Statement of Work
TASK ORDER 3

Colorado River Flow Relationships to Aquatic Habitat and State Threatened Species: Blue Sucker

Submitted by:

BIO-WEST, Inc.
1406 Three Points Road, Suite A-200
Pflugerville, Texas 78660

1. Overview

The lower Colorado River basin (Region K) supports a diverse ecological community that relies heavily on the quality and quantity of water moving through the system. The wide range of variables and conditions associated with biological communities in the lower Colorado River presents complexity in understanding its ecological processes. The LCRA-SAWS Water Project (LSWP) has the potential to alter the flow regime for the lower Colorado River. Additionally, the use of low-water dams or other instream structures may be necessary to facilitate the removal of water for the off-channel reservoirs. Therefore, the Colorado River Flow Relationships to Aquatic Habitat and State Threatened Species: Blue Sucker Study is necessary to assess potential impacts/benefits on the aquatic resources of the lower Colorado River with and without the project and also quantify the condition of the aquatic environment under different flow scenarios to satisfy federal and state permitting requirements and ensure the environmental principles set forth for this project.

Two of the environmental principles included in the LSWP contract relate directly to this study by stating that before project implementation, studies must prove that the project (1) "protects and benefits the lower Colorado River watershed and the LCRA Service Area, including municipal, industrial, agricultural, recreational, and environmental interests"; and (4) "provides for instream flows no less protective than those included in the LCRA Water Management Plan for the Lower Colorado River Basin, as approved by the Texas Commission on Environmental Quality.

Study Objectives

- Characterize the flow-habitat and flow-ecological relationships within the lower Colorado River and its riverine ecosystem from just downstream of Austin (i.e., Longhorn Dam) to Matagorda Bay (project area) to provide a means of assessing biological impacts/benefits of various flow regimes. A comprehensive ecologically based tool will be generated from existing studies and field-gathered data that will provide prediction capabilities necessary to evaluate the full range of flows from

low, to moderate, to high on ecological components of the lower Colorado River system throughout the annual hydrologic cycle.

- Characterize the essential life history requirements (migration, spawning, and recruitment) of the blue sucker to determine the degree that the flow-habitat and specific biological components for this species can be maintained under the resulting flow regime for the LSWP.

Specific questions to be addressed include the following:

1. What has happened (ecologically) in the lower Colorado River since LCRA's initial instream flow study?
2. Have the instream flow requirements developed for the LCRA Water Management Plan been tested under the current flow regime and will these requirements still be applicable if operational changes are incurred by the LSWP?
3. What is the impact of altering instream flows on the channel maintenance and sediment transport characteristics on a relatively free-flowing stretch of river?
4. What is the impact of altering instream flows on the riparian vegetation?
5. What is the impact of changing historical flow regimes on the native aquatic biodiversity and potential special aquatic sites in the lower Colorado River?
6. What is the impact/benefit of altering instream flows and the potential placement of instream structures on the blue sucker population in the lower Colorado River?
7. What is the impact of altering instream flows on the recreational use?

The BIO-WEST project team will conduct the Colorado River Flow Relationships to Aquatic Habitat and State Threatened Species: Blue Sucker study based on a combination of the original Detailed Study Plans (DSPs) developed for the LSWP and modifications recommended by the project team in the RFQ response. The following Statement of Work is specific to the Third Task Order that extends from January 1, 2006 through December 31, 2006. A schedule with costs is included.

All Task Order 1 activities were completed on schedule and within budget which efficiently led into the 2005 Task Order 2 scope, budget, and schedule. All Task Order 2 activities are anticpated to be completed on schedule and within budget which efficiently leads into the 2006 Task Order 3 (TO3) scope, budget, and schedule outlined in this TO3 Statement of Work.

2. Team Members

The following table presents key BIO-WEST Project team members that will need access to the LCRA Project Web Site.

TABLE 1. BIO-WEST PROJECT TEAM MEMBERS

Name	Position on Project
Edmund Oborny (BW)	Project Manager
Dr. Paul Holden (BW)	Principal
Dr. William Espey (EC)	Principal
Dr. David Harkins (EC)	Senior Expert – Engineer
Tim Osting (EC)	Engineer III
Roy Frye (H&C)	Senior Expert – Scientist
Joe Trungale (TES)	Engineer II
Dr. Chris Bunt (Biotactic)	Telemetry Expert
Darren Olsen (BW)	Fluvial Geomorphologist
Melissa Romigh (BW)	Biologist II
Michael Robertson (BW)	Biologist II
Melissa Stamp (BW)	Hydrologist / Watershed Scientist
Frank Chapa (EC)	CADD / GIS
Sandra Turner (BW)	Senior Editor
Chimene Oborny (BW)	Administrative Assistant

3. Work Breakdown Structure

The major work elements (Tasks) are presented in Table 3.

TABLE 3. WORK BREAKDOWN STRUCTURE

Task Number	Subtask Number	Name
TASK 1		**PROJECT MANAGEMENT / MEETINGS**
Subtasks	1.10	Contract / Project Management
	1.20	Task Coordination
	1.30	Meetings
TASK 2		**BIOLOGICAL DATA COLLECTION**
Subtasks	2.10	Supplemental fish guild sampling
	2.20	Data analysis and suitability criteria refinement
TASK 3		**BLUE SUCKER LIFE HISTORY ASSESSMENT**
Subtasks	3.10	Spawning surveys
	3.20	Larval/Juvenile sampling and habitat assessment
	3.30	Migration assessment
	3.40	Data reduction and analysis
TASK 4		**MODEL DEVELOPMENT**
Subtasks	4.10	Intensive sites – River 2D model development
	4.20	Intensive sites – calibrated River 2D models
	4.30	Habitat and recreation model development
	4.40	Draft habitat and recreation model results
	4.50	Sediment transport and riparian analysis
	4.60	Draft channel maintenance results
TASK 5		**ALTERNATIVES ANALYSIS**
Subtasks	5.10	Interim environmental criteria development
	5.20	Draft interim environmental criteria
	5.30	Refined interim environmental criteria
	5.40	Socioeconomic team interaction
	5.50	Permitting team interaction
TASK 6		**PROJECT DATA ANALYSIS AND REPORT PREPARATION**
Subtasks	6.10	Data reduction/analysis - draft Technical Report
	6.20	2006 Activities letter report

Key Assumptions: The key assumptions for Colorado River Flow Relationships to Aquatic Habitat and State Threatened Species: Blue Sucker project are presented below as well as described in the original DSPs and RFQ. One specific assumption for this task order is that all data and models will be delivered in final form in 2007. As stated in the original DSPs, the list of key assumptions is not meant to be exhaustive and it is likely that other assumptions may need to be made through the life of the project as the completion of tasks warrant their development.

5. Statement of Work

Task 1: Project Management / Meetings

Subtask 1.10 – Contract / Project Management
Subtask 1.20 – Task Coordination
Subtask 1.30 – Meetings (CH2M Hill and LCRA/SAWS)

Description of Work: Project management, contracting, task coordination, and internal and external communication are included in this category. Communication of progress with LCRA/SAWS and the CH2M Hill Project Management Team is extremely important. As depicted in the schedule, four face-to-face meetings are proposed for 2006. The early spring meeting will be with Martina Walker (LCRA) specifically to discuss the structure of the GIS data to be generated under this task order. A written response will be generated by Ms. Walker documenting whether the project team is meeting the LCRA GIS standards, and if not, how corrections to the format can be achieved by the project team to ensure compatibility when final products are delivered in 2007. In addition to these meetings, the BIO-WEST project team anticipates frequent communication via phone or email with the CH2M Hill Project Management Team.

Communication with the other study groups will also be a vital component in the success of the LSWP. The BIO-WEST project team will prepare for and participate in monthly Aquatic Habitat team conference calls and monthly project managers meetings. In addition, BIO-WEST will maintain frequent communication via phone/email or meetings with the other project teams to facilitate the proper coordination and integration of studies. The original Detailed Study Plans provide a good description of the interdependencies of the LSWP studies and highlight the critical path communications that the BIO-WEST project team will maintain during the project.

Key Assumptions:

- *Monthly Aquatic Habitat team conference calls.*
- *Four face-to-face meetings with CH2M Hill/LCRA/SAWS.*
- *GIS data will be modified, if necessary, in 2006 to ensure that it meets the project standards when submitted in final form in 2007.*
- *Monthly project manager meetings.*

- Attendance at one SRP workshop, SRP conference calls, and three Advisory Group meetings.

Deliverables: Monthly Progress Narratives with invoices
Task Leader: Edmund Oborny
Quality Control/Quality Assurance Leader : Dr. Paul Holden

TASK 2 – Biological Data Collection

Subtask 2.10 – Supplemental fish guild sampling

Description of Work: During the data review phase of TO1, it was hypothesized that the majority of the Mosier and Ray (1992) functional habitat groups would be suitable for the aquatic habitat modeling effort. However, during TO2 collection efforts it was determined that sampling in a broad range of flow conditions would add considerable strength to the database to support and/or refine those functional habitat groups. Therefore, one additional sampling effort in 2006 will be performed at river discharges between 800 and 1,500cfs by seining, backpack electrofishing, boat/barge electrofishing, or some combination of the three. Direct observations of fish with positive identification but not collected will also be noted. During the biological sampling, several habitat parameters will also be measured per individual sampling area. At a minimum, these will include velocity, depth, substrate, and cover (aquatic macrophytes and woody debris).

Key Assumptions:

- *Flow conditions along the lower Colorado River in 2006 will allow for sampling at appropriate discharges.*
- *The LCRA electrofishing boat/barge will be available for use and 2 LCRA fisheries biologists will assist in this field effort.*

Internal Deliverable: Internal Use for refinement of habitat suitability information.
Task Leader: Michael Robertson
Quality Control/Quality Assurance Leader : Edmund Oborny

Subtask 2.20 – Data Analysis and Suitability Criteria refinement

Description of Work: The supplemental fish sampling data collected in 2005 and 2006 will be reduced and analyzed. The data will then be combined with the Mosier and Ray database and evaluation of functional habitat groups using all information will be conducted. The range of suitable habitat conditions associated with each of these functional habitat groups will then be input into the habitat model to predict changes in available habitat for each respective group.

Key Assumptions:

- *The 10 functional habitat groups defined in Mosier and Ray (1992) provides a solid biological representation of the lower Colorado River, but can be strengthened by sampling at a wider range of flows.*

Internal Deliverable: Internal use for habitat model.
Task Leader: Michael Robertson
Quality Control/Quality Assurance Leader : Edmund Oborny

Task 3 – Blue Sucker Life History Assessment

Subtask 3.10 – Spawning Survey

Description of Work: As in 2005, spawning season surveys will be conducted in the spring of 2006 (March, April, and May). These surveys will be conducted at sites believed to be potential spawning locations based on spawning data collected and habitat assessments conducted in 2005 along the lower Colorado River.

The survey will involve two fisheries biologists traveling to these sites and conducting visual observations each week during the aforementioned months. During each site visit, measurements of potential triggering mechanisms (such as water temperature, flow, and available habitat [i.e. depth, velocity, substrate, and cover]) will be documented for each individual blue sucker that is observed spawning. The information gathered on individual spawning blue suckers over the study period will be compiled and analyzed to create specific habitat suitability criteria for this life stage. Digital photographs of the sites will also be taken during each site visit. When feasible, underwater video equipment will be used to locate and survey specific spawning habitat.

In conjunction with the migration study described in subtask 3.30, radio telemetry equipment will be used to locate individually tagged fish during these months. Upon observation/confirmation of spawning, specific information documenting the timing, location, specific habitat conditions, water quality, and spawning activities (i.e. behavior) will be collected. A GPS unit will be used to document the location of each observed individual blue sucker. Standard water quality parameters (water temperature, conductivity, pH, and dissolved oxygen) will be measured along with a detailed habitat characterization including depth, velocity, substrate, and instream cover in the immediate area and adjacent to the observed spawning. The habitat characterization will be conducted in a manner amenable for use in habitat suitability criteria development. Each parameter will then be analyzed to identify preferences (suitability) of that parameter and curves generated based on that analysis. Parameters for which spawning blue suckers appear to have a preference (e.g., are found within a narrow range or are chosen in higher frequency than other available habitats) will be incorporated into the habitat suitability criteria for spawning habitat to be used in the habitat model.

Key Assumptions:

- *The tagging of thirty individual blue suckers and subsequent survival will provide a representative sample of the blue sucker population in the lower Colorado River and will allow interpretation of spawning characteristics when coupled with the specific spawning survey data collection effort. Survival was a success in 2005 with over 75% survival.*
- *The biological data collected for the blue sucker over a 2 ½ year time period will be sufficient to describe the habitat suitability requirements of the species/lifestage for habitat modeling purposes.*

Internal Deliverable: Data inputs for blue sucker adult habitat and spawning habitat suitability criteria development.
Task Leader: Edmund Oborny
Quality Control/Quality Assurance Leader : Jeremy Webster

Subtask 3.20 – Larval/Juvenile Sampling and Habitat Assessment

Description of Work: Larval and juvenile sampling will be conducted in areas downstream of identified spawning areas as well as up to five additional sites located below spawning areas observed during 2005/2006 activities. These sites will be sampled from April to June (one time per month) and subsequently in August and November to track year class development and recruitment success. The sample areas in August and November will include the same areas sampled in the spring but also include habitat that would likely contain blue sucker juveniles (based on literature review). It is anticipated that a combination of seining, light traps, trawls, and dip netting associated with lights will be used for larval sampling. Backpack electrofishing with block nets, trawls and hoop nets will be employed as an additional collection method for juveniles.

Once larval or juvenile blue suckers are collected, detailed habitat information including depth, velocity, substrate, and instream cover in the immediate area and adjacent to the observations will be performed. As described above, the habitat characterization will be conducted in a manner amenable for use in habitat suitability criteria development. A GPS unit will be used to document the location where the larval or juvenile blue suckers are collected. Additionally, standard water quality parameters (water temperature, conductivity, pH, and dissolved oxygen) will be measured. The primary focus of this evaluation is to document the existence of larval/juvenile blue suckers in the lower Colorado River and define the associated habitat requirements. Detailed sampling to establish population estimates is not proposed.

Since no larval/juvenile blue suckers have been collected during 2005 activities to date (16 November 2005) it is possible that the third assumption listed below may be violated. In that case, additional scope items may be necessary. One possibility for supplementing the necessary data is an analysis of blue sucker juvenile habitat data being collected during an upcoming study of the Rio Grande. These data could potentially be used to establish habitat curves for juvenile blue suckers for use in the Colorado River habitat model. Another potential source of these data could be rearing and releasing tagged juveniles in the Lower Colorado River and then tracking their movements. This would include the collection of eggs and milt from blue sucker adults during the 2006 spawning season. An attempt would then be made to rear up larval, then juvenile blue suckers at the National Fish Hatchery and Technology Center (NFHTC) in San Marcos, TX. BIO-WEST has a strong working relationship with the NFHTC and has permission to use NFHTC facilities should this additional component be deemed necessary. Upon reaching a pre-determined length (anticipated 6 inches), a number of juvenile fish would be implanted with radio transmitters and released into the Colorado River for subsequent tracking and direct investigation of habitat use in the river. Neither of these components is included in the schedule or costing of the 2006 Scope of Work. If either component is deemed necessary, BIO-WEST will prepare a separate addendum including schedule and cost estimate.

Key Assumptions:

- *The biological data collected for the blue sucker over a 2 ½ year time period will be sufficient to describe the habitat suitability requirements of the species/lifestage for habitat modeling purposes.*

- *The primary focus of this evaluation is to document the existence of larval/juvenile blue suckers in the lower Colorado River and define the associated habitat requirements. Detailed sampling to establish population estimates is not proposed for this Task Order.*
- *The ability to capture ecologically meaningful numbers of larval/juvenile blue suckers.*

Internal Deliverable: Data inputs for larval/juvenile blue sucker habitat suitability criteria development and for assessment of placement of potential intake structures.

Task Leader: Mike Robertson
Quality Control/Quality Assurance Leader : Edmund Oborny

Subtask 3.30 – Migration Assessment

Description of Work: In 2006, the telemetry study will continue to add valuable data to that collected during the initial tagging effort in Fall 2004 and tracking efforts in 2005. Thirty blue suckers of various sizes were collected and tagged in Fall 2004. Additionally, a fixed telemetry station was established at the LCRA Lakeside Irrigation District River Facility. In 2006, manual tracking of the blue sucker will be conducted via boat during three surveys in the spring (coordinated with spawning surveys), one in late summer and one in late fall. Manual tracking will involve locating the individual and recording the coordinates using GPS. During one of the spring tracking efforts and during both the fall tracking efforts, detailed habitat information will be collected for the individual fish being tracked. This information will include depth, velocity, substrate, and instream cover in the area of and adjacent to located fish as well as measurement of standard water quality parameters. These data are important for evaluating the habitat suitability criteria for adult blue sucker to be used in the habitat model.

Key Assumptions:

- *Thirty individual blue suckers (or that portion that survives) provides a representative sample of the blue sucker population in the lower Colorado River and will allow interpretation of migration and adult habitat characteristics. Survival was a success in 2005 with over 75% survival.*
- *One year into the study we still are locating 29 of 30 tagged fish. However, three tags have been shed (these tags have been recovered) and it appears that three more tags may have been shed (unable to recover) while one tag was never located (thought to be tag malfunction) leaving a total of 23 of 30 tagged fish (76%) confirmed alive and active. Therefore, the important parameter at this point is not the number of fish but the health of the fish. We anticipate losing fish over the next two years to mortality, shedding, fishing, etc., however, if the remaining tagged fish still appear healthy (alive and congregating with other untagged blue suckers) we will continue this study component. If the fish are not congregating with other blue suckers and rapid mortality/shedding starts to occur, then we will shift to more conventional sampling techniques. Our experience so far is that this will not be the case.*
- *The biological data collected for the blue sucker over a 2 ½ year time period will be sufficient to describe the habitat suitability requirements of the species for habitat modeling purposes.*

Internal Deliverable: Data inputs to define habitat suitability curves for life stages of the blue sucker to be used in the habitat model and for assessment of placement of potential intake structures.

Task Leader: Edmund Oborny
Quality Control/Quality Assurance Leader : Mike Robertson

Subtask 3.40 – Data Reduction and Analysis

Description of Work: The blue sucker life history assessment data collected in 2006 will be reduced and analyzed. The data will then be used to develop species specific life-stage suitability criteria for inclusion in the habitat model.

Key Assumptions:

- *All assumptions outlined in Section 3 hold.*

Internal Deliverable: Draft and refined habitat suitability criteria for blue sucker life stages.
Task Leader: Jeremy Webster
Quality Control/Quality Assurance Leader : Edmund Oborny

Task 4 – Model Development

Subtask 4.10 – Intensive sites – River 2D Model Development

In 2005, River 2D was selected as the two-dimensional hydrodynamic model to be developed for each intensive site. As there was some confusion in the TO2 SOW terminology, we have included some definitions to assist with clarification. The term verification is used to determine whether the modeling code is mathematically sound. River 2D has been used extensively in instream studies and our canvas of experts has lead us to conclude that it has been verified. We will continuously evaluate the applicability of the model to the special situations that we may encounter in this study and make appropriate adjustments if necessary.

Calibration will be defined as the process by which we fine tune certain parameters (i.e. roughness and viscosity) to maximize measures (i.e. velocity and depth) of model performance. Validation is the comparison of known data versus the calibrated model results. During 2005, each time the project team collected stage-discharge data to develop our rating curves (each intensive site at 3 flows), we collected approximately 50 additional depth/velocity point measurements. Elevation contour maps and a random point generator were used to produce the quasi-random set of calibration/validation point locations. In 2006, the project team will use half of this velocity and depth data to calibrate the roughness and viscosity parameters in River2D and the other half to validate the model results and report uncertainty.

River 2D will be calibrated to the three measured water surfaces (high, medium, and low flow) by adjusting substrate roughness and, to a lesser degree, the eddy viscosity parameters. To adjust substrate roughness, substrate maps at each intensive site will include an estimated hydraulic roughness height based on the size of the largest particle in each substrate category. During the calibration phase of the hydrodynamics modeling, the roughness heights across all substrate types will be increased or decreased by a constant percentage until the modeled water surface matches the measured water surface. This will first be done at the moderate calibration flow. A check that the calibrated roughness performs accurately at the high and low calibration flows will be performed. If necessary an equivalent roughness height modifier regression will be used to scale roughness height over

the range of modeled flows. A similar procedure will be used to calibrate the viscosity parameters, which are used by the model to calculate viscosity at each node based upon local velocity. Since the three viscosity parameters are assigned as constants for all areas of the model, a modifier regression may be used to scale the parameters over the range of flows. When roughness height and viscosity adjustments are obtained that generate accurate modeled water surface elevations for all three flows, the hydrodynamics model will be assumed to be calibrated. All subsequent hydrodynamics modeling of the various flows for habitat modeling will be completed using calibrated channel roughness heights and viscosity parameter adjustments. Fifteen to 30 flows ranging from 10 to 3,000cfs will likely be modeled at each intensive site. This flow range covers the majority of median monthly flows in the historical range excluding temporary high rainfall and runoff events. This range builds on the 50 – 2,000 cfs range modeled by Mosier and Ray (1992).

Perform Sensitivity Analysis

Uncertainty in environmental models lies within characterizing the system. A riverine model uses generalized parameters to describe and simulate the physical characteristics of the river. These generalized parameters have uncertainty bounds associated with them, which leads to model uncertainty. Calibration of a hydrodynamic model aids in reducing, but not totally eliminating, model uncertainty. To calibrate a model, parameters are adjusted within their uncertainty ranges to ensure that simulation results adequately match data records as discussed above. Once calibrated, the project team will investigate the sensitivity of the hydrodynamic model results to changes in parameters. If the model is found to be highly sensitive to a parameter, efforts can be made to reduce the parameter uncertainty through further data analysis and/or additional validation data acquisition. The project team will work closely with the SRP during the performance of this sensitivity analysis.

Key Assumptions:

- *Hydrodynamic models calibrated by fall 2006.*
- *Final Models delivered in 2007.*

Deliverable: Subtask 4.20 is the deliverable of draft calibrated River 2D models for each intensive site.

Task Leader: Joe Trungale
Quality Control/Quality Assurance Leader : Tim Osting

Subtask 4.30 – Habitat and Recreation Model Development

Description of Work: The habitat modeling for each species and lifestage and recreational activity will be similar to a typical USFWS Physical Habitat Simulation (PHABSIM) analysis. Total weighted usable area (WUA) versus discharge will be computed between 10 and 3,000 cfs. Total WUA is simply the summation of the area resulting from multiplying the combined suitability for a node with the area the node represents. For an assessment of available blue sucker spawning habitat, a typical PHABSIM type effective spawning habitat analysis will be run where the suitability of a cell is based on the minimum suitability resulting from daily flow fluctuations. Additionally, the biological validation fisheries data

collected in 2005 will be used during habitat modeling to validate or modify the habitat modeling procedures.

The functional habitat groups developed in Mosier and Ray and refined through sampling activities under TO1-TO3 will be used for the overall aquatic community modeling. Individual habitat suitability curves for adult, spawning, juvenile, and larval blue suckers developed during sampling activities for this project and existing data will be used to address specific habitat needs of this species. Recreational activities including swimming, wade fishing, boating, kayaking, and canoeing will be modeled using existing suitability criteria for these activities.

Key Assumptions:

- *Habitat/Recreation models completed to draft form by fall 2006.*
- *Final Models delivered in 2007.*

Deliverable: Draft habitat and recreation model results. Subtask 4.40 is the deliverable of draft habitat and recreational model results for interim environmental criteria development.
Task Leader: Michael Robertson
Quality Control/Quality Assurance Leader : Edmund Oborny

Subtask 4.50 – Sediment Transport and Riparian Analysis

Description of Work: Based on the geomorphic reconnaissance of the project area in 2005, four distinct river reaches were identified to assist in the assessment of geomorphic features, sediment transport processes, and flow requirements for channel maintenance. The preliminary reaches are: a coarse-bedded/dam-influenced reach immediately below Longhorn Dam; a bedrock-influenced reach between the Bastrop area and the Columbus area where bedrock/ boulder outcrops largely control channel plan form and profile; a transition reach from the Columbus area to the Altair area; and an alluvial/coastal plain reach below Altair characterized by tighter, more regular meanders and fine-grained bed and bank material.

The focus of the 2006 channel maintenance tasks will be to apply the modified 2005 study plan in two "pilot" reaches. The two study reaches that have been chosen are the Austin to Bastrop and Columbus reaches. Within these two reaches, bedload transport rating curves will be developed in order to relate discharge to bedload sediment transport rates. It is anticipated that the bedload relationships will be developed either at existing USGS gage transect(s) or at existing HEC-RAS modeling transect(s) where hydraulic conditions and stage-discharge relationships have already been established. Data collection efforts will focus on gathering information for model (transport equation) inputs and calibration purposes. Suspended sediment rating curves will also be developed but will primarily be based on data provided by the Water Quality team and/or existing agency data.

Once the bedload and suspended sediment rating curves are established for the two reaches, effective discharge will be calculated for the existing and proposed flow regimes. The transport relationships will also be used in conjunction with discharge versus bar/floodplain inundation relationships (determined from the LCRA HEC-RAS model) to evaluate potential effects of flow regime changes on in-channel features such as sand and gravel bars, floodplain sediment deposition, riparian vegetation, etc.

In addition to the sediment transport analysis, the 2006 channel maintenance tasks will also include analysis of historical USGS gage discharge measurements (Smelser and Schmidt, 1998) to evaluate; streambed scour and fill patterns associated with flood events; historical and current trends in thalweg elevation (long-term degradation/aggradation); channel geometry adjustments through time (pre- and post-dam; current trends), and discharge magnitude required to initiate significant fill or scour. Topographic maps/available GIS coverages will be used to determine downstream trends in channel sinuosity/meander characteristics. Historical aerial photography and other available historical data will be used to assess channel planform stability/ change; pre- and post-dam characteristics.

Key Assumptions:

- *Suspended sediment rating curves will be provided by the Water Quality team.*
- *USGS historical gage data at Columbus, Austin and Bastrop will be readily available.*
- *Flow regime will be amenable for field work scheduled in 2006.*

Deliverable: Subtask 4.60 is the deliverable of draft results for interim environmental criteria development.
Task Leader: Melissa Stamp
Quality Control/Quality Assurance Leader : Darren Olsen

Task 5 – Alternatives Analysis

Subtask 5.10 – Interim Environmental Criteria Development

Description of Work: The development of interim environmental criteria will be conducted in two phases under TO3. The initial phase will involve a preliminary assessment based on preliminary hydrodynamic and habitat/recreation habitat model results. This initial assessment will also be dependant on the preliminary water quality (dissolved oxygen) vs. flow data to be provided by the Water Quality team. As these results will be preliminary, a certain level of conservativeness will be built in to the criteria. The intent of providing these initial estimates is to assist the Surface Water Availability team in their preliminary operations evaluation. The second phase will involve the refinement of those preliminary environmental criteria based on calibrated hydrodynamic models, more refined water quality model results, refined habitat suitability criteria, and inclusion of the sediment transport/riparian analysis results. These refined criteria will be provided in December 2006 but still remain interim until biological validation data scheduled for completion in spring 2007 is processed and incorporated into the model results.

Key Assumptions:

- *Water quality data provided from Water Quality team by late spring 2006. This data will include an evaluation of the dissolved oxygen concentrations within the river and diel fluctuations at the ranges of flows specified by the aquatic habitat team. These ranges will likely include flows determined to meet critical, suitable, and optimal physical aquatic habitat conditions.*
- *Hydrodynamic models calibrated by fall 2006.*

- *Habitat/Recreation models completed to draft form by fall 2006.*
- *Final Models delivered in 2007.*
- *Sediment Transport / riparian analysis completed to draft form by fall 2006.*

Deliverable: Subtasks 5.20 and 5.30 respectively are the deliverable of draft and refined interim environmental criteria to be submitted to the Surface Water Availability team.
Task Leader: Edmund Oborny
Quality Control/Quality Assurance Leader : Tim Osting

Subtask 5.40 – Socioeconomic Team Interaction

Description of Work: This task will include the coordination between the Aquatic Habitat team and the Socioeconomic team. Activities will include but are not limited to reviewing and commenting on technical memorandums prepared by the Socioeconomic team. See attached Socioeconomic Technical Memorandum for a detailed description of the Aquatic Habitat Study / Socioeconomic team interactions.

Key Assumptions:

- *Hydrodynamic models calibrated by fall 2006.*
- *Habitat/Recreation models completed to draft form by fall 2006.*
- *Final Models delivered in 2007.*
- *Recreational suitability criteria established in the literature is sufficient to address recreational activities for the lower Colorado River.*

Deliverable: Draft quantitative recreational and habitat impacts/benefits to be provided to the Socioeconomic team by October 6, 2005.
Task Leader: Edmund Oborny
Quality Control/Quality Assurance Leader : Mike Robertson

Subtask 5.50 – Permitting Team Interaction

Description of Work: This task will include the coordination between the Aquatic Habitat team and the Permitting team. This coordination will lead to the preparation of an existing conditions report as well as materials necessary for completion of the 2006 PVA. Additionally, the project team will coordinate on the preparation of the Draft Aquatic Habitat Technical report (initiated in 2006, but not scheduled for completion until 2007).

Key Assumptions:

- *Hydrodynamic models calibrated by fall 2006.*
- *Habitat/Recreation models completed to draft form by fall 2006.*
- *Final Models delivered in 2007.*
- *Recreational suitability criteria established in the literature is sufficient to address recreational activities for the lower Colorado River.*
- *Water quality data submitted by the Water Quality team.*

- *Flow scenarios over the potential intake structures will be provided by the Surface Water Availability team.*
- *Locations and sizes of potential intake structures will be provided by the Facilities Siting team.*
- *Project alternatives will be provided by the Surface Water Availability team.*

Deliverable: Draft existing conditions documentation submitted to the Permitting team. Recommendations provided to Facility Siting team on placement of instream structures for avoiding or minimizing any potential impacts to key aquatic habitat.
Task Leader: Edmund Oborny
Quality Control/Quality Assurance Leader : Mike Robertson

Task 6 – Project Data Analysis and Report Preparation

Subtask 6.10 – Data reduction/analysis – Draft Technical Report

Description of Work: The BIO-WEST project team will reduce and analyze data collected as part of the Aquatic Habitat study. The project team will then initiate the preparation of a technical report detailing the activities, methodologies, results, discussion, and conclusions of the Aquatic Habitat study. The report will not be completed until the biological validation data in the spring of 2007 is collected and processed. The project team will write sections of the technical report in a manner consistent with EIS document preparation for ease of incorporating this documentation into the overall permit application.

Key Assumptions:

- *All technical work (except 2007 biological validation sampling) will be completed by late fall 2006.*

2007 Deliverable: Draft technical report (Completed in 2007)
Task Leader: Edmund Oborny
Quality Control/Quality Assurance Leader : Tim Osting

Subtask 6.20 – 2006 Activities Letter Report

Description of Work: The BIO-WEST project team will submit a final progress letter report in mid-December summarizing activities conducted during TO3 and highlighting any potential fatal flaws identified during those activities.

Deliverable: TO3 Activities Letter Report
Task Leader: Edmund Oborny
Quality Control/Quality Assurance Leader : Dr. Paul Holden, Dr. William Espey