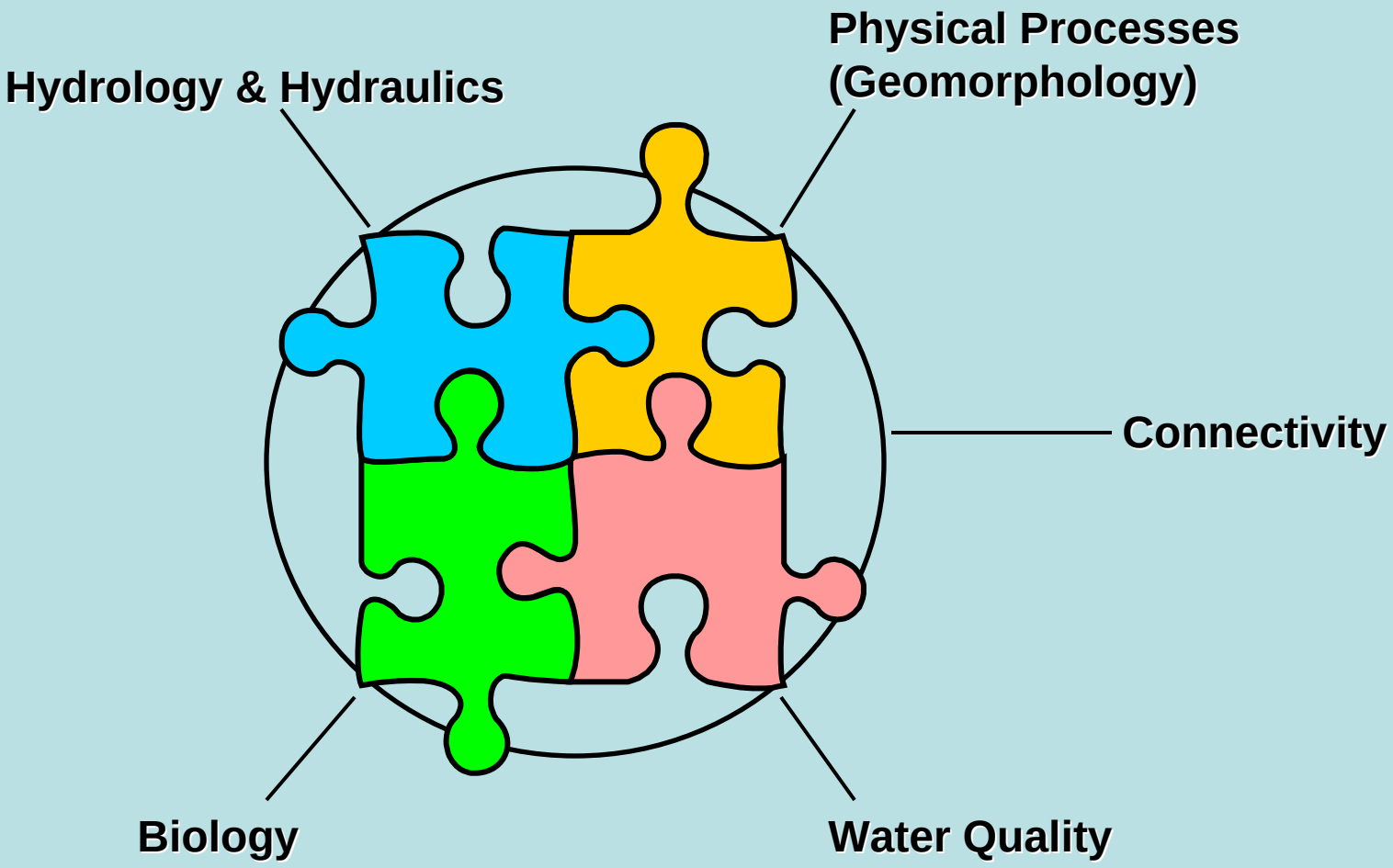
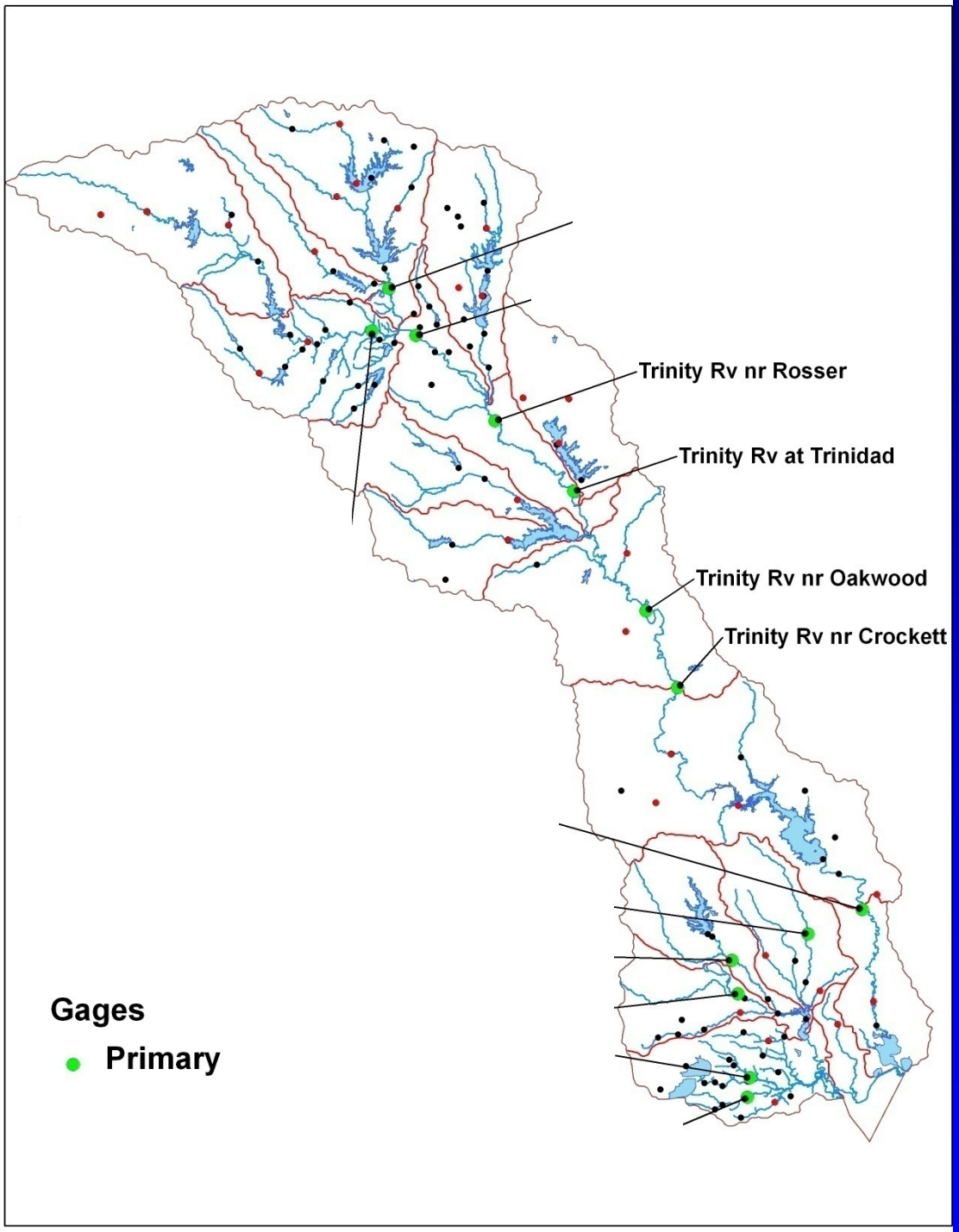
Trinity-San Jacinto BBEST
Development of Instream Flow Criteria

January 13, 2010

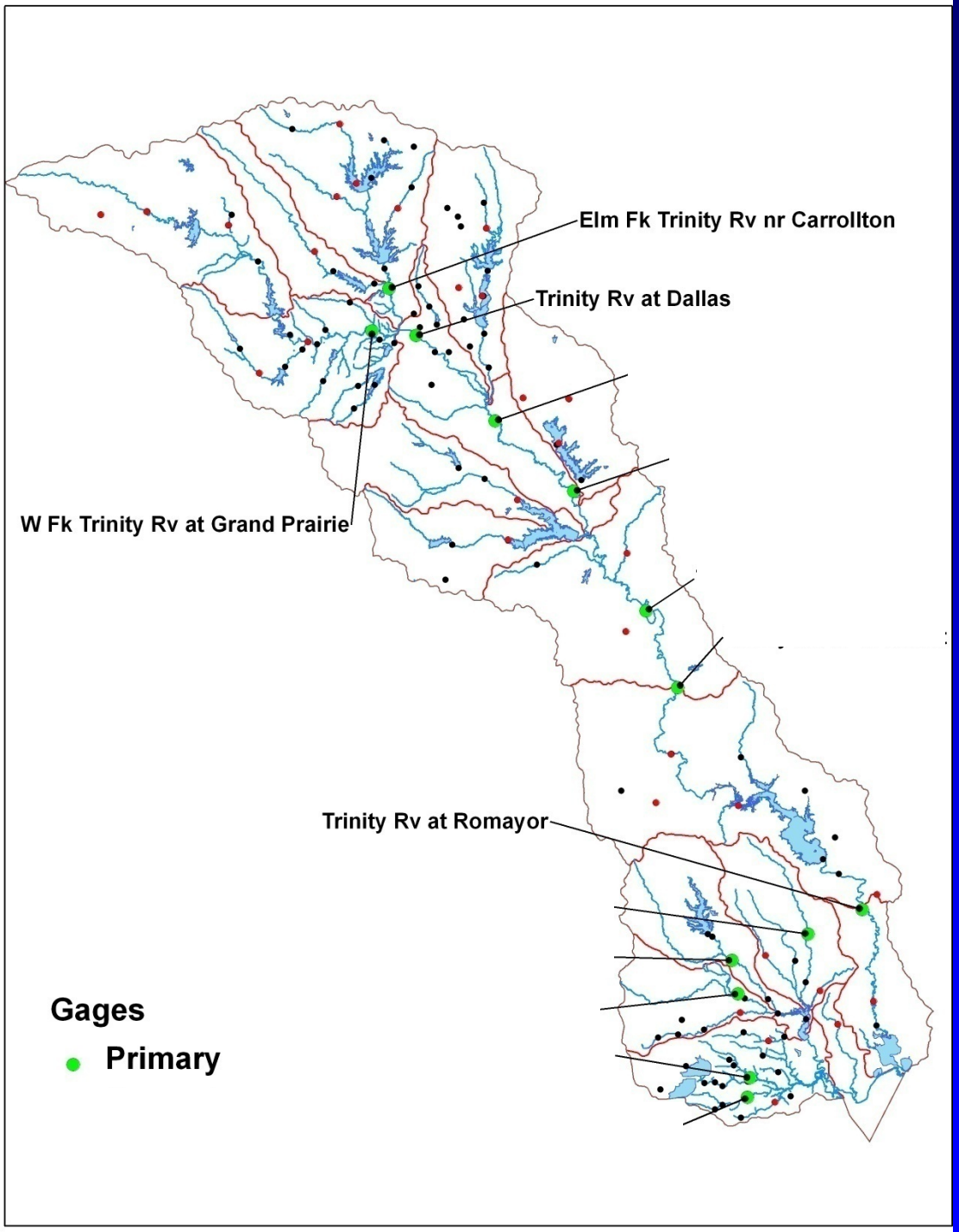
Multidisciplinary Data Collection and Evaluation



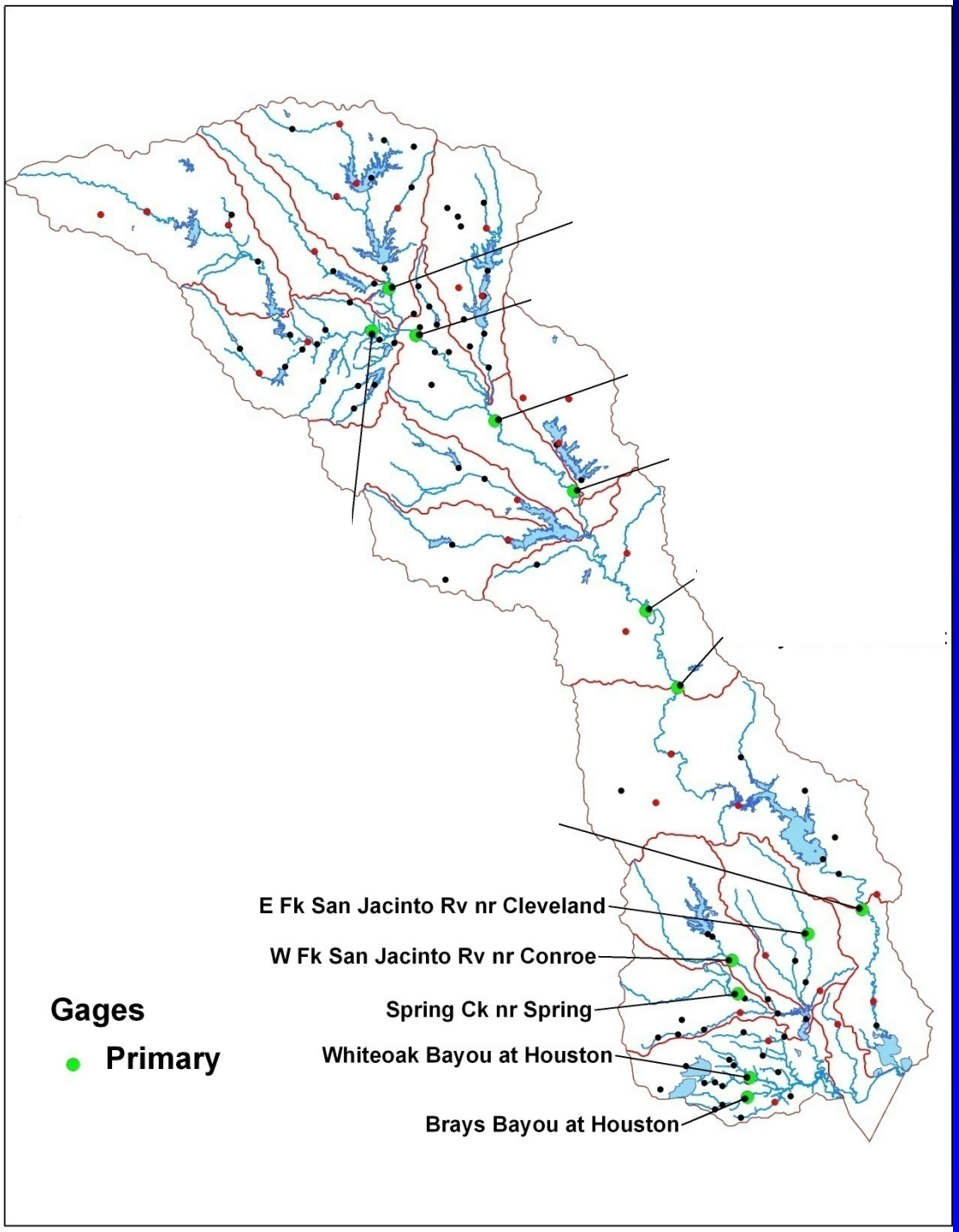
Primary 1st Tier Trinity Locations Identified



Primary 2nd Tier Trinity Locations Identified

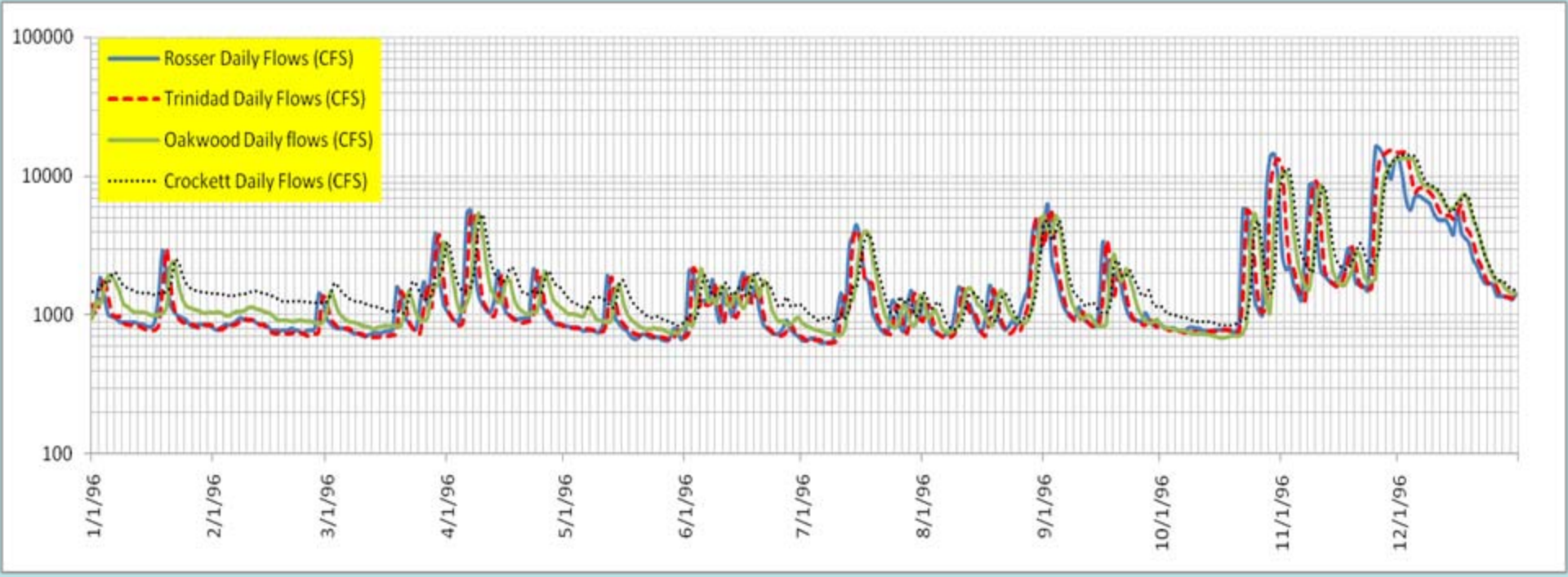


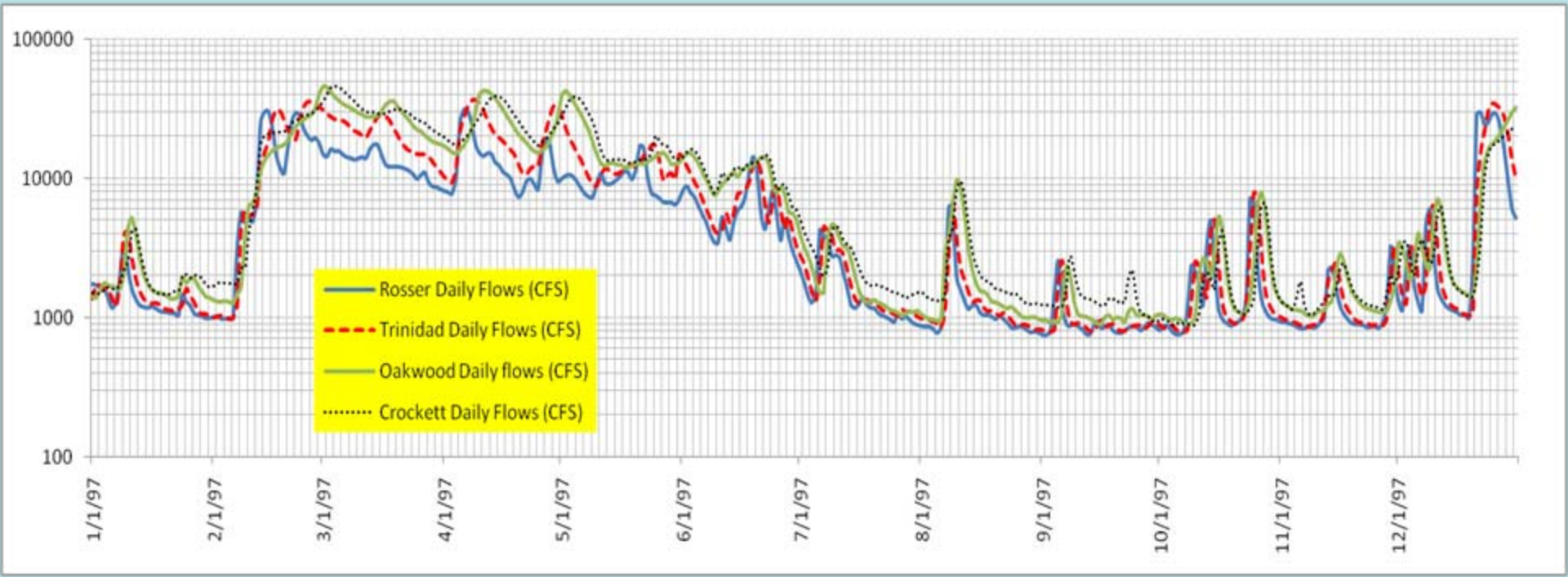
Primary San Jacinto Locations Identified



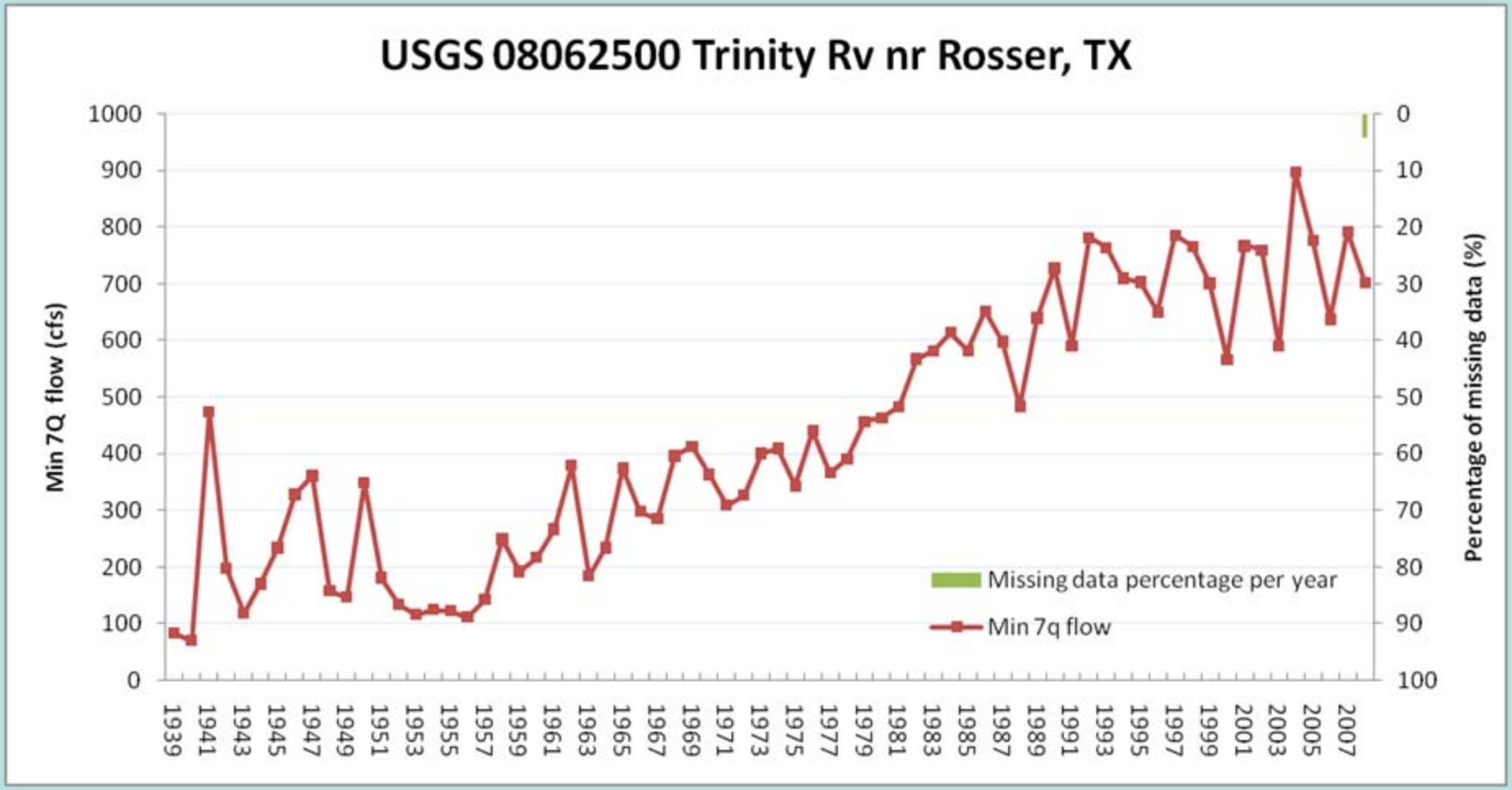
Hydrology

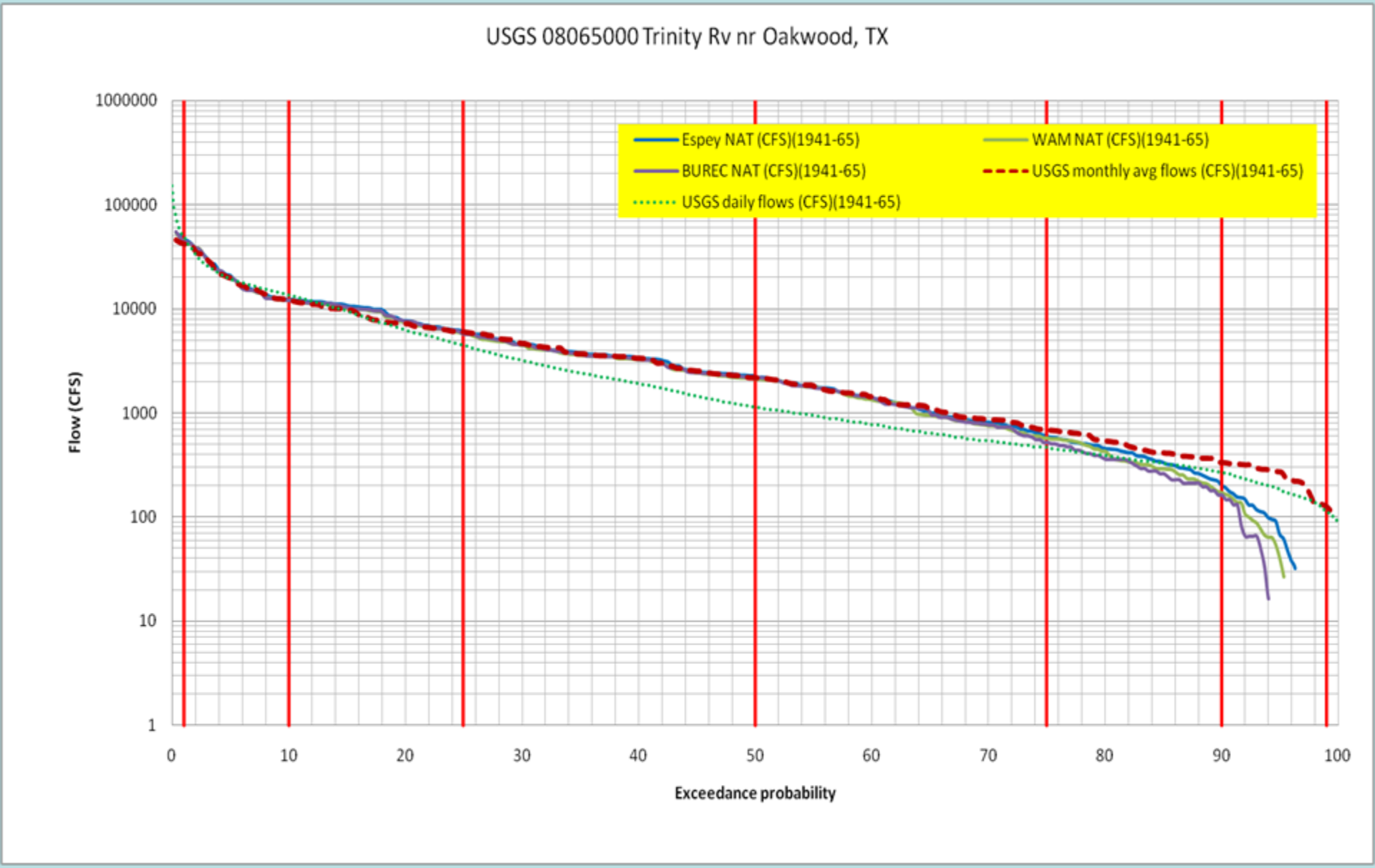
- Period of Record
- Time Series
- Trend
- Sources of Flow
- Flow Frequency
- External Influences and Changes
- Naturalized Flow
- HEFR, Crespo report

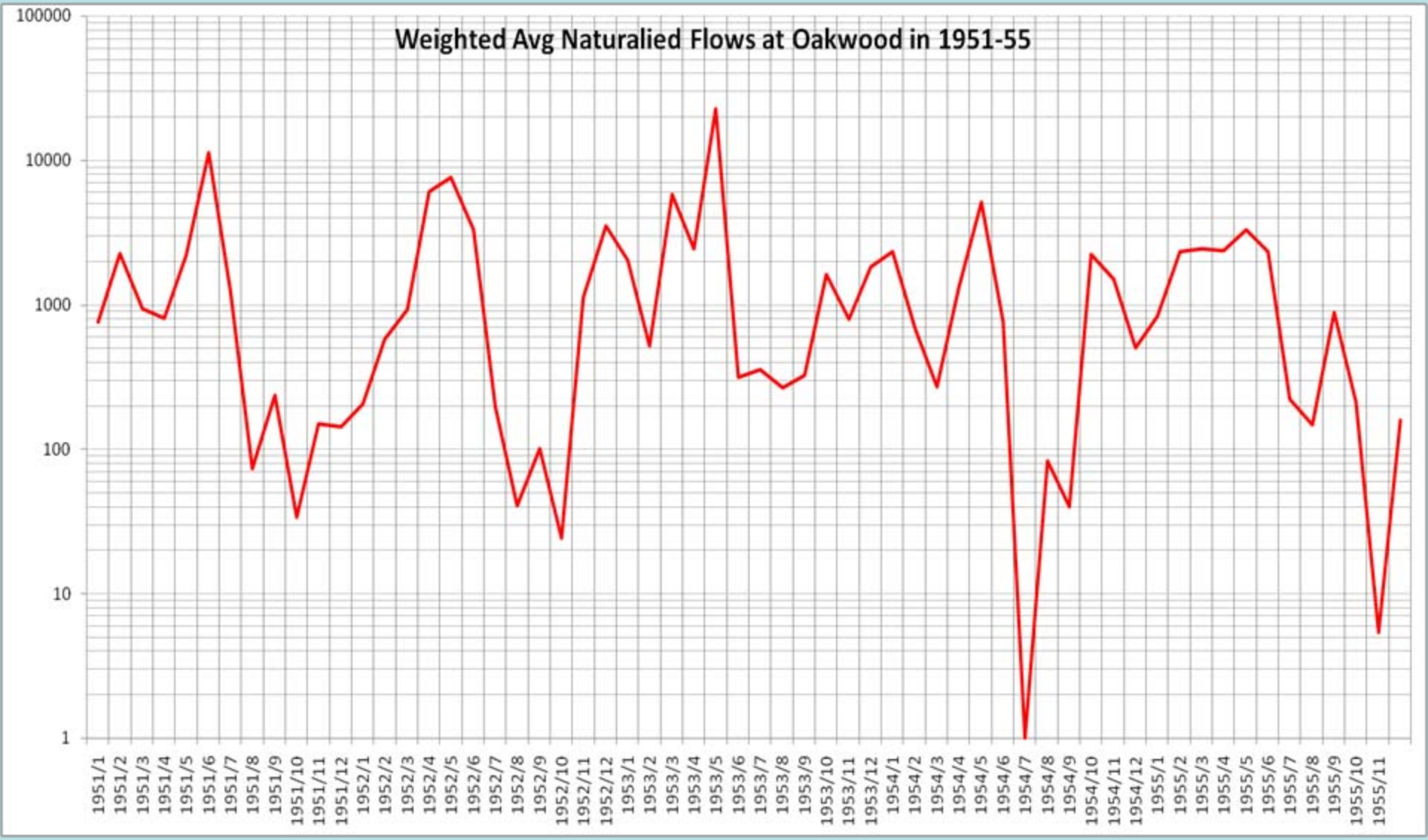

100000
10000
1000
100
Rosser Daily Flows (CFS)
Trinidad Daily Flows (CFS)
Oakwood Daily flows (CFS)
Crockett Daily Flows (CFS)
1/1/96
2/1/96
3/1/96
4/1/96
5/1/96
6/1/96
7/1/96
8/1/96
9/1/96
10/1/96
11/1/96
12/1/96


100000
10000
1000
100
Rosser Daily Flows (CFS)
Trinidad Daily Flows (CFS)
Oakwood Daily flows (CFS)
Crockett Daily Flows (CFS)
1/1/97
2/1/97
3/1/97
4/1/97
5/1/97
6/1/97
7/1/97
8/1/97
9/1/97
10/1/97
11/1/97
12/1/97

Historical Minimum 7-day Flows




USGS 08065000 Trinity Rv nr Oakwood, TX
Espey NAT (CFS)(1941-65)
WAM NAT (CFS)(1941-65)
BUREC NAT (CFS)(1941-65)
USGS monthly avg flows (CFS)(1941-65)
USGS daily flows (CFS)(1941-65)
Flow (CFS)
1000000
100000
10000
1000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Exceedance probability


Weighted Avg Naturalied Flows at Oakwood in 1951-55
100000
10000
1000
100
10
1
1951/1
1951/2
1951/3
1951/4
1951/5
1951/6
1951/7
1951/8
1951/9
1951/10
1951/11
1951/12
1952/1
1952/2
1952/3
1952/4
1952/5
1952/6
1952/7
1952/8
1952/9
1952/10
1952/11
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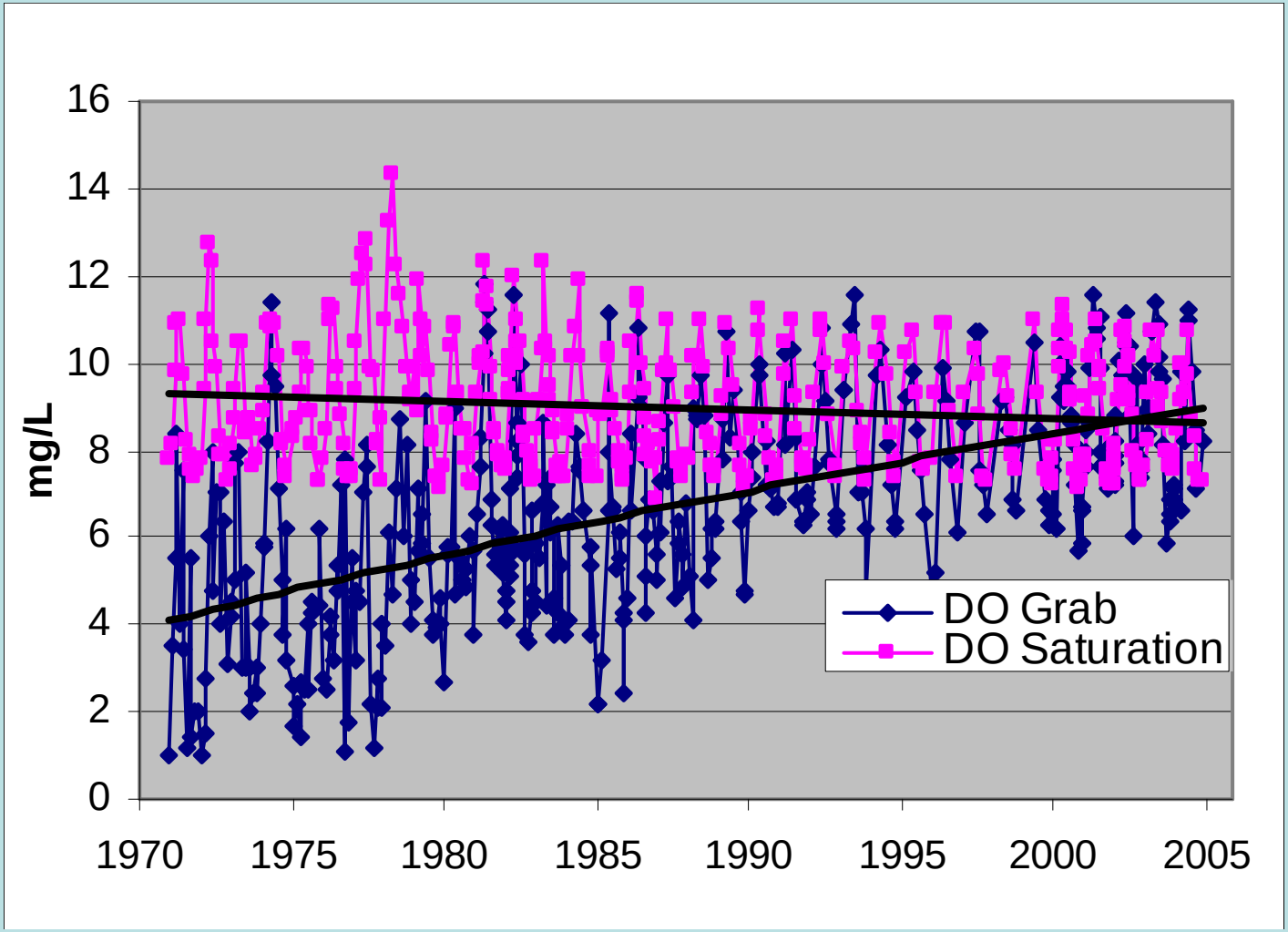
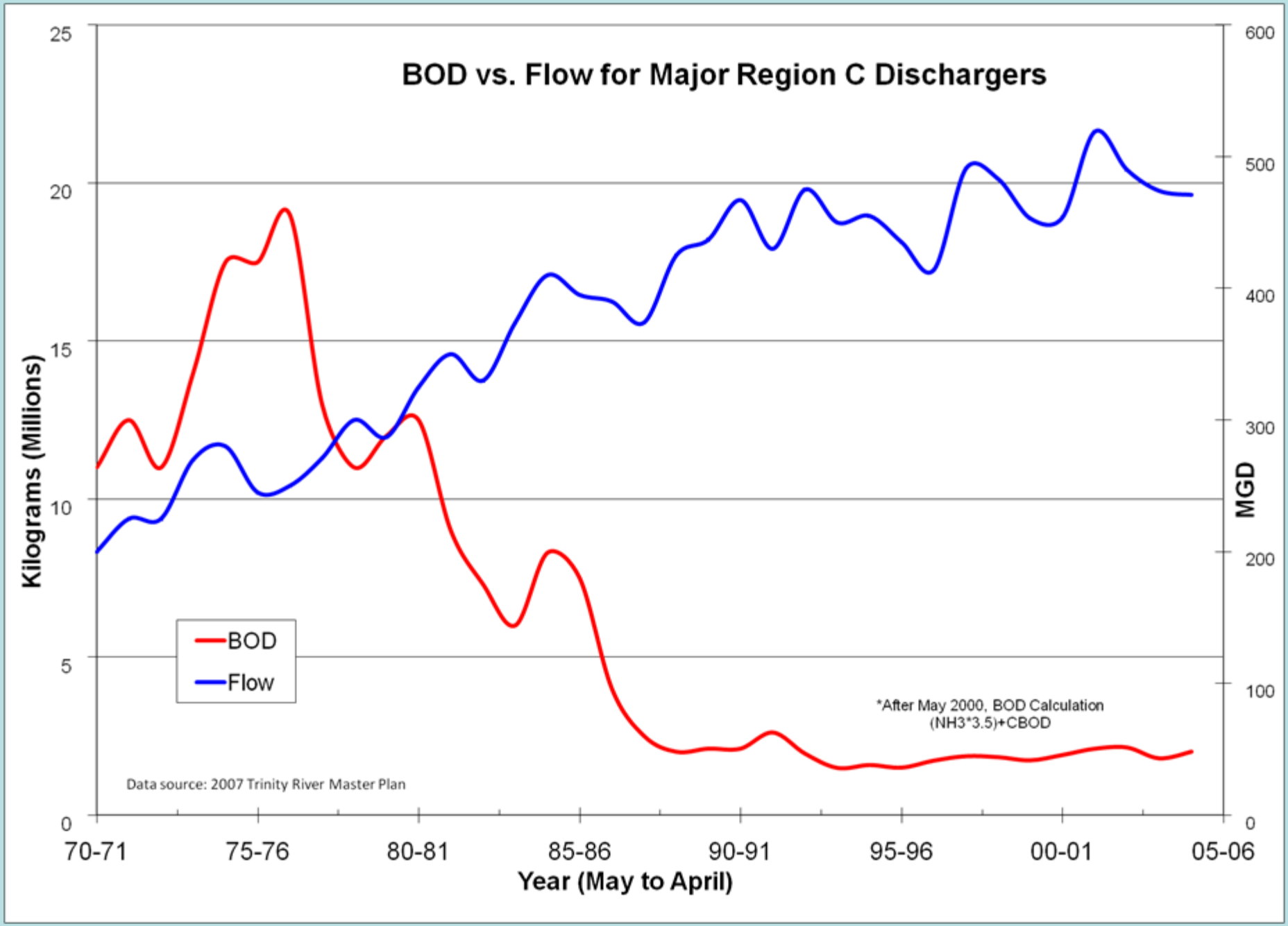
1954/3
1954/4
1954/5
1954/6
1954/7
1954/8
1954/9
1954/10
1954/11
1954/12
1955/1
1955/2
1955/3
1955/4
1955/5
1955/6
1955/7
1955/8
1955/9
1955/10
1955/11

Water Quality Information

- Period of Record, mostly 1970 –
- Trends, Flow correlations, etc
- Clean Rivers & many other reports
- WLAs, DO modeling
- TMDLs, Stream Standards
- TRA, TCEQ, HGAC, USGS databases
- Trinity & San Jacinto Overlay Reports

Historical Water Quality of the Trinity River



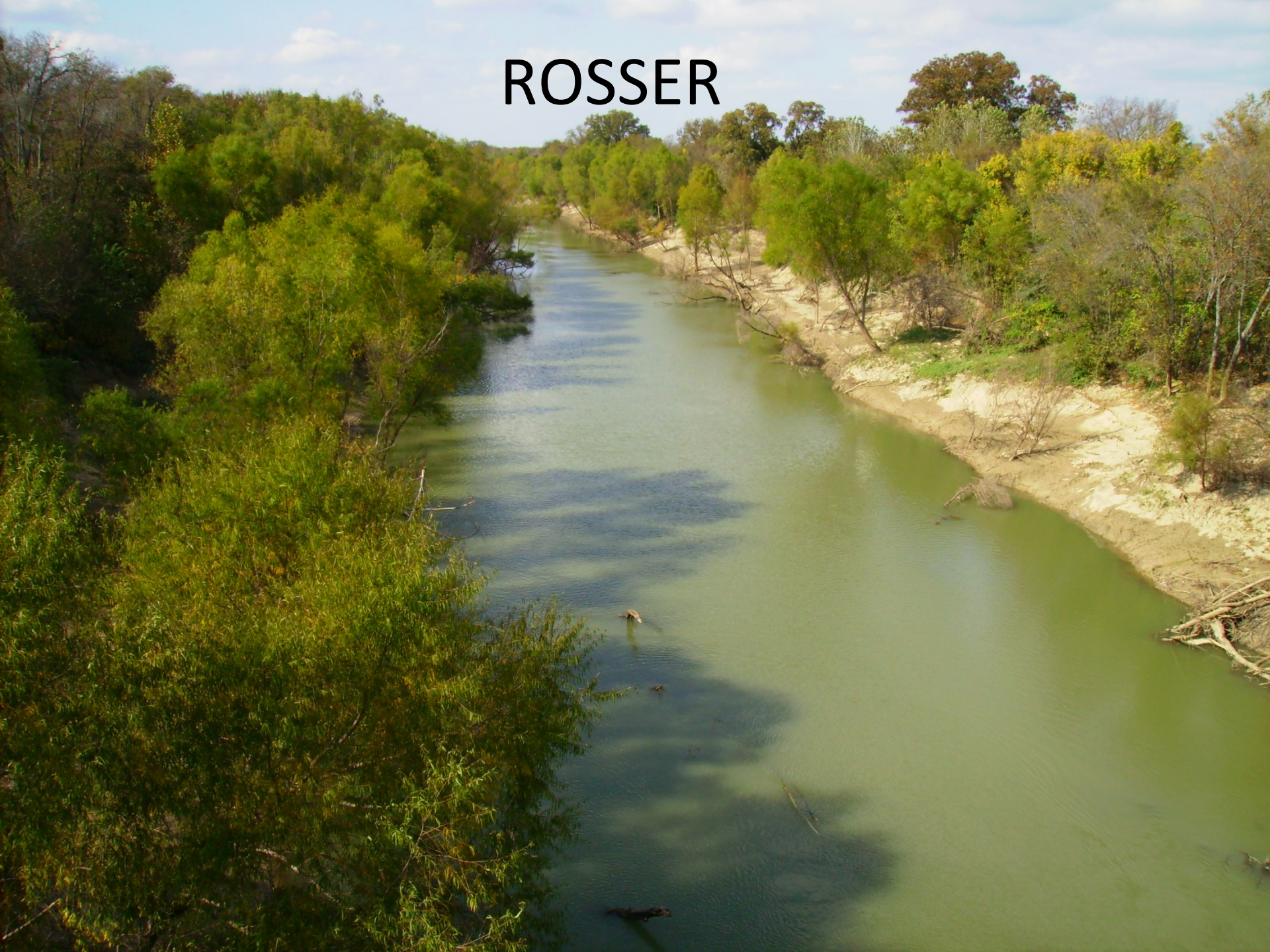

BOD vs. Flow for Major Region C Dischargers
Kilograms (Millions)
MGD
25
20
15
10
5
0
600
500
400
300
200
100
0
70-71
75-76
80-81
85-86
90-91
95-96
00-01
05-06
Year (May to April)
BOD
Flow
*After May 2000, BOD Calculation
(NH3*3.5)+CBOD
Data source: 2007 Trinity River Master Plan

Biology

- Guillen & Espey Literature Reviews
- Guillen & Espey Biology Interpretations and Overlays
  - Guilds, Focal Species, HSCs, Flow Relationships, etc.
- Other Observation & Analyses

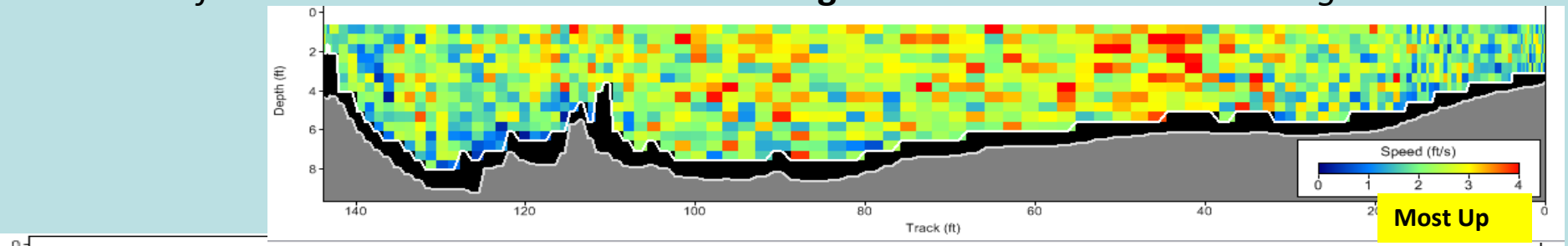
Geomorphologic Information

- Rating Curves
- Limited sediment data
- Cross Sections and Velocity
- Direct Observation
- Aerials
- Historical Photos
- Etc.

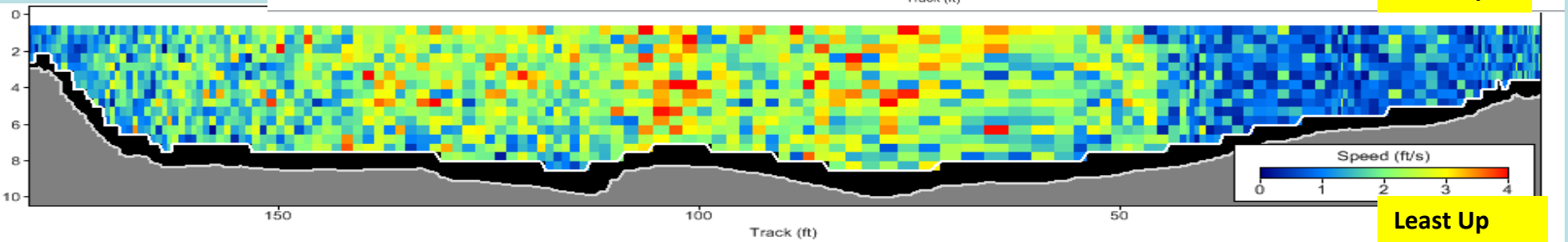

ROSSER

TRINIDAD

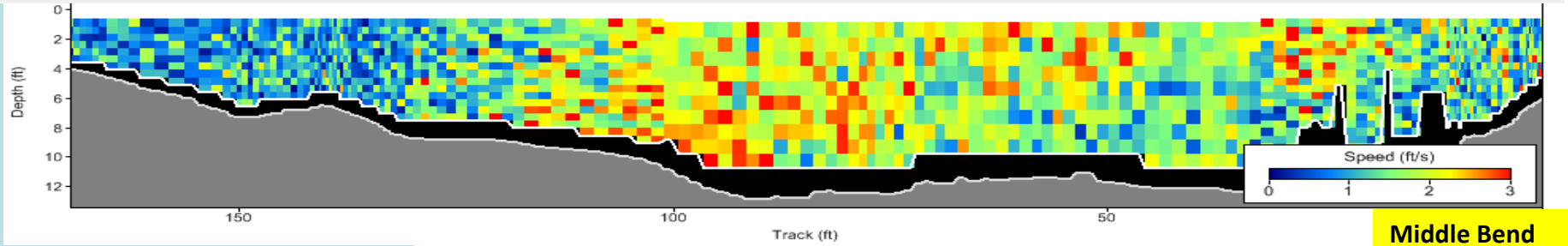
Left Bank **Transect 6 – 5 in Tight Bend near RM 304** *Right Bank*



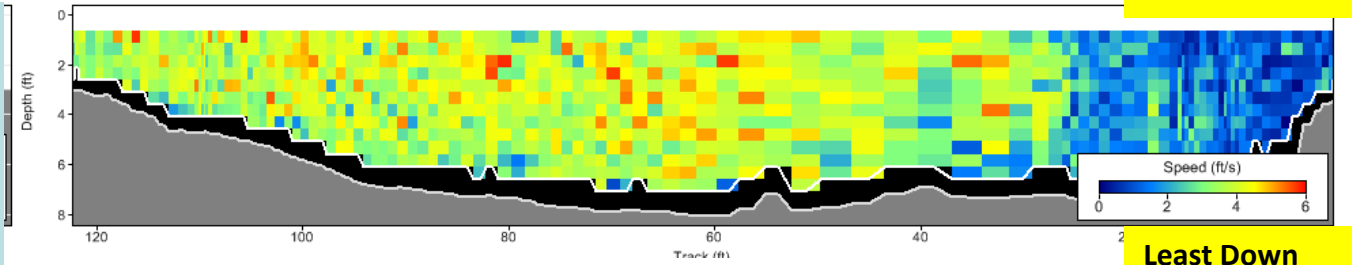
Most Up



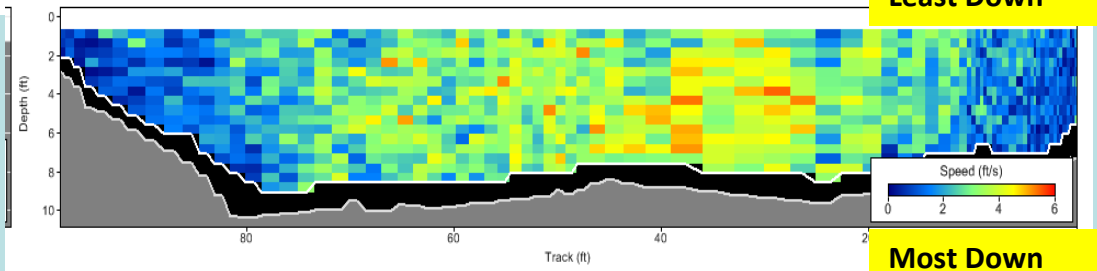
Least Up



Middle Bend



Least Down



Most Down

7 Transects 5 locations(cfs)

Mean Q	2125
Range	2031 - 2231

CONCLUSIONS FROM REVIEW OF 4 DISCIPLINES

- ABUNDANT FLOW & WQ DATA
- LIMITED GEOMORPHOLOGIC & BIOLOGY DATA
- NO DATA TYING BIOLOGIC FUNCTION TO ACTUAL FLOWS IN SJ & TRINITY
- NO ABILITY TO PREDICT EFFECT OF A FLOW CHANGE

POSSIBLE RECOMMENDATION APPROACHES

- NO RECOMMENDATION DUE TO LACK OF ADEQUATE DATA
- RECOMMEND ONLY SUBSISTENCE, ONE BASE, 2 SEASONS, AND O'BANK AT ONE SITE IN EACH BASIN
- RECOMMEND ADDITIONAL SITES & FLOW LEVELS TO GET CONSENSUS

RESULTING CONDITIONAL PHASED RECOMMENDATION

- COMPROMISE PHASED APPROACH
  - “RECOMMENDED” SITES & FLOWS
  - INVESTIGATION OF ADDITIONAL “CONDITIONAL” SITES & FLOWS THROUGH ADAPTIVE MANAGEMENT

Approach

Basin	USGS Gage Site	Recommended Amounts	Conditional Amounts
Trinity	Trinity River near Oakwood	X	X
	Trinity River at Romayor	X	X
	West Fork Trinity River at Grand Prairie		X
	Trinity River at Dallas		X
San Jacinto	West Fork San Jacinto River near Conroe	X	X
	East Fork San Jacinto River near Cleveland	X	X

Trinity at Oakwood

Overbank Flows	Historic Qp: 24,600 cfs Historic Duration is 18 to 61 (Average: 33) DEFINITION: Overbank flows are naturally driven, infrequent, high magnitude flow events that produce water levels that exceed channel banks and result in water entering the floodplain. BBEST does not recommend action be taken to produce such flows			
High Flow Pulses	DEFINITION: High flow pulses are short duration, high magnitude (but still within channel) flow events that occur during or immediately following rainfall events. PURPOSE: The BBEST recognizes that high flow pulses provide an important ecological function to riverine habitat. Lacking specific ecological data, conditional flow magnitudes identified are an arbitrary representation of high flow pulses, and not a representation of the flow necessary to support a sound ecological environment until such supporting specific ecological data are developed.			
Base Flows (cfs)	265 at (91% over 41 yrs)	322 at (95% over 41 yrs)	186 at (85% over 41 yrs)	162 at (82% over 41 yrs)
	DEFINITION: Base flows represent the range of "average" or "normal" flow conditions in the absence of significant precipitation or runoff events. PURPOSE: Maintain typical occurrence and persistence of consecutive base flow days			
Subsistence Flows (cfs)	98 at (100% over 41 yrs)	80 at (100% over 41 yrs)	75 at (97% over 41 yrs)	85 at (96% over 41 yrs)
	DEFINITION: An atypical, short-duration (days to weeks) low flow event PURPOSE: Maintain historical occurrence and persistence, prevent development of poor water quality conditions			

Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Winter			Spring			Summer			Fall		

Trinity at Romayor

Overbank Flows	Historic Qp: 44,600 cfs Historic Duration is 34 DEFINITION: Overbank flows are naturally driven, infrequent, high magnitude flow events that produce water levels that exceed channel banks and result in water entering the floodplain. BBEST does not recommend action be taken to produce such flows.			
High Flow Pulses	DEFINITION: High flow pulses are short duration, high magnitude (but still within channel) flow events that occur during or immediately following rainfall events. PURPOSE: The BBEST recognizes that high flow pulses provide an important ecological function to riverine habitat. Lacking specific ecological data, conditional flow magnitudes identified are an arbitrary representation of high flow pulses, and not a representation of the flow necessary to support a sound ecological environment until such supporting specific ecological data are developed.			
Base Flows (cfs)	744 at (91% over 44 yrs)	923 at (93% over 44 yrs)	510 at (83% over 44 yrs)	515 at (74% over 44 yrs)
	DEFINITION: Base flows represent the range of "average" or "normal" flow conditions in the absence of significant precipitation or runoff events. PURPOSE: Maintain typical occurrence and persistence of consecutive base flow days			
Subsistence Flows (cfs)	295 at (100% over 44 yrs)	290 at (100% over 44 yrs)	223 at (97% over 44 yrs)	240 at (95% over 44 yrs)
	DEFINITION: An atypical, short-duration (days to weeks) low flow event PURPOSE: Maintain historical occurrence and persistence, prevent development of poor water quality conditions			

Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Winter			Spring			Summer			Fall		

East Fork San Jacinto near Cleveland

Overbank Flows	Historic Qp: 16,000 cfs Historic Duration is 20 to 64 (Average: 36) DEFINITION: Overbank flows are naturally driven, infrequent, high magnitude flow events that produce water levels that exceed channel banks and result in water entering the floodplain. BBEST does not recommend action be taken to produce such flows.			
High Flow Pulses	DEFINITION: High flow pulses are short duration, high magnitude (but still within channel) flow events that occur during or immediately following rainfall events. PURPOSE: The BBEST recognizes that high flow pulses provide an important ecological function to riverine habitat. Lacking specific ecological data, conditional flow magnitudes identified are an arbitrary representation of high flow pulses, and not a representation of the flow necessary to support a sound ecological environment until such supporting specific ecological data are developed.			
Base Flows (cfs)	27 at (86% over 30 yrs)	28 at (90% over 30 yrs)	16 at (69% over 30 yrs)	16 at (66% over 30 yrs)
	DEFINITION: Base flows represent the range of "average" or "normal" flow conditions in the absence of significant precipitation or runoff events. PURPOSE: Maintain typical occurrence and persistence of consecutive base flow days			
Subsistence Flows (cfs)	10 at (100% over 30 yrs)	10 at (100% over 30 yrs)	9 at (91% over 30 yrs)	9 at (89% over 30 yrs)
	DEFINITION: An atypical, short-duration (days to weeks) low flow event PURPOSE: Maintain historical occurrence and persistence, prevent development of poor water quality conditions			

Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Winter			Spring			Summer			Fall		

West Fork San Jacinto near Conroe

Overbank Flows	Historic Qp: 16,800 cfs Historic Duration is 18 to 61 (Average: 33) DEFINITION: Overbank flows are naturally driven, infrequent, high magnitude flow events that produce water levels that exceed channel banks and result in water entering the floodplain. BBEST does not recommend action be taken to produce such flows.			
High Flow Pulses	DEFINITION: High flow pulses are short duration, high magnitude (but still within channel) flow events that occur during or immediately following rainfall events. PURPOSE: The BBEST recognizes that high flow pulses provide an important ecological function to riverine habitat. Lacking specific ecological data, conditional flow magnitudes identified are an arbitrary representation of high flow pulses, and not a representation of the flow necessary to support a sound ecological environment until such supporting specific ecological data are developed.			
Base Flows (cfs)	38 at (90% over 30 yrs)	47 at (90% over 30 yrs)	17 at (81% over 30 yrs)	16 at (77% over 30 yrs)
	DEFINITION: Base flows represent the range of "average" or "normal" flow conditions in the absence of significant precipitation or runoff events. PURPOSE: Maintain typical occurrence and persistence of consecutive base flow days			
Subsistence Flows (cfs)	10 at (100% over 30 yrs)	12 at (100% over 30 yrs)	10 at (95% over 30 yrs)	10 at (92% over 30 yrs)
	DEFINITION: An atypical, short-duration (days to weeks) low flow event PURPOSE: Maintain historical occurrence and persistence, prevent development of poor water quality conditions			

Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Winter			Spring			Summer			Fall		

Trinity near Oakwood

High Flow Pulses	Qp: 3,200 cfs at (34% over 41 yrs) Volume is 18,931 Duration is 5			Qp: 7,840 cfs at (31% over 41 yrs) Volume is 141,705 Duration is 11			Qp: 1,180 cfs at (40% over 41 yrs) Volume is #N/A Duration is 2			No recommendation		
Base Flows - Wet (cfs)	980			1080			470			370		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	Winter			Spring			Summer			Fall		

These are a reasonable represen the hydrology, but the relationsh between the ecological health of system and these magnitudes ar frequencies of flow has not yet b defined.
Defer to adaptive management to what is necessary for future scie support the utilization of these a in developing an instream flow recommendation or in a water pe context.

Trinity at Romayor

High Flow Pulses	Qp: 10,100 cfs at (28% over 44 yrs) Volume is 83,087 to 281,058 (152,814) Duration is 7 to 25 (13)			Qp: 10,900 cfs at (36% over 44 yrs) Volume is 106,220 to 319,381 (184,186) Duration is 8 to 29 (15)			Qp: 1,870 cfs at (46% over 44 yrs) Volume is 9,538 to 35,559 (18,417) Duration is 3 to 13 (7)			Qp: 2,560 cfs at (26% over 44 yrs) Volume is 15,903 to 51,774 (28,695) Duration is 4 to 15 (8)		
Base Flows - Wet (cfs)	1753			1900			910			720		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	Winter			Spring			Summer			Fall		

These are a reasonable repres of the hydrology, but the relati between the ecological health system and these magnitudes frequencies of flow has not yet defined.
Defer to adaptive management identify what is necessary for t science to support the utilizati these amounts in developing a instream flow recommendation water permitting context.

East Fork San Jacinto near Cleveland

High Flow Pulses	Qp: 475 cfs at (14% over 30 yrs) Volume is 5,055 Duration is 8			Qp: 687 cfs at (9% over 30 yrs) Volume is 6,769 Duration is 8				Qp: 94 cfs at (12% over 30 yrs) Volume is 288 Duration is 2			Qp: 56 cfs at (17% over 30 yrs) Volume is #N/A Duration is 2	
Base Flows - Wet (cfs)	80			64				34			38	
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	Winter			Spring			Summer			Fall		

These are a reasonable represen the hydrology, but the relationsh between the ecological health of system and these magnitudes an frequencies of flow has not yet b defined.
Defer to adaptive management to what is necessary for future scie support the utilization of these a in developing an instream flow recommendation or in a water pe context.

West Fork San Jacinto near Conroe

High Flow Pulses	Qp: 420 cfs at (30% over 30 yrs) Volume is 3,679 Duration is 7			Qp: 1,100 cfs at (13% over 30 yrs) Volume is 12,377 Duration is 9				Qp: 74 cfs at (25% over 30 yrs) Volume is 380 Duration is 2			No recommendation		These are a reasonable represen the hydrology, but the relationsh between the ecological health of system and these magnitudes ar frequencies of flow has not yet b defined. Defer to adaptive management to what is necessary for future scie support the utilization of these a in developing an instream flow recommendation or in a water pe context.
Base Flows - Wet (cfs)	111			88				38			47		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	
	Winter			Spring				Summer			Fall		

West Fork Trinity River at Grand Prairie

Overbank Flows	10,700 cfs Duration is 13 to 49 (25) DEFINITION: Overbank flows are naturally driven, infrequent, high magnitude flow events that produce water levels that exceed channel banks and result in water entering the floodplain. BBEST does not recommend action be taken to produce such flows.											
High Flow Pulses	Qp: 392 cfs at (89% over 30 yrs) Volume is 3,830 Duration is 4			Qp: 1,280 cfs at (19% over 30 yrs) Volume is 8,345 Duration is 8				Qp: 293 cfs at (32% over 30 yrs) Volume is 1,899 Duration is 3				No recommendation
Base Flows - Wet (cfs)	118			138				82				79
Base Flows (cfs)	45 at (85% over 30 yrs)			45 at (89% over 30 yrs)			35 at (82% over 30 yrs)			35 at (75% over 30 yrs)		
	DEFINITION: Base flows represent the range of "average" or "normal" flow conditions in the absense of significant precipitation or runoff events. PURPOSE: Maintain typical occurrence and persistence of consecutive base flow days											
Subsistence Flows (cfs)	19 at (99% over 30 yrs)			17 at (99% over 30 yrs)			16 at (97% over 30 yrs)			15 at (95% over 30 yrs)		
	DEFINITION: An atypical, short-duration (days to weeks) low flow event PURPOSE: Maintain historical occurrence and persistence, prevent development of poor water quality conditions											
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	Winter						Spring					

These are a reasonabl
representation of the
hydrology, but the rela
between the ecologica
of the system and thes
magnitudes and frequ
flow has not yet been
Defer to adaptive man
to identify what is nec
for future science to s
the utilization of these
amounts in developing
instream flow recomm
or in a water permittin
context.

Trinity River at Dallas

Overbank Flows	Qp: 11,100 cfs Duration is 10 to 41 (21) DEFINITION: Overbank flows are naturally driven, infrequent, high magnitude flow events that produce water levels that exceed channel banks and result in water entering the floodplain. BBEST does not recommend action be taken to produce such flows.			
High Flow Pulses	Qp: 758 cfs at (28% over 50 yrs) Volume is #N/A Duration is 3	Qp: 4,120 cfs at (16% over 50 yrs) Volume is 41,998 Duration is 9	Qp: 660 cfs at (29% over 50 yrs) Volume is 685 Duration is 3	No recommendation
Base Flows - Wet (cfs)	272	304	225	198
Base Flows (cfs)	31 at (87% over 50 yrs)	37 at (90% over 50 yrs)	32 at (86% over 50 yrs)	26 at (82% over 50 yrs)
	DEFINITION: Base flows represent the range of "average" or "normal" flow conditions in the absense of significant precipitation or runoff events. PURPOSE: Maintain typical occurrence and persistence of consecutive base flow days			
Subsistence Flows (cfs)	15 at (93% over 50 yrs)			
	DEFINITION: An atypical, short-duration (days to weeks) low flow event PURPOSE: Maintain historical occurrence and persistence, prevent development of poor water quality conditions			

Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Winter						Spring					

These are a reasonabl
representation of the
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flow has not yet been
Defer to adaptive man
to identify what is nec
for future science to s
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amounts in developing
instream flow recomm
or in a water permittin
context.

Application/Implementation

- If TCEQ encounters permitting that involves segments not addressed by the Recommended Stations, the following are presented for consideration:
  - Consider the Conditional Recommended Stations and associated Conditional Recommended flow regimes in the performance of a permit specific analysis.
  - Consider that a water availability analysis at any location upstream of a recommended site can evaluate the potential impacts on instream flows at the recommended site.
  - Apply a drainage area adjustment based on the size of the drainage area above the proposed permit site.
  - “It should be noted that for any future large water development projects, such as reservoirs, a site specific study may be required as part of the permitting process.” (SAC -Geographic Scope of Instream Flow Recommendations, April 3, 2009)

Instream Flow Recommendation-2

Trinity at Oakwood

Overbank Flows	Q: 24,600 cfs with Frequency 1 per 2 years Volume is 626,471 Duration is 26			
High Flow Pulses	Q: 15,000 cfs with Frequency 2 per year Volume is 326,119 Duration is 18			
	Q: 11,200 cfs with Frequency 1 per season Volume is 257,289 Duration is 14 Q: 3,200 cfs with Frequency 2 per season Volume is 18,931 Duration is 5	Q: 15,700 cfs with Frequency 1 per season Volume is 362,910 Duration is 19 Q: 7,840 cfs with Frequency 2 per season Volume is 141,705 Duration is 11	Q: 2,930 cfs with Frequency 1 per season Volume is 26,246 Duration is 5 Q: 1,180 cfs with Frequency 2 per season Volume is 4,866 Duration is 2	Q: 3,050 cfs with Frequency 1 per season Volume is 39,239 Duration is 5
Base Flows (cfs)	1110	1398	682	819
	623	820	411	439
	340	458	257	265
Subsistence Flows (cfs)	196	280	70	101
	Dec, Jan, Feb	Mar, Apr, May, Jun	Jul, Aug, Sep	Oct, Nov
	Winter	Spring	Summer	Fall

Hydrologic Conditions	
	Wet
	Average
	Dry
	Subsistence

High Flow Pulse Characteristics	
	F = Frequency (per season)
	D = Duration (days)
	Q = Peak Flows (cfs)
	V = Volume (ac-ft)

Instream Flow Recommendation-2 (cont'd)

Trinity at Oakwood

- Base flow, Winter, Subsistence Condition: 196 cfs with attainment frequency of 95% of the time
- Base flow, Winter, Dry Condition: 340 cfs with attainment frequency of 85% of the time
- Base flow, Winter, Average Condition: 623 cfs with attainment frequency of 72% of the time
- Base flow, Winter, Wet Condition: 1,110 cfs with attainment frequency of 58% of the time
- Base flow, Spring, Subsistence Condition: 280 cfs with attainment frequency of 95% of the time
- Base flow, Spring, Dry Condition: 458 cfs with attainment frequency of 89% of the time
- Base flow, Spring, Average Condition: 820 cfs with attainment frequency of 79% of the time
- Base flow, Spring, Wet Condition: 1,398 cfs with attainment frequency of 66% of the time
- Base flow, Summer, Subsistence Condition: 70 cfs with attainment frequency of 95% of the time
- Base flow, Summer, Dry Condition: 257 cfs with attainment frequency of 69% of the time
- Base flow, Summer, Average Condition: 411 cfs with attainment frequency of 53% of the time
- Base flow, Summer, Wet Condition: 682 cfs with attainment frequency of 36% of the time
- Base flow, Fall, Subsistence Condition: 101 cfs with attainment frequency of 95% of the time
- Base flow, Fall, Dry Condition: 265 cfs with attainment frequency of 73% of the time
- Base flow, Fall, Average Condition: 439 cfs with attainment frequency of 57% of the time
- Base flow, Fall, Wet Condition: 819 cfs with attainment frequency of 41% of the time

TURCO EXPLANATION

- The term best available science is certainly open to interpretation, and although there are statements in this section that suggest to me that best available science could be "professional opinion," in the context of this exercise I believe that that is a recipe for non-consensus as all of us have a professional opinion based on our experience and background and my limit of best available science may be more or less rigorous than others. The discussion of uncertainty in the ecological information on page 51 is the type of information that leads me to favor a less complex approach to the in stream flow recommendation.

- My experience in hydrology and, in particular, modeling leads me to the conclusion that at this time, for these basins, the "less complex" approach is the appropriate course of action. Although HEFR model will provide a multitude of different base flows and high flow pulses; I do not feel the a priori data on Trinity or San Jacinto supports that level of complexity outlined in section 2.2. There is no question that in other streams in other areas, like the Lower Colorado River in Texas and the other rivers elsewhere in the US mentioned in section 2.2 of the report, variability in base flow and high flow pulses is important, however, assigning a specific flow rate and a frequency without much of any information about the site is premature.