Texas Environmental Flows Program
Science Advisory Committee

Instream Flow Regime Application Example

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Sabine & Neches BBEST
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HDR

Topics of Discussion

1) Why Flow Regime Application Examples are Necessary
2) Flow Regime Components, HEFR Matrix, and Hydrologic Conditions
3) Instream Flow Regime Application Example for Big Sandy Reservoir
4) Attainment Frequencies
5) Questions, Comments, & Discussion

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Why Application Examples are Necessary

1) Time series of flows from flow regime application examples provide frequency & duration data that support science-based "overlays" including geomorphology, biology (e.g., salinity response), water quality, etc.
2) BBESTs must have some measure of understanding of the actual future flow regimes that may result from implementation of recommended environmental flow regimes in order to ensure that a sound ecological environment can be supported on a long-term basis.
3) Finite infrastructure examples (e.g., operations of a major proposed project, full use of existing water rights) avoid the highly impracticable assumption that, once environmental flow standards are implemented, the only flow remaining in a stream or passing into an estuarine system will be the environmental flow prescription itself.

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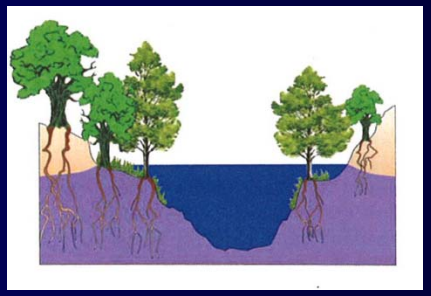
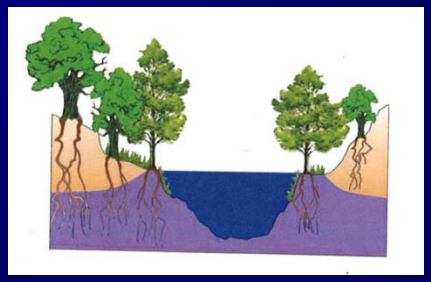
HEFR Matrix for Big Sandy Creek, Sabine River Basin

Overbank Flows	Qp: 2,930 cfs with Frequency 1 per 2 years Volume is 35,703 Duration is 30			
	Overbank flows may cause extensive damage to private property and endanger the public. Therefore, the Sabine-Neches BBEST recognizes the ecological benefits of these events, but cannot recommend such events be produced.			
High Flow Pulses	Qp: 942 cfs with Frequency 1 per season Volume is 14,544 Duration is 16	Qp: 950 cfs with Frequency 1 per season Volume is 12,852 Duration is 19	Qp: 132 cfs with Frequency 1 per season Volume is 2,054 Duration is 11	Qp: 367 cfs with Frequency 1 per season Volume is 6,055 Duration is 14
	Qp: 358 cfs with Frequency 2 per season Volume is 5,932 Duration is 10	Qp: 313 cfs with Frequency 2 per season Volume is 5,062 Duration is 13	Qp: 50 cfs with Frequency 2 per season Volume is 671 Duration is 6	Qp: 130 cfs with Frequency 2 per season Volume is 2,189 Duration is 9
	Translation of seasonal pulse flows of specified frequencies into environmental flow standards and permit conditions may result in less frequent occurrence of high flow pulses as a result of the issuance of new surface water appropriations or amendments. This reduced frequency of occurrence is deemed an acceptable environmental risk at this time, subject to review as new studies and information become available.			
Base Flows (cfs)	163	111	26	63
	106	51	18	36
	66	30	14	20
	Seasonal base flows represent thresholds for environmental protection based on current scientific understanding of fluvial and estuarine ecosystems. As new studies and monitoring information become available, these base flow thresholds may be revised.			
Subsistence Flows (cfs)	20	9	8	8
	Translation of seasonal subsistence flows into environmental flow standards and permit conditions should not result in more frequent occurrence of flows less than the recommended seasonal subsistence values as a result of the issuance of new surface water appropriations or amendments.			
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec
	Winter	Spring	Summer	Fall

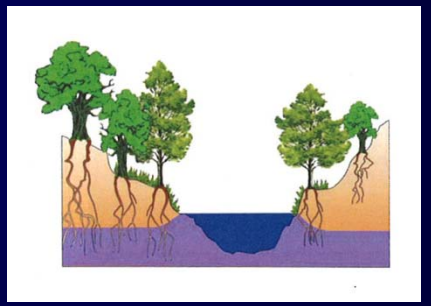
Overbank

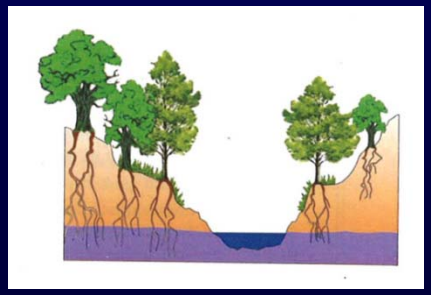




High Pulse

Base





Subsistence

Subsistence & Base Flows

	Winter	Spring	Summer	Fall
Base Flows (cfs)	163	111	26	63
	106	51	18	36
	66	30	14	20
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Subsistence Flows (cfs)	20	9	8	8
	Translation of seasonal subsistence flows into environmental flow standards and permit conditions should not result in more frequent occurrence of flows less than the recommended seasonal subsistence values as a result of the issuance of new surface water appropriations or amendments.			
	Jan, Feb, Mar	Apr, May, Jun	Jul, Aug, Sep	Oct, Nov, Dec

Wet

Average

Dry

Seasons

High Flow Pulses & Overbank Flows

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Wet

Dry & Average

Hydrologic Condition

1) Hydrologic condition (i.e., Dry, Average, or Wet) at any specific location is defined on the basis of cumulative water supply storage in major reservoirs located upstream and the frequency of occurrence of such storage subject to full use of authorized water rights.
2) The S&NBBEST recommends that the applicable hydrologic condition for the entire season be defined on the basis of an assessment of hydrologic condition at the beginning of the season thereby recognizing drought persistence and practical operations.

Instream Flow Regime Application Example

Flow Regime → **Permit Conditions**

Nomenclature

Q = Inflow (varies daily)

S = Subsistence Flow (varies w/ season)

B = Base Flow (varies w/ season & hydrologic condition)

P_2 = Pulse Flow (2/Season) (varies w/ season)

P_1 = Pulse Flow (1/Season) (varies w/ season)

Dry Hydrologic Condition

Situation	Inflow Pass-Through
a) Q < S	a) Q (inflow)
b) B > Q > S	b) S (subsistence flow)
c) P_2 > Q > B	c) B (base flow)
d) Q > P_2, Sep-Feb	d) B
e) Q > P_2, Mar-Aug, Zero Pulses in Season	e) Q <= P_2, up to Duration or Volume
f) Q > P_2, Mar-Aug, One+ Pulses in Season	f) B

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Average Hydrologic Condition

Situation	Inflow Pass-Through
a) Q < B	a) Q
b) P_2 > Q > B	b) B
c) Q > P_2, Zero or One Pulses in Season	c) Q <= P_2, up to Duration or Volume
d) Q > P_2, Two+ Pulses in Season	d) B

Wet Hydrologic Condition

Situation	Inflow Pass-Through
a) Q < B	a) Q
b) P_1 > Q > B	b) B
c) Q > P_1, Zero Pulses in Season	c) Q <= P_1, up to Duration or Volume
d) Q > P_1, One+ Pulses in Season	d) B

General Notes

1) Downstream runoff, water deliveries, hydropower releases, and inflow passage for senior water rights contribute to maintenance of recommended flow regimes.
2) Each season is independent of the preceding and subsequent seasons with respect to high flow pulse frequency.
3) With regard to recommended high flow pulses in the Spring and Summer seasons under Dry hydrologic conditions, the Spring season should be shifted to March through May and the Summer season should be shifted to June through August. These smaller-magnitude pulses serve critical ecological functions, including cues for synchronized fish spawning, passive transport of fertilized eggs and larvae into retention zones, and re-suspension of silt.

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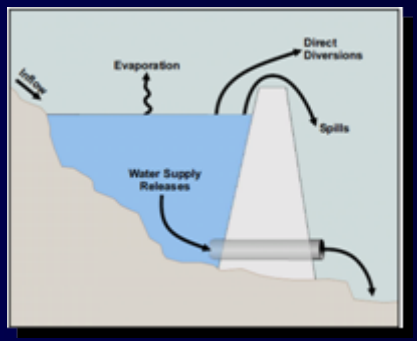
Big Sandy Reservoir Example



- Intended to illustrate the translation of a flow regime into permit conditions and demonstrate the potential effects on instream flows and their frequency of occurrence.
- Big Sandy Reservoir would have a storage capacity of about 76,200 acft at the top of the conservation pool.
- This project is not recommended to meet projected needs for additional water supply in the current State Water Plan and its construction would occur, if ever, well beyond the 50-year state water planning horizon.
- Operation with direct diversion of firm yield subject to daily flow regime application simulated in Microsoft Excel.

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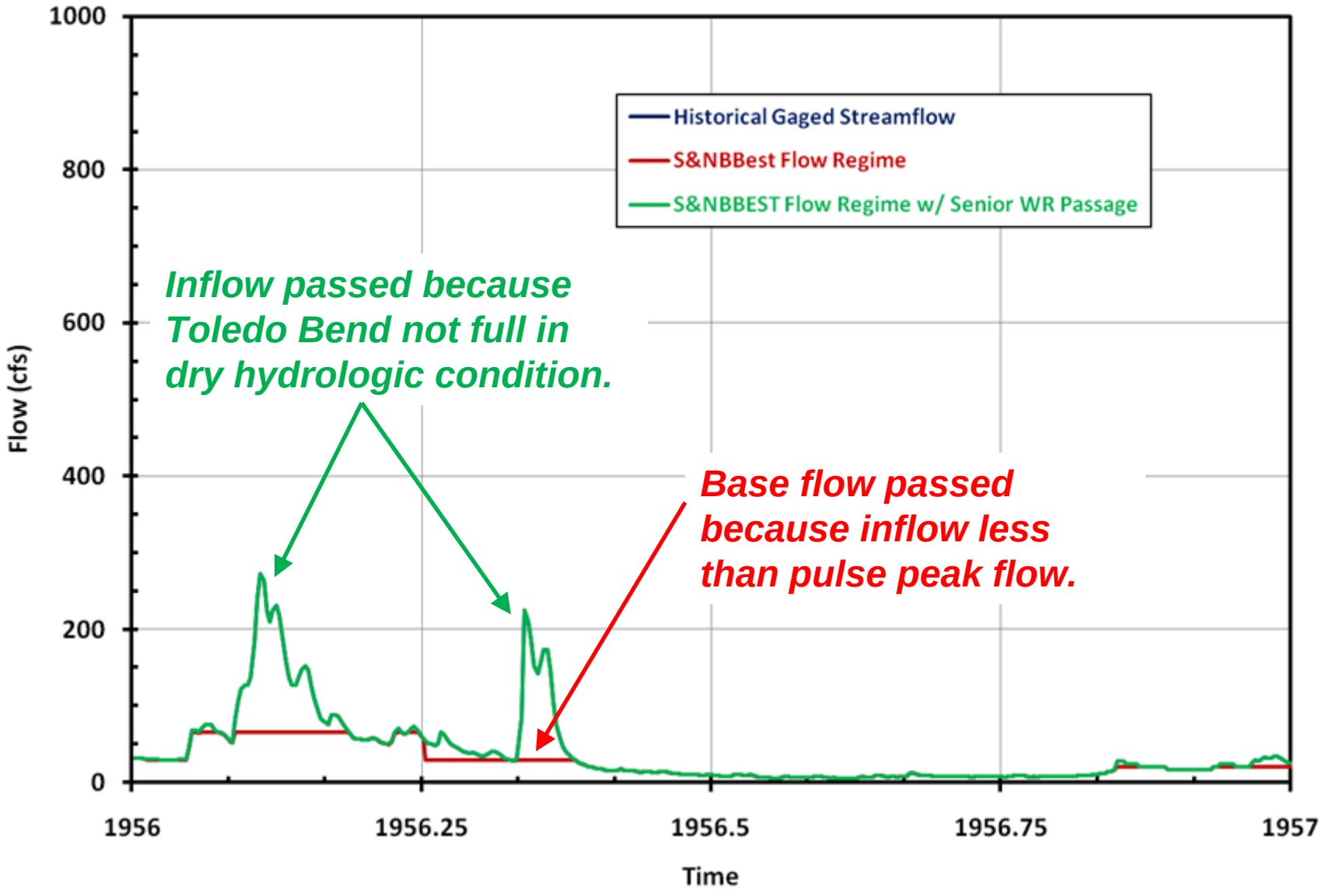
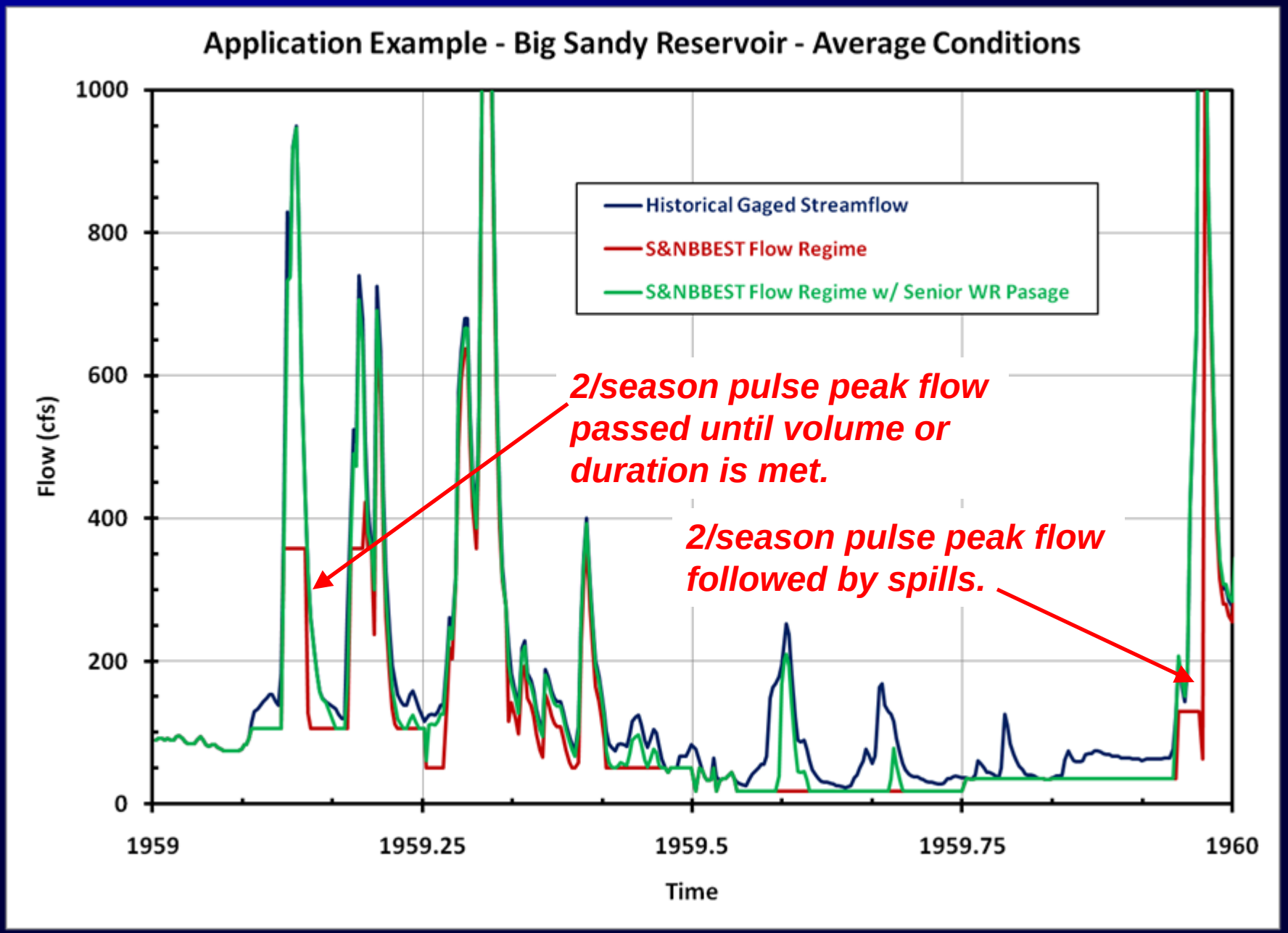
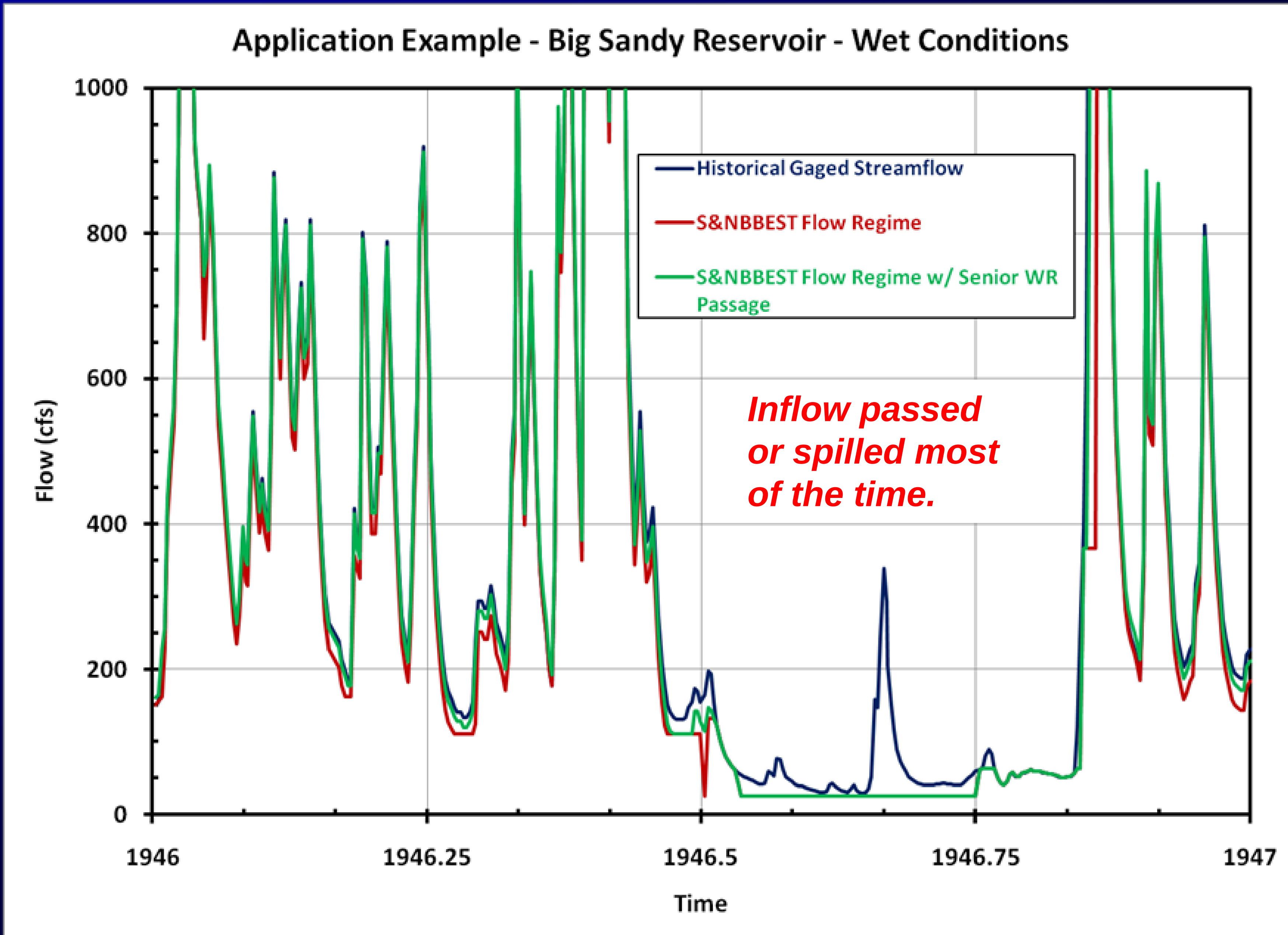
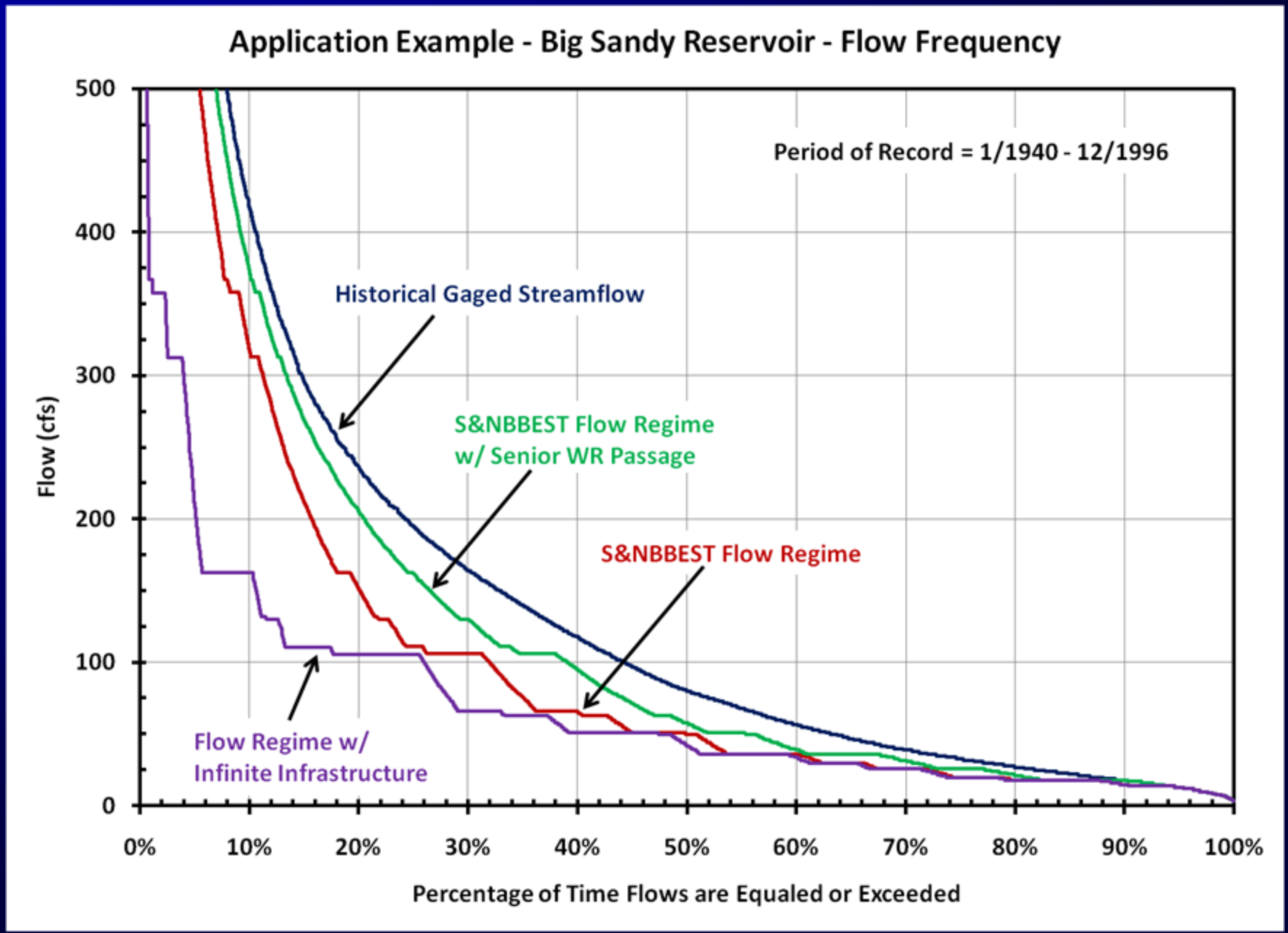
Application Example - Big Sandy Reservoir - Dry Conditions




Application Example - Big Sandy Reservoir - Average Conditions
Historical Gaged Streamflow
S&NBBEST Flow Regime
S&NBBEST Flow Regime w/ Senior WR Pasage
2/season pulse peak flow passed until volume or duration is met.
2/season pulse peak flow followed by spills.
Flow (cfs)
Time
1000
800
600
400
200
0
1959
1959.25
1959.5
1959.75
1960


Application Example - Big Sandy Reservoir - Wet Conditions
Flow (cfs)
1000
800
600
400
200
0
1946
1946.25
1946.5
1946.75
1947
Time
Historical Gaged Streamflow
S&NBBEST Flow Regime
S&NBBEST Flow Regime w/ Senior WR Passage
Inflow passed or spilled most of the time.


Application Example - Big Sandy Reservoir - Flow Frequency
Period of Record = 1/1940 - 12/1996
Historical Gaged Streamflow
S&NBBEST Flow Regime
w/ Senior WR Passage
S&NBBEST Flow Regime
Flow Regime w/
Infinite Infrastructure
Flow (cfs)
500
400
300
200
100
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percentage of Time Flows are Equaled or Exceeded

Attainment Frequencies

1) Preservation of the full range of historical flow components (and their historical frequencies of occurrence) is logically considered to support a sound ecological environment.
2) Based on review and analysis of currently available information (hydrology, sediment dynamics, water quality, & biology), the S&NBBEST recognizes that some lesser quantities of flow and/or lesser frequencies of occurrence may be adequate for environmental protection.

Attainment Frequencies (cont'd)

3) There is decreasing certainty regarding flow frequency necessary to sustain a sound ecological environment as one moves up through the flow regime components.
4) Translation of seasonal subsistence flows into environmental flow standards and permit conditions should not result in more frequent occurrence of flows less than the recommended seasonal subsistence values.
5) Seasonal base flows represent thresholds for environmental protection based on current scientific understanding of fluvial & estuarine ecosystems.

Attainment Frequencies (cont'd)

6) Reduced frequency of seasonal pulse flow occurrence is deemed an acceptable environmental risk at this time, subject to review as new studies and information become available.
7) Ecological benefits of overbank flows are recognized, but it is not recommended that such events be produced.

Questions, Comments, & Discussion