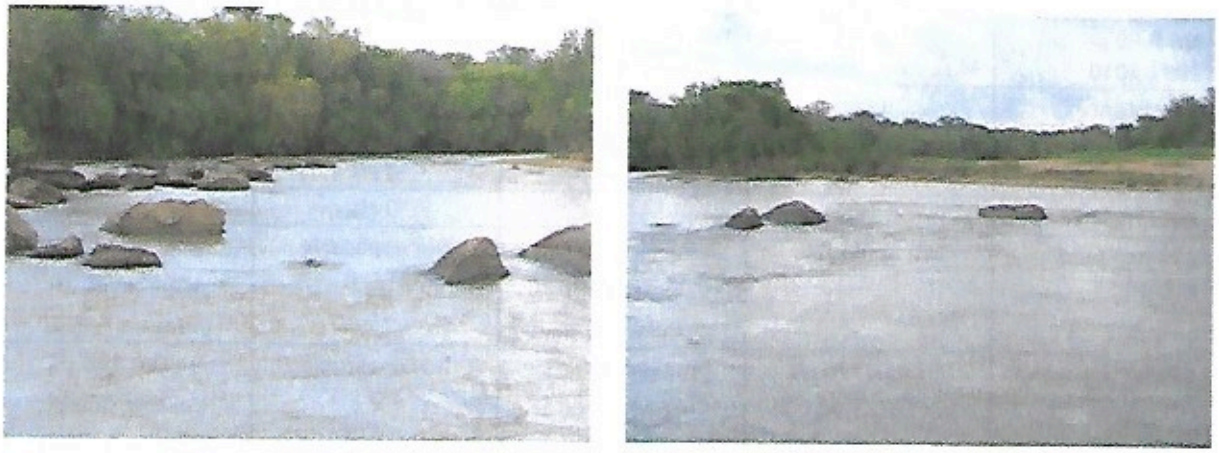
2.3 Lower Colorado

2.3.1 Colorado River at Bastrop

USGS Gage 08159200



Typical view of riffle habitat in the Colorado River near Bastrop, facing upstream (left) and across the river (right) (Courtesy of BIO-WEST, Inc.).

General Area Description (USGS 2010, BIO-WEST 2008)

- Along a bend in the river at the crossing of Highway 71 in Bastrop County
- Extends from below Longhorn Dam to Bastrop
- No records of days without flow at this gage
- Examined as part of an instream flow study in 2004-2007
- Instream habitat modeling conducted within this reach
- HECRAS modeling conducted within this reach
- Intensive biological and physical data collection activities conducted 2004-2007 (BIO-WEST, Inc. 2004, BIO-WEST, Inc. 2005, BIO-WEST, Inc. 2006, BIO-WEST, Inc. 2007)
- Biological sampling conducted within this reach; included blue sucker tagging and tracking
- Land use practices have altered the lateral extent of riparian communities along the river
- Native riparian areas support mixed bottomland hardwood species

USGS Gage 08159200 Description

Bastrop County, Texas	Hydrologic Unit: 12090301	Latitude 30°06'16", Longitude 97°19'09" NAD27
Drainage area: 39,979 square miles	Contributing drainage area: 28,576 square miles	
Datum of gage: 307.38 feet above sea level NGVD29	Flood stage occurs at 23 feet above the USGS gage elevation (NWS 2010)	

Site Description

- Review of aerial photography with Google Earth
  - 12 mile reach, from one mile upstream of the city of Bastrop to the crossing of Highway 95 in Smithville

- Flows dates
  - January 22, 1995: 452 cfs
  - January 8, 1996: 427 cfs
  - December 30, 1997: 673 cfs
  - December 30, 2002: 2,670 cfs
  - October 21, 2005: 598 cfs
  - April 29, 2006: 1,210 cfs
  - February 28, 2008: 616 cfs
  - October 30, 2008: 318 cfs
  - November 24, 2009: 753 cfs
- Habitats
  - Multiple in-channel islands and sand bank deposits along bends occurred downstream of the city of Bastrop
  - Lower terraces along bends had herbaceous vegetation
  - Significant portions of the riparian corridor cleared of woody vegetation up to the banks of the river in this reach
  - Only a few small areas of wooded riparian communities between the city of Bastrop and the city of Smithville

Wetlands

The main features identified on the National Wetland Inventory maps (USFWS 2010) included:

- Frequent areas adjacent to the river channel that are occasionally or seasonally inundated, some of which support herbaceous or woody vegetation
- Many features occur at bends in the river
- Numerous in-channel islands
- Numerous intermittent streams flow into the Colorado River

Riparian/Floodplain Vegetation

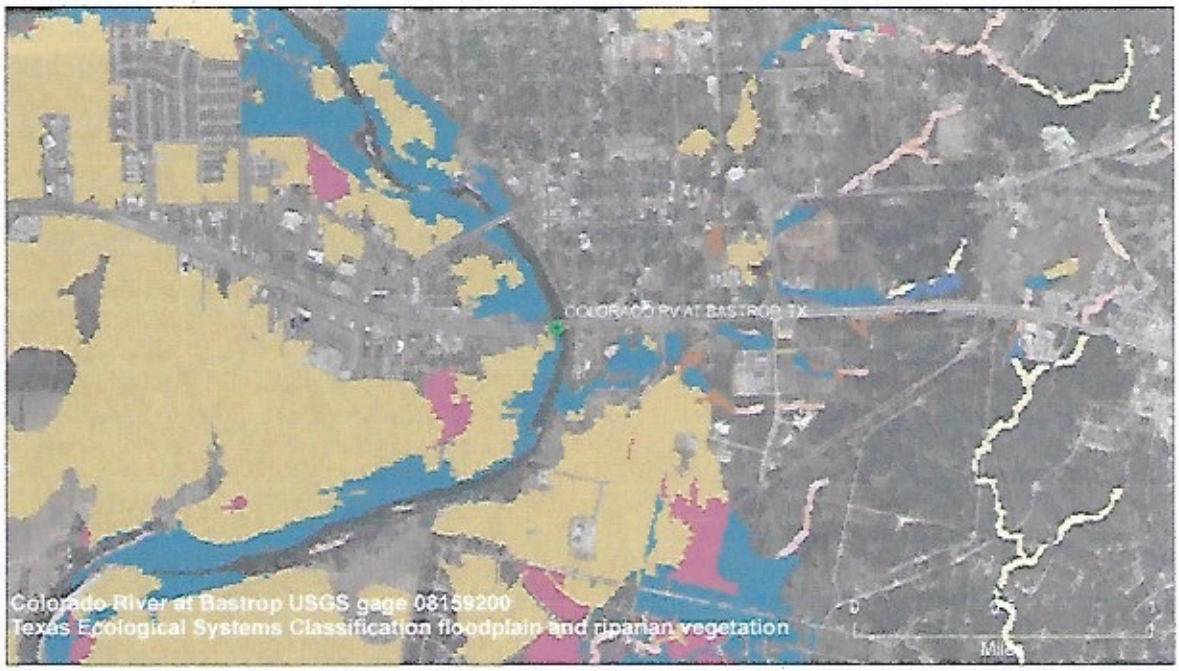
Riparian vegetation communities in this reach are generally wide on both sides of the river, with gradual slopes from a low terrace to an upper terrace. The cut bank side of the river has a narrow riparian corridor following a steep slope from the water's edge to the top of the bank. There is a narrow corridor of floodplain hardwood forest vegetation along most of the river in this reach, with wide bands of floodplain herbaceous vegetation outside of the wooded corridors on the low floodplain terraces. These communities consist of two main vegetation types in the "Central Texas" region (see Riparian Vegetation Map below; German et al. 2009):

- Floodplain hardwood forest
  - Mainly deciduous trees such as pecan, white ash, cedar elm, American elm, sugar hackberry, willows, and eastern cottonwood
- Floodplain herbaceous vegetation
  - Non-native grass species such as bermudagrass and Johnsongrass may frequently dominate this vegetation type

  - Scattered shrubs such as mesquite and juniper common
  - Eastern gamagrass or switchgrass may dominate some lowland sites
- Field survey of the riparian zone in this reach in 2005 observed
  - Black willow and green ash trees along the water's edge, and American elm, sugar hackberry, Chinese tallow, American sycamore, and Eastern cottonwood on the banks (BIO-WEST unpublished data)

HECRAS results and TESCP riparian vegetation communities were evaluated along the Bastrop reach (see figures below). The water's edge lines for the 2-year and 5-year flow events follow the Colorado River and tributary channels. The 10-year event appears to inundate most of the floodplain hardwood forest communities along the main stem of the Colorado River and floodplain herbaceous vegetation along lower terraces. There are wide sections of floodplain herbaceous vegetation communities that are inundated only at the 500-year flow event, although much of this area is pastureland.

The black willow and green ash trees present along the banks within this reach indicate that base flows are important to the riparian community, as both of these species are shallow-rooted and would require a shallow depth to the water table during the growing season. Black willow trees are also not drought tolerant. The distribution of American elm, American sycamore and cottonwood on the banks indicate that pulse flows are also important. Sycamore and cottonwood seeds are typically dispersed by water, and moist soils are necessary to prevent desiccation and allow germination. Cottonwood seeds require specific germination sites of freshly scoured, moist mineral substrates within 1–2 weeks of seeding, and recruitment likely does not occur every year. The pulse flows that occur every 5–10 years likely maintain the germination sites for cottonwood, and maintaining these pulse flows in the environmental flow regime would likely allow the persistence of this species in the community.



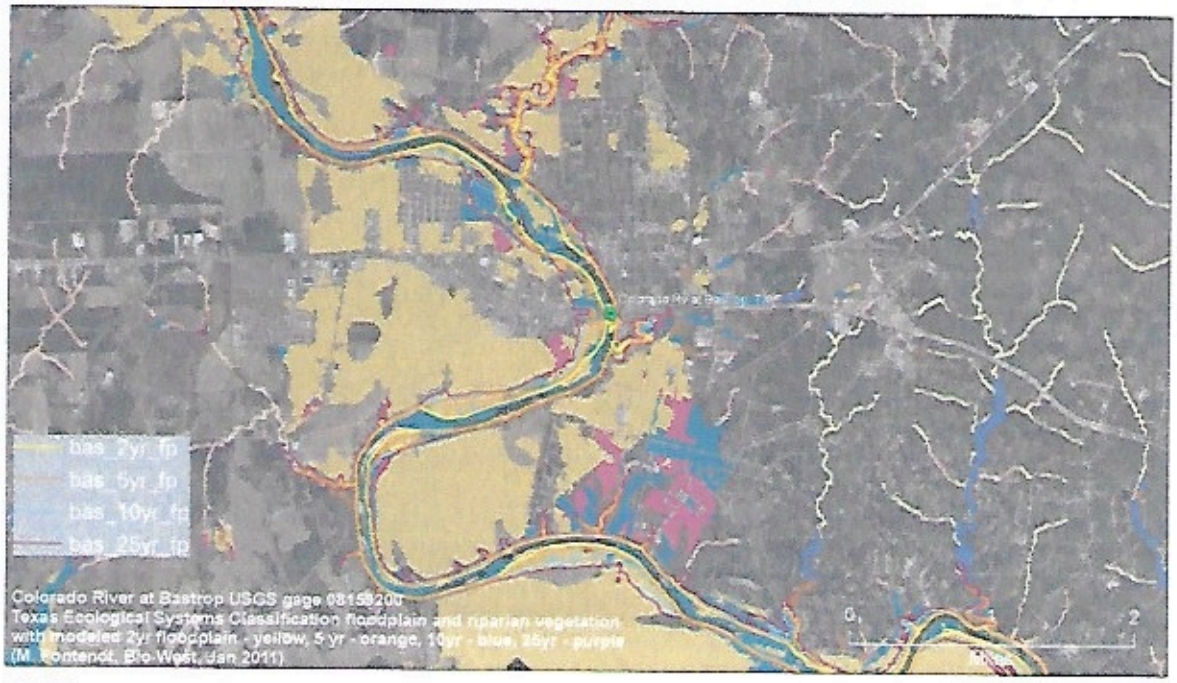
Legend

COMMON_NAM

- Central Texas Floodplain Deciduous Shrubland
- Central Texas Floodplain Hardwood / Evergreen Forest
- Central Texas Floodplain Hardwood Forest
- Central Texas Floodplain Herbaceous Vegetation
- Central Texas Floodplain Juniper Forest
- Central Texas Riparian Evergreen Shrubland
- Central Texas Riparian Hardwood / Evergreen Forest
- Central Texas Riparian Hardwood Forest
- Central Texas Riparian Herbaceous Vegetation
- Central Texas Riparian Juniper Forest

Sources: Texas Ecological System Classification project, TPWD, 2010 www.tpwd.state.tx.us/landwater/land/maps/gis/ecop/index.phtml
Horizontal datum: NAD83
Contact: Lynne Hamlin, Water Resources Branch, TPWD, lhamlin@tpwd.state.tx.us. Map created Jun, 2011
Disclaimer: While every attempt was made to present the information as accurately as possible, no claims are made to the completeness or accuracy of the information shown hereon nor to its suitability for a particular use. Scale and location are approximate.

Texas Ecological Systems Classification of Riparian and Floodplain Vegetation for the Colorado River at Bastrop



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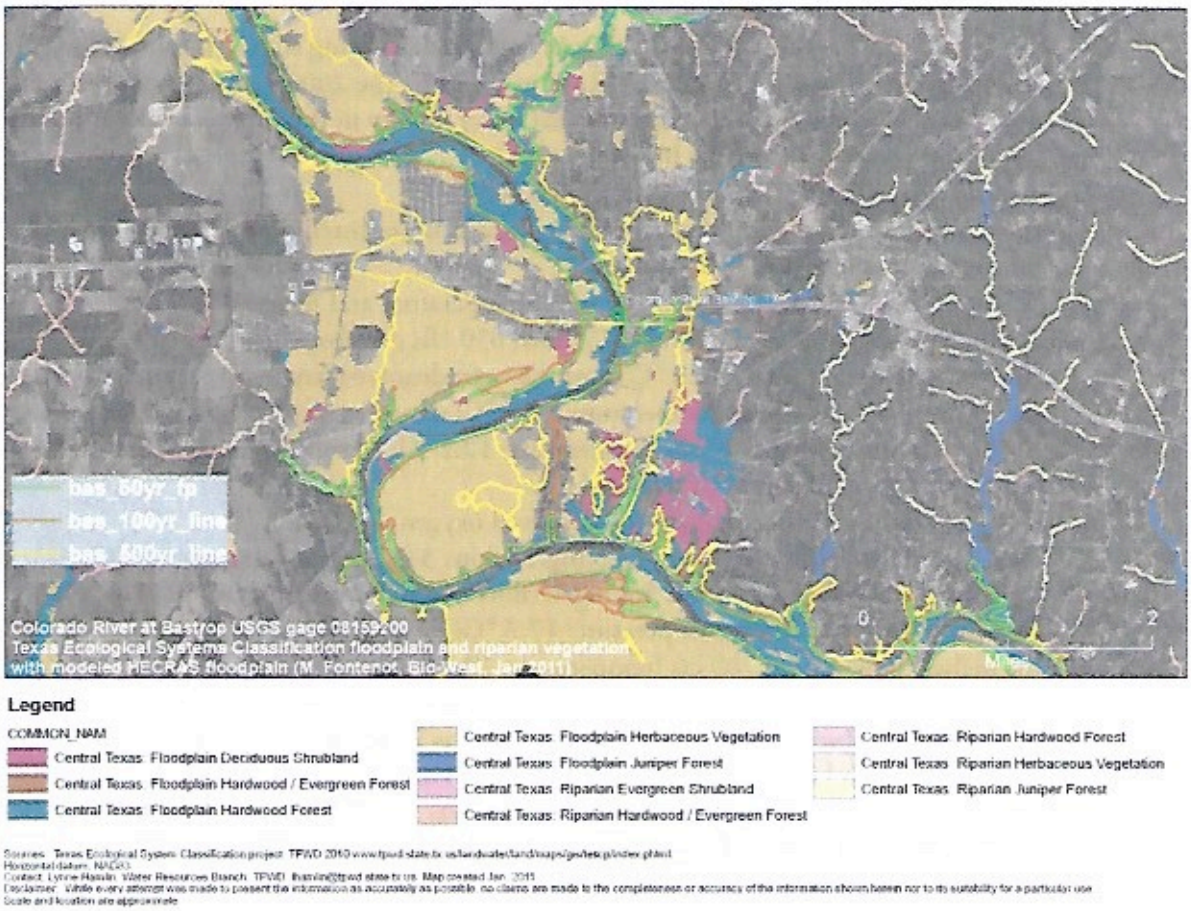
HECRAS model results near the Bastrop gage for the 2-year, 5-year, 10-year, and 25-year flow events



HECRAS model results near the Bastrop gage for the 50-year, 100-year, and 500-year flow events

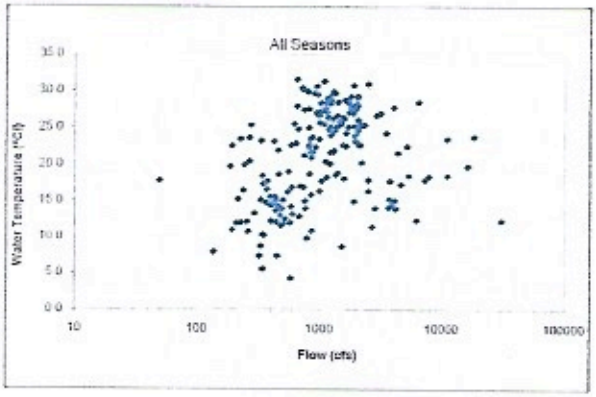
Biology

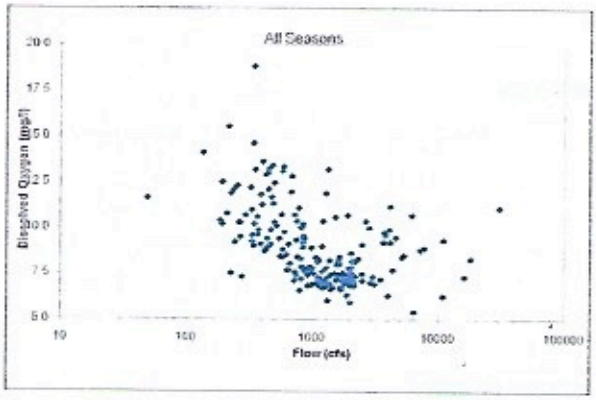
Aquatic habitat use data were collected at 10 sites from Longhorn Dam to Wharton in 2004–2007 using various fish sampling techniques including seining, backpack electrofishing, barge electrofishing, and boat electrofishing. 50 species of fish collected. A habitat guild approach was used to assess aquatic habitat modeled over a range of flows using River2D models at each site (BIO-WEST, Inc. 2008). Life-history information, a radio telemetry study to identify adult habitat, and field confirmation of spawning habitat for blue suckers was used to supplement the fish guild approach.

Water Quality

- The water quality period of record for this gage is 10/07/82 – 06/09/2010
- Relationships between flow and water quality parameters
  - NO2+NO3–N decreases with increasing flow.

  - Total phosphorus decreases with increasing flow.
  - Specific conductance decreases with increasing flow.
  - pH decreases with increasing flow.
- According to the 2008 Texas Water Quality Inventory, this gaging station is located in the Water Quality Segment 1434, Colorado River at Bastrop. The 2008 Texas Water Quality Inventory Basin Assessment Data indicates that water quality in this segment fully supports the designated exceptional aquatic life use.
- Water quality impairments, if any, listed on the 303(d) list
  - The segment of river where this gage site is located is not listed on the 303(d) list.
- Relationship between temperature and flow
  - No correlation was observed between water temperature and flow.
  - The highest temperature was 31.49 °C (flow: 650 cfs; dissolved oxygen: 7.69 mg/L).
  - The lowest temperature was 4.3 °C (flow: 581 cfs; dissolved oxygen: 13.1 mg/L).
  - The lowest flow was 49 cfs (temperature: 17.7 °C; dissolved oxygen: 11.63 mg/L).
  - The highest flow was 30,700 cfs (temperature: 12.2 °C; dissolved oxygen: 11.1 mg/L).
- Relationship between dissolved oxygen and flow
  - No correlation was observed between dissolved oxygen and flow.
  - The highest dissolved oxygen was 18.8 mg/L (flow: 343 cfs; temperature: 5.6 °C).
  - The lowest dissolved oxygen was 5.4 mg/L (flow of 6367 cfs; temperature: 28.4 °C).
  - The lowest flow was 49 cfs (temperature: 17.7 °C; dissolved oxygen: 11.63 mg/L).
  - The highest flow was 30,700 cfs (temperature: 12.2 °C; dissolved oxygen: 11.1 mg/L).
- Observations compared to the Texas Surface Water Quality Standards (TSWQS) criteria
  - The maximum observed chloride concentration was 204 mg/L.
  - The minimum and maximum pH values were 7.14 and 9.
  - The highest observed instantaneous temperature was 31.49 °C.
  - The minimum observed dissolved oxygen concentration was 5.4 mg/L. Two dissolved oxygen measurements were less than 6 mg/L.





Geomorphology

Two sites along the lower Colorado River were modeled for sediment transport and effective discharge in the LSWP study: La Grange and Columbus. It was found that the greatest proportion

of total sediment is transported by low flows (at both sites). At La Grange, the peak occurs at the discharge increment of about 1,700 cfs, when sand-sized particles are being transported while little to no gravel is mobile. At La Grange, a strong secondary peak is evident at the discharge increment between about 26,000-29,000 cfs, which is the effective discharge for gravel at the site. This gravel-based effective discharge is important for channel (and riffle) maintenance, and flows of this size reach the top of the banks. Flows of this size are equaled or exceeded between 0.5% to 2% of the time (BIO-WEST, Inc. 2008).

The geomorphic analyses conducted by the LSWP study utilize different terminology and are related to different aspects of the river's geomorphology than the geomorphic analyses conducted by the BBEST at other gages in the basin.

Flow Regime Interpretations

The instream flow study conducted as part of the LCRA SAWS Water Project (LSWP) identified four components of the hydrologic regime to integrate as part of the environmental flow regime: subsistence flows, base flows, high flow pulses, and overbank flows. The following description of the integration of these aspects of the hydrological record and ecological responses is provided from BIO-WEST, Inc. (2008).

Subsistence flows: Infrequent, seasonal periods of low flows. The primary objective of this component is to maintain water quality criteria. The secondary objectives are to provide important low flow life cycle cues or refugia habitat. The 95th percent habitat exceedence level was evaluated, and the 95th percent exceedence flow was the recommended subsistence flow.

Base flows: Normal flow conditions between storm events. The objective of this component is to ensure adequate habitat conditions, including variability, to support the natural biological community.

Pulse flows: Short-duration, within channel, high flow events following storm events. The objective of this component is to maintain important physical habitat features and provide longitudinal connectivity along the river channel.

Overbank flows: Infrequent, high flow events that exceed the normal channel. The objective of this component is to maintain riparian areas and provide lateral connectivity between the river channel and active floodplain.

HEFR/Hydrologic Regime

	Winter	Spring	Summer	Fall
Overbank Flows		Qp: 106,619 cfs with Average Frequency 1 per 5 years Regressed Volume is 381,163 to 1,298,125 (703,418) Regressed Duration is 3 to 18 (8)		
		Qp: 66,456 cfs with Average Frequency 1 per 2 years Regressed Volume is 224,971 to 764,817 (414,803) Regressed Duration is 3 to 16 (7)		
		Qp: 41,716 cfs with Average Frequency 1 per year Regressed Volume is 133,810 to 454,273 (246,549) Regressed Duration is 3 to 14 (6)		
High Flow Pulses	Qp: 4,648 cfs with Average Frequency 1 per season Regressed Volume is 13,857 to 56,670 (28,022) Regressed Duration is 2 to 12 (5)	Qp: 30,744 cfs with Average Frequency 1 per season Regressed Volume is 90,493 to 286,767 (161,088) Regressed Duration is 2 to 10 (5)	Qp: 11,179 cfs with Average Frequency 1 per season Regressed Volume is 33,699 to 106,072 (59,787) Regressed Duration is 2 to 10 (5)	Qp: 23,684 cfs with Average Frequency 1 per season Regressed Volume is 73,319 to 239,966 (132,437) Regressed Duration is 2 to 12 (5)
	Qp: 1,573 cfs with Average Frequency 2 per season Regressed Volume is 3,845 to 15,865 (7,810) Regressed Duration is 1 to 7 (3)	Qp: 20,082 cfs with Average Frequency 2 per season Regressed Volume is 55,554 to 175,756 (98,813) Regressed Duration is 2 to 8 (4)	Qp: 2,495 cfs with Average Frequency 2 per season Regressed Volume is 6,221 to 19,688 (11,067) Regressed Duration is 1 to 6 (3)	Qp: 10,558 cfs with Average Frequency 2 per season Regressed Volume is 29,468 to 96,240 (53,254) Regressed Duration is 2 to 10 (4)
Base Flows (cfs)	717(42.2%) 495(59.8%) 342(76.9%)	1511(43.1%) 870(59.9%) 495(76.6%)	990(39.4%) 642(54.0%) 387(68.4%)	963(42.1%) 562(56.8%) 372(72.0%)
Subsistence Flows (cfs)	207(95.1%)	202(95.1%)	81(95.0%)	137(95.1%)

Flow Levels
High (75th %ile)
Medium (50th %ile)
Low (25th %ile)
Subsistence

Notes:

1. Period of Record used : 12/31/1899 to 12/31/1939
2. Q95 calculation used for subsistence flows. Annual Q95 value is 159 cfs.

Recommended Environmental Flow Regime

Two flow record periods were evaluated during the LSWP study: the existing condition (1975–2004) and pre-1940 (1898–1939). An evaluation of the hydrology, habitat time series modeling results, sediment transport analyses, and water quality results indicated that the pre-1940 flow regime is different from the existing flow regime. To maintain natural habitat diversity, hydrologic character, and water quality, the pre-1940 time period was selected for the development of instream flow guidelines (BIO-WEST, Inc. 2008).

The recommended environmental flow regime for the Colorado River at Bastrop includes monthly regimes for subsistence and two levels of base flow, and periodic pulse flows, channel maintenance flows and overbank flows. It should be noted that the pulse, channel maintenance and overbank flow recommendations are the same amongst the Bastrop, Columbus, and Wharton gages.

Colorado River at Bastrop, USGS Gage 08159200, Recommended Environmental Flow Regime

Flow	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Subsistence	208	274	274	184	275	202	137	123	123	127	180	186
Base – Dry	313	317	274	287	579	418	347	194	236	245	283	311
Base - Average	433	497	497	635	824	733	610	381	423	433	424	450
Pulse flow -Base	Magnitude (2,000 to 3,000 cfs); Frequency (8-10 times annually); Duration (3-5 days)											
Pulse flow - High	Magnitude (8,000 cfs); Frequency (2 events in a 3-year period); Duration (2-3 days)											
Channel Maintenance	Magnitude (27,000 to 30,000 cfs); Frequency (1 event in 3 year period); Duration (3 days)											
Overbank	Magnitude (>30,000 cfs); Frequency and Duration (naturally driven)											

Season 1

1 pulse/1.5 y

No Compromise
2 professional teams concur
Will not give up this site

Impacted by 5731 permit

Appendix A

Bay City
Wharton Flows
passed Scoping Stakeholders by Section