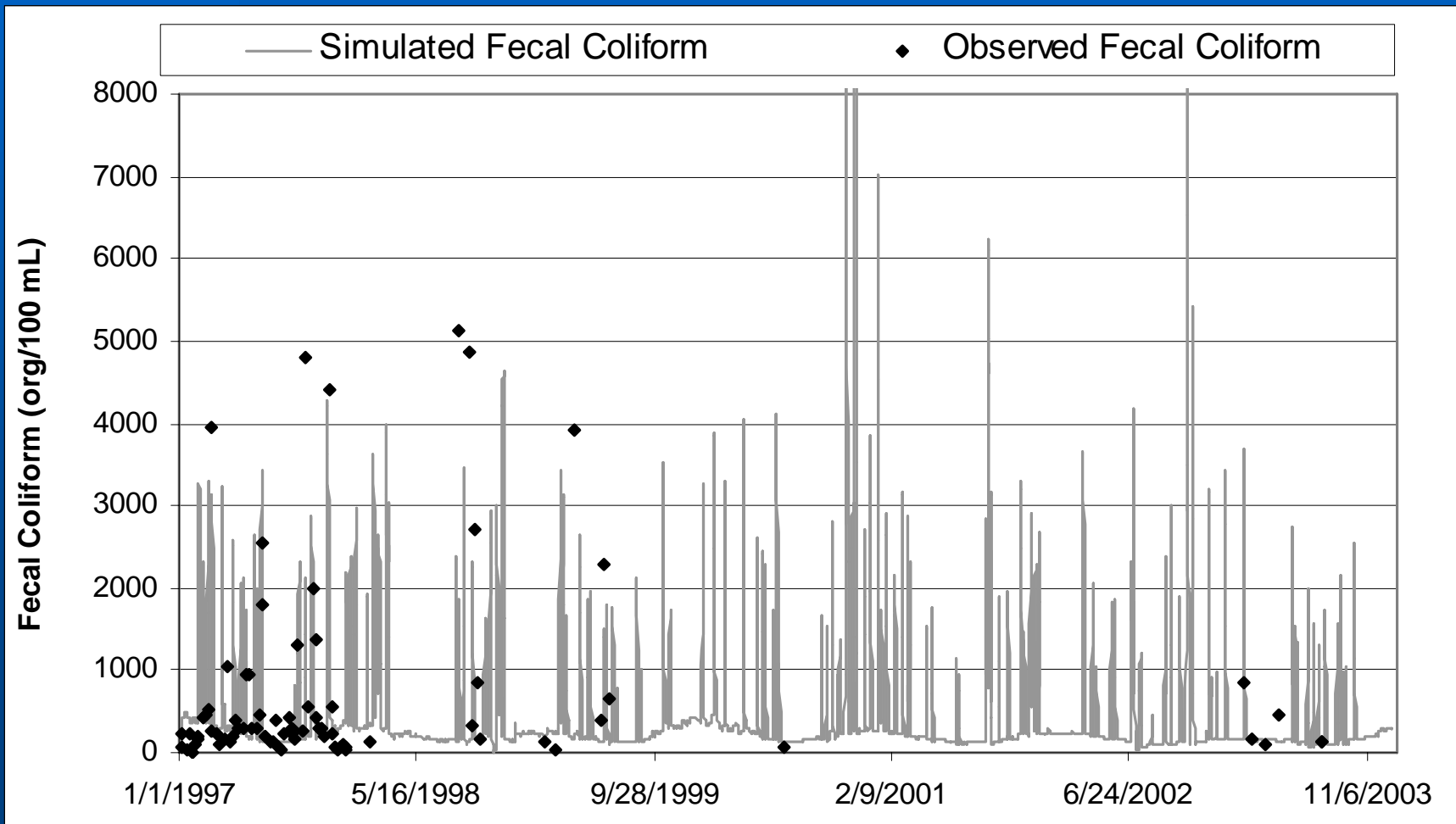
Upper Reach		Outer Reach		Central Reach	
RCHRES	Fecal Coliform (10 <sup>6</sup> count/day)	RCHRES	Fecal Coliform (10 <sup>6</sup> count/day)	RCHRES	Fecal Coliform (10 <sup>6</sup> count/day)
33	432	4	936	51	110
34	888	5	312	50	13
39	1272	6	432	52	175
29	1608	46	1128	15	3648
1	696	7	840	14	28080
32	1608	8	1152	53	22032
2	816	9	936	54	77760
44	672	10	840	55	29376
30	912	13	1680	56	47520
40	1200	11	1128	17	21168
3	312	20	312	16	43200
31	648	23	1104	57	10800
41	816	12	26	58	60480
43	792	49	20	72	38016
38	408			73	86400
48	696			74	28944
42	223			75	69120
47	480			21	324000
45	936				
37	888				
35	1488				

# Salado Watershed Loading Rates by Land Use

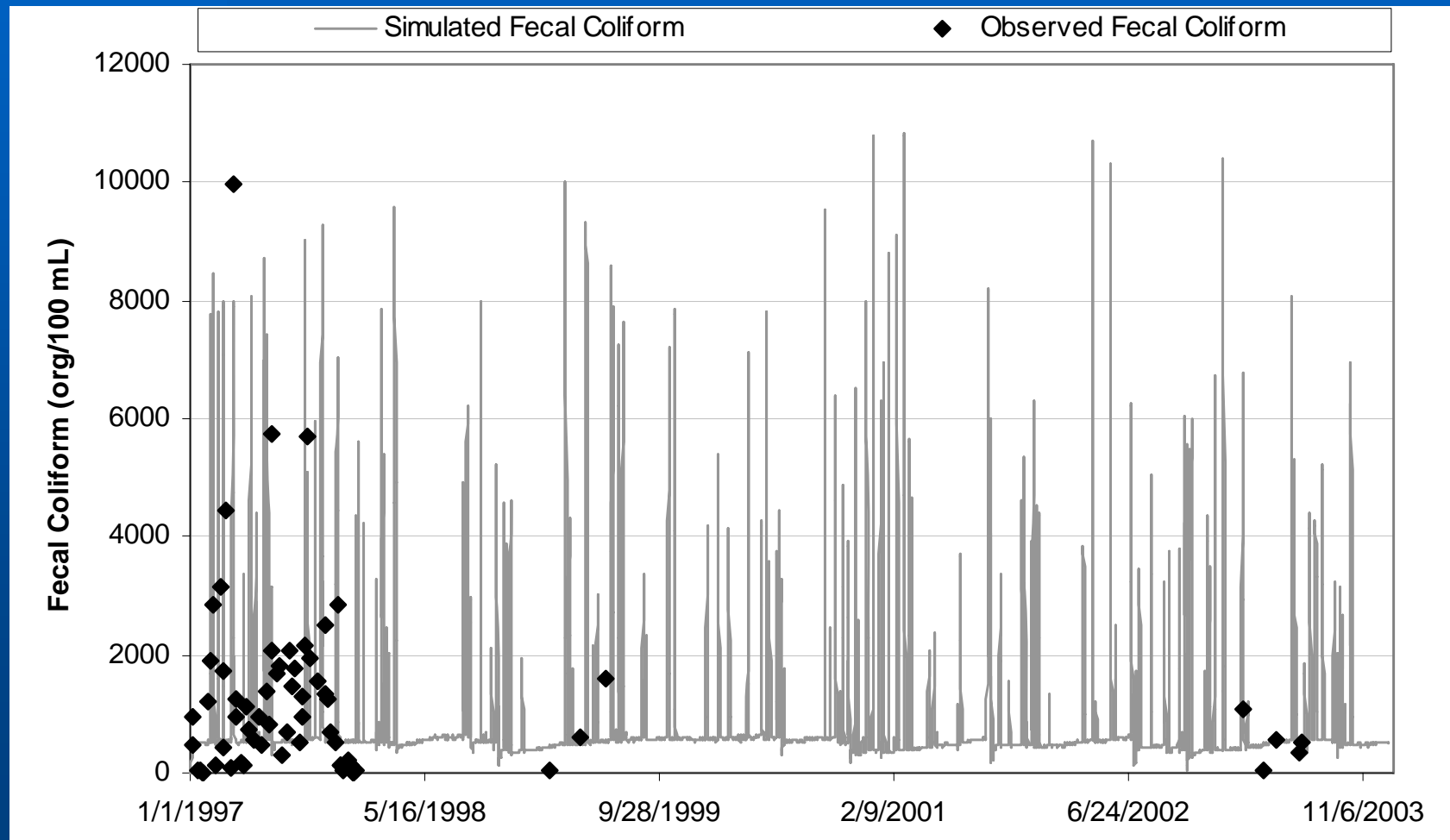


Upper Reach			Outer Reach		
Description	ACQOP (10 <sup>6</sup> counts/ac/day)	SQOLIM (10 <sup>6</sup> counts/ac)	Description	ACQOP (10 <sup>6</sup> counts/ac/day)	SQOLIM (10 <sup>6</sup> counts/ac)
Forest_Rech_Upper	14000	25000	Forest_Rech_Outer	140000	250000
Comm_Ind_Rech_Upper	12	22	Comm_Ind_Rech_Outer	650	1150
Resident_Rech_Upper	12	22	Resident_Rech_Outer	650	1150
Rangeland_Rech_Upper	13000	24000	Rangeland_Rech_Outer	130000	240000
Forest_Non_Rech_Uppe	14000	25000	Forest_Non_Rech_Out	140000	250000
Comm_Ind_Non_Rech_Up	12	22	Com_Ind_Non_Rech_Out	650	1150
Resident_Non_Rech_Up	12	22	Res_Non_Rech_Outer	650	1150
Rangeland_Non_Rech_U	13000	24000	Range_Non_Rech_Outer	130000	240000
Com_Ind_Rech_Upper	12	22	Res_Non_Rech_Outer	650	1150
Res_Recharge_Upper	12	22	Com_Ind_Non_Rech_Out	650	1150
Res_Non_Rech_Upper	12	22	Com_Ind_Rech_Outer	650	1150
Com_Ind_Non_Rech_Up	12	22	Res_Recharge_Outer	650	1150
Central Reach			Walzem Creek		
Description	ACQOP (10 <sup>6</sup> counts/ac/day)	SQOLIM (10 <sup>6</sup> counts/ac)	Description	ACQOP (10 <sup>6</sup> counts/ac/day)	SQOLIM (10 <sup>6</sup> counts/ac)
Forest_Non_Rech_Cent	39000	70000	Comm_Indust_Walzem	1200	2100
Com_Ind_Non_Rech_Cen	24000	42000	Residential_Walzem	1200	2100
Res_Non_Rech_Central	24000	42000	Rangeland_Walzem	3900	7000
Range_Non_Rec_Centra	39000	70000	Residential_Walzem	6000	11000
Res_Non_Rech_Central	24000	44000	Com_Indust_Walzem	6000	11000
Com_Ind_Non_Rech_Cen	24000	44000			

# Simulated and Observed Fecal Coliform Loop 13, Salado Creek



# Simulated and Observed Fecal Coliform Walzem Creek at Holbrook Rd.





# San Antonio River Model Calibration for Fecal Coliform Runoff Events

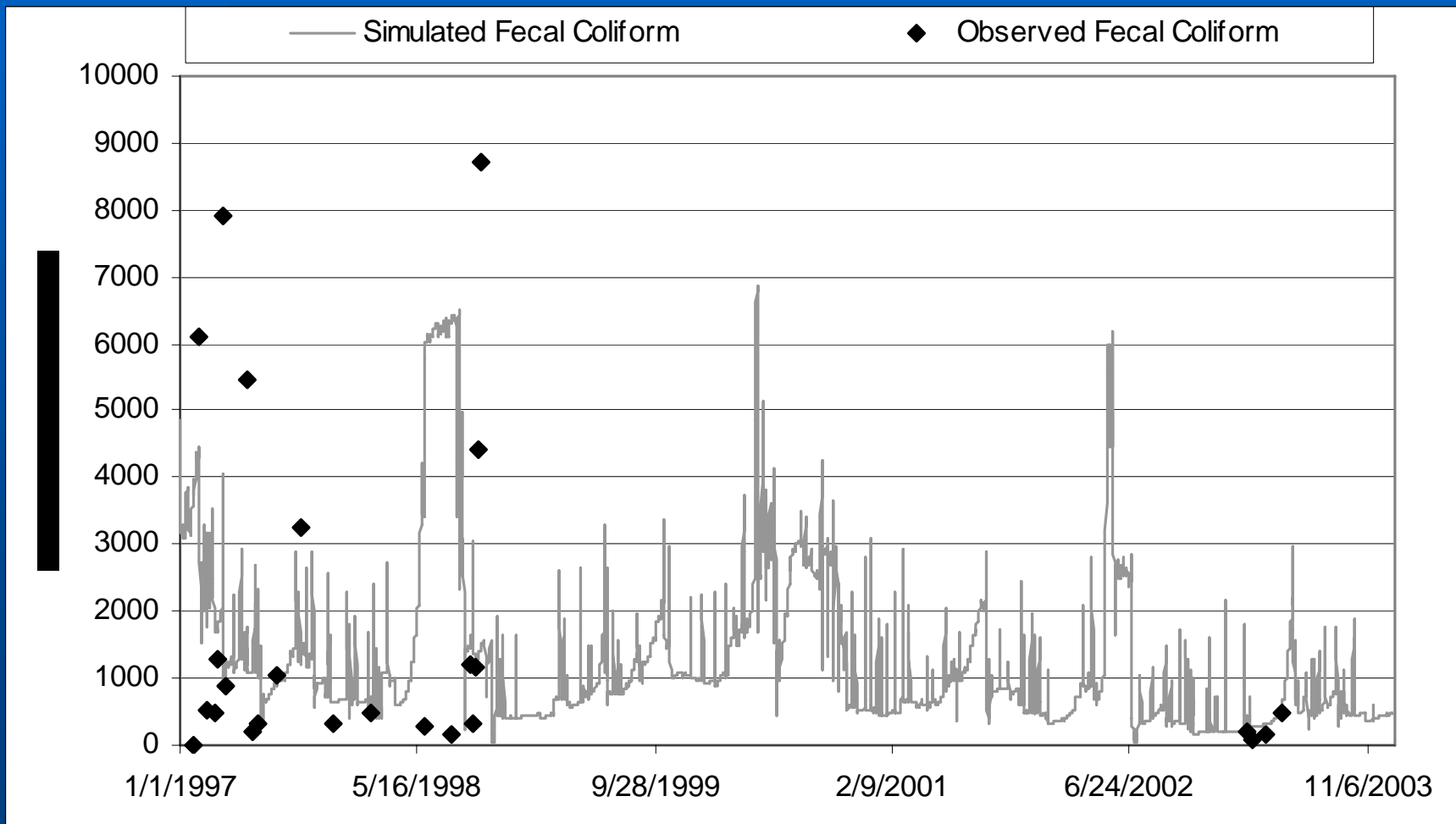
<b>Station Location</b>	<b>Model Location</b>	<b>Observed Data Median Values (org/100 mL)</b>	<b>Simulated Data Median Values (org/100 mL)</b>
Alamo	RCH 62	1190	1290
Mitchell	RCH 67	8130	1020
Loop 410	RCH 71	920	908.5
IH 37	RCH 78	650	670.5
FM 1604	RCH 25	683	632.5
FM 791	RCH 28	477.5	544

# San Antonio River Model Calibration for Fecal Coliform Baseflow Events

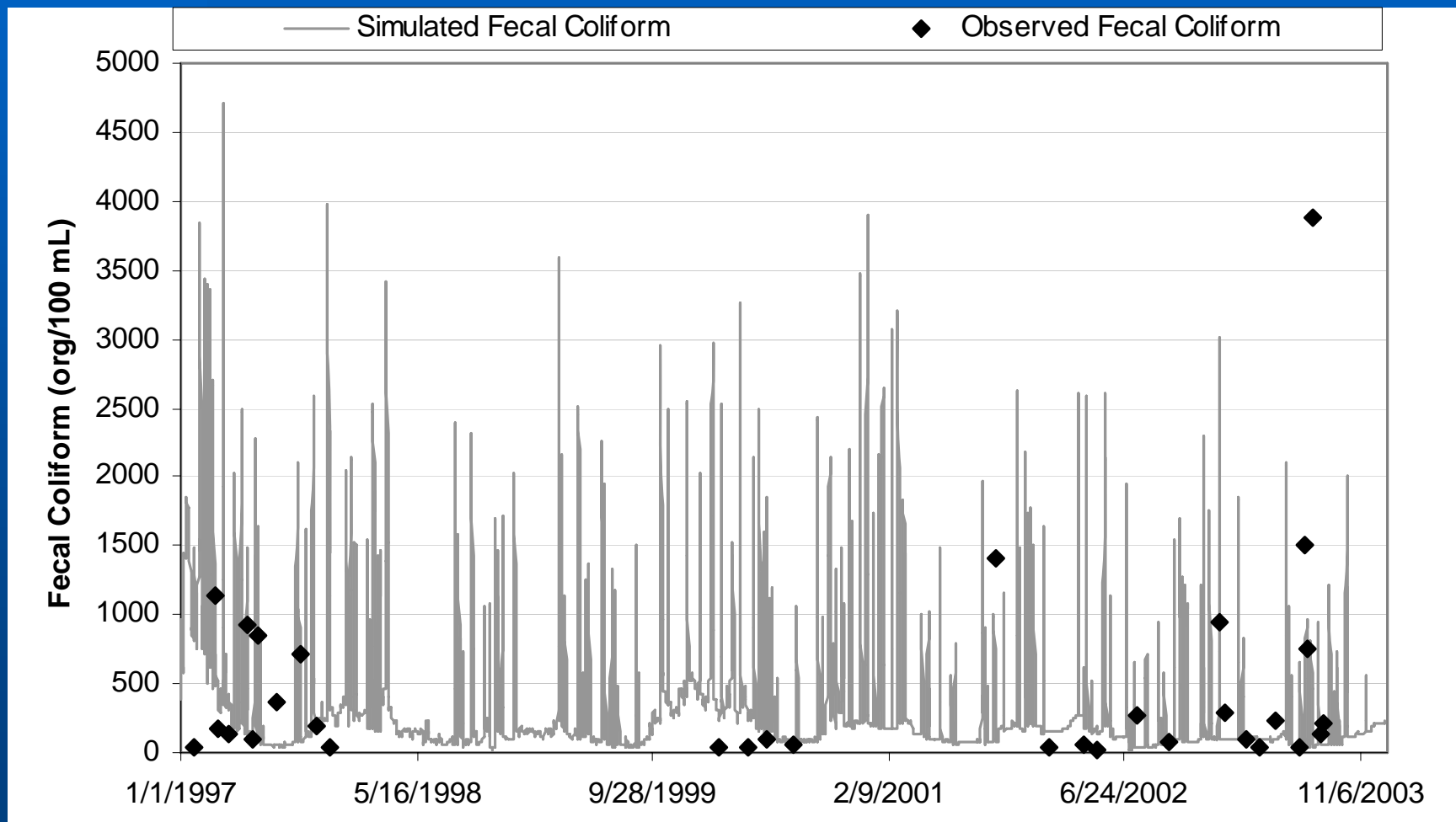


<b>Station Location</b>	<b>Model Location</b>	<b>Observed Data Median Values (org/100 mL)</b>	<b>Simulated Data Median Values (org/100 mL)</b>
Alamo	RCH 62	320	793
Mitchell	RCH 67	470	375
Loop 410	RCH 71	85	145
IH 37	RCH 78	57	83.3
FM 1604	RCH 25	58	77.75
FM 791	RCH 28	100	103

# Simulated and Observed Fecal Coliform Alamo St., USAR



# Simulated and Observed Fecal Coliform Loop 410, USAR





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# Part II – TMDL Loading Allocations





# Calculation of TMDL

TMDLs are the sum of the individual waste load allocations (WLAs) for point sources, load allocations (LAs) for non-point sources and natural background conditions, and a margin of safety (MOS).

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{MOS}$$



# Goals of TMDL

- **TMDL Target**
  - **200 org/100 mL Fecal Coliform**
- **MOS 5%**
  - **10 org/100 mL Fecal Coliform**



# Wasteload Allocations (Point Sources)

- **Salado Creek**
  - No reductions
- **Walzem Creek**
  - No reductions
- **Upper San Antonio River**
  - 97.5% Reduction on San Antonio Zoo



# WLAs of Point Sources in the Watersheds

Segment	Point Source	Existing Load (org/yr)	% Reduction	WLA (org/yr)	Total WLA (org/yr)
Salado Creek	SAWS Reclaimed 4	7.40E+09	0	7.40E+09	7.40E+09
Walzem Creek	None	0	0	0	0
Upper San Antonio River	San Antonio Zoo	3.62E+14	97.5	9.27E+12	1.21E+13
	SAWS Reclaimed 1	2.76E+12	0	2.76E+12	
	SAWS Reclaimed 2	6.39E+10	0	6.39E+10	
	SAWS Reclaimed 3	6.72E+09	0	6.72E+09	
	Floresville WWTP	7.35E+09	0	7.35E+09	



# Load Allocations

(Land-based loadings, direct NPS loadings)

- **Salado Creek**
  - 81% reduction in washoff bacterial loads from residential and commercial/industrial land uses in the central zone
  - 90% reduction in direct NPS in central zone
- **Walzem Creek**
  - 81% reduction in washoff bacterial loads from residential and commercial/industrial land uses in the central zone
  - 75% reduction in direct NPS in central zone
- **Upper San Antonio River**
  - 98% reduction in direct NPS, FM 1604 – FM 791



# Salado Creek TMDL Load Reductions (%)

RCHRES	NAME	PERLND (pervious)				IMPLND (impervious)		DIRECT SOURCES
		Forest	Rangeland	Residential	Commercial / Industrial	Residential	Commercial / Industrial	
UPPER ZONE		0	0	0	0	0	0	0
OUTER ZONE		0	0	0	0	0	0	0
CENTRAL ZONE								
RCHRES 12	SALADO CR	0	0	81	81	81	81	0
RCHRES 49	SALADO CR at 410	0	0	81	81	81	81	0
RCHRES 51	Beitel Cr	0	0	81	81	81	81	0
RCHRES 50	SALADO CR	0	0	81	81	81	81	0
RCHRES 52	SALADO CR	0	0	81	81	81	81	0
RCHRES 15	Walzem Creek	0	0	81	81	81	81	75
RCHRES 14	SALADO CR	0	0	81	81	81	81	90
RCHRES 53	SALADO CR	0	0	81	81	81	81	90
RCHRES 54	SALADO CR	0	0	81	81	81	81	90
RCHRES 55	SALADO CR	0	0	81	81	81	81	90
RCHRES 56	SALADO CR	0	0	81	81	81	81	90
RCHRES 17	SALADO CR	0	0	81	81	81	81	90
RCHRES 16	Unknown	0	0	81	81	81	81	90
RCHRES 57	SALADO CR	0	0	81	81	81	81	90
RCHRES 58	SALADO CR	0	0	81	81	81	81	90
RCHRES 72	SALADO CR	0	0	81	81	81	81	90
RCHRES 73	SALADO CR	0	0	81	81	81	81	90
RCHRES 74	SALADO CR at 13	0	0	81	81	81	81	90
RCHRES 75	SALADO CR	0	0	81	81	81	81	80
RCHRES 21	Rosillo Cr	0	0	81	81	81	81	80

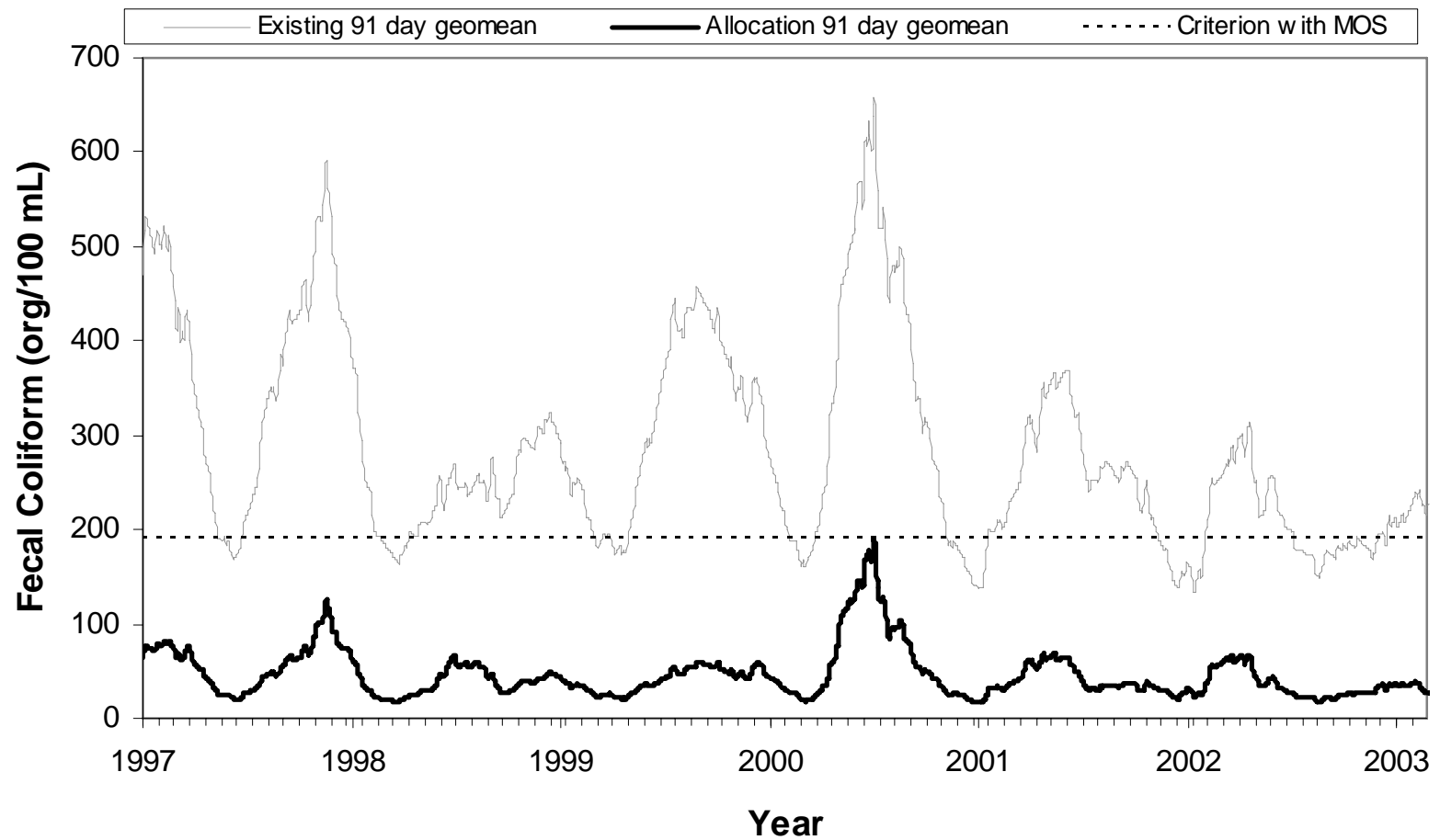


# Salado Creek Load Allocations for Central Zone

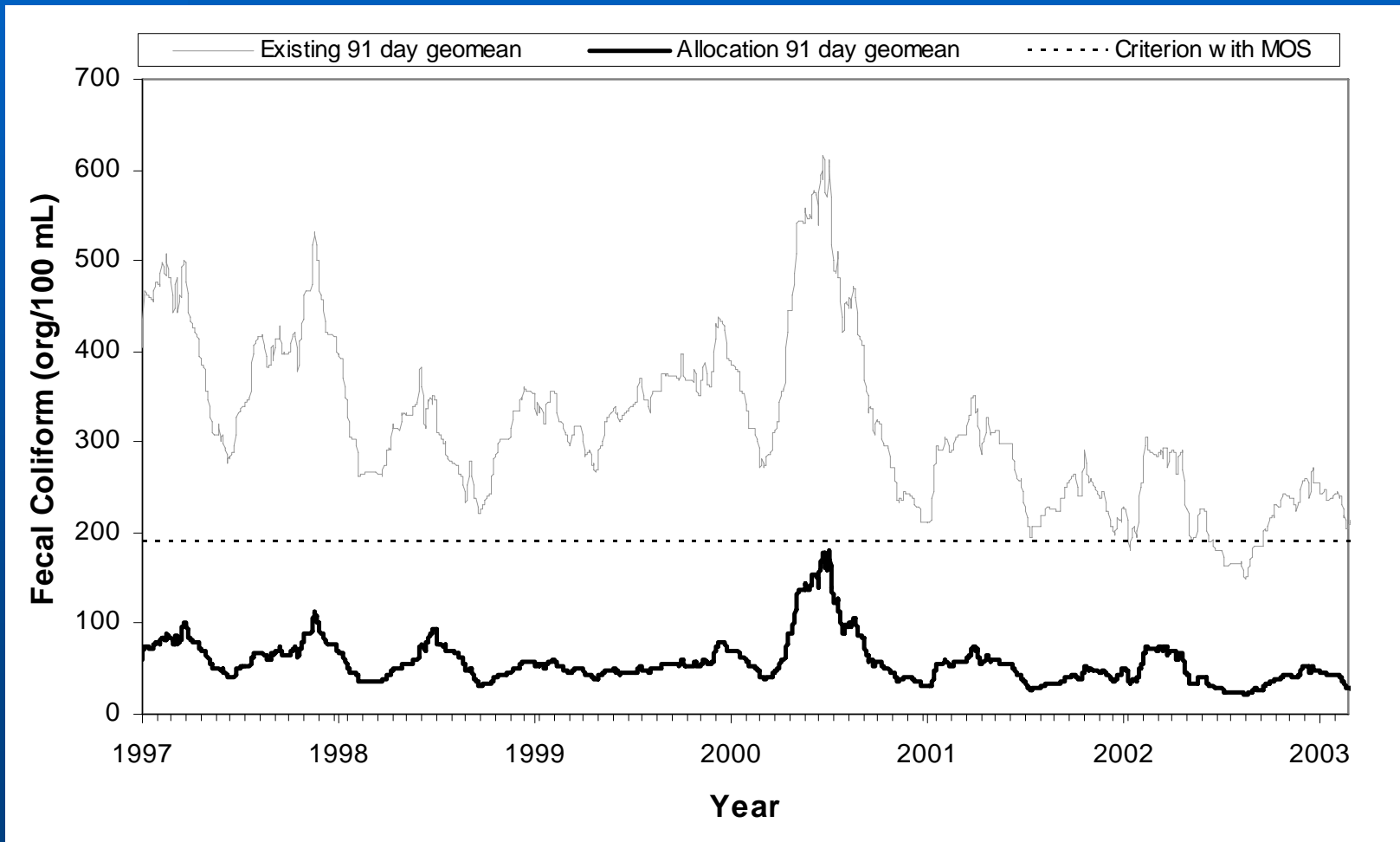
RCHRES	NAME	PERLND (pervious) (Org/yr)				IMPLND (impervious) (Org/yr)		DIRECT SOURCES (Org/yr)
		Forest	Rangeland	Residential	Commercial / Industrial	Residential	Commercial / Industrial	
<b>CENTRAL ZONE</b>								
RCHRES 12	SALADO CR	--	3.87E+12	1.79E+11	1.61E+11	2.03E+11	1.11E+12	9.71E+09
RCHRES 49	SALADO CR at 410	--	4.16E+12	4.00E+11	2.22E+11	4.56E+11	1.54E+12	7.30E+09
RCHRES 51	Beitel Cr	--	5.28E+13	2.19E+12	9.99E+11	2.52E+12	6.89E+12	4.04E+10
RCHRES 50	SALADO CR	--	7.27E+12	7.52E+11	2.19E+11	8.62E+11	1.50E+12	4.82E+09
RCHRES 52	SALADO CR	--	7.62E+12	3.07E+11	8.74E+10	3.55E+11	6.00E+11	2.55E+11
RCHRES 15	Walzem Creek	--	7.05E+12	6.28E+11	1.98E+11	7.18E+11	1.37E+12	3.26E+11
RCHRES 14	SALADO CR	--	3.23E+12	2.12E+11	9.48E+10	2.45E+11	6.59E+11	5.70E+10
RCHRES 53	SALADO CR	--	2.02E+12	6.45E+10	1.33E+11	7.61E+10	9.21E+11	4.91E+11
RCHRES 54	SALADO CR	--	7.22E+12	5.19E+11	9.27E+11	6.00E+11	6.40E+12	1.53E+11
RCHRES 55	SALADO CR	--	3.62E+12	--	2.54E+11	--	1.75E+12	6.01E+10
RCHRES 56	SALADO CR	--	1.73E+13	2.55E+11	4.16E+11	2.96E+11	2.87E+12	9.81E+10
RCHRES 17	SALADO CR	--	2.77E+12	1.14E+11	1.76E+11	1.35E+11	1.22E+12	4.31E+10
RCHRES 16	Unknown	--	9.49E+12	3.52E+11	3.69E+11	4.06E+11	2.55E+12	8.85E+10
RCHRES 57	SALADO CR	--	4.16E+11	1.96E+10	2.94E+10	2.54E+10	2.03E+11	2.20E+10
RCHRES 58	SALADO CR	--	9.95E+12	6.23E+11	1.36E+11	7.18E+11	9.38E+11	3.71E+11
RCHRES 72	SALADO CR	--	1.29E+13	4.23E+11	1.45E+11	4.90E+11	9.97E+11	2.31E+11
RCHRES 73	SALADO CR	--	1.84E+13	1.75E+12	2.37E+11	2.01E+12	1.64E+12	2.27E+11
RCHRES 74	SALADO CR at 13	--	6.79E+12	1.08E+11	1.55E+10	1.27E+11	1.10E+11	7.62E+10
RCHRES 75	SALADO CR	--	1.89E+13	3.02E+10	5.55E+10	3.38E+10	3.89E+11	1.39E+10
RCHRES 21	Rosillo Cr	--	1.62E+14	1.87E+12	1.38E+12	2.15E+12	9.55E+12	6.58E+10
	<b>Totals:</b>	--	<b>3.58E+14</b>	<b>1.08E+13</b>	<b>6.26E+12</b>	<b>1.24E+13</b>	<b>4.32E+13</b>	<b>2.64E+12</b>

Note: Allocated loads for Upper and Outer zones are same as existing loads.

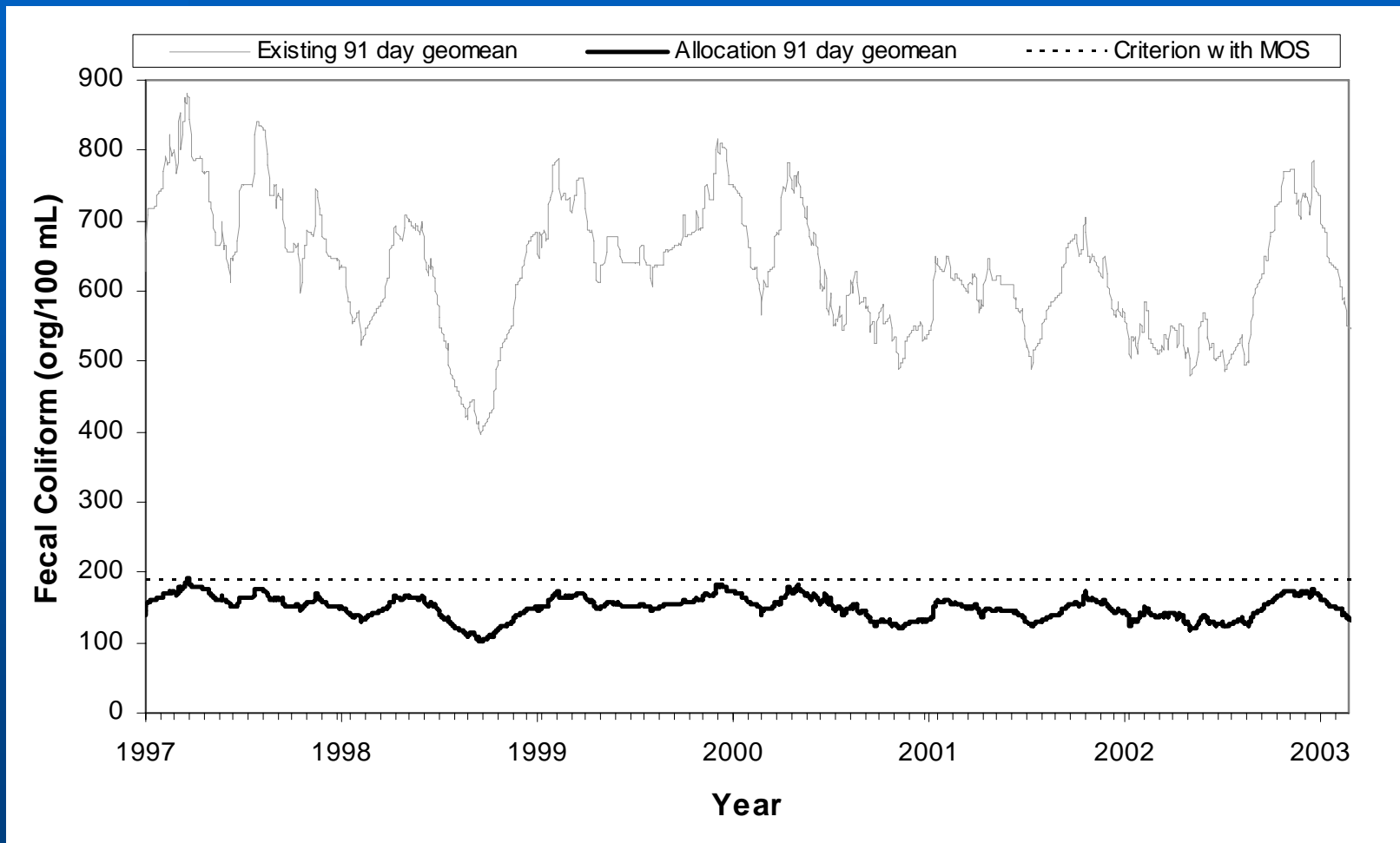
# Fecal Coliform Allocation Results Salado Creek at Loop 13



# Fecal Coliform Allocation Results Salado Creek at Woodburn



# Fecal Coliform Allocation Results Walzem Creek at Holbrooke Rd.





# USAR Load Allocations

## Outer Zone

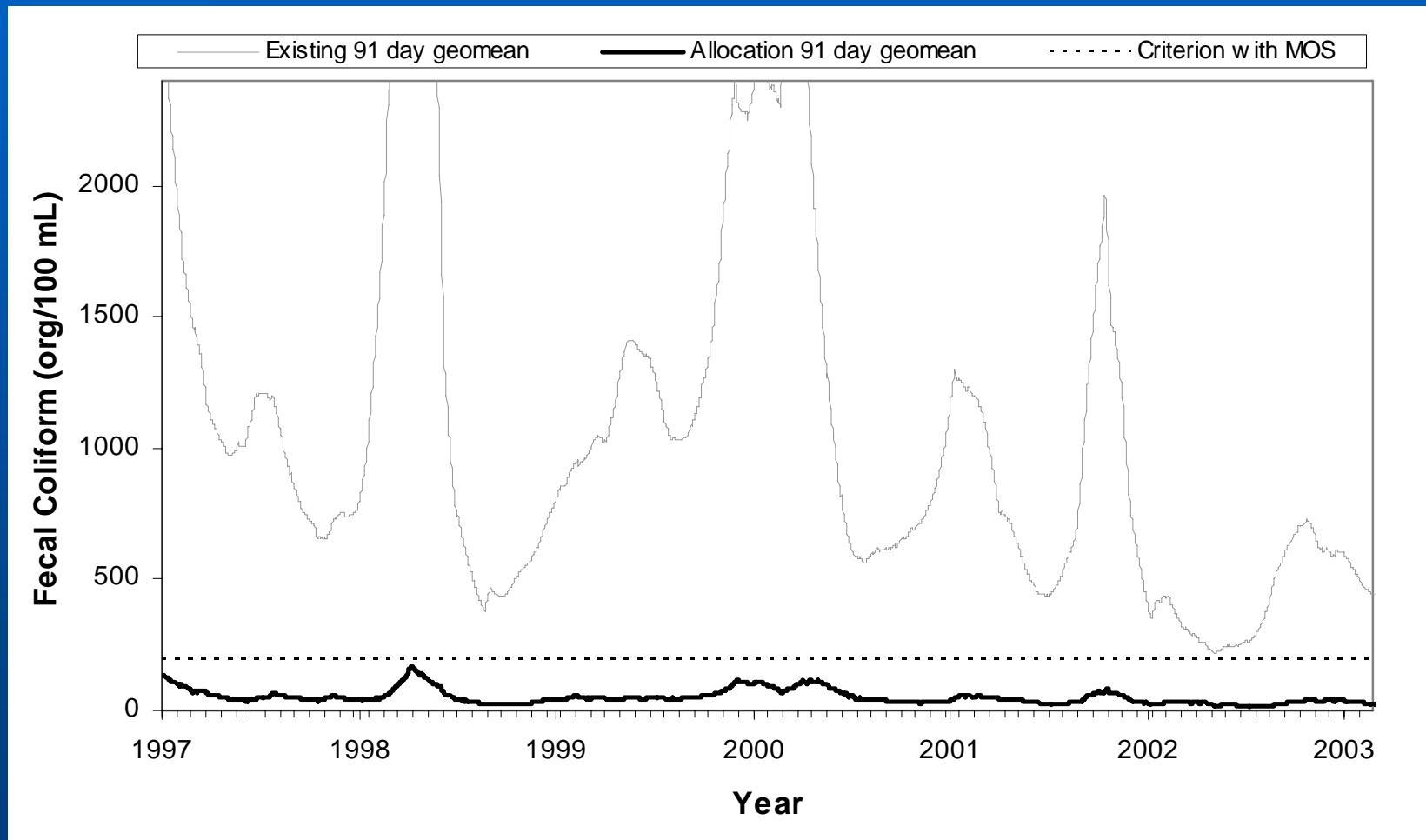


RCHRES	NAME	PERLND (pervious) (org/yr)					IMPLND (impervious) (org/yr)		DIRECT SOURCES (Org/yr)
		Forest	Rangeland	Residential	Commercial / Industrial	Cropland	Residential	Commercial / Industrial	
OUTER ZONE									
79	SAN ANTONIO R	2.91E+11	2.76E+14	5.99E+11	3.32E+10	1.08E+11	2.52E+12	1.88E+12	2.37E+11
78	SAN ANTONIO R at Med	4.85E+10	2.89E+13	7.46E+10	0.00E+00	0.00E+00	3.14E+11	0.00E+00	7.35E+10
80	SAN ANTONIO R	8.34E+12	1.79E+14	2.21E+11	1.64E+10	9.44E+10	9.31E+11	9.31E+11	2.12E+11
25	SAN ANTONIO R at Elm	0.00E+00	1.83E+13	0.00E+00	0.00E+00	4.82E+10	0.00E+00	6.50E+10	5.26E+10
24	*Braunig	2.91E+11	2.26E+14	5.63E+11	2.80E+11	9.74E+10	2.37E+12	1.59E+13	2.55E+11
26	SAN ANTONIO R	2.30E+14	4.85E+13	1.78E+11	4.76E+10	9.02E+12	7.47E+11	2.71E+12	7.87E+11
27	CALAVERAS C	3.76E+14	5.06E+14	1.33E+12	5.80E+11	3.88E+13	5.60E+12	3.30E+13	1.10E+12
84	SAN ANTONIO R	2.20E+14	1.11E+14	1.00E+11	4.95E+10	1.25E+13	4.22E+11	2.81E+12	2.89E+11
81	SAN ANTONIO R	3.00E+14	3.91E+13	3.52E+10	2.22E+11	4.22E+12	1.48E+11	1.26E+13	2.51E+11
83	SAN ANTONIO R	8.95E+14	2.55E+14	1.26E+12	3.96E+11	5.30E+13	5.32E+12	2.25E+13	8.94E+11
82	SAN ANTONIO R	3.66E+13	9.84E+12	0.00E+00	0.00E+00	9.65E+12	0.00E+00	0.00E+00	3.06E+11
28	SAN ANTONIO R at Fal	4.05E+13	3.86E+14	1.29E+10	0.00E+00	2.96E+13	5.41E+10	0.00E+00	7.92E+11
	TOTALS:	2.11E+15	2.08E+15	4.38E+12	1.63E+12	1.57E+14	1.84E+13	9.24E+13	5.24E+12

Note: Allocated loads for the Central zone is same as existing loads.

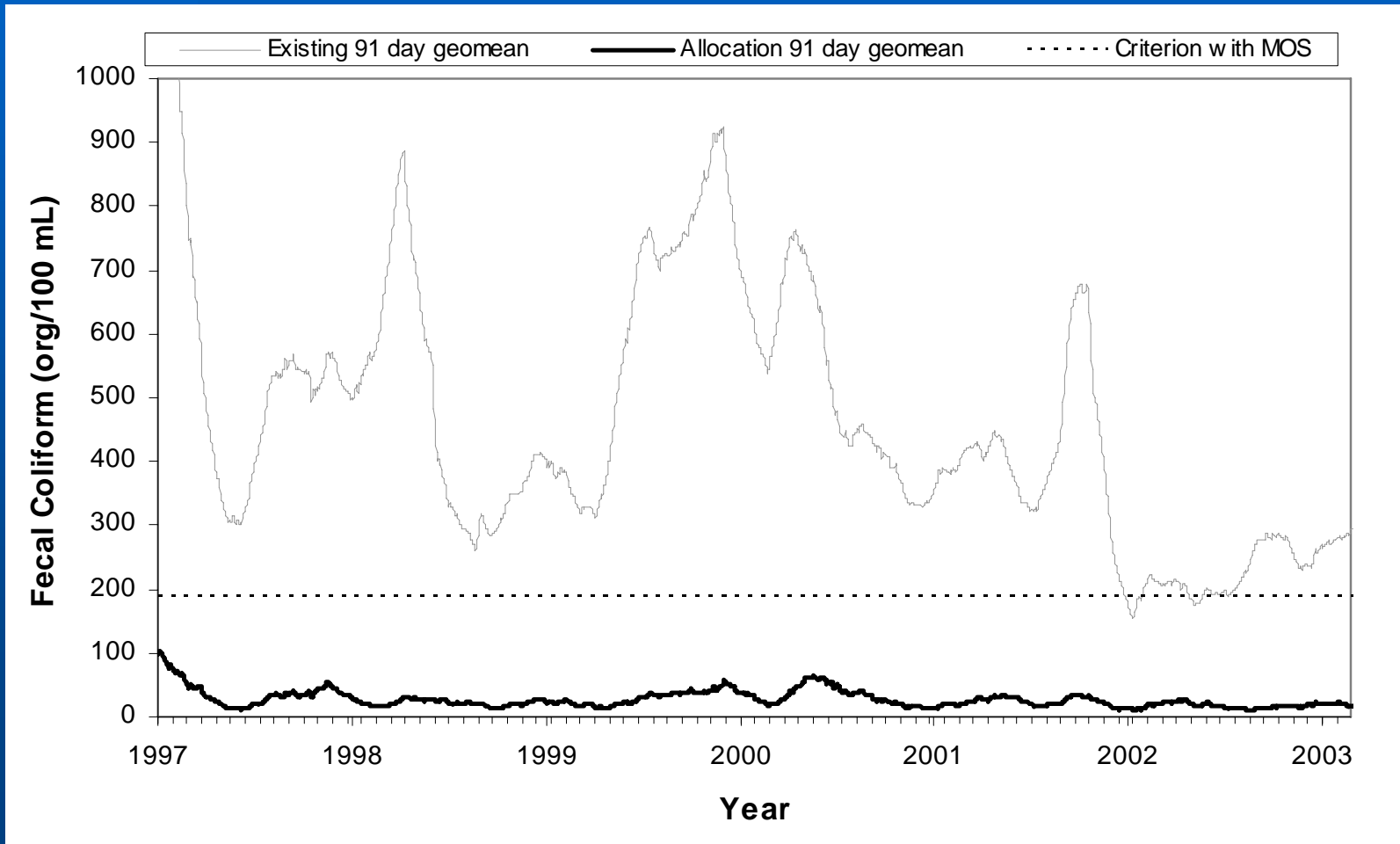


# Fecal Coliform Allocation Results Upper San Antonio River at Alamo St.



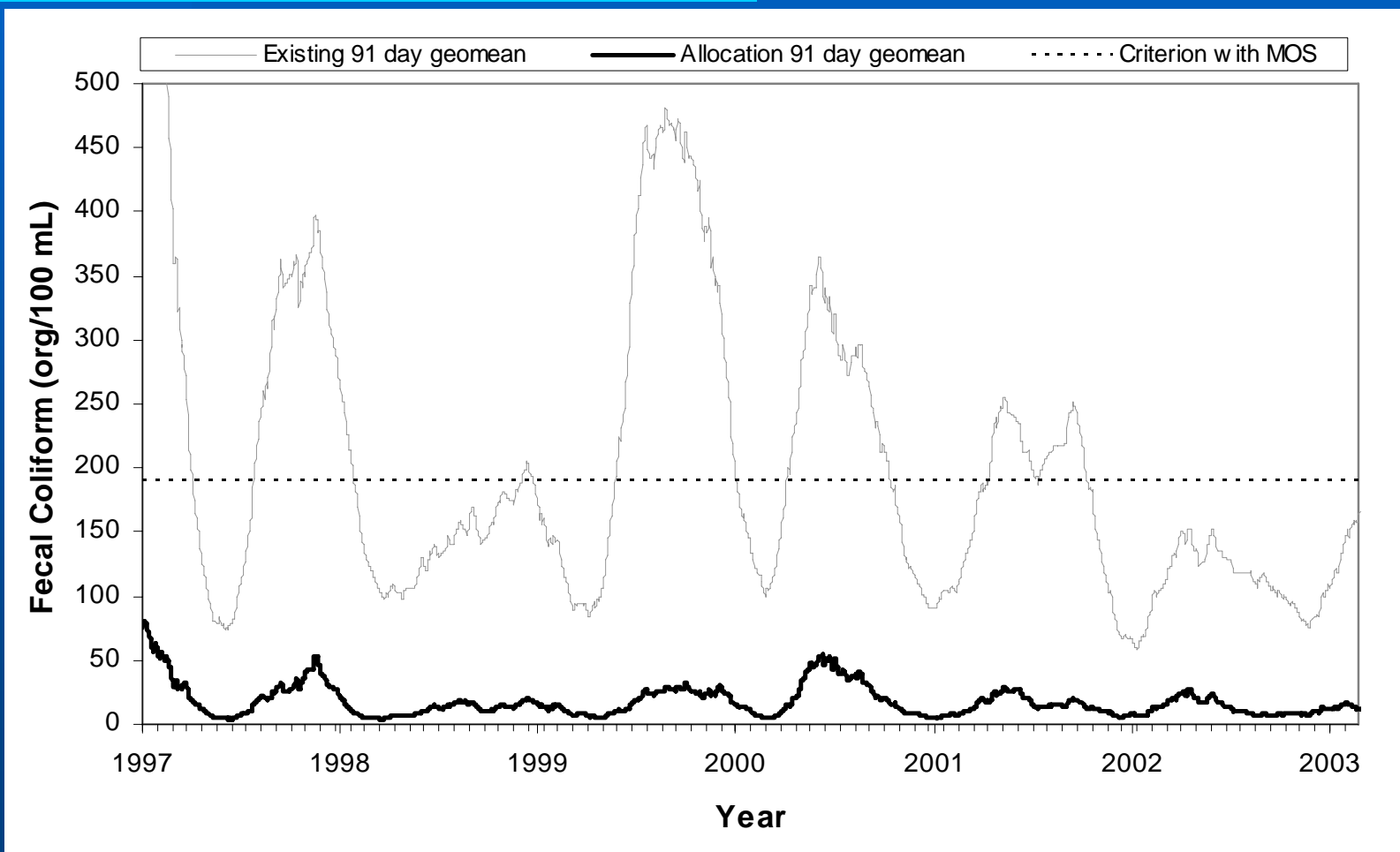


# Fecal Coliform Allocation Results Upper San Antonio River at Mitchell St.



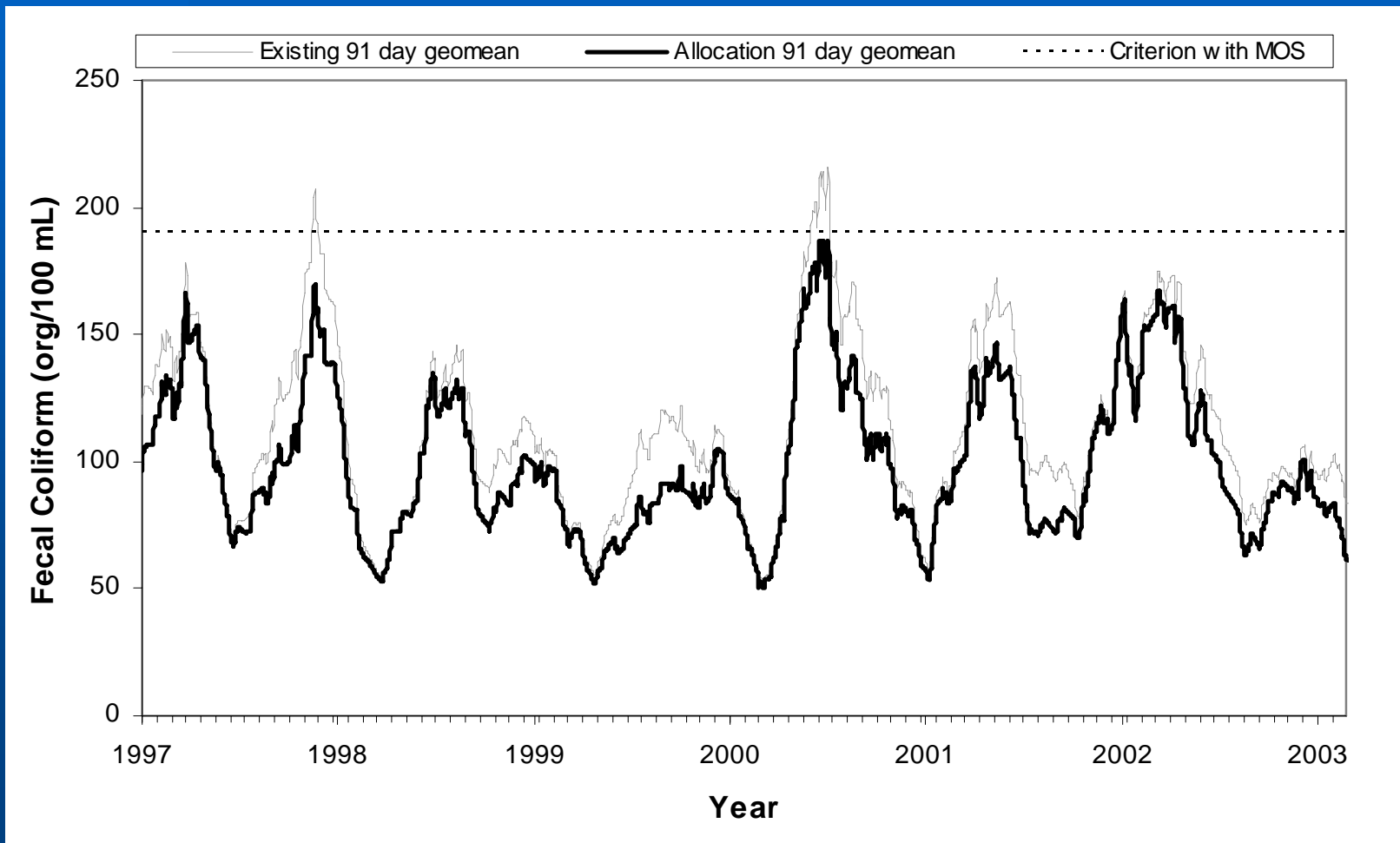


# Fecal Coliform Allocation Results Upper San Antonio River at Loop 410



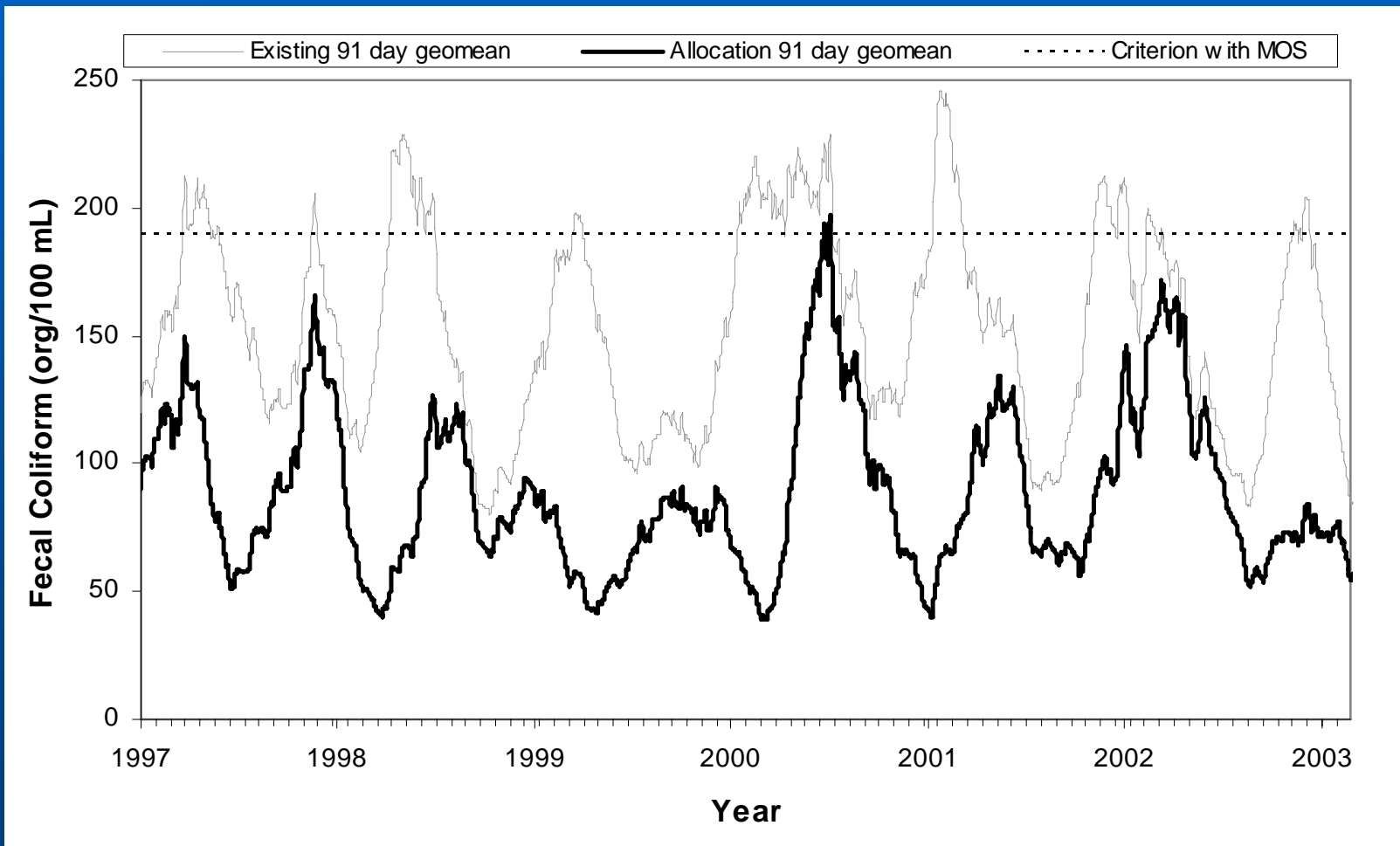


# Fecal Coliform Allocation Results Upper San Antonio River at FM 1604





# Fecal Coliform Allocation Results Upper San Antonio River at FM 541





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# Part III – Bacterial Source Tracking Results

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# Bacterial Source Tracking (BST)



- Method: Ribotyping
  - Genetic fingerprints of *E. coli* strains
  - Genes that code for ribosome RNA
  - Distinguish between different bacterial strains
  - Lab Results from El Paso Agricultural Research and Extension Center, El Paso, Texas
- Library of Known Bacteria Types (Knowns)
  - Salado Creek/Upper San Antonio River: 500 Samples
  - Lower San Antonio River: 200 Samples

# BST Water Samples (Unknowns)



## Upper San Antonio River

- Station 12912 – At Hildebrand - # 80 samples
- Station 14256 – At Mitchell St. - # 80 samples
- Station 15308 – Loop 410 - # 80 samples
- Station 12883 – At Dietz Rd. # 80 samples

## Lower San Antonio River

- Station 12794 – At SH 72 - # 90 samples
- Station 12790 – At FM 2506 - # 90 samples

## Salado Creek

- Station 12876 – SH 368 –# 80 samples
- Station 12698 – Walzem Creek at Holbrook Rd.– # 83 samples
- Station 15645 – Upstream From Commerce St. – # 84 samples
- Station 12864 – Loop 13 –# 83 samples



# Summary of Source Identifications

## Upper San Antonio River Water Isolates

(n =301)\*

Source	Number Isolates ERIC-PCR (>85% similarity)	% of Identified Isolates (of Total)	Number Isolates RiboPrinting (>85% similarity)	% of Identified Isolates (of Total)
Wildlife	95 (29 wild mammal +66 wild bird)	32	97 (14 wild mammal +83 wild bird)	32
Domestic sewage	49	16	68	23
Zoo animals	43	14	56	19
Domestic pets	25	8	29	10
Livestock	9	3	12	4
Unidentified	80	27	39	13

\*Eighty isolates (27%) and 39 isolates (13%) were unidentified using ERIC-PCR and RiboPrinting, respectively



# Summary of Source IDs

## Upper San Antonio River Ambient Water RiboPrinting (n=301, 262 identified)

	USAR at Hildebrand St.		USAR at Mitchell St.		USAR at Loop 410		USAR at Dietz Rd.	
	Number Isolates (>85% similarity)	% of Total Isolates	Number Isolates (>85% similarity)	% of Total Isolates	Number Isolates (>85% similarity)	% of Total Isolates	Number Isolates (>85% similarity)	% of Total Isolates
Zoo animal	12	<b>16</b>	18	<b>26</b>	11	<b>14</b>	15	<b>19</b>
Wild bird @ zoo	12	<b>16</b>	14	<b>20</b>	21	<b>28</b>	7	<b>9</b>
Other wild bird	4	<b>5</b>	7	<b>10</b>	10	<b>13</b>	8	<b>10</b>
Wild mammal	1	<b>1</b>	4	<b>6</b>	2	<b>3</b>	7	<b>9</b>
Livestock	4	<b>5</b>	3	<b>4</b>	3	<b>4</b>	2	<b>3</b>
Domestic pet	10	<b>13</b>	3	<b>4</b>	5	<b>7</b>	11	<b>14</b>
Domestic sewage	25	<b>32</b>	12	<b>17</b>	13	<b>17</b>	18	<b>23</b>
Unidentified	9	<b>12</b>	9	<b>13</b>	11	<b>14</b>	10	<b>13</b>



# Summary of Source IDs

## Upper San Antonio River Ambient Water

### ERIC-PCR (n=301, 221 identified)

	USAR at Hildebrand St.		USAR at Mitchell St.		USAR at Loop 410		USAR at Dietz Rd.	
	Number Isolates (>85% similarity)	% of Total Isolates	Number Isolates (>85% similarity)	% of Total Isolates	Number Isolates (>85% similarity)	% of Total Isolates	Number Isolates (>85% similarity)	% of Total Isolates
Zoo animal	8	<b>10</b>	11	<b>16</b>	10	<b>13</b>	14	<b>18</b>
Wild bird @ zoo	17	<b>22</b>	12	<b>17</b>	13	<b>17</b>	3	<b>4</b>
Other wild bird	4	<b>5</b>	7	<b>10</b>	3	<b>4</b>	7	<b>9</b>
Wild mammal	8	<b>10</b>	6	<b>9</b>	10	<b>13</b>	5	<b>6</b>
Livestock	2	<b>3</b>	3	<b>4</b>	2	<b>3</b>	2	<b>3</b>
Domestic pet	4	<b>5</b>	5	<b>7</b>	5	<b>7</b>	11	<b>14</b>
Domestic sewage	14	<b>18</b>	10	<b>14</b>	11	<b>14</b>	14	<b>18</b>
Unidentified	20	<b>26</b>	16	<b>23</b>	22	<b>29</b>	22	<b>28</b>



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# Part IV – Implementation

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# Implementation

- SARA taking first step in implementation
- TCEQ is funding Watershed Protection Plan
- Examine key sources of bacteria and potential control measures
- Receive input from stakeholders
- Report due 31 Aug 06



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Questions / Comments ?

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