December 19, 2011

The Honorable Troy Fraser, Co-Chair
Environmental Flows Advisory Group
P. O. Box 12068 – Capitol Station
Austin, TX 78711

The Honorable Allan Ritter, Co-Chair
Environmental Flows Advisory Group
P. O. Box 2910
Austin, TX 78768-2910

Dear Senator Fraser and Representative Ritter:

The Basin and Bay Expert Science Team (BBEST) for the Nueces River and Corpus Christi and Baffin Bays completed their environmental flow recommendation report on October 28, 2011. The report was submitted to the Environmental Flows Advisory Group (EFAG), the Texas Commission on Environmental Quality (TCEQ), and their Basin and Bay Area Stakeholder Committee.

The report is very comprehensive and clearly represents a substantial effort by the members of the science team to address their charge as stipulated in Senate Bill 3. The state can be proud we have so many dedicated scientists willing to participate in this program.

Attached are review comments prepared and adopted by the Texas Environmental Flows Science Advisory Committee (SAC) pursuant to Texas Water Code **Sec. 11.02362(q)**, as added by Senate Bill 3 in the 80th Texas Legislature, 2007. The statute calls for the SAC to provide input to the EFAG for its use in reviewing the BBEST environmental flow analyses and environmental flow regime recommendations. The attached review follows a modified framework adopted by the SAC in December 2010, and reflects the consensus opinion of the SAC members. Should the advisory group deem it appropriate to submit comments to the TCEQ as they undertake rulemaking for this basin, the SAC trusts that you will find the enclosed review helpful, and we stand ready to support your preparation of comments in any way you deem appropriate.

Sincerely,

Robert J. Huston
SAC Chairman

CC: Con Mims, Nueces River and Corpus Christi and Baffin Bays Area Stakeholder Committee Chair
Sam Vaugh, Nueces River and Corpus Christi and Baffin Bays BBEST Chair
Mark Vickery, Executive Director, Texas Commission on Environmental Quality

Memorandum

To: **Environmental Flows Advisory Group (EFAG)**
From: **Texas Environmental Flows Science Advisory Committee (SAC)**
Date: **December 19, 2011**
Re: **Review comments on Nueces River and Corpus Christi and Baffin Bays Basin and Bay Expert Science Team (NBBEST) Environmental Flow Regime Recommendations Report dated October 28, 2011**

Introduction

The Nueces River and Corpus Christi and Baffin Bays Basin and Bay Expert Science Team (NBBEST) submitted its environmental flow analyses and environmental flow regime recommendations to its Stakeholder Committee, the EFAG and the Texas Commission on Environmental Quality (TCEQ) on October 28, 2011, and this was followed by a presentation to the SAC at its regular meeting on November 2, 2011. Texas Water Code **Sec. 11.02362 (q),** as added by Senate Bill 3 in the 80th Texas Legislature, 2007 (SB 3), provides that "In accordance with the applicable schedule…the advisory group, with input from the science advisory committee, shall review the environmental flow analyses and environmental flow regime recommendations submitted by each basin and bay expert science team. If appropriate the advisory group shall submit comments on the analyses and recommendations to the commission for use by the commission in adopting rules under Section 11.1471. Comments must be submitted not later than six months after the date of receipt of the analyses and recommendations." This memorandum represents the SAC's input to the EFAG based on our review of the NBBEST report.

The SAC notes that the work of the Nueces BBEST is unique for at least five reasons: 1) the NBBEST was formed and started the SB3 process earlier because a preexisting group called the Nueces Estuary Advisory Committee was allowed under the statute to expand and form the basin stakeholder committee (Nueces BBASC) and begin work, 2) the estuarine group had more coastal data and flow studies available than other BBESTs, 3) the NBBEST had to deal with a drier climate than previous BBESTs, with many intermittently flowing streams and marine and hypersaline estuaries, 4) the Nueces estuary already has an existing regulation for environmental flows that is similar in many respects to an SB3 flow regime, and finally 5) the NBBEST concluded that some estuaries in their geographic region were not ecologically sound.

SAC Review and Comments

1. Do the environmental flow analyses conducted by the BBEST appear to be based on a consideration of all reasonably available science, without regard to the need for water for other uses?

1.1 Has the BBEST identified and considered available literature and data? Were relevant scientific data and/or analyses discounted by the BBEST?

The literature reviews are excellent. The NBBEST relied upon guidance provided by the SAC and took advantage of literature reviews provided by other basins' BBEST reports. Relative to instream flow, an exceptional description of the Nueces Basin ecological systems was presented considering the somewhat limited amount of available information. It does not appear that the NBBEST discounted any instream data or analyses, other than streamflow data determined to be from gauges with insufficient records.

The NBBEST benefited by at least four long-term, detailed, studies previously conducted for the Nueces Estuary specifically addressing environmental flow needs: The Texas Water Development Board funded studies performed by the University of Texas Marine Science Institute from 1988 – 1996, the Bureau of Reclamation Demonstration Project (1994-2000), the City of Corpus Christi Nueces River Overflow Channel Project (2002-2010), and the Army Corps of Engineers Nueces Basin Feasibility Study (2007-present).

The NBBEST report provides an excellent description of the basins and bays as they exist today, plus a review of the changes that have occurred in Nueces Bay and Nueces Delta since 1900. The presentation (in Section 2.0) of the ecoregions within the watersheds and bays is excellent. The coupling of photographs for each individual site with the flow regimes was exceptionally helpful (Section 6.1). The NBBEST directly used the extensive information available for the Nueces estuary, and Nueces, Corpus Christi, and Baffin Bays, as well as the significantly more limited information available for the Nueces River and its tributaries.

1.2 Are the data sources and methods adequately documented?

While the report does not specifically cite all the individual SAC guidance documents that were likely used in the NBBEST's deliberations, the basic data sources are well documented with a considerable amount of that information presented in the detailed Appendices. There are several instances of citations appearing in the body of the report that are absent in the Reference list, without any obvious reason for doing so. The methods for most data analyses relative to the estuarine recommendations were adequately documented.

However, the methods for determination of instream flow recommendations are somewhat disappointing, given the importance of these recommendations and the additional time and data resources afforded to this BBEST. The NBBEST states on Page 3-2, **"Based on the recommendation of the National Research Council (NRC, 2005), and consistent with Maidment, et al. (2005), the SAC (2009) implemented the HEFR Methodology."** The HEFR methodology was never "implemented" by the SAC nor was the SAC's consideration of HEFR for environmental flow analyses based on NRC recommendations or information from Maidment. Rather, HEFR was simply deemed a useful tool for the

determination of an environmental flow regime, in conjunction with consideration of water quality, geomorphologic, and biologic components. (See SAC-2009-1 - HEFR methodology guidance document). We further note that the apparent reference to the HEFR Guidance on page 3-2 is incorrect in that the SAC HEFR document is not listed in the references. In fact, the NBBEST report is somewhat inconsistent in its references to documents listed in Section 8 – References, particularly when referencing numerous SAC guidance documents.

While an impressive body of work is presented in the determination of physical-habitat requirements as a function of flow, the following NBBEST statement (Page 3-39) indicates that it predetermined that this work would only be used to verify historical hydrology-based instream flow recommendations, **"We utilized flow-habitat modeling in the biological overlay to answer the following question: *Do the hydrology-based flow regime recommendations maintain sufficient instream habitat quality, quantity, and diversity that provide a sound ecological environment?* "** It is the SAC's opinion that setting up a question to only use site-specific flow-habitat data to verify historical hydrology-based flow regimes from the onset sidesteps the biological overlay process. The additional work that was conducted by the state agencies and subsequently analyzed by consultants and the NBBEST should have been evaluated first on its merit of setting or adjusting recommendations via the overlay process, only falling back to a verification mode if that is all that it was deemed useful for. However, the text throughout this section is somewhat ambiguous on this subject and this may in fact have been the process as suggested by the following statement on Page 3-65, **"In part as a result of the uncertainties described in the paragraphs above, the BBEST decided it was not appropriate to set flow regime values based on the habitat suitability analysis, but it was appropriate to conclude that HEFR-based flows support instream habitat."**

How exactly the detailed depictions of WUA curves and associated tables for the individual fish species resulted in (or "indicated") the recommendation of maintenance of the historical HEFR flows is the crux, when it had just been deemed too uncertain to use to set or adjust any recommendation. It is recognized that this is a complex topic and may simply have been an oversight with difficult schedule demands. Thus, the BBASC will be well served by receiving additional clarification from the NBBEST on their method of instream flow recommendation development; in particular, the role (if any) that the habitat analysis played in setting the recommended flow regimes.

Also, a clear presentation is not provided as to exactly how zero flows were handled in the development of the recommended instream flow regimes, but the NBBEST does note that "**Subsistence flow recommendations of no less than 1 cfs by the Nueces BBEST for intermittent gage locations ensures that ecological functions associated with subsistence flow will be supported no less frequently than they have been historically."** While this somewhat arbitrary floor on subsistence flows certainly is protective of ecological functions under low-flow conditions, it would be helpful if the NBBEST had offered a more concise explanation of how the zero-flow issue was or was

not addressed in the development of the recommended instream flow regimes and the extent to which zero-flows were accounted for in the HEFR analyses that formed the bases for the recommended instream flow regimes.

The water quality, riparian, and geomorphology methodologies were based on more limited data sets and don't provide any inconsistencies, nor do they directly alter any HEFR recommendations.

1.3 To what extent has the BBEST considered factors extraneous to the ecosystem, especially societal constraints, such as other water needs?

External societal factors did not play a role in the methodologies or recommendations of flow regimes to protect ecological soundness. However, other factors were reviewed and discussed in the context of issues that drive flow regimes. A preliminary evaluation of environmental flow regime recommendations with WAMs was conducted and presented in Sections 6.3. We presume that this was presented only as an example of how the proposed flow recommendations might be interpreted so as to assist the BBASC with their charge.

A unique aspect of the Nueces estuary with regard to the major reservoirs in the basin is that these reservoirs have been governed by a special permit condition regarding inflows since construction of Choke Canyon Reservoir in 1983 and adoption of a TCEQ Agreed Order requiring environmental flows since 1990. These special conditions are discussed in Section 6.2. While the flow requirements have changed several times, the current Agreed Order of 2001 establishes monthly pass-through targets that depend on the elevation of the Choke Canyon Reservoir and the salinity of Nueces Bay. The NBBEST correctly did not allow the existence of this current rule to constrain the development of their environmental flow recommendations.

2. Did the BBEST perform an environmental flow analysis that resulted in a recommended environmental flow regime adequate to support a sound ecological environment and to maintain the productivity, extent and persistence of key aquatic habitats in and along the affected water bodies?

2.1 How is a sound environment defined and assessed for both riverine (lotic) and estuarine systems? What metrics of ecosystem health were used?

Section 1.3 presents a good overview, definition, and discussion of nuances regarding a sound ecological environment. A consensus was reached on the definition of a sound ecological environment. The NBBEST followed the SAC lead in adopting the definition of a sound environment offered by earlier science advisory groups. They expand the discussion to describe unsound as, **"An unhealthy environment is where human modifications of the flow regime have reduced or eliminated important physical, chemical, or biological features, and significantly altered or reduced native biological community structure."** There is

not a specific discussion in this section on metrics of instream ecosystem health beyond the acknowledgement that **"...a review of available biological, physical, and chemical data indicates that Nueces basin streams maintain acceptable sound environments."** For the estuary, the NBBEST used changes in hydrology, marsh plants, and shellfish populations as indicators of soundness.

2.2 How were locations selected for environmental flow analysis? Are these shown to be representative of and adequate to protect the basin? Was the process and rationale for selection adequately described? Were environmental flow regimes recommended for each selected site? Was a procedure presented by which the flow regime at other locations could be estimated?

The NBBEST selected gage locations for instream flow recommendations that provide good coverage across basin conditions. Locations for instream flow recommendations were based primarily on stream gage distribution and period of record, with consideration of hydrology, biology, water quality, geomorphology, water availability and water supply planning, all of which were thoroughly described. A procedure for flow regime determination at other locations is not stated, but the NBBEST does recommend that TCEQ develop such a method considering drainage area adjustments, effects of Edwards and other aquifer recharge zones, springflow contributions, channel losses, soil cover complex, etc.

The NBBEST makes estuarine environmental flow recommendations for only the Nueces Delta and Nueces Bay. The NBBEST opines that Corpus Christi Bay, Baffin Bay, and Laguna Madre do not require inflow recommendations because these are marine and hypersaline environments, the biological resources are adapted to conditions with very little freshwater inflow, and these bays are in sound ecological health as is. This essentially is recommending the status quo. The SAC concurs with a lack of an environmental flow recommendation for these bays because it would be inappropriate to create environmental flow regulations for these conditions and ecological soundness in these systems are not frequently driven by inflow. It is likely that the environmental flow recommendation for Nueces Bay would also benefit Corpus Christi Bay, but this is not described in the report. Finally, while Oso Bay is declared to be a sound ecological environment (p. 1-9), no flow recommendations are made for this bay.

Relative to the linkage between instream and estuarine flow requirements, one major inconsistency is that instream flow regimes are developed for Oso Creek and San Fernando Creek, even though no inflow regime is recommended for Oso Bay (fed by Oso Creek) nor Baffin Bay (fed by San Fernando Creek which flows to Cayo del Grullo, a tertiary bay flowing into Baffin Bay). These creeks would be largely dry except where supported by return flows or specific rainfall events. If flow was not dominated by return flow, then an instream flow recommendation still might make sense for instream habitat purposes, even if not specifically needed for estuarine health, but these distinctions are not discussed in the report. For these two bays, the NBBEST opines that the natural flow conditions do not drive soundness and thus there is no inflow regime requirement. As such, it is

interesting that Oso Creek (wastewater dominated) and San Fernando Creek were given instream flow regime recommendations.

2.3 How were the historical flow periods defined and evaluated? How was a particular period selected as the basis for determining the flow regime?

For the instream flow analyses, Section 3.2.2 provides a good description accompanied by several figures relative to the period of record discussion. The NBBEST selected 7 representative sites throughout the basin and compared pre- and post-development, and the full period of record. Following the exercise, it was concluded, **"Upon consideration of these significant changes in streamflow, the Nueces BBEST decided to apply HEFR for early (pre-development) and late (post-development) sub-periods as well as the full period of record at each selected streamflow gaging station..."** A graphical depiction of several of hydrological changes at the representative sites are presented, and then the section abruptly ends with the statement, **"On July 29, 2011, the Nueces BBEST chose by consensus to use HEFR results based on the full period of record to form the basis of its instream flow regime recommendations subject to the ongoing ecological overlay process."** It will be important for the NBBEST to articulate in future correspondence with the BBASC why this decision was made for all gages, as it does not appear that the ecological overlays resulted in any HEFR adjustments.

For the estuarine analyses, the full period of record from 1941 to present was used. The record was divided into three periods: 1941–1957 before Wesley Seale Dam was constructed forming Lake Corpus Christi, 1958-1982 before impoundment of Choke Canyon Reservoir, and 1983-2009 the period after the impoundment of Choke Canyon Reservoir. The significance of these periods is that inflow to the estuary decreased 39% from the first to second period, and 99% in the third period.

2.4 Was a sound ecological environment determined to exist at each selected site during the selected period? If not, were the underlying causes and/or modifications needed identified?

For the instream flows, a sound ecological environment was determined at all 20 locations with the caveat that this includes four stations that have undergone substantial hydrological modifications over the years. Two of these locations are below major reservoirs, while another (Oso Creek) is nearly 100% dominated by wastewater discharges.

For the coast, Corpus Christi Bay, Oso Bay, Baffin Bay, and Laguna Madre were deemed to be sound, but this conclusion was reached for different reasons in each bay (Section 1.3). The NBBEST concludes that freshwater has little direct impact on Corpus Christi Bay, including relatively limited reduction in salinity, even from large-scale floods. Baffin Bay and Laguna Madre are little affected by development and are naturally hypersaline. Oso Bay, with salinities largely driven by waste water treatment plant discharges, was found to provide habitat for many plant and animal species.

However, the NBBEST found that Nueces Bay and Nueces Delta are no longer ecologically sound environments (Section 1.3.2). The report presents a review of the natural history and environmental changes that occurred in the Nueces Delta and Nueces Bay over the past century (Section 2.8), and how these changes have been influenced by humans. The NBBEST concludes that the existing estuarine environments of the Nueces Estuary are not ecologically sound because: 1) hydrological alterations have caused the salinities in the Nueces Delta to be higher than in Nueces Bay, which results in a loss of a salinity gradient that influences zonation found in an ecologically sound estuary, 2) reduced overbanking below the Calallen tidal dam, and 3) reduced sediment supply, which is leading to erosion of the delta. The biological consequence is that the system has lost shellfish populations (which are indicators of freshwater inflow effects). The basis of this opinion is outlined in Sections 2.8, 4.3, and 4.4, which paints a picture of an estuary that at one time (i.e., in the 19th century) was much fresher and more productive. However, diminished freshwater inflows have contributed to it becoming more saline, less productive, and "more barren," as primarily indicated by the reductions of oysters and *Rangia* clams. The SAC believes this broad picture of an unsound Nueces Delta and Bay relative to that of the late 19th and early 20th Century is probably correct.

However, the relationship of increased salinity to periods of reservoir operation in the 20th century is open to other explanations. For example, the precipitation regime is apparently different during the three periods analyzed by the NBBEST (Figure 4.1.2 of the WAM-naturalized flow). Also, there has been some work in assembling historic precipitation data and dendroclimatology to construct variations in climate over the years, dating back to the early 19th century, and this information could have provided a more complete picture (see, e.g. Stahle and Cleaveland, 1995, Cleaveland, 2006, Banner et al., 2010 for dendrochronological studies in Texas; Loaiciga et al., 1993, for a general overview of the use of dendrochronology in hydrology; Lowry, 1959 and Mové et al., 1988 for analysis and historical data on drought cycles in Texas). During this entire period, the Nueces basin has alternated between high rainfall and low rainfall periods.

In addition to the many hydrological changes that have occurred in the Nueces Basin, it is possible that factors other than altered inflow play a role in the higher salinities. . Deepening of the ship channels could have introduced more oceanic salinity water from the Gulf of Mexico during tidal events, and the Nueces Bay power plant uses somewhat higher salinity ship channel water for cooling and discharges it into Nueces Bay. Given more time and resources for detailed studies, it would be useful to develop a salt budget for future planning purposes, and perhaps this should be included in the adaptive management phase.

Finally, the NBBEST report concludes that "restoration" of the Nueces Bay and Delta ecosystem is dependent upon restoring inflow. The bay has been greatly affected by other physical changes, especially dredging and dredged material disposal for navigation projects. Because large quantities of shell were removed,

oyster reef restoration (as well as increased flow) might be necessary for full restoration. Again, evaluation of options for managing the multiple stressors in this system should be included in the adaptive management work plan.

2.5 Was a functional relationship between flow regimes and ecological health developed? Or, were proxy or intermediate variables used? Are assumptions underlying the methodology clearly stated? To what extent were overlay considerations (sediment transport, water quality, nutrients, etc.) addressed?

For instream flows, a version of PHABSIM was used at three locations where site-specific field data were collected. The measure of ecological health was, in effect, abundance of individual fish species and associated habitat requirements, namely depth, velocity, and substrate. The individual photograph of each fish focal species provides a useful connection to existing conditions. The report does excellent work in presenting the WUA curves and the conversion of those results into a series of highly informative tables (Tables 3.3.3 through 3.3.8).

Along the way several key instream flow analysis decisions were reached by the NBBEST. The most puzzling is at the very start of the habitat modeling (Section 3.3.1.1.4), with the question posed to be addressed by the analysis (see 1.2 above). Nevertheless, the second major decision was the selection of the 0.5 habitat suitability value and above for all analysis. When a typical instream habitat model is run, it generates a range of habitat suitability values from 0 to 1 across and down the stream channel for evaluation. A zero does not register as habitat while a 1 is most preferred by whatever species you are working with. Choosing 0.5 and above means that you are only considering habitat in the river that is average to preferred. This is not uncommon in instream science and only highlighted here to carry forward the discussion.

The third important decision point was the selection of an "enoughness" threshold, which was developed and explained in one paragraph on page 3-42. An enoughness threshold is defined as a minimum percentage of maximum habitat that constitutes sufficient habitat for a particular species. Several percentages were evaluated and the NBBEST ultimately selected 75 percent for all three base flow ranges, and 20 percent for subsistence conditions. Some discussion or analysis in the report justifying these thresholds would have been informative and helpful in understanding the final recommendations, even though professional judgment is very much part of science and inherent in the BBEST process.

So, to answer the question of verifying the historical hydrology, the NBBEST then conducted an exercise to evaluate the HEFR results. For example, to receive an affirmative, a Base-Low HEFR result would need to provide 75% of the maximum habitat (remember not any habitat, but 0.5 or greater habitat) with the flow number generated by HEFR for each fish focal species. This is shown for each fish focal species for each of the three base flows and subsistence flow by the shaded boxes on Table 3.3.5 (Frio River at Concan) [see below, Page 3-46 NBBEST report]. Any unshaded boxes were then reviewed by the BBEST and in

all three model sites agreed acceptable by the NBBEST as no alterations were made via this analysis to any HEFR base or subsistence flow numbers in this report.

Table 3.3.5. Percent of maximum weighted usable habitat area with a 0.5 minimum quality threshold for 8 focal species resulting from Nueces BBEST flow recommendations at the Frio River at Concan. Shown are percentages for Subsistence and all three ranges of Base Flows. Shaded cells are those flows meeting "enoughness" thresholds of 20 percent for Subsistence flows and 75 percent for all three ranges of Base Flows.

Focal Species	Flow Component	Percent of Maximum Weighted Usable Area			
		Winter	Spring	Summer	Fall
Greenthroat darter	Subsistence	41%	38%	38%	38%
	Base-Low	82%	80%	73%	75%
	Base-Medium	90%	89%	83%	86%
	Base-High	96%	96%	93%	96%
Central stoneroller	Subsistence	60%	56%	56%	56%
	Base-Low	95%	92%	87%	89%
	Base-Medium	97%	98%	95%	97%
	Base-High	97%	97%	97%	97%
Texas shiner	Subsistence	57%	55%	55%	55%
	Base-Low	83%	80%	79%	79%
	Base-Medium	90%	89%	83%	87%
	Base-High	95%	94%	92%	94%
Guadalupe bass	Subsistence	63%	61%	61%	61%
	Base-Low	85%	84%	78%	80%
	Base-Medium	89%	88%	85%	87%
	Base-High	94%	94%	92%	94%
Gray redhorse	Subsistence	78%	76%	77%	77%
	Base-Low	91%	90%	88%	89%
	Base-Medium	94%	93%	91%	92%
	Base-High	95%	95%	94%	95%
Channel catfish, Adult	Subsistence	74%	73%	73%	73%
	Base-Low	84%	82%	82%	82%
	Base-Medium	87%	87%	84%	86%
	Base-High	89%	89%	89%	89%
Longear sunfish	Subsistence	78%	77%	77%	77%
	Base-Low	91%	90%	88%	88%
	Base-Medium	94%	93%	91%	92%
	Base-High	96%	96%	95%	96%
Largemouth bass	Subsistence	81%	80%	80%	80%
	Base-Low	92%	92%	90%	91%
	Base-Medium	93%	93%	92%	93%
	Base-High	97%	97%	95%	97%

The NBBEST did not take this analysis further to try and tease out some flow-ecological relationships that have been so very elusive throughout the SB3 process. For instance, it is interesting that for the Nueces River at Laguna (Table 3.3.3, NBBEST report) the lowest percent of maximum for Subsistence for any species is 49% whereas the enoughness threshold was selected at 20%. Conversely, a highly altered site (Nueces at Three Rivers, Table 3.3.7, NBBEST report) had percents of maximum habitat values below the enoughness threshold, yet this site was still deemed sound. The wide-range of habitat conditions deemed as "acceptable" subsistence conditions presented with these two examples beckons further analysis. Furthermore, an evaluation of the very same tables

shows that for all three examples the Base-High enoughness threshold of 75% was nearly always exceeded. In fact, the Frio at Concan site (Table 3.3.5, above) has Base-High percent of maximums for all species in the 90% or higher range, yet no alterations to HEFR were discussed. It will be important for the NBBEST to provide further clarification to the BBASC as to why the flow-habitat modeling work was not further explored or utilized.

The water quality, riparian, and geomorphology overlays for instream flows are generally well done. The water quality analysis is thorough and demonstrates the uniqueness of this basin with intermittent streams and extended periods of zero flows. The discussion of the primary purpose of pulse flows in replenishing perennial pools was very well written and informative. In general, even with the many challenges in this basin, high quality of river water is typical at most stations even under low-flow conditions. The riparian overlay is a well-written description of the dependence the riparian community upon river flow. However, site-specific data appears quite limited system-wide and this overlay could not be used to support any adjustments. The geomorphology overlay presents several water planning examples similar to what has been presented in previous BBEST reports. The report is unclear whether or not there is a direct interaction or effect of the geomorphic overlay on HEFR recommendations. Were pulses added to the HEFR regime in order to gain more total annual volume, which in turn would create more sediment yield or were those pulses already programmed in the default HEFR configuration? This is another area where the SAC recommends that the NBBEST should have extended conversations with the BBASC on the role of the multiple tiers of pulses.

In the estuarine analysis, the NBBEST benefited by at least four long-term and detailed studies performed specifically to identify flow-ecological relationships in Nueces Bay and Nueces Delta (see SAC comment 1.1 above). During those studies, extensive examinations of flow conditions and biological responses to flow regimes were made over all trophic levels. These studies were used to evaluate how flow regimes are related to ecological health, and to make recommendations for a flow regime to maintain ecological soundness. In addition, new work was commissioned by the NBBEST (using funds made available by reducing the SAC budget) to use a relatively new statistical technique called boosted regression trees (BRT) that uses the TPWD coastal fisheries monitoring program data and additional variables such as distance from the river or pass to calculate the preferred salinity zone of species and likelihood of finding these organisms under different salinity conditions. Together, these five studies were used to form the basis for a unique and credible approach that identified focal species (marsh plants, benthic infauna, and nekton), develop quantitative metrics between salinity and ecological integrity as evidenced by abundance, distribution, and diversity patterns as indicators of estuarine health, and make recommendations for baseline freshwater inflow needs and a regime to maintain these estuarine indicators in a healthy state (Section 4).

The nutrient consideration (Section 5.2) is limited to relatively recent data so temporal changes could not be addressed. The sediment consideration (Section 5.3) does take a long term view and is quite clear in the changes that have occurred. It recognizes that the recommended instream flow pulses in the recommendations will not provide the historical sediment inflows that existed before the development of the watershed and urbanization of the estuary.

2.6 Was a sound ecological environment demonstrated to be achieved at each selected site under conditions of the recommended flow regime?

Yes, for instream at all selected sites. However, to a certain extent, this was moot, since the stream and river segments were determined to be presently healthy, and the flow regime recommendation was to revert to historical-data-based flows (HEFR statistics for the instream flows), even though strict adherence to the HEFR-based flows and associated attainment frequencies does not specifically preserve the historical statistics of all flows.

Although well presented, it was not demonstrated that all of the flow components of the recommended instream flow regimes, including three levels of base flow and up to fifteen levels of seasonally-dependent high-flow pulses, are necessary to protect a sound ecological environment. It was unclear whether the NBBEST evaluated the potential for simplifying this matrix.

For the various estuarine systems, the attainment of the flow recommendations is somewhat more complex. Thus far, other bays along the Texas coast were characterized by their BBESTs as currently supporting a Sound Ecological Environment (SEE), despite a wide range of modifications from the natural condition, so consequently the inflow recommendations were designed to support what are essentially current conditions. The NBBEST made the judgment that a portion of their estuarine area, Nueces Delta and Nueces Bay, did not pass the SEE muster. This judgment is based on a combination of historical information documenting how Nueces Bay once had thriving oyster and *Rangia* clam populations that are no longer present, and an understanding of the changes in inflows that have occurred as the human population has increased. This judgment required establishment of freshwater inflow needs and has led to very different estuary inflow recommendations for Nueces Bay than currently exist (compare Figures 6.2.1 and 6.2.2).

Our goal in providing SAC comments is not to question the judgment of BBESTs on what constitutes a SEE, but rather to insure that there is a measure of consistency in scientific methods and practicality in the recommendations put forward. On the consistency point, there is little difference in scientific approach employed by the NBBEST and other BBESTs. The other BBESTs developed recommendations to protect conditions that exist now as a result of the many man-made changes, while the NBBEST has developed recommendations to

determine inflow needs to achieve a SEE, and consequently would create conditions that would theoretically restore shellfish and marsh habitats.

There is nothing wrong with setting an inflow regime goal at a level that appears to have existed before major population moved into the watershed and water needs developed. That would seem to be a perfectly valid goal that offers opportunities to approach the habitat improvements identified with a number of methods. But while the goal is established by the NBBEST, the BBASC must also consider the human water needs under existing or projected water demand scenarios. Section 6.2 presents a comparison of the existing Agreed Order to the NBBEST recommended flow regimes.

One point lacks clarity, the last paragraph on page 5-3 simply says it is not appropriate to compare the river inflow regime to the bay regime because they are different, when in fact the river is the conveyance of water supply for the City of Corpus Christi, so the flow at Mathis is not related to flows at Calallen that would enter the bay. The section 5.4 language is more explicit in the recommended regime not being achieved and the opportunities to explore alternative ways.

2.7 Is uncertainty in the analyses described or quantified? Where models were employed, was the extent of validation and associated predictive errors described and quantified?

While variability is dealt with in nearly all the technical analyses in Sections 3 and 4, it is not addressed in the flow recommendations in Section 6. In fact, the term "uncertainty" appears only in the instream modeling section, pertaining to flow-habitat modeling, specifically with regard to habitat criteria and hydraulic modeling (where it is addressed qualitatively), and nowhere else in the document - especially not in the estuary section. The analytical tools that were used would very easily enable the estimation of uncertainty bounds, and it would have been beneficial if the NBBEST addressed uncertainty more fully. We observe that some of the numbers in Table 4.5.1 are thresholds (e.g., 166,000 ac-ft/yr) while some are midrange, about which there is considerable leeway, as suggested by the range of optimal salinities for the focal species.

Summary

The Nueces BBEST was in the fortunate position that allowed it to start its work early, and indeed present a report almost five months prior to its due date, which provides the BBASC additional time to complete their deliberations. Overall, the NBBEST is to be commended for all the hard work conducted and for advancing the understanding of ecological conditions throughout the basin. The report is a detailed presentation with well-documented science, contains a focused approach, and takes on the difficult but necessary issue of sound ecological environment in a thoughtful way. Section 7 which addresses Adaptive Management is an excellent addition to this report. It is thorough, its presentation succinct, and it establishes a good foundation for the Work Plan to be developed by the BBASC.

The finding that Nueces Bay and Nueces Delta are unsound ecological environments presents a unique challenge to the Nueces BBASC, not heretofore faced by any other BBASC nor the TCEQ; namely, to consider development of management goals to move toward a sound ecological environment for Nueces Bay and Nueces Delta. Furthermore, because the Mathis gage instream flow regime does not represent flow to the bay, this presents an additional challenge to formulating recommended standards, and strategies to meet the standards to the maximum extent possible.

The Nueces Bay recommendation is presented in Table 4.5.1 (page 4-43, and then again in Table 6.1.2.1. There is one point of confusion, and that is whether the NBBEST is recommending the application of both seasonal and annual flow volumes. The footnote to Table 4.5.1 adds to the confusion and appears to be an operational recommendation. The SAC suggests that the NBBEST clarify the application of this recommendation to the Stakeholders.

In Section 6, two projects and alternatives are examined which culminate in conclusions on page 6.38 as follows, **"These two examples also highlight the very significant differences between perennial and intermittent streams and between the relative ecological risks associated with on-channel reservoirs as compared to run-of-river diversions with (or without) off-channel storage. Regarding the latter point, *the Nueces BBEST recommends regulatory consideration of site-specific geomorphology and aquatic and riparian habitat studies in the permitting of any large, on-channel reservoirs in the Nueces River Basin.*"** This site specific study recommendation raises a valid point, and the NBBEST should hold extensive conversations with the BBASC to explain the basis of this recommendation.

Although an excellent report overall, there are a few places where the report could have provided more explanation and these are highlighted below:

- While the data analyses presented in the estuary section of the report and much of it is excellent ancillary information that fills out the picture of the Nueces estuary and ecosystem, some of it is obscure and its immediate bearing on the inflow issue is not at all clear. This makes it difficult to follow the reasoning that results in recommendation presented in Table 4.5.1. This could have been easily clarified by inserting statements of why the NBBEST is addressing this topic, what the conclusion is, how we are going to use the result. For example, while the drought analysis is very interesting, how was it used?
- The relation between Rincon flow and (pore) salinity shown in Fig 4.3.4 is clear, as is the relation of *Spartina* coverage to salinity in Figs 4.3.2 and 4.3.3. A better explanation of how the NBBEST arrives at 166,000 ac-ft/yr (which appears only in the caption of Table 4.3.1) in the Nueces would have been helpful.
- While it looks like the Salt03 vs. cumulative monthly inflow at Calallen gage in Fig. 4.2.1 is the main device for relating flow to salinity, it is not clear how this is related to the TPWD monitoring results displayed in maps in Fig. 4.1.5.

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