Science Review Panel Comments On:

Draft Instream Flow Guidelines Development Colorado River Flow Relationships to Aquatic Habitat and State Threatened Species: Blue Sucker

Colorado River - Aquatic Habitat and Water Quality
Committee Chairs: Tom Arsuffi; Larry Hauck
Members: Khaled Bali, Thom Hardy, Doug Slack, Greg Stunz

April 25, 2007. Aquatic Habitat Team Response: The Aquatic Habitat team appreciates the review by the SRP of the Draft Instream Flow Guidelines Development Colorado River Flow Relationships to Aquatic Habitat and State Threatened Species: Blue Sucker. Responses to specific comments/suggestions are inserted below.

The purpose of this interim report is to take the results-to-date of the LSWP studies and develop draft instream flow guidelines for the lower Colorado River specific to the LSWP. To do this, the report integrated critical components of the TIFP (TIFP DRAFT 2006) and National Research Council (NRC 2005) to ensure compliance with all anticipated state-mandated requirements. The document provides an overview of the LSWP status relative to each of the four key instream flow technical components (hydrology and hydraulics, biology, geomorphology, and water quality), describes the integration of the four study components, and provides preliminary recommendations for instream flow guidelines for the lower Colorado River specific to the LSWP.

This report did a good job of presenting the results of a variety of analyses associated with establishing several types of environmental flows for the Colorado River, the rationale for doing so, and effective visual and textual presentations of results. SRP appreciated inclusion of Appendices A-E, for a more detailed documentation of the life history summaries, habitat suitability criteria, etc.

Response: Thank you!

Below are SRP general and specific comments and review of this report.

Page 3. 2.0. Study Components & Hydrology and Hydraulics.

"Healthy floodplains act as "sponges" that store water during high flow events and release it back to the channel during low flow periods. This function serves to dampen downstream flood peaks (and associated flood damages) and helps ensure that adequate baseflows are available to aquatic communities during seasonal dry periods."

"For example, wet periods that are characterized by large overbank floods are important for creating habitat complexity and promoting lateral and longitudinal nutrient cycling. However, if major flooding occurred every year, the frequent disturbance would prevent riparian communities from becoming established and would compromise the stability of aquatic communities."

The Colorado River does not have a flood plain that acts specifically in the way these statements imply. Instead it seems the statements better apply to tropical river systems that have predictable overbank flooding annually and flood plains are important structural and functional ecosystem components - life cycles of many organisms are keyed to use overbank inundated lands for reproductive and food resources. Tropical river systems have well developed riparian communities despite annual flooding. The "sponge" capacity of a watershed and flood plain is a function of topography, geomorphology, soil depth and composition and bedrock proximity to surface. The point here is how do these statements specifically relate to the Colorado River and the LSWP. As this report later shows, since the construction of the Highland Lakes, frequency and magnitude of floods has decreased such that the potential effect of flooding causing the proposed negative effect on the riparian communities of the Colorado River are reduced.

Response: Good Point. We will revise this section to apply more directly to the Colorado River floodplain.

Please clarify the meaning and usage of the term "hydrological cycling" in the context of the sentence, *"On a smaller scale, river hydraulics (the patterns of water movement inside the channel) can be as important as hydrologic cycling."*

Response: We propose to revise this statement as follows. "On a smaller scale, the patterns of water movement inside the channel (i.e., river hydraulics) can be as important to individual organisms as the overall flow regime."

Page 5. 2.3. Geomorphology.

The project team makes a good point that when streamflow or sediment supply is changed by dams, diversions, or other alterations, channel equilibrium may be disturbed and should be considered when developing the instream flow guidelines. They justify the point that habitat will not be effectively protected over the long term, if an instream flow recommendation is developed solely on an analysis of existing hydraulic habitat in a rapidly widening or incising river.

No response needed.

Page 10. Second Paragraph below Table 3.1, third sentence.

'… model edges.' It would be more correct to indicate you extended the upstream and downstream boundaries of the mesh to remove the influence of numerical goodies as suggested. However, the way it reads now, I could also justify the interpretation that this occurred along the longitudinal boundaries on both sides of the channel but I do not think this is what is intended to be implied.

Response: The referenced sentence will be replaced as follows: Based upon field data, the model mesh included channel areas both upstream and downstream of site

boundaries. Habitat was not considered in these "extra" upstream and downstream areas located outside the site boundaries. The model included these extra areas to ensure depth and velocity fields inside the site boundaries were not influenced by spurious numerical effects that have potential to occur at upstream and downstream ends. Similarly, the model mesh included near-channel floodplain area on both sides of the channel to ensure wetted water edges along the banks did not touch model edges.

Page 10. Last sentence. What did you adjust and what specifically was carried forward? Was it the 'mesh', bed elevations, x-y locations, water surface elevations? Vague at best.

Response: To clarify what was adjusted, sentence will be revised as follows: At each site, the same geometric mesh was used for all modeled flow rates; adjustments to the bed elevations and x-y locations made at a particular steady-state flow rate were carried through to each of the other flow rates at the same site.

Page 11. Paragraph below Figure 3.5. What model predictions were used to track what field observations? I assume you mean primarily the longitudinal water surface profile? Be specific please for those you are also educating. Second sentence: These are not mechanisms! Adjusting these parameters to match observations was the mechanism used to calibrate the model.

Response: Sentences will be changed to read: Calibration proceeded by adjusting model inputs so model predictions of water surface elevation tracked field observations. Roughness, bathymetry and the downstream water surface elevation boundary condition were the three model parameters adjusted to calibrate the models.

Page 11. 2nd Paragraph below Figure 3.5. You say 'bathymetric complexities were incorporated to match observed water surface profiles.' What does this mean? Did you modify the topography using professional judgment so that the induced topography in the mesh made the water surface match?

Response: We will revise to clarify intent: In limited areas exhibiting abrupt, localized changes in water surface elevation, bathymetric complexities (e.g., areas with rock outcrops or ridges forming water surface steps) were incorporated into the mesh where bathymetric, photographic and/or water surface elevation data was available. Based upon professional judgment, additional changes to bathymetry were made in localized areas (e.g., within secondary channels or within constricted areas of the main channel during very low flow) to ensure predicted flow rate, wetted width, water edge and/or water surface elevations match observations.

Page 18 top Paragraph. Did you only interpolate values from Somerville (1958) or did you also extrapolate? If you interpolated only no big deal, if not, big deal on how you extended the table values.

Response: For the draft report, 5 of the 7 habitat categories were interpolated. Of the remaining 2 that were extrapolated, only 1 had a sample size considerably greater than the largest sample size (1,000) in the Somerville (1958). We have worked directly with Dr. Hardy to address the extrapolation technique most appropriate for this specific situation and will revise in the final version.

Page 28. 3.3.2 Sediment Rating Curves

The discussion on this page is confusing and difficult to follow, in part because there are multiple "steepenings" and "increases" associated with water surface slopes and rating curves derived from equations.

Response: We will add text to help clarify this section in the final report.

Pages 27-32. 3.3.2 Sediment Rating Curves

Here, Colorado River flows and sediment rating curves under natural (pre 1940) and existing (post 1940) conditions are described. In particular, text suggests effects on shoreline, riparian, sediment deposition and movement, pools and other structure function river elements under higher (existing, 1,000 - 2,000 cfs) and lower (natural, < 500 cfs) summertime conditions. Although such contrasts appear plausible, given general trends on rivers due to higher versus lower flows, SRP suggests such conclusions may be too deterministic, given the large variability of stream ecosystems and the variety of "resetting" mechanisms such as floods that the project team discusses. For example, *"A return to more natural summertime baseflow conditions would likely lead to more stable (i.e., less mobile) substrate conditions, which could have positive implications for macroinvertebrate productivity and species richness."* Biodiversity of macroinvertebrates is a function of multiple factors operating on a variety of spatial and temporal scales**.** Rather than stability, macroinvertebrates are suggested to reach highest diversity at intermediate levels of disturbance. Our point is that we don't know if the difference between <500 cfs is biologically significant from 1000+ cfs on macroinvertebrate productivity and diversity. See Vinson & Hawkins 1998. (Annu. Rev. Entomol. 43:271–93. Biodiversity of stream insects). There is no mention of the effects of pre- versus post- flows on Colorado River structure and function and macroinvertebrates during other seasons, nor whether flows in other seasons could override proposed effects of summer flow seasonal patterns.

Response: We agree that as worded, substrate stability stands out as important to macroinvertebrates. What was meant by "lead to a more stable substrate condition…" was not complete stability but simply more than constant sand transport. We agree with the SRP that intermediate levels of disturbance create some of the highest levels of macroinvertebrate diversity. We will re-word to include that statement and replace the discussion on stability with a description of how having constant sand transport at the higher flows creates a high level of disturbance, whereas reduced flows during the summer causes a lower level of disturbance. Yet, even with the lower base flows a level of intermediate disturbance does exist.

Page 34. Pulse flow Hydrologic Evaluation

SRP appreciated the inclusion of the Nature Conservancy's Index of Hydrologic Alteration in their analysis of the effects of the Highland Lakes on flow patterns in the Colorado River.

As seen in Table 3.4, existing high pulse characteristics remain quite similar to pre-1940 values for both the IHA and EFC parameters. This is because many of the lower magnitude high flow events on the lower Colorado River are caused by rainstorms that occur below the Lake Travis Watershed. These events are not affected by the Highland Lakes system. In contrast, the larger-magnitude high flow events (floods with frequencies of once per year or less) on the lower Colorado River have been substantially altered by the Highland Lakes. This is evident in the IHA results for annual 1-day and 3-day maximum flows (Table 3.4).

No response needed.

Pages 35-37. 3.4 Water Quality

The SRP review of the Water Quality Scenario Report observed that results (Table 2.2, including 2060 demands) showed DO levels are borderline compliant. Further, Appendix A Sensitivity Analysis (and Table A-1, effect of higher temperatures associated with global warming on DO concentrations) shows that a 1^{o}C increase takes DO below the 6 mg/l standard (although still in compliance because of error considerations), but out of compliance with 2 and 3 degree C increases in temperature. In contrast, this report concludes, "*However, even under these extreme conditions, LSWP water quality modeling predicts average and diel DO concentrations in the river will be acceptable to meet the needs of the lower Colorado River aquatic community.*" First, SRP was unaware that diel DO concentrations were modeled for future project conditions. Second, It would be helpful, provide consistency and prevent confusion, if these two reports were integrated with respect to water quality and DO concentrations with and without the project in different years. Presumably, the differences between the two reports are a result of using different flows or other inputs into the QualTX model.

Response: The subsistence and base flow instream flow guidelines are not based on the LSWP meeting the TCEQ water quality standard of 6.0 mg/L dissolved oxygen for "exceptional" aquatic life use. Therefore, the statement quoted above refers to water quality modeling showing that at these guideline flows dissolved oxygen would only rarely fall below 5.0 mg/L and for only small segments of the river. The project team feels that during these periods of lower than average discharge, DO conditions in the river as modeled do not pose a threat to the lower Colorado River aquatic community. Specific references will be added to support this claim in the final report. It is correct that diel DO concentrations were not modeled for future project conditions. We will remove the phrase, "diel DO concentrations" from that

sentence and discuss future conditions further with the LSWP water quality team.

As the WQ report is focused on TCEQ standards and the Instream Flow report on aquatic health it might be more confusing to completely integrate these efforts. However, more text will be added to explain these differences and that different scenarios were modeled for these studies.

Page 40. When I look at the habitat modeling and see small patches out among the trees I wonder if these were included in the total habitat areas over all ranges of flows?

Response: The Utley site has the most extensive set of side-channels of any site, and one of the reasons the site was chosen was to characterize this type of habitat. The only other site exhibiting similar features is the LaGrange site, and those channels are less extensive than at Utley. Side channel areas were included in the total habitat area for all flow rates, even at those flow rates where they are disconnected. The River2D model incorporates a crude groundwater flow component and that feature is the mechanism by which wetted area appears in disconnected areas. While that initially sounds like spurious model output, model predictions exhibit good agreement with on-site GPS measurements of water edge at 407 cfs where small pools are completely disconnected from the main channel (Figure 3.6).

Page 43. Figures 4.5, 4.6

Explain again how percent of maximum habitat per measured discharge can sum up to more than %100. SRP recalls this discussion at the October 2006 workshop, but several of us cannot recall how it was resolved. Also, because this will be a public document, it might be useful if the project team provided an explanation of the methodology relative to the construction of the figure. This would aid readers in understanding the figure and how it does not violate mathematical principles (summation > 100%) they were taught in school.

Response: In the percent of maximum habitat figure (Figure 4.6), the different habitat types at the same flow are not supposed to add up to 100%. The figure describes the percent of maximum habitat for each individual habitat type. For example in Figure 4.6, rapids – adult blue sucker habitat reaches its maximum (100% - Figure 4.5 [@67,000 ft2/1000ft]) at 2,000 cfs, while it only meets approximately 52% (Figure 4.5 [@35,000 ft2/1000ft]) of its maximum area at 500cfs. The figure title, legend, and report text will be modified to specify the percent of maximum habitat per individual habitat type.

Page 44 Last full paragraph. Are you suggesting that this all only applies to large river systems? Are small river systems exempt from such things?

Response: No and No. We will replace "large river" with "riverine"

Page 45. Section 4.2.2. All this logic is difficult to buy into. Your WUA curves all maximize well below 5000 cfs which is your cutoff level for the time series so as not to be influenced by poor habitat at high flows. Yet all your WUA relationships all have poor habitat at 3000, 4000, etc. Why not just say it makes sense to separate the base flow component, give it the record, get base flow out, and go on with the analyses. This all seems to make it read way more cooked than it is.

Response: This section will be revised to clarify our use of the base flow analysis.

Page 52. Table 4.3. Summary of physical and biological differences predicted between existing and pre-1940 flow regimes.

Table 4.3 is a very informative and useful summary table. That said, it would also be helpful and useful if TABLE 4.3 were supplemented with a summary table providing quantifiable analysis. For example, habitat diversity (1st row) comparing the 2 flow regimes states there is less habitat diversity in the period 1975-2004 than pre-1940. Can this result be presented as a mean plus or minus a measure of variation, so a reader can get a feel for the magnitude of the difference stated?

Response: Figures 4.8 – 4.16 were included to help describe the summary table. We will provide a reference in the table to refer to these figures.

Also, an SRP question. How is diversity being defined and used by the project team, there are several different uses in the ecological literature? For example, diversity simply is number of taxa occurring in an area. In other uses, diversity has 2 components, a variety component (# of different species/taxa) and an equitability components (# species and distribution of individuals collected). It is important that this report make clear what aspect of diversity was measured and reported. The variety and equitability components are usually reported as diversity indices such as Shannon-Wiener, Brillouins etc.

Response: For the discussion surrounding Table 4.3, habitat diversity is dealing with equitability of the different habitat types.

Row 6 (Sediment Transport - macroinvertebrate stability) of Table 4.3 states, *"More base flow sediment transport reduces substrate stability thus reducing marcroinvertebrate productivity and species richness. Less base flow sediment transport supports substrate stability and increases macroinvertebrate productivity and species richness."*

This is a much too definitive statement to make without justification in the form of Colorado River macroinvertebrate community structure information, biomass production, stability criteria (resistance, resilience), functional feeding group analysis, disturbance regime and literature review. From an empirical and theoretical perspective, stability is not always positively related to diversity. The Intermediate Diversity Hypothesis (IDH) predicts highest diversity at intermediate levels of disturbance and lower diversity when conditions are stable. IDH has been applied to stream ecosystems with variable success. SRP suggests that more speculative components of tables such as 4.3 be avoided unless derived from data of current studies and/or are clearly designated as hypotheses and

justified by a literature review if that information for the Colorado River is unavailable.

Response: We agree with the comment that our reference to macroinvertebrate productivity and species richness goes beyond what Colorado River data can support. We will tone down this discussion and replace references of stability with description of disturbance level as discussed on Response to pages 27-32 above.

Page 55. Figure 4.17. Habitat durations for rapids/adult blue sucker for January and July at the Bastrop Reach for both flow regimes.

Figure 4.17 is unclear as the legend indicates the graph is for 2 times (January and July) at 2 flow regimes and there are 7 habitats evaluated. This suggests there should be 28 lines on the graph, yet there are only 7. This needs clarification.

Response: Figure 4.17 has the wrong legend. It should read, "Habitat durations for All Habitat Types for April at the Bastrop Reach." This will be changed in the text and list of figures.

General SRP comment. Overall the framework for picking the component flows for each component of the flow regime is good. What would help however, is show a hydrograph that identifies over what time period each of these flow components are in 'operation'.

Response: Thank you! We will include a hydrograph that identifies these time periods in the final report.

Page 63. 4.3 Pulse flow and Overbanking Flow Development

SRP concurs with the project team that base and high flow pulses are critical and needed elements of any instream flow recommendations for the Colorado River because of the many and varied multiple environmental benefits discussed in the report. The pulse flows should be implemented as much as possible.

No response needed.

Page 64. Monitoring recommendations.

SRP agrees with the project team that measuring bedload transport during lower-magnitude "base pulse" events would help determine whether the modeled sand and gravel transport thresholds are accurate and that surrogate techniques such as painted rock studies and pre- and post-base pulse event transect surveys can be effective and pre- and post- high flow event surveys and photography could also be used to help determine the flow magnitude that effectively scours aquatic and herbaceous/emergent riparian vegetation.

No response needed

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Page 72. Figure 8.1.

There may be a labeling mistake in this figure where LSWP Subsistence (purple) should be LSWP Base – Dry (red) and vice versa.

Response: The figure on the pdf is correct. This may be a color print issue?