TRANS-TEXAS WATER PROGRAM

West Central Study Area

Phase II

Comments

March 1998

HDR Engineering, Inc.

San Antonio River Authority

San Antonio Water System

Edwards Aquifer Authority

Guadalupe-Blanco River Authority

Lower Colorado River Authority

Bexar Metropolitan Water District

Nueces River Authority

Canyon Lake Water Supply Corporation

Bexar-Medina-Atascosa Counties WCID No. 1

Texas Natural Resource Conservation Commission

Texas Parks and Wildlife Department

Texas Water Development Board

GUADALUPE-SAN ANTONIO RIVER BASIN MODEL MODIFICATIONS AND ENHANCEMENTS

TRANS TEX
C3-23-98-4

TEXAS WATER DEVELOPMENT BOARD

March 18, 1998

Mr. Steve Raabe, P.E.
San Antonio River Authority
P.O. Box 830027
San Antonio, Texas 78283-0027

Re: Texas Water Development Board (Board staff) Comments on Trans-Texas Water Program "Guadalupe-San Antonio River Basin Model Modifications and Enhancements"

Dear Mr. Raabe:

Board staff has reviewed the above-referenced report and have no comments on the draft report.

The Board looks forward to receiving one (1) unbound camera-ready original and nine (9) bound double-sided copies of the Final Report on this planning project. Please contact Mr. Gordon Thorn, Director, Research and Planning Funds Management Division, at (512) 463-7979, if you have any questions about the Board's comments.

Sincerely,

Tommy Knowles

Tommy Knowles
Deputy Executive Administrator
for Planning

CONCEPTUAL EVALUATION OF SPRINGFLOW RECIRCULATION

TRANSTEX
03-31-98-1

TEXAS
PARKS AND WILDLIFE DEPARTMENT

4200 SMITH SCHOOL ROAD • AUSTIN, TEXAS 78744 • 512-389-4800

March 27, 1998

Mr. Steve Raabe, P.E.
San Antonio River Authority
P.O. Box 830027
San Antonio, TX 78283-0027

Mr. Raabe:

Texas Parks and Wildlife Department staff have received the following Trans-Texas draft reports:

- Updated Evaluation of Potential Reservoirs in the Guadalupe River Basin
- Conceptual Evaluation of Springflow Recirculation
- Edwards Aquifer Recharge Update
- Modification of Principle Spillways at Existing Flood Control Projects for Recharge Enhancement
- Summary Report of Water Supply Alternatives

Staff comments are presented in the appendix concerning the concept of springflow evaluation. No comments are offered at this time on the other draft reports due to the compressed time schedule afforded for review. We look forward to continuing our work with the Region L Planning Group to identify the most environmentally responsible solutions to the regions water needs.

Sincerely,

Randall E. Moss

Randall E. Moss, Ph. D.
Coordinator, River Studies Program
Resource Protection Division

Appendix

Texas Parks and Wildlife Department staff comments concerning the draft report entitled, "Conceptual Evaluation of Springflow Recirculation" prepared by HDR Engineering, Inc. dated March 1998.

Although the concept of springflow recirculation is intriguing and should be further evaluated, it is appropriate to point out that some of the benefits attributed to recirculation could be achieved by reducing pumping of the Edwards Aquifer. The preliminary results presented in the draft report indicate that there will be impacts to instream flows in the Guadalupe River downstream of the diversion point and minor impacts to major senior water rights. What would the impacts be if "minimum" flows at Comal Springs were required to be 150 or 200 cubic feet per second (cfs), which may be more appropriate. The tradeoffs associated with providing additional private groundwater resources at the expense of public surface waters and its users will need to be assessed, as will other legal and institutional issues. Further analyses and enhancements to the model, including the ability to manage on a daily basis, would allow water planners to balance tradeoffs. In addition it will be necessary to evaluate springflow recirculation in combination with other supply options to more accurately assess impacts to aquatic environments.

It was not clear why 60 cfs was chosen as the flow to provide at Comal Springs. The U.S. Fish and Wildlife Service (USFWS) stated in their filings that with very effective ramshorn snail control and the ability to control the timing and duration of low springflows, flow levels could be reduced to 60 cfs for short time periods during certain times of the year. If additional evaluations are done, the model should recognize that, according the USFWS, flows greater than 150 cfs at Comal Springs are needed "to avoid appreciable reduction in the likelihood of survival and recovery of the fountain darter." Two-hundred (200) cfs is the springflow at Comal Springs at which fountain darters begin to be "taken" as springflow drops. Also, consideration should be given to the habitat requirements of the endangered Comal Springs riffle beetle, Comal Springs dryopid beetle, and Peck's cave amphipod.

Although it is tempting to try to predict fisheries harvest (Table 3.1-1 and 3.1-2) it is not necessarily valid to evaluate the impact to San Antonio Bay by calculating fisheries harvests for a single supply option. In addition to cumulative impacts to the estuary associated with the combination of all water development projects, it is also necessary to consider other factors such as nutrient and sediment loads and salinities in sensitive estuarine and deltaic habitats. The fisheries harvest relationships are intended to relate harvest to inflow for use in TWDB's TxEMP optimization model. Results of the optimization model yield a range of annual freshwater inflow targets, distributed by month, that would provide the freshwater, sediments and nutrients for an ecologically sound estuary. The San Antonio and Guadalupe Rivers should be managed with the goal of providing freshwater inflows to San Antonio Bay to meet the monthly freshwater inflow targets.

The option of temporarily halting recirculation diversions during critical shortages to minimize impacts on downstream water rights was discussed. What effect(s) would this temporary (duration?) halting of recirculation diversions have on discharge from springs, especially considering that the timing would likely coincide with drought or dry conditions?

TRANSTEX
03-27-98-1

INLAND OCEAN, INC.

March 26, 1998

P.O. Box 6949
San Antonio, Texas 78209-0949
Telephone (210) 366-2882
Fax (210) 366-2885

Mr. Steven J. Raabe
San Antonio River Authority
P.O. Box 83027
San Antonio, Texas 78283

Re: Comments Concerning
Trans-Texas Water Program
Conceptual Evaluation of
Springflow Recirculation

Dear Sir:

The report provides some interesting and welcome data that should prove helpful to implementing a water plan for the region. My comments follow:

1. On page 6-1 in the Summary, the diversions were limited to above 60 cfs from Comal Springs and 160 cfs from the combined springs. More water could be made available for use if these amounts are also allowed to be recirculated. Springflow would be maintained for longer periods and water levels would improve in the two scenarios of 200 cfs and 400 cfs.

The scenario of recirculating these additional amounts should also be considered since they have already passed through the springs and have served the purpose of providing for enhanced springflow.

2. On page 6-4 and 7-1 of the Conclusion, the statements are made concerning whether the 400 cfs option is economical. The word "however" in the last sentence of the second paragraph on page 7-1 should be omitted.

Whether the project becomes economical is dependent on many choices and policy decisions that are not yet made. The incremental cost is not a good standard to determine the value of various alternatives. If this option in conjunction with recharge or flood control or interbasin transfers proves to be a viable solution at an overall reasonable cost then the subjective statement on economics may prove incorrect.

"Is not economical" should be removed as it renders a judgement we are not yet able to make.

3. There are many options to consider in the future (some have been mentioned) including other diversions to recharge from the Guadalupe River.

Sincerely,

Hans R. F. Helland

TRANS-TEXAS WATER PROGRAM

WEST CENTRAL STUDY AREA

DRAFT

PHASE 2

CONCEPTUAL EVALUATION OF SPRINGFLOW RECIRCULATION

San Antonio River Authority
San Antonio Water System
Edwards Aquifer Authority
Guadalupe-Blanco River Authority
Lower Colorado River Authority
Bexar Metropolitan Water District
Nueces River Authority
Canyon Lake Water Supply Corporation
Bexar-Medina-Atascosa Counties WCID No. 1
Texas Natural Resource Conservation Commission
Texas Parks and Wildlife Department
Texas Water Development Board

This document is released for the purpose of review under the authority of Samuel Kent Vaugh, P.E. Texas P.E. No. 63487 Date: March 6, 1998.

HDR

HDR Engineering, Inc.

Austin, Texas

March 1998

This document is released for the purpose of review under the authority of Larry F. Land, P.E. Texas P.E. No. 31380 Date: March 6, 1998.

This document is released for the purpose of review under the authority of Kenneth Leo Choffel, P.E. Texas P.E. No. 45686 Date: March 6, 1998.

INLAND OCEAN, INC.

P.O. Box 6949
San Antonio, Texas 78209-0949
Telephone (210) 366-2882
Fax (210) 366-2885

March 26, 1998

Mr. Steven J. Raabe
San Antonio River Authority
P.O. Box 830027
San Antonio, Texas 78283

Re: Comments on
Trans-Texas Water Program
Modification of Principal
Spillways at Existing Flood
Control Projects

Dear Sir:

Thank you for pursuing and finalizing this work.

On page 2-2 in the last paragraph, it is mentioned that 6 of the 10 Salado Creek flood control structures were not considered for further study. On page 6-1 the sites 4, 5 6, and 10 were left open for future assessment. With #8 out due to comments on page 2-2 that leaves one without any comment in this part of the report.

It is also not clear why the other five (except #8) were not considered. If it was cost related that should be mentioned. The reasons of existing development, commercial activity and downstream water rights are not clear. The flood pool and easement required should not change with this operation. If there is a water right problem, what is it, it may make sense to buy it, depending upon what it is.

A more detailed discussion of these reasons itemized by individual dam site may be a necessary appendix.

Sincerely,

Hans R. F. Helland

TRANS-TEXAS WATER PROGRAM

WEST CENTRAL STUDY AREA

PHASE 2

MODIFICATION OF PRINCIPAL SPILLWAYS AT EXISTING FLOOD CONTROL PROJECTS FOR RECHARGE ENHANCEMENT

San Antonio River Authority
San Antonio Water System
Edwards Aquifer Authority
Guadalupe-Blanco River Authority
Lower Colorado River Authority
Bexar Metropolitan Water District
Nueces River Authority
Canyon Lake Water Supply Corporation
Bexar-Medina-Atascosa Counties WCID No. 1
Texas Natural Resource Conservation Commission
Texas Parks and Wildlife Department
Texas Water Development Board

This document is released for the purpose of review under the authority of David D. Dunn, P.E. Texas P.E. No. 82630 Date: March 6, 1998.

HDR Engineering, Inc.

Austin, Texas

This document is released for the purpose of review under the authority of Kelly Jay Kaatz, P.E. Texas P.E. No. 75421 Date: March 6, 1998.

March 1998

This document is released for the purpose of review under the authority of Samuel Kent Vaugh, P.E. Texas P.E. No. 63487 Date: March 6, 1998.

GUADALUPE-SAN ANTONIO RIVER BASIN ENVIRONMENTAL CRITERIA REFINEMENT

TRANSTEX
C4-03-98-7

TEXAS WATER DEVELOPMENT BOARD

March 25, 1998

Mr. Steven J. Raabe, P.E.
San Antonio River Authority
P.O. Box 830027
San Antonio, Texas 78283-0027

Re: Texas Water Development Board (Board staff) Comments on Trans-Texas Water Program "Guadalupe-San Antonio River Basin Environmental Criteria Refinement"

Dear Mr. Raabe:

Board staff has reviewed the above-referenced report and offer the following comments shown in Attachment 1.

The Board looks forward to receiving one (1) unbound camera-ready original and nine (9) bound double-sided copies of the Final Report on this planning project. Please contact Mr. Gordon Thorn, Director, Research and Planning Funds Management Division, at (512) 463-7979, if you have any questions about the Board's comments.

Sincerely,

Tommy Knowles
Deputy Executive Administrator
for Planning

cc: Sam Vaugh, P.E. , HDR Engineering, Inc.
Gordon Thorn. TWDB

ATTACHMENT 1

TEXAS WATER DEVELOPMENT BOARD

COMMENTS ON TRANS-TEXAS WATER PROGRAM
"Guadalupe-San Antonio River Basin Environmental Criteria Refinement"

This report is a general environmental criteria evaluation on the alternative water supply projects for the San Antonio and Guadalupe River basins, based on the three-zoned Environmental Water Needs Criteria of the Consensus Planning Process, referred to as the "Consensus Criteria." The contractors have met with all the elements in the Scope of Services, have provided exceptional descriptions of the evolution of the consensus criteria through an interagency team of scientists and engineers, and have well documented these discussions within the report. However, we take exception to the statements made about the Consensus Criteria causing unnecessary restrictions on reservoir operations.

The consensus process provides for aquatic life protection, while providing as much firm yield as can safely be developed by water supply projects. While it is true that the transition through boundaries between the three zones under the Consensus Criteria results in diminishing diversions as ambient streamflows approaches the flow limits, all environmental criteria do that in one way or another. The Consensus Water Planning Committee recognized that these environmental criteria are generalized for the entire state and in some cases may cause operational difficulties. However, any difficulties of this type can be dealt with through the permitting process.

Although the Consensus Criteria are provided in Appendix A of this report, there are numerous missing pages, suggesting that only one side of the two-sided document was copied and included in the appendix.

We recommend that the contractor remove the statement (3:33-34)implying that the Consensus Criteria are unnecessarily restrictive during times of plentiful flow (the Zone 1 period), in part because it will give readers a false impression of the environmentally safe operating rules developed by scientists and engineers in a rigorous interagency process. The Consensus Criteria were established to provide an operational criteria for balancing the needs of water storage with environmental needs.

The transition through the various zones of the Consensus Criteria is described in the draft report as an operational process that will lead to

ramping flow in transition through each zone. We understand that this is probably true and that it may be necessary to implement a "smoothing function"in the permitting process to avoid these unsteady flows. The authors are correct in their assessment that the river flow triggers for the various zone will result in ramping flows. It is not our intent for that to actually occur, and we believe that a smooth transition between the zones should be implemented during the permitting process. The Consensus Criteria are intended to be a water planning criteria. The permitting process will require site-specific field assessments, rather than blind use of the Consensus Criteria. If there are any operational difficulties that may apply to a specific reservoir project, then it will be determined and dealt with in the permitting process.

TEXAS
PARKS AND WILDLIFE DEPARTMENT
4200 SMITH SCHOOL ROAD • AUSTIN, TEXAS 78744 • 512-389-4800

March 27, 1998

Mr. Fred Pfeiffer, General Manager
Chairman of the Policy Management Committee
of the Trans-Texas Water Program, West Central Study Area
San Antonio River Authority
P.O. Box 830027
San Antonio, TX 78283-0027

Dear Mr. Pfeiffer:

Texas Parks and Wildlife Department staff reviewed the draft report titled, "Guadalupe-San Antonio River Basin: Environmental Criteria Refinement" prepared by HDR Engineering, Inc. and Paul Price Associates, Inc. dated March 1998 and have the following comments.

One strong conclusion that can be drawn from the HDR effort is that planning cannot parallel regulatory type environmental studies if those studies do not contribute to realistic environmental assessments. The water quality modelling on the San Antonio River can be summarized as: if a high quality effluent is discharged that dominates the instream flows of the river and the actual basis of water quality standards (especially aquatic life uses) are not considered, then any instream flow is adequate to maintain water quality. That is not a particularly meaningful result. For the Guadalupe River, to model through mainstem impoundments that are characterized by massive amounts of aquatic vegetation rather that break the modelling into reasonable segments as would a TNRCC modeler, then to superficially address aquatic life use, extrapolate from an upper San Marcos River biological sample to the Guadalupe R. mainstream at Victoria for habitat conclusions is inappropriate.

It was apparent that the intent of the Environmental Criteria Subcommittee was to refine, for sensitivity analysis, "the selection of appropriate desired minimum instream flows for Zones 2 and 3" based upon regional features specific to the Guadalupe-San Antonio River Basin, "not to reassess all aspects of the Consensus Criteria" (Proposed Work Plan - Environmental Criteria Refinement; HDR Engineering, Inc./Paul Price Associates, Inc.; July 24, 1997). However, Department staff believe that the process of "refinement" is beyond the scope of this project. For example, staggering triggers and target flows and ramping of diversion rates through zones defeats the purpose of having triggers and target flows and effectively limit protection of instream flows to Zone 3 target flows designed for maintenance of water quality. Given that the recommendation of one single minimum flow (25th percentile flows for the month of August; Section 3.2.2) for Zone 2 contradicts the tenets upon which the Consensus Criteria were developed (specifically, that seasonal variation in streamflow is a necessary component of healthy aquatic ecosystems) and that refining Zone 2 target flows had

little or no effect on increased firm yield (Section 4.0 - Sensitivity Analysis) Zone 2 manipulations should be abandoned.

Department staff believe that extrapolation of results from an instream flow study on the San Marcos River to the macrohabitats and biology of the Guadalupe-San Antonio River Basin (presented in Section 3.0) cannot be adequately evaluated and should be considered fundamentally flawed. The document "Instream Flow Study of the San Marcos River" prepared by Paul Price Associates, Inc. is not available for review by TPWD staff, has not to our knowledge received any peer review, and is a document used to support a water right application by the City of San Marcos. Staff contend that the foundation of the extrapolation is flawed (see attached comments), consequently the conjecture that minimum monthly 25th percentile flows (i.e. August 25th percentile flows) are protective of biological resources in the Guadalupe and San Antonio Rivers is erroneous. Furthermore, Section 3.0 contains technical errors, substantial oversights and unsupported generalizations and assumptions. Staff comments on the draft report are included as an appendix.

We look forward to continuing our work with the Region L Planning Group to identify the most environmentally responsible solutions to the the regions water needs.

Sincerely,

Larry D. McKinney by REM

Larry D. McKinney, Ph. D.
Senior Director for Water and Resource Protection

Appendix

Texas Parks and Wildlife Department (TPWD) staff comments concerning the draft report entitled "Guadalupe-San Antonio River Basin: Environmental Criteria Refinement" prepared by HDR Engineering, Inc. and Paul Price Associates, Inc. dated March 1998.

Pg. 1-1 TPWD staff would advise against calling the 7Q2 "the water quality standard used by the TNRCC." The State of Texas Water Quality Standards (§§307.3) describes the 7Q2 as the flow used for determining the allowable discharge load to a stream; not as a standard. In addition, the low flow criteria are identified as being "solely for the purpose of defining the flow conditions under which water quality standards apply to a given waterbody. Low flow criteria...are not for the purpose of regulating flows in waterbodies in any manner or requiring that minimum flows be maintained in classified streams."

Pg. 2-3 Table 2-1 CR = Contact Recreation; A "Type 1" impact could result in a lowering of the DO if complete mixing of the effluent and receiving water has not occurred prior to diversion.

Pg. 2-17 Detailing the limits of QUAL-TX is important and beneficial. For example, are these limitations severe enough to preclude the use of QUAL-TX for setting minimum streamflow conditions? What seems especially pernicious are steady state assumptions, the limitations of the model when dealing with plant respiration, and the use of 24-hour averaging rather than daily minima. How does the model handle flows into backwaters, reservoirs, and pools?

Pg. 2-18 Is it appropriate to use "naturalized" 7Q2 flows. TNRCC water quality modeling uses 7Q2's derived from the last 20 years of data. Effluent limits are based on existing conditions, not a mythical naturalized flow.

Pg. 2-83 What is the idealized 7Q2 baseflow? How is it calculated?

Pg. 2-93 Based on maintaining water quality as measured by DO, the Zone 3 flow at Falls City could be reduced below 10 cfs and at Goliad to less than 1% of the published 7Q2. It is possible that the TNRCC would have to declare degradation. Stream impairment could be severe and chronic. This demonstrates the fallacy of using DO as a surrogate measurement of water quality.

In general, how would increased re-use affect the results of this analysis? decreased input from groundwater sources?

BIOLOGICAL STUDIES

GENERAL COMMENTS

Extrapolation of San Marcos River Conditions to Guadalupe and San Antonio Rivers

The report extrapolates on conditions drawn from a detailed instream flow study on the lower San Marcos River to estimate proposed similar conditions in the lower Guadalupe and San Antonio rivers. The study of fish habitat and instream flows in the San Marcos River was not available for review by TPWD staff, has not to our knowledge received any peer review, and is a document used to support a water right application by the City of San Marcos. These factors preclude a reasonable assessment of its relevance and credibility, and its use to form a basis of extrapolation from aquatic habitats of the San Marcos River to the Guadalupe and San Antonio Rivers. Additionally, any habitat similarities among the lower San Marcos River and the lower Guadalupe and San Antonio Rivers are likely superficial at most, and any specific comparisons among these respective stretches of streams may well lead to gross experimental error and flawed conclusions regarding instream flow requirements.

A comparison of stream habitats cannot be isolated from the other factors that play a role in the distribution and habitat use of stream fishes. For example, the river continuum concept discusses the longitudinal succession of physical, chemical, and biological characteristics of streams. The report does not address this important stream ecology concept in the extrapolation. Another oversight concerns the effect of water quality on the distribution of aquatic organisms and their utilization of stream habitat. Another confounding issue is related to the transferability of results from fish habitat utilization data collected from the San Marcos River to the other rivers. The instream flow literature is replete with studies assessing transferability of habitat utilization data. This report purely assumes that habitat utilization would be similar between river systems; no tests of transferability were conducted nor discussion of transferability issues relevant to the assumptions. A presumed similarity in macrohabitats and fish communities does not necessarily lead to similarity in habitat utilization.

Although the natural flow frequencies indicate that the highest and lowest median daily streamflows occur in the months of May and August (respectively) for the three river systems, the magnitude of these flows is very different (Pg. 3-19 and Figure 3-1). Another example is that median average daily discharge of the two river systems is vastly different as reported (San Marcos River = 202 cfs and Guadalupe River at Victoria = 985 cfs). The effect of hydrologic scale on the feasibility of the extrapolation was not adequately addressed. Given the differences in hydrologic scale, it is difficult to conceive how macrohabitats in the lower portion of the San Marcos River can be considered sufficiently similar to those in the Guadalupe and San Antonio Rivers to form a foundation for extrapolating habitat utilization and instream flow recommendations.

Target Flows

The use of the term "minimum flow" is inappropriate in the context of Consensus-Based Environmental Water Needs Criteria. The more appropriate term is target flow; this term indicates a flow regime that differs for each month and varies depending on hydrologic conditions. Minimum flow refers to one single "protective" flow regardless of month, season, or hydrologic condition.

The construction of one single "minimum flow" (25th percentile flows for the month of August) for Zone 2 contradicts the tenets upon which the Consensus Criteria were developed (specifically that seasonal variation in streamflow is a necessary component of healthy aquatic ecosystems). Stream ecosystems are dynamic for a multitude of reasons: hydrological variability, longitudinal succession, dynamics in biological communities, physical and chemical dynamics, etc. Maintaining stream ecosystem dynamics is vital for maintaining biological diversity and integrity. "Minimum flows" ignore the importance of ecosystem dynamics, habitat bottlenecks, energetics, long-term reproductive success, community ecology, stream ecology, feeding ecology and many other ecological considerations, water quality, aquatic-terrestrial interactions, and geomorphological characteristics, too name a few. Seasonal variation in the target flows is not merely a "postulated need to mimic seasonal variability" but was based on a firm foundation of stream ecology and supported by the Instream Flow Subcommittee of the Ecological Needs Technical Advisory Committee, the Instream Flow Task Force, and is one of the characteristics of healthy aquatic ecosystems (Consensus-based Water Planning). Its importance is also well indicated in the literature.

Riffle Habitat and Invertebrates

This section of the report also makes repeated mention of the paucity of shallow riffle habitat in the lower Guadalupe River, and it further suggests that the "inundated" (not clearly defined) conditions observed in the lower river are not the norm. However, with historically higher flows in the Guadalupe (pre-reservoir/aquifer pumping), the "inundated" condition may well have been more common in this lower river system although hydrological modifications may have caused some channel alterations. Shallow riffle habitat for this stretch of stream probably has never been substantial because river flows likely were higher in the past. The report correctly identifies snags as providing important habitat for aquatic invertebrates. Such habitat is abundant in most coastal streams in the southern U.S. and its importance is well documented in the literature. However, the report appears to assume that shallow riffle habitat is the key habitat for macroinvertebrates in this system and that the deeper runs do not provide substantial habitat. Conversely, runs in this portion of the river provide ample habitat for aquatic invertebrates and assuming they do not is a serious flaw in the logic of this report. Although shallow riffle habitat is a critical habitat type (first to show impacts of diversions) it is also easier for biologists to sample, not necessarily a "better" habitat for invertebrates. Certainly, the species composition among these types of habitats is in part different, but deeper runs and snags clearly are the dominant habitat.

Other General Comments

Unsupported statements and assumptions are made frequently, some of which are critical to evaluating the credibility of this report.

Unsupported statements that setup biased interpretations are found within the report. For example, 41% of the species in the Guadalupe are known to maintain populations in lentic habitats. This may be true in some cases, but to state that these species would also be tolerant of prolonged periods of low to zero flow is completely unfounded. This narrow focus ignores the importance of long-term success of species, water quality considerations, competition and predation, etc. In fact, a multitude of interconnected factors determine survivability , which is very different than tolerance. Dissolved oxygen levels can be depleted as water temperatures rise and respiration increases in pools with low or low flow. Competition and predation increases as habitat availability and food resources diminish. Just because some stream fishes can maintain populations in lentic habitats under certain conditions does not mean those species can survive prolonged periods of low or no flow under all conditions.

SPECIFIC COMMENTS

Pg. 3-2 Direct diversion projects are discussed as isolated events. Cumulative effects on lotic ecosystems can be rather extreme. For example, direct diversion projects located downstream of hydropower operations, flood storage reservoirs, or deep storage reservoirs or other direct diversions can exacerbate hydrological, physical, and water quality impacts.

Pg. 3-5, paragraph 3 ("At flows as high..."): This sentence suggests that the inundated condition is not normal. However, with historically higher flows in the Guadalupe (pre-reservoir/aquifer demands) the "inundated" condition may have been more common in this lower river system.

Pgs. 3-7–3-8 Table 3-1 "FS" should be defined fluvial specialists and "HG" defined habitat generalists in the table caption. "L" should be defined lentic in table caption and lentic defined. Do all the habitat generalists in the table: occur only in lentic habitats, survive in lentic habitats, or can suffice in lentic habitats over long time periods? The classification system employed creates difficulty in evaluating the basis for eliminating species from evaluation.

On page 3-9, habitat generalists are defined as species that use a variety of lotic habitats, and which may display a variable selectivity with respect to physical habitat. Habitat generalists are excluded from the evaluation because they tend to be poor indicators of critical flow conditions. This generalization seems to ignore or not incorporate the later portion of the definition and is unreasonable. Not all habitat generalists at all times are poor indicators of critical flow conditions. For example, are all populations of blacktail shiners habitat generalists; are there critical life stages for some habitat generalists?

The designation of *Dionda* spp. as habitat generalists is questionable given that they inhabit spring-influenced headwaters. Like-wise the exotic suckermouth catfish is designated habitat generalist. What is the basis for this?

Fishes designated as plateau species were eliminated from the evaluation. The basis for this is unclear.

Problems with fish distributions were identified. (e.g., *Notropis chalybaeus* occurs within the Guadalupe Basin only as a disjunct population in the San Marcos River headwaters (Hubbs et al. 1991.))

Pg. 3-10 The fish species noted to have increased in abundance with improving water quality (threadfin shad, green sunfish, longear sunfish, warmouth) are not species typically associated with high water quality; nor are common carp. Is there a direct correlation between improving water quality and fish diversity/abundance, or is some other variable responsible?

Pg. 3-11, paragraph 2 *Procambarus clarki* is spelled incorrectly. Last sentence: according to Robert Howells (TPWD, Heart of the Hills Research Station), this statement is incorrect, *i.e.*, native mussel populations in the lower Guadalupe River have sharply declined over the years and both in terms of species richness and abundance.

Pg. 3-11, paragraph 3 Again, shallow riffle habitat at this area may never have been abundant because river flows likely were higher; thus runs and snags probably served, as they do today, as important habitats for macroinvertebrates. Why assume that shallow riffle habitat is the key habitat is this system? Shallow riffle habitat is only easier for biologists to sample, not necessarily a better habitat for invertebrates.

Pg. 3-12 and 3-13 (Table 3-2) Several comments as follows:

a. There is no particular order to this table with respect to phylogeny. For the Trichoptera, for example, several genera are listed under the family Leptoceridae rather than under the families to which they actually belong. Other examples are found in the remainder of the Table.

b. Specimens of the caddisfly genera *Agraylea* and *Glossosoma*, and the family Limnephilidae certainly were not collected from the lower Guadalupe River. For *Agraylea* and *Glossosoma* this would represent range extensions of several hundred miles. Moreover, it also is doubtful that representatives of *Culoptila* and *Leucotrichia* were collected in that the lower Guadalupe River would represent highly atypical habitat for these genera. Astonishingly, no examples of the caddisfly genus *Smicridea* were reported although *S. fasciatella* is quite common in this stretch of river.

c. *Protoptila* is spelled incorrectly.

d. Ceratopogonidae is spelled incorrectly.

e. The genus *Simulium* (family Simuliidae) is incorrectly listed with the Chironomidae.

f. Neither of the two stonefly genera reported would be expected to occur in the Guadalupe River and certainly not *Pteronarcys*. Again, examinations of previously known distributions of these genera should be made before reporting them from collections. *Anacroneuria* does occur in Texas, but not that far south. Surprisingly, *Neoperla clyme* nor *Acroneuria arida* were reported; both of which were reported from this location in the published literature. The former species actually is quite abundant in the lower Guadalupe River.

g. Why were the large specimens of *Corydalus* and *Corbicula* excluded from the biomass estimates? Simply because they were large? If so, this makes little sense.

Pg. 3-14 caglei is misspelled. New information about habitat requirements and the distribution of Cagle's map turtle were not fully considered in the report. No reference is made to two very important works, among others, on Cagle's map turtle (Killebrew 1991, 1997). One specific point extracted from Killebrew (1991; Habitat characteristics and feeding ecology of Cagle's map turtle (*Graptemys caglei*) within the proposed Cuero and Lindenau reservoir sites; prepared for TPWD) is that "adult males spend most of their time feeding in riffle and transition areas." Why the analysis of map turtle habitat is restricted to Victoria County reach of the Guadalupe River is not clear. Cagle's map turtle is found only in the Guadalupe River system in Kerr, Kendall, Comal, Guadalupe, Gonzales, Dewitt, and Victoria Counties. According to the Federal Register (Vol. 58, No. 13; January 22, 1993) "the petition to list Cagle's map turtle is warranted but precluded by listing actions of higher priority." Although published five years ago, the supplementary information in the petition finding provides a much better synopsis of Cagle's map turtle biology.

Pg. 3-14 The blue sucker actually is listed as a state threatened species and is not considered endangered.

Pg. 3-14 The last paragraph is confusing; the jump from the Guadalupe and San Marcos River studies to the "Bastrop reach" of the Colorado River needs further clarification.

Pg. 3-16, last sentence and Pg. 3-23 In reference to the movement of riffles down the bedslope toward the center of the channel, are there any data available to support this statement concerning riffle movement. Additionally, riffle habitat may not have the same quality or quantity if displaced toward the center of the channel. For example, the amount and quality of cover may change, the depth and velocity distributions may be altered and the type of substrate may differ. Consequently, habitat utilization may differ as well.

Pg. 3-16 Where are the cross sections from 1994? Were the measurements made at the same location as the 1974 study? There does appear to be a difference between the comparable cross sections (2 and 3 at the higher flows); but there is no low flow data for comparison. Cross sections 1 and 4 only have information from a single flow which makes comparisons difficult.

Pg. 3-17 It is not valid to extrapolate limited information about habitat-discharge relations for the Guadalupe River at Victoria upstream to lake Dunlap.

Pg. 3-28, Paragraph 1, last sentence Records were not found of river darter occurring in the "lower portions" of the Guadalupe River; this is surprising since Kuehne (1955) reported them in DeWitt County in the 50's and are recorded in Table 3-1 as occurring in the lower Guadalupe River. The use of "lower" is confusing and is misleading in the context of the statement.

Pg. 3-29 first sentence No data is provided to support the presumption that the need to provide spawning and juvenile foraging habitat during the spring, does not apply to the San Marcos. The presumption's validity cannot be evaluated and it contradicts well established tenets in stream ecology. Yet, this presumption is unreasonably extended to the Lower Guadalupe and San Antonio Rivers.

Pg. 3-30, first paragraph "Speckled chub populations would appear to be adequately protected by requiring passage flow substantially lower than the 25th percentile of the wetter months. Other species would appear to be adequately protected year round at flows approximating the 25th percentile for the driest month." These statements are unsupported and illustrate the lack of consideration for the complexity and dynamics of stream ecosystems.

POPULATION, WATER DEMAND, AND WATER SUPPLY PROJECTIONS

TRANSTEX
C3-18-98-5

INLAND OCEAN, INC.

P.O. Box 6949
San Antonio, Texas 78209-0949
Telephone (210) 366-2882
Fax (210) 366-2885

March 17, 1998

Mr. Steven Raabe
San Antonio River Authority
P.O. Box 830027
San Antonio, Texas 78283-0027

Re: Comments on Trans-Texas Phase II Population, Water Demand and Water Supply Projections

Dear Steve:

The following two comments concern the Draft report noted above.

1. Page 27; The Industrial Water Demand Projections increase in Calhoun County by 373% or 91,419 acre feet. Other than low 1990 usage, what is the reason for the extraordinary large increase?

   The magnitude is so great that it deserves special comment in the report.

2. Appendix C; The Analysis of Water Availability for Existing Rights appears to concern water rights and not use.

   As we know actual use is significantly lower than the permit amounts. The model can be run utilizing actual uses under the permits and should be to get an accurate reflection of the impacts on downstream needs.

Sincerely,

Hans R. F. Helland

HRFH:dk

Enclosure

TRANS-TEXAS WATER PROGRAM

West Central
Study Area

Phase II

Population,
Water Demand,
and Water
Supply Projections

San Antonio River
Authority

San Antonio Water
System

Edwards Aquifer
Authority

Guadalupe-Blanco
River Authority

Lower Colorado
River Authority

Bexar Metropolitan
Water District

Nueces River
Authority

Canyon Lake Water
Supply Corporation

Bexar-Medina-Atascosa
Counties WCID No. 1

Texas Natural Resource
Conservation Commission

Texas Parks and
Wildlife Department

Texas Water
Development Board

January, 1998

DRAFT

HDR

HDR Engineering, Inc.

Austin, Texas

TRANSTEL
02-17-98-2

LCRA
THE POWER TO MAKE A DIFFERENCE.

February 13, 1998

Mr. Steven Raabe, P.E.
San Antonio River Authority
P.O. Box 830027
San Antonio, TX 78283-0027

Dear Steve:

It was good to see you again at the ASR presentation. I look forward to getting back in the thick of regional water planning.

In that regard, I am sending you my comments on the draft Phase II HDR report, "Population, Water Demand and Water Supply Projections". These comments focus solely on the Colorado River Basin and adjacent areas within the LCRA water service territory.

The format of listing all supplies and demands by county is a useful way to present the data. However, it has limitations that should be pointed out in the text on pages 139 and 140. Particularly it should be noted that water demands have not been allocated to surface water or groundwater sources. Some sources may not be feasible or available to supply some demands. I don't expect that such an allocation should be done in this report. But it should be pointed out that summing the water sources and demands and comparing these totals gives a far too simplistic view of the actual water supply situation.

In reviewing the water shortage/surplus calculations by county I discovered a variety of inconsistencies and errors. These are noted as follows.

Footnote 4: This footnote is used in a number of places in Table 4-4 (p. 144,147 & 150) but has different percentages of Run-of-River (ROR) water rights availability in each case. All the footnotes need to be rechecked to make sure they are properly assigned.

Page 144: The allocation of Highland Lakes water to Fayette County is given as 63,863 acre-feet. It appears that all the Highland Lakes water allocated to LCRA's power plants was put in this county. The actual allocation is 15,000 for Llano County, 10,750 for Bastrop County and 38,101 for Fayette.

P.O. Box 220 • Austin, TX 78767-0220 • (512) 473-3200 • (512) 473-3298 FAX

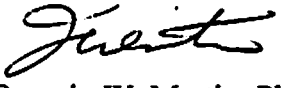
Page 146: The ROR water right availabilities listed for Matagorda County are far too high. Footnote 4 indicates that the percentage of availability is a weighted average of the water available for the Gulf Coast Irrigation District and South Texas Project. The availability percentages used for Matagorda County range from 58% to 42% of the full water rights. By far the majority of the ROR for Matagorda County is in the Gulf Coast right and the percentage of availability ranges from only 38% to 13% of the right (Table D, page D-1). Further, the STP right is for 102,000 acre-feet annually and during the historical drought it can't divert that full right. From page VII-19 of the TWDB Report LP-60 (1978), STP could divert an average of 43,000 acre-ft/yr during the 1941-1965 period, 32,000 acre-ft/yr during the 1946-1956 period, and in the lowest diversion year (1954) only 3,000 acre-ft. I don't see how the 42% diversion percentage for the lowest diversion year could be reached when Gulf Coast and STP could divert only 13% and 3%, respectively, of their maximum water rights in such a year.

Page 150: From Footnotes 3 and 6, the percentages for Wharton's Colorado River ROR water rights availability are indicated to be a mix of Garwood's and City of Austin's water rights availability. Using the City of Austin's availability to determine Wharton County's water availability is inappropriate. The Pierce Ranch water rights should be used instead.

The corrections and clarifications noted above will have a significant influence on the overall area water supply and demand balance shown on pages 150-151.

Thank you for the opportunity to provide these comments. If I can provide any additional information, please feel free to contact me at 1-800-776-5272, ext. 4064.

Sincerely,



Quentin W. Martin, Ph.D., P.E.
Chief Water Resources Planner

cc: Dr. Herb Grubb
Mr. Cole Rowland

TRANSTEX
0212-98-2

Feb.10,1998

Mr Steven J. Raabe,

As a member of the West Central Trans-Texas Technical Input Group (TIG) I submit the following comments on the draft report on "Population, Water Demand and Water Supply Projections" for the West Central Policy Management Committee on the technical work projeced by HDR Engineering,Inc.

Figure 2-1 which shows an almost straight line from 1990 to 2050, is not an accurate portrayal . The data would show a curve reflecting seasonal changes from 1990 to the year 1998. And this should be indicated in a solid line.

The projection into the future should be indicated by a dashed or dotted line.

This was pointed out in my comments regarding previous work done by HDR Engineering, Inc.

It appears that these comments were ignored by HDR and there seems to be no real sincere effort to correct the fictious projections by HDR Eng., Inc.

I doubt that any corporation or government institution can accurately predict the population to the year 2050.

At my own expense I gave testimony to the Senate on their SB 1 encouraging more scientific study of the existing data.

The Senate chose to listen to the testimony of the political-guided Director of the Sierra Club rather than the available scientific data available to them by the Texas Natueral Reesources Commission.

I earnestly request that the Trans-Texas Water Program review the facts and accept the comments by the West Central Trans-Texas Technical Input Group.

If the systematic review and analyses of the facts are not properly arranged, you will not have the truth and thus will not have a technically sound projection to present to the Texas Water Development Board for its use in upcoming Senate Bill 1 planning process.

Sincerely Thomas M. Culbertson

Thomas M. Culbertson, Hydrologist
511 Westwood Dr.
San Antonio, Texas 78212

TRANSTEX
02-26-98-1

TEXAS WATER DEVELOPMENT BOARD

February 23, 1998

Mr. Steven J. Raabe, P.E.
San Antonio River Authority
P.O. Box 830027
San Antonio, Texas 78283-0027

Re: Texas Water Development Board (Board staff) Comments on Trans-Texas Water Program "Population, Water Demand, and Water Supply Projections", West Central Study Area, Phase II

Dear Mr. Raabe:

Board staff has reviewed the above-referenced report and offer the following comments shown in Attachment 1.

The Board looks forward to receiving one (1) unbound camera-ready original and nine (9) bound double-sided copies of the Final Report on this planning project. Please contact Mr. Gordon Thorn, Director, Research and Planning Funds Management Division, at
(512) 463-7979, if you have any questions about the Board's comments.

Sincerely,

Tommy Knowles
Deputy Executive Administrator
for Planning

cc: Mr. Herb Grubb, HDR Engineering, Inc.

ATTACHMENT 1

TEXAS WATER DEVELOPMENT BOARD

COMMENTS ON TRANS-TEXAS WATER PROGRAM
"Population, Water Demand, and Water Supply Projections"
West Central Study Area, Phase II

1. There are some minor differences between the Board's consensus irrigation water use projections and those presented in the report. The irrigation projections in the report include irrigation losses while the Board's do not.

2. The groundwater supply projections are based on the Board's 1990 projections. Updated projections from the 1997 Texas Water Plan are now available from the Board.

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LOCKHART, TEXAS 78644
FAX# 512-398-2327

SARA

FEB 0 3 1998

FAX COVER SHEET

TO: STEVEN J. RAABE, P.E.
SAN ANTONIO RIVER AUTHORITY
FAX NUMBER: 210-227-4323

FROM: WARREN P. KIRKSEY

COMMENTS:

1 OF _____ PAGES

1.11-3.8 GC

TRANS-TEXAS WATER PROGRAM
WEST CENTRAL STUDY AREA
POPULATION, WATER DEMAND AND WATER SUPPLY PROJECTIONS REPORT
TECHNICAL INPUT GROUP
JANUARY 30, 1998

SUBMITTED BY: Warren P. Kirksey

COMMENTS: I have reviewed the draft report on "Population, Water Domand and Water Supply Projections" for the West Central Study Area and have no changes or additions at this time. The report is complete and well prepared.

PLEASE ATTACH ADDITIONAL SHEETS IF NECESSARY

PLEASE RETURN TO
STEVEN J. RAABE, P.E.
SAN ANTONIO RIVER AUTHORITY
P.O. BOX 830027
SAN ANTONIO, TEXAS 78283-0027
(210) 227-1373
FAX (210) 227-4323

EDWARDS AQUIFER RECHARGE ANALYSES
PHASE II

TRANSTX
03-23-98-3

TEXAS WATER DEVELOPMENT BOARD

March 18, 1998

Mr. Steven J. Raabe, P.E.
San Antonio River Authority
P.O. Box 830027
San Antonio, Texas 78283-0027

Re: Texas Water Development Board (Board staff) Comments on Trans-Texas Water Program "Edwards Aquifer Recharge Analyses"

Dear Mr. Raabe:

Board staff has reviewed the above-referenced report and offer the following comments:

- A Hydrogeologic Setting Index was not provided for the Leon/Helotes/Government projects.
- The report indicated that data was collected from the required sources, but the actual data was not provided in the report.

The Board looks forward to receiving one (1) unbound camera-ready original and nine (9) bound double-sided copies of the Final Report on this planning project. Please contact Mr. Gordon Thorn, Director, Research and Planning Funds Management Division, at (512) 463-7979, if you have any questions about the Board's comments.

Sincerely,

Tommy Knowles
Deputy Executive Administrator
for Planning

TRANSTEX
C4-C8-98-2

TEXAS WATER DEVELOPMENT BOARD

April 2, 1998

Mr. Steven J. Raabe, P.E.
San Antonio River Authority
P.O. Box 830027
San Antonio, Texas 78283-0027

Re: Texas Water Development Board (Board staff) Comments on Trans-Texas Water Program "Edwards Aquifer Recharge Analyses, Phase II"

Dear Mr. Raabe:

Board staff has reviewed the above-referenced report and offer the following comment.

- The report indicates that data were collected from the required sources, but such actual data was not provided in the report.

The Board looks forward to receiving one (1) unbound camera-ready original and nine (9) bound double-sided copies of the Final Report on this planning project. Please contact Mr. Gordon Thorn, Director, Research and Planning Funds Management Division, at (512) 463-7979, if you have any questions about the Board's comments.

Sincerely,

Tommy Knowles
Deputy Executive Administrator
for Planning

UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

TRANSTEX
C-348-98-4

INLAND OCEAN, INC.

P.O. Box 6949
San Antonio, Texas 78209-0949
Telephone (210) 366-2882
Fax (210) 366-2885

March 17, 1998

Mr. Steven Raabe
San Antonio River Authority
P.O.Box 830027
San Antonio, Texas 78283-0027

Re: Comments on Draft
Guadalupe-San Antonio
River Basin Recharge
Enhancement Study
Feasibility Assessment

Dear Steve:

As in previous reports on recharge projects, the maximum as well as an optimum size were presented in tabular form. The maximum options should also be presented.

The same good reasons for the Northern Bexar/Medina County project on page 3-2 would also apply to Cibolo Creek (size #12) option discussed on the top of page 3-6. Storage above 10,000 acre feet may be needed for flood control, recirculation of excess streamflow, utilization of flood releases and transfers to the recharge zone areas west of the Cibolo site. The potential impacts to Bat Cave and Natural Bridge Caverns should be investigated further with a Cibolo Creek storage up to 50,000 acre feet.

The combined program mentioned on page 3-10 which includes 4 Nueces Basin projects previously studied should not exclude other potential sites in the Nueces Basin or other sizes for these 4 projects. The other projects are still viable and could be used for flood control, receipt of Guadalupe River Basin diversions, enhanced recharge and discharge locations for other diversions. These projects should not be forgotten but mentioned as a sub-group.

Please pass these comments on to the appropriate people.

Sincerely,

Hans R. F. Helland

HRFH:dk

Enclosure

cc: Samuel K. Vaugh

DRAFT

TRANS-TEXAS WATER PROGRAM

WEST CENTRAL STUDY AREA

PHASE 2

GUADALUPE - SAN ANTONIO RIVER BASIN RECHARGE ENHANCEMENT STUDY FEASIBILITY ASSESSMENT

San Antonio River Authority
San Antonio Water System
Edwards Aquifer Authority
Guadalupe-Blanco River Authority
Lower Colorado River Authority
Bexar Metropolitan Water District
Nueces River Authority
Canyon Lake Water Supply Corporation
Bexar-Medina-Atascosa Counties WCID No. 1
Texas Natural Resource Conservation Commission
Texas Parks and Wildlife Department
Texas Water Development Board

This document is released for the purpose of review under the authority of Samuel Kent Vaugh, P.E. Texas P.E. No. 63487 Date: February 20, 1998.

This document is released for the purpose of review under the authority of Richard A. Shoemaker, P.E. Texas P.E. No. 64598 Date: February 20, 1998.

This document is released for the purpose of review under the authority of Kelly D. Payne, P.E. Texas P.E. No. 82053 Date: February 20, 1998.

This document is released for the purpose of review under the authority of Kelly Jay Kaatz, P.E. Texas P.E. No. 75421 Date: February 20, 1998.

HDR Engineering, Inc.

Austin, Texas

February 1998

TRANSTEX
03-25-98-2

Bat Conservation International, Inc.

Post Office Box 162603 • Austin, Texas 78716 • 512/327-9721 • FAX 327-9724

March 26, 1998

Steven J. Raabe
P.E. Project Manager
San Antonio River Authority
P.O. Box 830027
San Antonio, Texas 78283-0027

RE: Cibolo Creek Reservoir Project and Bracken Bat Cave

Dear Mr. Raabe,

The purpose of this letter is to address the development of the Cibolo Creek reservoir project and its potential impact on the nearby Bracken Bat Cave. Bracken Cave is home to the largest known bat maternity colony in the world.[1] An estimated 20 million Mexican free-tailed bats (*Tadarida brasiliensis*) use this cave each March through October to give birth and raise their young.

The bats in this colony provide many ecological and economic benefits. It is estimated that the Mexican free-tails from this one cave, as they spread out over the surrounding farmland, can consume up to 200 tons of insects *each night*.[2] Recent research has shown that a large proportion of these insects are corn earworm moths (also known as cotton bollworm moths), the most damaging agricultural pest in America.[3]

Decisions that have the potential to impact this colony may have international consequences. Dramatic declines of migratory populations of free-tails have been noted in both the United States and Mexico. Although migratory species such as these provide challenging management issues, cooperative international programs have made conservation of the Mexican free-tailed bat a top priority.

Bat Conservation International, Inc., is a non-profit organization dedicated to the protection of bats and their habitats. We own and protect Bracken Cave, and are deeply concerned about any plans for water development in the area of the cave that might have a direct or indirect effect on the cave's suitability as bat habitat. We are especially concerned about the different scenarios centered on Cibolo Creek.

It is stated in the Guadalupe-San Antonio River Basin Recharge Enhancement Study Feasibility Assessment (Trans-Texas Water Program, West Central Study Area, Phase 2) that the most cost effective project of recharge enhancement in this basin is the Cibolo Creek project at an optimum size of 1,000 acft. The third lowest unit cost would be achieved by enlarging the storage capacity of the Cibolo Creek project from 1,000 to 5,000 acft. The 10th ranked project is Cibolo Creek at a capacity of 10,000 acft and the 12th ranked project is Cibolo Creek at 50,000 acft. With regard to this last project, the study states, "At this larger size, the potential environmental and socioeconomic impacts to Bracken Bat Cave and Natural Bridge Caverns are not likely to be worth the relatively small amounts of additional average and drought recharge enhancement obtained by enlarging the project."

Because it is uncertain how a reservoir would affect the cave, we advocate that serious consideration be given to the impact of a Cibolo Creek project of any size. These impacts might include microclimatic changes in or around the cave. (For instance, changes in temperature or humidity could have a negative impact on the bat colony. Mexican free-tails in particular are very sensitive to temperature and environmental conditions.) Furthermore, the residential or commercial development associated with a reservoir might also induce changes. (For example, what would be the impact of septic systems or altered water runoff patterns on the cave?)

We understand that the current plans for a reservoir on Cibolo Creek are in the preliminary phases of development, and we urge that appropriate attention be paid to Bracken Cave in the planning process. We would be pleased to consult on the possible impacts that the different recharge capacities might have on the cave. Our primary objective is to preserve and protect one of the world's most unique and valuable wildlife habitat sites.

If you have questions or would like more information at this time, please contact BCI's Executive Director, Dr. Merlin Tuttle, or staff biologist Brian Keeley at (512) 327-9721. We would also be very happy to arrange a visit to Bracken Cave for you, your staff or any others involved in the reservoir's decision-making process. Thank you for your attention.

Sincerely,

Michael L. Cook
Chairman

Brian Keeley
Staff Biologist

1. Bracken Cave: A Priceless Resource. *BATS*. 10 (3): 3-4. 1992.

2. McCracken, G. Bats Aloft: a study of high-altitude feeding. *BATS*. 14(3):7-10. 1996.

3. Whitaker, J., C. Neefus, and T. Kunz. Dietary variation in the Mexican free-tailed bat, *Tadarida brasiliensis mexicana*. Journal of Mammology. 77(3):716-724. 1996.

RANSTEX
03-10-98-1

TEXAS
PARKS AND WILDLIFE DEPARTMENT
4200 SMITH SCHOOL ROAD • AUSTIN, TEXAS 78744 • 512-389-4800

March 9, 1998

ANDREW SANSOM
EXECUTIVE DIRECTOR

Mr. Steve Raabe
San Antonio River Authority
P. O. Box 830027
San Antonio, Texas 78283-0027

Re: West Central Trans Texas Phase II Updated Evaluation of Potential Reservoirs in the Guadalupe River Basin

Dear ~~Mr. Raabe~~ Steve:

I have reviewed the above referenced document and have the following suggestions to offer:

Page ES1, paragraph 1: replace "instream flow requirements" with "environmental flow requirements". The environmental planning criteria were developed to estimate both bay and estuary and instream flow requirements in cases where no better information exists. This change should be made throughout the document.

Page ES2, paragraph 2, item (3): delete "San Antonio Bay" as it is redundant with Guadalupe Estuary. Same changes for page ES2, paragraph 2, last sentence.

Page ES2, paragraph 2, third sentence: replace "release" with "pass-through".

Page 2-1, paragraph 2, third sentence: "consensus" is misspelled.

Page 2-2, paragraph 2, third sentence: delete this sentence. The second sentence in this paragraph adequately describes the intent of the criteria.

Page 2-3, paragraph 1, first sentence: replace "needs" with "flow".

Page 2-3, paragraph 1, second sentence: insert "monthly" before "median" and before "25th percentile".

Consider moving or copying the second paragraph from section 3.84 to section 2. It is a good description of TPWD's role in the regulatory process. Add "fish" before "and wildlife" in the third sentence.

Page 3-10, paragraph 2, second sentence: Replace with "As a new reservoir project without a current operating permit, site-specific studies may be required to address environmental flow requirements". This same change needs to be made to pages 3-31, 3-47, 3-58, 3-66, 3-75 and 3-83. The environmental planning criteria, although being considered for use in permitting small projects (5000 ac-ft or less) are used to estimate environmental flow needs. Site-specific studies especially to determine instream flow impacts, will still be required for major projects.

Page3-10, paragraph 3, first sentence: "The criteria for freshwater inflow to bays and estuaries are assumed to be met if the consensus criteria are met". "Consensus" is misspelled.

There needs to be more discussion explaining what this means, especially since page 3-4, assumption (2), states "no increase in shortages in target flows at the saltwater barrier (Bays and Estuaries flow requirements, Bays and Estuaries flow)". I assume the target flows are the results of the TPWD/TWDB freshwater inflow determination analysis. That study is complete, although the report is in final draft form, and should probably be referenced. It should be clear that the results of the freshwater inflow studies (i.e. environmental flow requirements derived from a site-specific study) are available and being used in this analysis. The environmental planning criteria state that where inflow values are known, they should be used for projects within 200 river miles of the coast. For projects such as Cuero and Goliad, it is probably safe to assume the monthly median pass-throughs reasonably approximate the pro-rated portion of the Bay and Estuary target.

Please call me at 512/912-7015 if you have any questions.

Sincerely,

C S Loeffler

Cindy Loeffler, P.E.
Water Resources Team Leader
Resource Protection Division

CL:mg

Cc: Sam Vaugh, HDR Engineering, Inc.

TKAWSTEX
CB-2.3-98-2

TEXAS WATER DEVELOPMENT BOARD

March 18, 1998

Mr. Steven J. Raabe, P.E.
San Antonio River Authority
P.O. Box 830027
San Antonio, Texas 78283-0027

Re: Texas Water Development Board (Board staff) Comments on Trans-Texas Water Program "Updated Evaluation of Potential Reservoirs in the Guadalupe River Basin"

Dear Mr. Raabe:

Board staff has reviewed the above-referenced report and offer the following comments shown in Attachment 1.

The Board looks forward to receiving one (1) unbound camera-ready original and nine (9) bound double-sided copies of the Final Report on this planning project. Please contact Mr. Gordon Thorn, Director, Research and Planning Funds Management Division, at (512) 463-7979, if you have any questions about the Board's comments.

Sincerely,

Tommy Knowles
Deputy Executive Administrator
for Planning

ATTACHMENT 1

TEXAS WATER DEVELOPMENT BOARD

COMMENTS ON TRANS-TEXAS WATER PROGRAM
"Updated Evaluation of Potential Reservoirs in the Guadalupe River Basin"

- Page 3-8, 2nd paragraph, there is reference to "Bottomland and riparian forest." Bottomland forest , as used here, is a forest type, rather than the wetland community defined by the U.S. Fish and Wildlife Service, and used in federal wetland delineation requirements for a Corps of Engineers 404 Permit. The bottomland forest definition is credited via a citation in the previous paragraph to Espy-Huston & Associates, Inc (EH&A) report to the GBRA published in 1986, entitled *Water Availability Study for the Guadalupe and San Antonio River Basins.* This EH&A report is referred to throughout the draft report, without reference to the many other studies and reports that have been conducted for the Guadalupe River. Please clarify that the bottomland forest terminology used in this report is not the same as the bottomland forested wetlands used in the federal wetland delineation criteria.

- The source of information for percentages of each forest type and number of acres given for each potential reservoir is not given. Please include.

- If the EH&A report was intended to be the source (based on citation in previous paragraph), please provide that information.

- Several vegetation surveys and wildlife habitat evaluations have been conducted at potential reservoir sites by the TPWD, via interagency contract with the TWDB. Reports have been completed for Cuero, Sandies, and Cibolo Creek reservoir sites. None of these reports were included in the analyses done for this draft report. These reports should be given appropriate review and included in the analyses for the final report.

- Wetlands are discussed on the next page, 3-9, for the potential Cuero project, in which bottomland forests are not included as a wetland type. Thus, it is obvious that this draft report's use of the term bottomland forest is meant to define a forest type, rather than a wetland community. This forest type should be defined in the introduction of the report, in order to avoid confusion with the wetland community type in the same name.

- The 3rd paragraph list several wetland types in the project area, including the number of acres of wetland. There is no reference to a report or source of information, which should be given.

- Page 2-29: Bottomland and Riparian Forests types are mixed in the description of forest types for the proposed Sandies Reservoir, which seem inappropriate since they are two distinct different types of forest in this drainage. The reference to EH&A for the percent of wooded area and acreage of each forest type is confusing since there is no information relating to those data in the report.

- Wetland acreage are referenced to the EH&A report, even though there is no data in that report for such information. Wetlands are not inventoried in the EH&A report.

- The EH&A report provides only a brief discussion about "hydric habitats" on pages 2-8&9 (this is report #142 in the TWDB library).

- Wetland areas are given in the draft report for the potential Dilworth Reservoir (page 3-74) and Cloptin Crossing Reservoir (pages 3-82 & 83). Include citations for the source of this information.

- Page 3-10: It is stated that plant and animal species listed by the USFWS and TPWD are the only criteria used to identify potential threats to rare species. Previous reviews of the Phase I reports have indicated a need to include the TOES list, but this deficiency still persists in the Phase II reports. There is no reference to the USFWS and TPWD lists, thereby leaving the reader unknowing if the latest state and federal listings were used. Federal Candidate Species listing are updated frequently in the Federal Register, but none of the federal Candidate Species are listed in this draft report. Please correct the incomplete and unreferenced reporting of threatened and endangered species.

- Page 3-75: The statement about the potential Dilworth Reservoir reads "the area may provide potential habitat for ten threatened, endangered, or candidate species." The ten species are not identified, nor is the source of information from which this information was obtained. Please give the citation for this statement.

- Page 3-83: There is the statement that "Although TPWD data files show no reports of any endangered or threatened species within the footprint of the proposed (Cloptin Crossing Reservoir) recharge project, few surveys in the area have been conducted and an intensive survey of the project area would be required to assess the habitats within the project area accurately and determine the possibility of any associated threatened or endangered species occurrences." Based on this unreferenced statement, only state listed species were used in the analysis, or possibly federal species on the TPWD list may have been used that are based on old listing information that is no longer pertinent. The TPWD list includes <u>all</u> federal listed species by definition, but candidate species may not be shown. Federally listed species are updated periodically on the TPWD list, but the older state list will not be current for either state or federally listed species. It is important that the latest published lists be used in these assessments.

- Appendix F contains the list of "Protected, Endangered, and Threatened Species" by county. The inconsistency in these tables makes for an inconsistent evaluation of all the potential reservoir sites. For instance, Tables 1,2,3,4,5,6a, and 7 do not show TOES listed species; however, Table 6 does show TOES listed species. The layout for this table is inverted from the other tables. No candidate species are listed on any of the tables, and no citations are provided for any of this information.

- Page 1-1 second sentence, paragraph 1.2, entitled "Objective." The sentence reads as follows: "This consistency will allow for direct comparisons among the projects described herein, *was* well as comparisons.....Phase II." The *was* in this sentence

should be replaced with the word *as*, so it correctly reads "*... as well as comparisons.....*"

- Other environmental topics were dealt with adequately in the draft report. The institutional agreements between the TWDB, TPWD, and the TNRCC were well described. The application of the consensus environmental criteria to the various reservoir alternatives was well done, showing the impacts to bay and estuary inflow and instream flow.

SUMMARY REPORT OF WATER SUPPLY ALTERNATIVES

TRANSTEX
C4-10-98-1

TEXAS WATER DEVELOPMENT BOARD

March 24, 1998

Mr. Steven J. Raabe, P.E.
San Antonio River Authority
P.O. Box 830027
San Antonio, Texas 78283-0027

Re: Texas Water Development Board (Board staff) Comments on Trans-Texas Water Program "Summary Report of Water Supply Alternatives"

Dear Mr. Raabe:

Board staff has reviewed the above-referenced report and offer the following comments shown in Attachment 1.

The Board looks forward to receiving one (1) unbound camera-ready original and nine (9) bound double-sided copies of the Final Report on this planning project. Please contact Mr. Gordon Thorn, Director, Research and Planning Funds Management Division, at (512) 463-7979, if you have any questions about the Board's comments.

Sincerely,

Tommy Knowles
Deputy Executive Administrator
for Planning

cc: Herb Grubb, HDR Engineering, Inc.

SARA

APR 10 1998

ATTACHMENT 1

TEXAS WATER DEVELOPMENT BOARD

COMMENTS ON TRANS-TEXAS WATER PROGRAM
"Summary Report of Water Supply Alternatives"

- Page 4-1 gives the brief discussion of other alternatives. The text says that several of the alternatives evaluated on a stand-alone basis should not be evaluated in combination with one another. Please provide a one-by-one listing of combinations of alternatives.

- Page 5-1 uses the work "principals" and the word "principles". The context of the discussion shows that the proper word, used consistently, should be "principles" (defined as "broad and basic rules or truths").

- Tasks outlined in the scope of work appear to have been addressed. The datasheets on each alternative and the graphics Figures 3-2 through 3-5, which visually show how each alternative rates relative to all other alternatives based on unit cost, quantity of water obtained, etc. are especially good.

TRANSTEX
C3-30-98-1

INLAND OCEAN, INC.

P.O. Box 6949
San Antonio, Texas 78209-0949
Telephone (210) 366-2882
Fax (210) 366-2885

March 17, 1998

Mr. Steven Raabe
San Antonio River Authority
P.O.Box 830027
San Antonio, Texas 78283-0027

Re: Comments =
Summary Report of
Water Supply Alternatives

Dear Steve :

Please find enclosed comments concerning the treatment of the recharge and diversion to recharge options in the March, 1998, Draft of the Summary Report of Water Supply Alternatives.

Each individual recharge project should be shown on the Summary as a separate option since they can each stand alone. So for L-18 you would have L-18a - L-18j, etc.

If there are any questions pertaining to these comments please let me know.

Sincerely,

Hans R. F. Helland

HRFH:dk

Enclosures

INLAND OCEAN, INC.

March 17, 1998

P.O. Box 6949
San Antonio, Texas 78209-0949
Telephone (210) 366-2882
Fax (210) 366-2885

Mr. Sam Vaugh
HDR Engineering, Inc.
2211 S. IH 35, Suite 300
Austin, Texas 78741-6536

Dear Sam:

The items highlighted on the enclosed Summary Report of Water Supply Alternatives need to be changed or expanded.

Providing drought yield numbers is not an indication of a recharge structure's value. As we both know a recharge structure is a conduit (diversion) by which water is directed to an underground storage reservoir. The amount of water it diverts during a dry period is only one variable in the equation to determine firm yield of the underground reservoir. Obviously storage is a major determinate to firm yield and a decision as to its use which will be left to politics. A proper comparison to these recharge options as currently presented in the Summary would be to put the yield for each surface reservoir based on the flow into the reservoir during the drought period, ignoring storage. Obviously that would not be an accurate portrayal of a surface reservoir yield, just as the drought condition numbers are not an accurate representation of recharge.

The recharge options (L-17, L-18, L-23 and S-13) should all be presented under average conditions. The Type 1 and Type 2 (L-17 & L-18) should also show the maximum option. The optimum has excluded some projects. The decision to exclude is one that should be left to the current policy makers.

The Guadalupe River diversions to the recharge zone (G-30, G-32 and G-33) should also be presented with average numbers and with the various pipeline options.

The true and accurate value of recharge and the diversions is masked by representing them under drought conditions and not reporting all the options.

Obviously the rankings will need to be altered accordingly.

Sincerely,

Hans R. F. Helland

HRFH:dk
Enclosures

DRAFT

TRANS-TEXAS WATER PROGRAM

WEST CENTRAL STUDY AREA

PHASE 2

SUMMARY REPORT OF WATER SUPPLY ALTERNATIVES

San Antonio River Authority
San Antonio Water System
Edwards Aquifer Authority
Guadalupe-Blanco River Authority
Lower Colorado River Authority
Bexar Metropolitan Water District
Nueces River Authority
Canyon Lake Water Supply Corporation
Bexar-Medina-Atascosa Counties WCID No. 1
Texas Natural Resource Conservation Commission
Texas Parks and Wildlife Department
Texas Water Development Board

This document is released for the purpose of review under the authority of Herbert W. Grubb, Ph.D. Date: March 6, 1998.

HDR Engineering, Inc.

Austin, Texas

This document is released for the purpose of review under the authority of Kenneth L. Choffel, P.E. Texas P.E. No. 45686 Date: March 6, 1998.

March 1998

Table 3-1

Water Supply Options--32-County West Central Trans-Texas Study Area
Comparison and Order
Trans-Texas Water Program

Appendix Page No.	Appendix Option No	Water Supply Options	Quantity of Water acft/yr	Quantity of Water Order[4]	Unit Cost of Water 1st Qt. 1996 Prices $/acft	Unit Cost of Water 1st Qt. 1996 Prices Order[5]	Acres Impacted Long-Term No.	Acres Impacted Long-Term Order[6]
		Conservation / Local Alternatives						
1	L-10	Demand Reduction (Water Conservation)	90,000	23	276	5	0	3
2	L-11	Exchange Reclaimed Water for Edwards Irrigation Water	38,000	58	475	24	127	15
3	L-12	Exchange Reclaimed Water for BMA Medina Lake Water (Included with Option S-13)		NA		NA		NA
4	L-13A	Recycling/Reuse Plans by SAWS	35,000	64	380	8	0	4
5	L-13B	Reclaimed Water to Edwards Aquifer	92,000	22	771	61	240	34
6	L-14	Transfer of Reclaimed Water to Corpus Christi via Choke Canyon(Mitigation for other Options)		NA		NA		NA
7	L-15	Purchase or Lease of Edwards Irrigation Water for Municipal and Industrial Use	68,900	37	152	3	0	2
8	L-16	Demineralization of Edwards "Bad Water"	0	NA		NA		NA
9	L-17	Natural Recharge-Type 1 Projects; Nueces/Guadalupe/San Antonio Basins (1947-56 Drought Average)	35,600	63	466	22	4,660	80
10	L-18A	Natural Recharge-Type 2 Projects; Nueces/Guadalupe/San Antonio Basins (1947-56 Drought Average)	33,870	65	458	20	4,186	79
11	L-23A	Edwards Recirculation-Sustainable Yield Pumpage, Lake Dunlap Diversion to Recharge Zone	87,000	27	350	6	414	53
12	L-23B	Edwards Recirculation-Sustainable Yield Pumpage, Gonzales&Lake Dunlap Diversion to Recharge Zone	118,000	17	774	62	1,004	61
13	L-24	Flood Retarding Structures Outlet Modifications for Recharge Enhancement	1,000	106	7	1	0	1
14	L-19	Springflow Augmentation		NA		NA		NA
		Nueces River Basin						
15	N-10	Nueces River Basin Water Rights	0					
		San Antonio River Basin						
16	S-10[1]	Unappropriated Streamflow near Elmendorf--1988 Return Flows; 1947-56 Drought Average	15,100	NA		NA		NA
17	S-11[1]	Unappropriated Streamflow near Falls City--1988 Return Flows; 1947-56 Drought Average	15,100	NA		NA		NA
18	S-12[1]	Unappropriated Streamflow near Goliad--1988 Return Flows; 1947-56 Drought Average	27,600	NA		NA		NA
19	S-13A	Medina Lake--Divert & inject to aquifer; 1947-56 Drought Average	26,700	70	896	76	172	31
20	S-13B	Medina Lake--Divert to aquifer recharge zone; 1947-56 Drought Average	26,700	71	614	40	172	30

Table 3-1 Continued Next Page

Appendix Page No.	Appendix Option No	Water Supply Options	Quantity of Water acft/yr	Quantity of Water Order[4]	Unit Cost of Water 1st Qt. 1996 Prices $/acft	Unit Cost of Water Order[5]	Acres Impacted Long-Term No.	Acres Impacted Long-Term Order[6]
21	S-13C	Medina Lake--Divert to WTP; Firm Yield with 20,200 acft/yr recharge	29,000	69	451	19	298	35
22	S-13D	Medina Lake--Buy rights and release to Applewhite; Firm yield with 22,600 acft recharge	37,500	59	619	42	2,717	72
23	S-14A	Applewhite Reservoir--Divert & inject to aquifer; 1947-56 Drought Average	22,500	73	1,184	92	2,889	75
24	S-14B	Applewhite Reservoir--Divert to aquifer recharge zone; 1947-56 Drought Average	22,500	74	1,305	98	2,898	76
25	S-14C	Applewhite Reservoir--Divert to WTP; Firm yield	7,700	93	1,518	100	2,717	73
26	S-14D	Applewhite Reservoir--Operated in conjunction with Medina Lake; Firm yield to WTP	14,900	84	1,518	101	2,717	74
27	S-15A	Cibolo Reservoir--Divert & inject to aquifer; Firm yield	32,300	66	1,246	95	16,872	94
28	S-15B	Cibolo Reservoir--Divert to aquifer recharge zone; Firm yield	32,300	67	1,281	97	16,881	95
29	S-15C	Cibolo Reservoir--Divert to WTP; Firm yield	32,300	68	1,145	91	16,700	90
30	S-15Da	Cibolo Reservoir with Imported Water from the San Antonio River; Firm yield to WTP	75,600	29	712	51	16,746	91
31	S-15Db	Cibolo Reservoir with Imported Water from the San Antonio & Guadalupe Rivers;Firm yield to WTP	79,600	28	822	68	16,804	93
32	S-15Dc	Cibolo Reservoir with Imported Water from the San Antonio/Guadalupe/Colorado Rivers; Firm YtoWTP	162,900	12	723	53	17,272	96
33	S-15Ea	Cibolo Reservoir with Imported Water from the Guadalupe River at the SaltWaterBarrier-FY	65,100	41	965	82	16,779	92
34	S-15Eb	Cibolo Reservoir with Imported Water from the Guadalupe River at the Salt Water Barrier, and the Colorado River below Garwood--Firm yield	132,000	15	786	66	17,366	97
35	S-16A	Goliad Reservoir--Divert & inject to aquifer; Firm yield	115,500	18	709	49	28,147	102
36	S-16B	Goliad Reservoir--Divert to aquifer recharge zone; Firm yield	115,500	19	748	57	28,147	103
37	S-16C	Goliad Reservoir--Divert to WTP; Firm yield	115,500	20	662	43	28,147	101
38	S-17	Upper Cibolo Creek Reservoir Cost Analyses--Firm yield	8,700	89	2,016	102	3,400	78
		Guadalupe River Basin						
39	G-10	Unapp.Streamflow near Gonzales--1947-56 Drought Avg.& 400,000acft/yr Aquifer pumpage	33,200	NA		NA		NA
40	G-11	Unapp.Streamflow near Cuero--1947-56 Drought Avg.& 400,000acft/yr Aquifer pumpage	34,900	NA		NA		NA
41	G-12	Unapp.Streamflow at Salt Water Barrier--1947-56 Drou.Avg.& 400,000acft/yr Aquifer pump	33,800	NA		NA		NA
42	G-13A	San Marcos River Div--Unapp flow below Blanco Confluence; Inject to aquifer,1947-56 DA	6,600	94	3,689	105	325	41
43	G-13B	San Marcos River Div--Unapp flow below Blanco Confluence;To recharge zone1947-56 DA	6,600	95	2,452	103	455	55
44	G-14A	Guadalupe River Div--Unapp flow at Lake Dunlap; Inject to aquifer, 1947-56 Drought Avg.	3,500	100	5,870	106	232	33
45	G-14B	Guadalupe River Div--Unapp flow at Lake Dunlap; To recharge zone, 1947-56 Drought Avg.	3,500	101	3,483	104	362	48
46	G-15A	Canyon Lake Released to Lake Dunlap--Divert & inject to aquifer; Firm yield	10,000	85	775	64	232	32
47	G-15B	Canyon Lake Released to Lake Dunlap--Divert to aquifer recharge zone; Firm yield	10,000	86	543	32	362	47
48	G-15C	Canyon Lake Released to Lake Dunlap--Divert to aquifer recharge zone; Firm yield	15,000	76	473	23	362	46

Table 3-1 Continued Next Page

Appendix Page No.	Appendix Option No	Water Supply Options	Quantity of Water acft/yr	Order[4]	Unit Cost of Water 1st Qt. 1996 Prices $/acft	Order[5]	Acres Impacted Long-Term No.	Order[6]
49	G-15D	Canyon Lake Released to Lake Dunlap--Divert to WTP; Firm yield	10,000	87	540	31	131	23
50	G-15E	Canyon Lake Released to Lake Dunlap--Divert to WTP; Firm yield	15,000	77	504	28	131	22
51	G-16A	Cuero Reservoir--Divert & inject to aquifer; Firm yield (Phase I Environmental Criteria)	168,000	10	697	47	41,672	105
52	G-16B	Cuero Reservoir--Divert to aquifer recharge zone; Firm yield(Phase I Environmental Criteria)	168,000	11	740	56	41,681	106
53	G-16C1	Cuero Reservoir--Divert to WTP; Firm yield (TWDB/TNRCC/TPWD Consensus Envir. Crireria)	145,448	14	775	63	41,500	104
54	G-17A	Sandies Reservoir--Divert & inject to aquifer; Firm yield(Phase I Environmental Criteria)	45,800	52	1,227	94	27,047	99
55	G-17B	Sandies Reservoir--Divert to aquifer recharge zone; Firm yield(Phase I Environmental Criteria)	45,800	53	1,266	96	27,056	100
56	G-17C1	Sandies Reservoir--Divert to WTP; Firm yield(TWDB/TNRCC/TPWD Consensus Envir.Cri.)	74,741	34	827	70	26,875	98
57	G-18A	McFaddin Reservoir--Buy Water Rights in Calhoun Co, Divert & inject to aquifer; Firm yield	37,000	60	929	77	1,745	69
58	G-18B	McFaddin Reservoir--Buy Water Rights in Calhoun Co, Divert to aquifer recharge zone; Firm yield	37,000	61	968	83	1,875	71
59	G-18C	McFaddin Reservoir--Buy Water Rights in Calhoun Co, Divert to WTP; Firm yield	37,000	62	847	73	1,644	66
60	G-19	Guadalupe River Dam 7--Raw water at reservoir; Firm yield (Consensus Rnvironmental Criteria)	30,927	NA	804	NA	12,830	NA
61	G-20	Gonzales Reservoir--Raw water at reservoir; Firm yield(Consensus Environmental Criteria)	75,093	NA	320	NA	21,370	NA
62	G-21	Lockhart Reservoir--Raw water at reservoir; Firm yield(Consensus Environmental Criteria)	6,339	NA	618	NA	2,910	NA
63	G-22	Dilworth Reservoir--Raw water at reservoir; Firm yield(Consensus Environmental Criteria)	18,195	NA	590	NA	15,400	NA
64	G-23A	Canyon Lake Area WS (Areas adjacent to Canyon Lake)--2020 Demands	3,470	102	1,008	86	46	10
65	G-23B	Canyon Lake Area WS (Smithson Valley, Bulverde,and Oak Village North Areas)-2020Dem	1,280	105	1,487	99	16	5
66	G-24	Wimberley and Woodcreek WS from Canyon Lake, with G-23A & 2020 Demands	1,424	104	963	80	40	9
67	G-25	Northeast Hays and Northwest Caldwell Counties WS from near Lake Dunlap--2020 Dem	1,920	103	1,220	93	52	11
68	G-26	Md-Cities (III-35 and Highway 78) WS From Near Lake Dunlap--2020 Demands	25,166	72	483	27	36	7
69	G-27	Guadalupe River Diversion Near Lake Dunlap to North WTP, with Transfer of Downstream Rights	49,785	51	749	58	36	8
70	G-28	Guadalupe River Diversion Near GonzalesTo NWTP with Transfer of Downstream Rights (WolEC)[3]	71,260	35	828	71	102	12
71	L-20	Transfer of SAWS Reclaimed Water to Coleto Creek Reservoir	8,400	90	138	2	23	6
72	G-30	Guadalupe River Diversion Near Comfort to Recharge Zone via Medina Lake--Drought Ave	9,900	88	720	52	300	36
73	G-32	Diversion of Canyon Lake Flood Storage to Recharge Zone via Cibolo Creek--LongTermAv	16,100	75	750	59	537	58
74	G-33	Guadalupe River Diversions Near Lake Dunlap to Recharge Zone with Enhanced Springflow, Water Rights Transfer, and Unappropriated Streamflow--1947-56 Drought Ave.	70,300	36	394	11	414	54
75	G-34A[2]	Canyon Lake Water to Canyon Lake WSC/Bulverde/North Bexar Co--Uniform Delivery	5,000	96	605	39	130	17
76	G-34B[2]	Canyon Lake Water to Canyon Lake WSC/Bulverde/North Bexar Co--Summer Peak Del.	5,000	97	829	72	130	19
77	G-34C[2]	Canyon Lake Water to Canyon Lake WSC/Bulverde/North Bexar Co--Uniform Delivery	8,000	91	479	25	130	16
78	G-34D[2]	Canyon Lake Water to Canyon Lake WSC/Bulverde/North Bexar Co--Summer Peak Del.	8,000	92	683	45	130	18

Table 3-1 Continued Next Page

Recharge:

L-17, L-18, L-23 & S-13

1. Invalid Comparison due to:

   a. Quantity of Water - understated due to:

      1. Drought Yields
      2. Left some projects out.

   b. Unit Cost of Water - overstated due to:

      1. Drought Condition Cost
      2. Imcomplete due to 1.a(2) above.

2. Corrected Numbers for comparison Purposes:

   a. L-17 - Type 1 Projects

	Ac.Ft.	$/Ac.Ft.	
Per Report:	75,900	$216	(Optimum)
	146,985	310	(Maximum)

   b. L-18 - Type 2 Projects -

	Ac.Ft.	$/Ac.Ft.	
Per Report:	125,327	$209	(Optimum)
With all Projects Except Medina Lake; Nueces Basin	96,210	$260	(Maximum)
Guad./SA Basin	68,172	$163	(Per New Tr.Tx Phase 2 Report)
	164,382	220	

   c. L-23A and L-23B: Edwards Recirculation - Average condition numbers should be presented.

   d. S-13A and S-13B: Medina Lake - Average condition mumbers should be presented.

   e. G-10 thru G-14:

Summary of Recharge Enhancement Programs-Type 2 Reservoirs

Rank*	Project	Percent Capacity	Capacity (acft)	Surface Area (ac)	Average Conditions: Recharge Enhancement (acft/yr)	Average Conditions: Cost/Unit Recharge Enhancement ($/acft/yr)
100% Conservation Capacity						
1	Lower Sabinal	100	35,000	1,430	18,400	$145
2	Lower Verde	100	24,000	1,730	6,220	$215
3	Lower Hondo	100	28,000	1,260	9,420	$255
4	Lower Frio	100	50,000	1,760	14,400	$267
5	Indian Creek	100	165,000	7,650	34,500	$267
6	Lower Dry Frio	100	30,000	1,190	6,170	$306
7	Lower Seco	100	28,000	1,630	5,240	$422
8	Elm Creek	100	6,940	370	670	$463
9	Little Blanco	100	2,930	210	390	$662
10	Quihi Creek	100	1,570	120	150	$811
11	Leona River	100	2,930	220	280	$911
12	Blanco	100	6,580	260	370	$1,318
	Total		380,950	17,830	96,210	
	Weighted Average					$260

Summary of Recharge Enhancement Programs-Type 1 Reservoirs

Rank*	Project	Percent Capacity	Capacity (acft)	Surface Area (ac)	Average Conditions: Recharge Enhancement (acft/yr)	Average Conditions: Cost/Unit Recharge Enhancement ($/acft/yr)
100% Conservation Capacity						
1	Upper Dry Frio	100	60,000	1,800	9,420	$330
2	Upper Verde	100	23,000	880	4,600	$339
3	Upper Sabinal	100	93,300	3,110	14,670	$357
4	Upper Hondo	100	47,000	2,000	8,360	$361
5	Montell	100	252,300	6,190	34,200	$381
6	Upper Seco	100	23,000	900	3,820	$398
7	Concan	100	149,000	3,840	12,210	$486
	Total		647,600	18,720	87,280	
	Weighted Average					$383

TABLE ES-3
Summary of Recharge Enhancement Programs-Type 2 Reservoirs

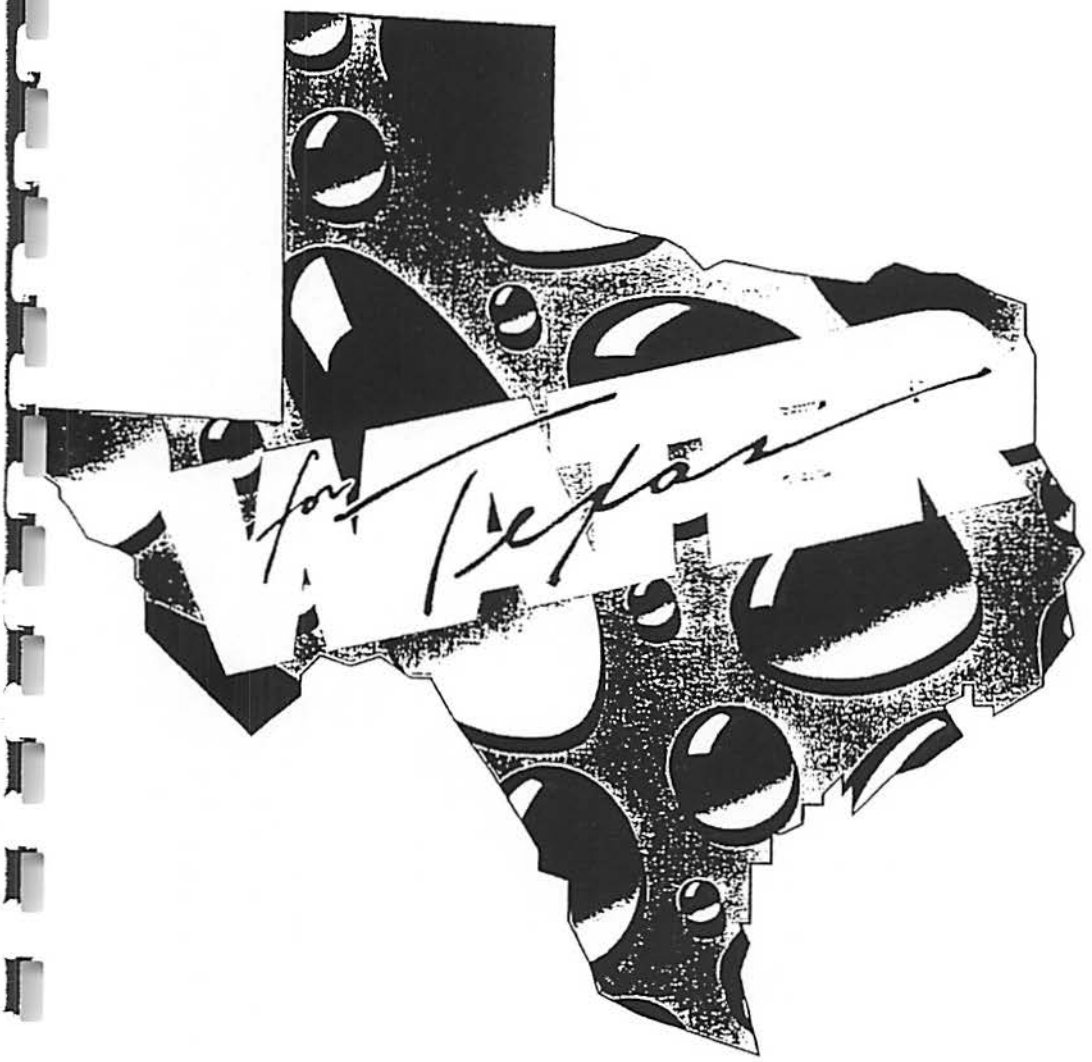
Rank*	Project	Percent Capacity	Capacity (acft)	Surface Area (ac)	Average Conditions		Drought Conditions		Reduction in Median Estuarine Inflow (acft/yr)	Reduction in CC/LCC System Yield (acft/yr)
					Recharge Enhancement (acft/yr)	Cost/Unit Recharge Enhancement ($/acft/yr)	Recharge Enhancement (acft/yr)	Cost/Unit Recharge Enhancement ($/acft/yr)		
100% Conservation Capacity										
1	Lower Sabinal	100	35,000	1,430	18,400	$145	2,770	$965	0	30
2	Lower Verde	100	24,000	1,730	6,220	$215	1,980	$676	0	120
3	Lower Hondo	100	28,000	1,260	9,420	$255	1,190	$2,021	0	0
4	Lower Frio	100	50,000	1,760	14,400	$267	3,180	$1,211	0	0
5	Indian Creek	100	165,000	7,650	34,500	$267	14,600	$630	5,250	2,080
6	Lower Dry Frio	100	30,000	1,190	6,170	$306	1,360	$1,387	0	0
7	Lower Seco	100	28,000	1,630	5,240	$422	290	$7,632	0	0
8	Elm Creek	100	6,940	370	670	$463	120	$2,584	0	0
9	Little Blanco	100	2,930	210	390	$662	100	$2,583	0	0
10	Quihi Creek	100	1,570	120	150	$811	30	$4,057	0	0
11	Leona River	100	2,930	220	280	$911	60	$4,253	0	0
12	Blanco	100	6,580	260	370	$1,318	110	$4,434	0	0
	Total		380,950	17,830	96,210		25,790		5,250	2,230
	Weighted Average					$260		$969		
Optimum Conservation Capacity										
1	Lower Sabinal	10	3,500	280	7,720	$66	2,300	$221	0	30
2	Lower Frio	10	5,000	340	5,940	$114	2,020	$337	0	0
3	Lower Verde	10	2,400	230	3,150	$134	1,380	$306	0	120
4	Lower Hondo	10	2,800	230	3,930	$150	1,190	$494	0	0
5	Indian Creek	25	41,250	2,770	26,500	$213	12,920	$437	4,970	1,500
6	Lower Dry Frio	25	7,500	420	4,090	$216	1,360	$650	0	0
7	Lower Seco	10	2,800	220	2,520	$238	290	$2,069	0	0
8	Elm Creek	100	6,940	370	670	$463	120	$2,584	0	0
9	Little Blanco	100	2,930	210	390	$662	100	$2,583	0	0
10	Quihi Creek	100	1,570	120	150	$811	30	$4,057	0	0
11	Leona River	100	2,930	220	280	$911	60	$4,253	0	0
12	Blanco	100	6,580	260	370	$1,318	110	$4,434	0	0
	Total		86,200	5,670	55,710		21,880		4,970	1,650
	Weighted Average					$193		$492		
Example Type 2 Program**										
1	Lower Sabinal	50	17,500	960	15,350	$104	2,770	$575	0	30
2	Lower Frio	25	12,500	820	9,530	$141	3,180	$424	0	0
3	Lower Hondo	10	2,800	230	3,930	$150	1,190	$494	0	0
4	Lower Verde	25	6,000	500	4,630	$159	1,970	$373	0	120
5	Indian Creek	25	41,250	2,770	26,500	$213	12,920	$437	4,970	1500
6	Lower Dry Frio	25	7,500	420	4,090	$216	1,360	$650	0	0
	Total		87,550	5,700	64,030		23,390		4,970	1650
	Average					$169		$461		

*Rank is based on Cost/Unit Recharge Enhancement for Average Conditions.
**Program includes projects with a Cost/Unit Recharge Enhancement for Average Conditions less than $217/acft/yr ($0.67/1,000 gallons).

TRANS-TEXAS WATER PROGRAM

West Central
Study Area
Phase I
Interim Report

Volume 2



San Antonio River Authority

San Antonio Water System

Edwards Underground Water District

Guadalupe-Blanco River Authority

Lower Colorado River Authority

Bexar Metropolitan Water District

Nueces River Authority

Texas Water Development Board

May, 1994

HDR

HDR Engineering, Inc.
in association with
Paul Price Associates, Inc.
LBG-Guyton Associates
Espey-Huston & Associates, Inc.

Table 3.8-4
Summary of Costs for Recharge Enhancement Programs - Type 1 Reservoirs (L-17)

Type 1 Project	Total Project Costs[1]	Total Annual Costs[1,3]	Drought Conditions Recharge Enhancement[1] (acft/yr)	Annual Water Cost for Drought Conditions ($/acft/yr)
Maximum Conservation Capacity Program				
Montell	$141,893,000	$15,106,000	17,850	$846
Upper Dry Frio	37,633,000	3,481,000	2,900	1,200
Concan	71,534,000	6,662,000	3,890	1,713
Upper Sabinal	62,969,000	5,880,000	2,590	2,270
Upper Hondo	36,556,000	3,383,000	1,140	2,968
Upper Verde	18,300,000	1,748,000	1,910	915
Cloptin Crossing[2]	93,960,000	9,332,000	40,690	229
TOTAL	$462,845,000	$45,592,000	70,970	—
WEIGHTED AVERAGE	—	—	—	$642
Optimum Conservation Capacity Program				
Montell	$61,507,000	$7,441,000	14,750	$504
Upper Dry Frio	15,654,000	1,447,000	2,630	550
Concan	21,312,000	1,999,000	3,850	519
Upper Sabinal	19,512,000	1,839,000	2,590	710
Upper Hondo	14,144,000	1,307,000	1,140	1,146
Upper Verde	9,582,000	941,000	1,910	493
Upper Blanco	14,258,000	1,410,000	8,750	161
TOTAL	$155,969,000	$16,384,000	35,620	—
WEIGHTED AVERAGE	—	—	—	$460

[1]Total project costs, annual costs, and recharge enhancement quantities for all projects (except Cloptin Crossing and Upper Blanco) were taken from November 1991 report entitled "Regional Water Supply Planning Study Phase III Recharge Enhancement" prepared by HDR Engineering, Inc. All cost figures were increased by a CCI of 12 percent to obtain 1994 estimated costs.
[2]Total project costs and annual costs for the Cloptin Crossing site were obtained from 1986 Espey, Huston & Associates' report entitled "Water Availability Study for the Guadalupe and San Antonio River Basins", and updated to 1994 cost based on CCI with addition of Capitalized Interest. Recharge enhancement quantities for the Cloptin Crossing site were obtained from a September 1993 Report entitled "Recharge Enhancement Study, Guadalupe-San Antonio River Basin" prepared by HDR Engineering, Inc.
[3]Total annual cost includes cost to purchase water rights in San Antonio Basin to offset effects of yield impacts on Choke Canyon/Lake Corpus Christi Reservoir system.

Table 3.8-1
Summary of Recharge Enhancement Potential for Type 1 Reservoir Programs

Type 1 Project	Percent Capacity	Capacity (acft)	Surface Area (ac)	Recharge Enhancement (acft/yr) 1934-1989 Average Conditions	Recharge Enhancement (acft/yr) 1947-1956 Drought Conditions	Reduction in Average Estuarine Inflow (acft/yr)	Reduction in CC/LCC System Yield (acft/yr)
Maximum Conservation Capacity Program							
Montell	100	252,300	6,190	39,220	17,850	5,510[E]	3,700[E]
Upper Dry Frio	100	60,000	1,800	9,540	2,900	1,400[E]	600[E]
Concan	100	149,000	3,840	15,950	3,890	2,400[E]	1,100[E]
Upper Sabinal	100	93,300	3,110	19,000	2,590	2,800[E]	1,500[E]
Upper Hondo	100	47,000	2,000	9,420	1,140	1,400[E]	600[E]
Upper Verde	100	23,000	880	5,580	1,910	800[E]	200[E]
Cloptin Crossing	100	283,400	6,060	48,275	40,690	16,000[E]	0
TOTAL		908,000	23,880	146,985	70,970		7,700[E]
Optimum Conservation Capacity Program							
Montell	10	25,230	1,460	32,090	14,750	3,700[E]	3,200[E]
Upper Dry Frio	10	6,000	440	5,840	2,630	800[E]	200[E]
Concan	10	14,900	710	8,740	3,850	1,300[E]	500[E]
Upper Sabinal	10	9,330	550	11,240	2,590	1,700[E]	700[E]
Upper Hondo	10	4,700	350	4,700	1,140	700[E]	200[E]
Upper Verde	25	5,750	350	4,540	1,910	700[E]	100[E]
Upper Blanco	N/A	24,290	800	8,750[E]	8,750	11,400[E]	0
TOTAL		90,200	4,660	75,900	35,620		4,900[E]

[E] - Estimated on the basis of comparisons with recent work performed on the Type-2 recharge structures.

River Basin shows that natural recharge of the Carrizo-Wilcox aquifer would be reduced by less than 1 percent. Frequency of overbank inundation in the braided reach of the Nueces River would be reduced by less than 1 percent while the frequency of zero flows (which presently occur about 40 percent of the time) would be essentially unaffected.

Table 3.9-1
Summary of Recharge Enhancement Potential for Type 2 Reservoir Program (L-18)

Type 2 Project	Capacity (acft)	Surface Area (ac)	Recharge Enhancement (acft/yr) 1934-1989 Average Conditions[1,2]	Recharge Enhancement (acft/yr) 1947-1956 Drought Conditions[1,2]	Reduction in Average Estuarine Inflow[1,2] (acft/yr)	Reduction in CC/LCC System Yield[1] (acft/yr)
Nueces River Basin Type-2 Program						
Indian Creek	61,750	3,657	29,307	18,596	2,998	2,953
Lower Frio	17,500	1,099	17,064	3,980	2,594	1,152
Lower Sabinal	8,750	454	16,442	2,358	2,566	1,229
Lower Hondo	2,800	232	6,779	1,193	1,134	403
Lower Verde	3,600	334	4,850	1,719	728	170
Subtotal - Nueces Basin	94,400	5,776	74,442	27,846	10,020	5,907
San Antonio-Guadalupe Basin Type-2 Program - New Structures						
San Geronimo	3,500	330(E)	1,715	560	—	N/A
Cibolo Dam No. 1	10,000	500(E)	8,485	1,265	—	N/A
Dry Comal	2,075	265	1,335	520	—	N/A
Lower Blanco	35,230	1,052	31,495	19,465	—	N/A
Leon/Helotes/Gov.	25,200	1,380(E)	5,205	1,815	—	N/A
San Antonio-Guadalupe Basin Type-2 Program - Outlet Modifications						
Salado Creek FRS	—	—	485	0	—	N/A
Dry Comal FRS	—	—	1,145	390	—	N/A
San Marcos FRS	—	—	1,020	125	—	N/A
Subtotal GSA Basins	76,005	3,527(E)	50,885	24,140	32,700(E)	N/A
TOTAL ALL BASINS	170,405	9,303(E)	125,327	51,986	42,720(E)	5,907

(E) - Estimated.

[1]Recharge enhancement, estuarine inflow reduction and CC/LCC system yield reduction quantities for all Nueces River Basin projects were taken from April 19, 1994 Progress Meeting No. 3 Report for "Nueces River Basin Edwards Aquifer Recharge Enhancement Study - Phase IVA," prepared by HDR Engineering, Inc.

[2]Recharge enhancement quantities and estimates of Estuarine Inflow Reductions for all San Antonio and Guadalupe River Basin projects were taken from September 1993 report entitled "Guadalupe-San Antonio River Basin Recharge Enhancement Study," prepared by HDR Engineering, Inc.

Table 3.9-5
Summary of Costs for Recharge Enhancement Programs - Type 2 Reservoirs (L-18)

Type 2 Recharge Program	Total Program Costs[1,2]	Total Annual Costs[1,2]	Drought Conditions Recharge Enhancement[1] (acft/yr)	Annual Water Cost for Drought Conditions ($/acft/yr)
Nueces River Program	$143,256,000	$16,446,000	27,846	$591
San Antonio and Guadalupe River Programs	105,647,000	9,808,000	24,140	406
TOTAL	$248,903,000	$26,254,000	51,986	$505

[1]Total program costs, annual costs, and recharge enhancement quantities for the Nueces River Program were taken from April 19, 1994 Progress Meeting No. 3 Report for "Nueces River Basin Edwards Aquifer Recharge Enhancement Study - Phase VIA" prepared by HDR Engineering, Inc.
[2]Total program costs and annual costs for the San Antonio and Guadalupe River Programs were estimated based on the unit costs of storage for the composite Nueces River Program (i.e., without the Indian Creek pipeline) inflated by 5 percent to account for potential land price differences and the potential cost of the SCS outlet modification program.

3.9.6 Implementation Issues

In order to fully evaluate the potential benefits to well yields and springflows from development of the Type 2 recharge program, additional modeling work is required. Additionally, the projects in the San Antonio and Guadalupe River Basins need to have site specific cost estimates prepared so the optimum size project at each site can be determined.

The Trans-Texas environmental criteria may need to be applied (if determined to be appropriate) to the recharge projects in subsequent study phases.

1. Necessary permits could include:
   a. TNRCC Water Right and Storage permits;
   b. U.S. Army Corps of Engineers Sections 10 and 404 dredge and fill permits for the reservoir and pipelines;
   c. GLO Sand and Gravel Removal permits; and
   d. GLO Easement for use of state-owned land.

2. Permitting, at a minimum, will require these studies:
   a. Bay and estuary inflow impact;
   b. Habitat mitigation plan;
   c. Environmental studies; and
   d. Cultural resource studies.

3. Right-of-way must be acquired.

4. Relocations and crossings:
   a. Highways and railroad; and
   b. Other utilities.

Guadalupe River Diversions to Recharge Zone

G-30, G-32, G-33

1. Invalid Comparison:

   a. Quantity of Water - understated

      1. Drought yields
      2. Left out various pipeline options.

   b. Unit Cost of Water - overstated

      1. Drought Condition Cost.
      2. Incomplete due to 1.a.(2) above.

2. Corrected Numbers for Comparison Purposes:

   a. G-30 - Diversion near Comfort to Rech. Zone via Medina Lake.

Pipeline Size	Ac.Ft.	$/Ac.Ft.
72"	37,800	$239
96"	50,050	243
120"	58,500	276

   b. G-32 - Diversion of Canyon Lake Flood Storage to Rech. Zone via Cibolo Creek

      Ok. shown as an Average.

   c. G-33 - Diversion near Lake Dunlap to Rech. Zone

Pipeline Size	Ac.Ft.	$/Ac.Ft.
84"	123,200	$264
96"	152,800	260
120"	208,900	267

TRANS-TEXAS WATER PROGRAM

WEST CENTRAL STUDY AREA

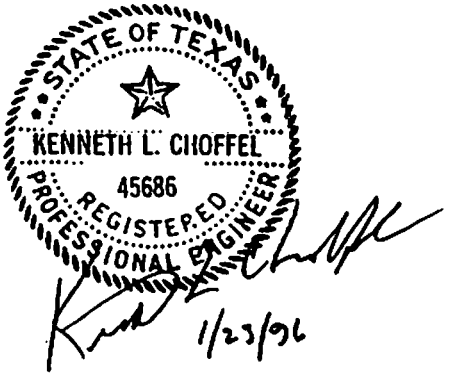
PHASE I

INTERIM REPORT

VOLUME 4

Prepared for

San Antonio River Authority
San Antonio Water System
Edwards Underground Water District
Guadalupe-Blanco River Authority
Lower Colorado River Authority
Bexar Metropolitan Water District
Nueces River Authority
Texas Water Development Board



by

HDR Engineering, Inc.
in association with
Paul Price Associates, Inc.
LBG-Guyton Associates
H.B. Zachry Company

January, 1996

HDR
HDR Engineering, Inc.

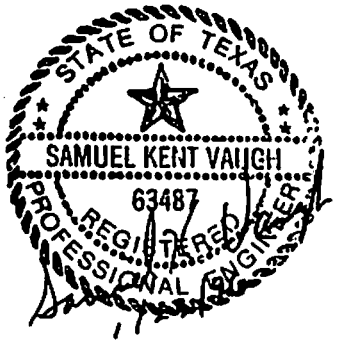


Table 3.43-1
Cost Estimate for Guadalupe River Diversion Near Comfort to Recharge Zone Via Medina Lake (G-30)
(Mid 1994 Prices)

Item	Diversion to Recharge Zone	
	Long-Term Average[1]	Drought Average[2]
Capital Costs		
Transmission and Pumping	$ 34,682,000	
Delivery System	4,555,000	
Total Capital Cost	$ 39,237,000	
Engineering, Contingencies, and Legal Costs	12,484,000	
Land Acquisition	353,000	
Environmental Studies and Mitigation	2,327,000	
Interest During Construction	2,474,000	
Total Project Cost	$ 56,875,000	
Annual Costs		
Annual Debt Service	$ 5,328,000	$ 5,328,000
Annual Operation and Maintenance	738,000	738,000
Purchase of Water	265,000	265,000
Annual Power Cost	2, 700,000	706,000
Total Annual Cost	$ 9,031,000	$ 7,037,000
Available Project Yield (acft/yr)	37,800	9,900
Annual Cost of Water ($/acft/yr)	$ 239	$ 711

[1] Long-term average based on 1934-89 historical period.
[2] Drought average based on 1947-56 historical period.

2. Permitting will require these studies:
   a. Instream flow issues and impact.
   b. Environmental studies.
   c. Evaluation of potential impacts to recreation.
3. Agreement with Guadalupe-Blanco River Authority for purchase of firm yield reduction at Canyon Lake.
4. Agreement with Bexar-Medina-Atascosa Counties Water Control and Improvement District to transport water through Medina Lake, and to construct an intake and pump station at Diversion Lake to transfer Guadalupe River water to the recharge zone.

Table 1
Cost Estimate for Guadalupe River Diversion Near Comfort to Recharge Zone via Medina Lake Based on 96" Transmission Pipeline
(Mid 1994 Prices)

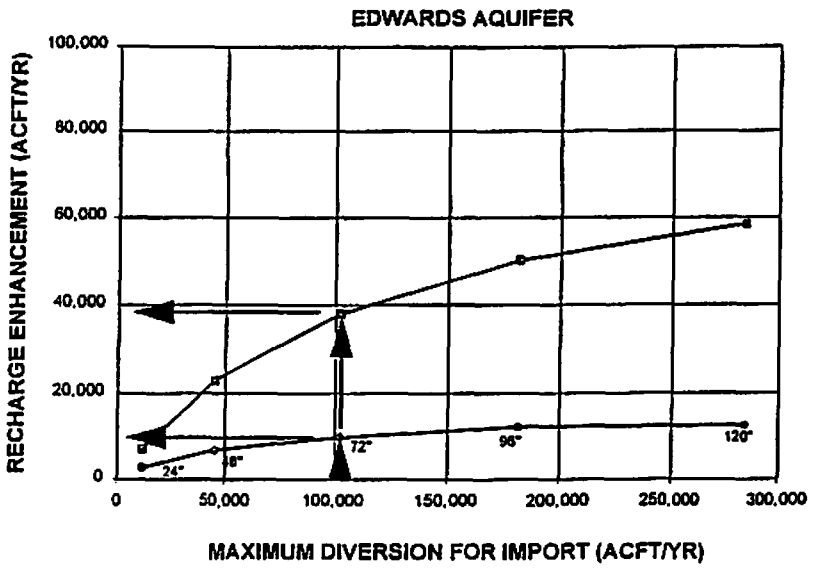
Item	Diversion to Recharge Zone	
	Long-Term Average[1]	Drought Average[2]
Capital Costs		
Transmission and Pumping	$ 46,148,000	
Delivery System	8,806,000	
Total Capital Costs	$ 54,954,000	
Engineering, Contingencies, and Legal Costs	$ 17,347,000	
Land Acquisition	446,000	
Environmental Studies and Mitigation	2,718,000	
Interest During Construction	3,558,000	
Total Project Costs	$ 79,023,000	
Annual Costs		
Debt Service	$ 7,403,000	$ 7,403,000
Operation and Maintenance	992,000	992,000
Purchase of Water	297,000	297,000
Power	3,495,000	843,000
Total Annual Cost	$ 12,187,000	$ 9,535,000
Average Project Yield (acft/yr)	50,050	12,150
Annual Unit Cost of Water ($/acft/yr)	$243	$785

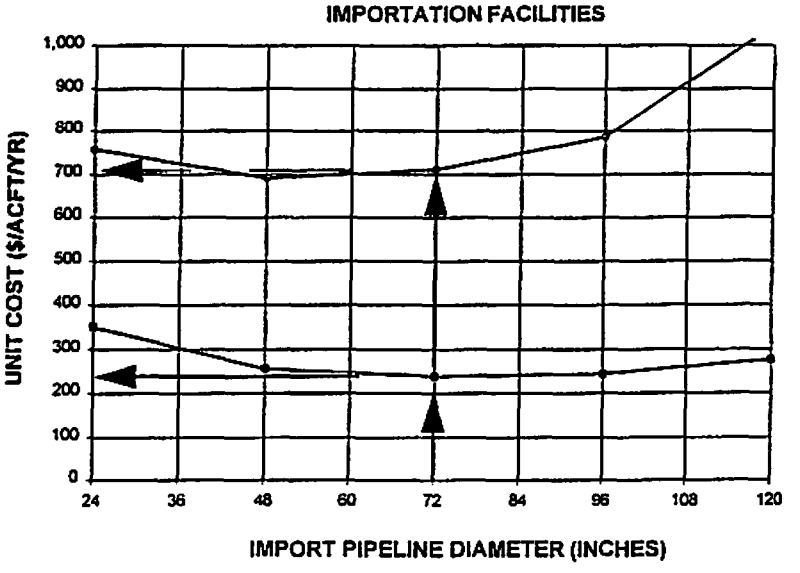
[1] Long-term average based on 1934-89 historical period.
[2] Drought average based on 1947-56 historical period.

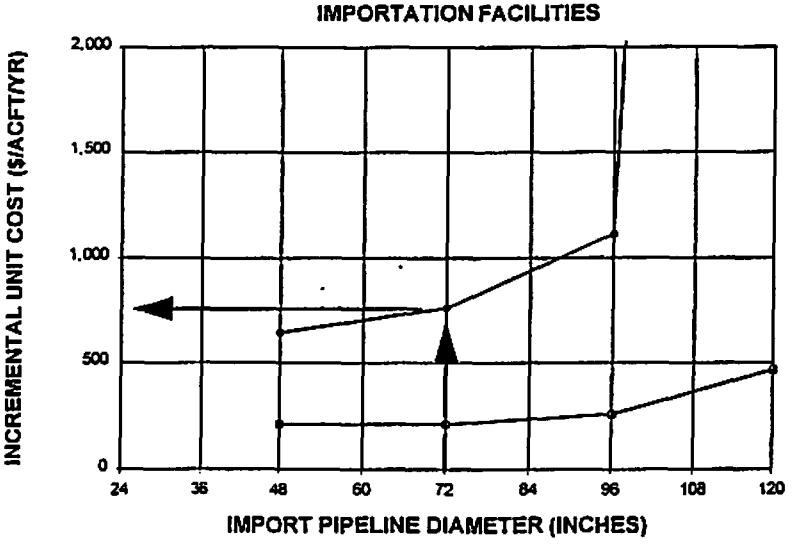
Table 2
Cost Estimate for Guadalupe River Diversion Near Comfort to Recharge Zone via Medina Lake Based on 120" Transmission Pipeline
(Mid 1994 Prices)

Item	Diversion to Recharge Zone	
	Long-Term Average[1]	Drought Average[2]
Capital Costs		
Transmission and Pumping	$ 66,027,000	
Delivery System	12,383,000	
Total Capital Costs	$ 78,410,000	
Engineering, Contingencies, and Legal Costs	$ 24,530,000	
Land Acquisition	491,000	
Environmental Studies and Mitigation	2,989,000	
Interest During Construction	4,996,000	
Total Project Costs	$111,416,000	
Annual Costs		
Debt Service	$ 10,437,000	$ 10,437,000
Operation and Maintenance	1,349,000	1,349,000
Purchase of Water	313,000	313,000
Power	4,036,000	851,000
Total Annual Cost	$ 16,135,000	$ 12,950,000
Average Project Yield (acft/yr)	58,500	12,370
Annual Unit Cost of Water ($/acft/yr)	$276	$1,047

[1] Long-term average based on 1934-89 historical period.
[2] Drought average based on 1947-56 historical period.







ASSUMPTIONS:

1. DIVERSIONS FROM THE GUADALUPE RIVER NEAR COMFORT FOR IMPORT TO THE EDWARDS AQUIFER RECHARGE ZONE IN NORTHERN BEXAR COUNTY VIA MEDINA LAKE.
2. COST OF RECHARGE ENHANCEMENT STRUCTURES INCLUDED TO ENSURE THAT IMPORTED WATERS ENTER THE EDWARDS AQUIFER.
3. 90 PERCENT EFFICIENCY ASSUMED FOR DELIVERY OF WATER DIVERTED FROM THE GUADALUPE RIVER TO THE RECHARGE ZONE TO ACCOUNT FOR POTENTIAL LOSSES IN MASON CREEK AND THE MEDINA RIVER AS WELL AS EVAPORATION AT MEDINA LAKE.
4. SPRINGFLOWS RESULTING FROM FIXED EDWARDS AQUIFER PUMPAGE OF 400,000 ACFT/YR.
5. HYDROPOWER WATER RIGHTS FULLY SUBORDINATED TO CANYON LAKE.
6. RETURN FLOWS SET AT RATES OBSERVED IN 1988.

LEGEND:

- LONG-TERM AVERAGE (1934-89)
- DROUGHT AVERAGE (1947-56)

TRANS TEXAS WATER PROGRAM / WEST CENTRAL STUDY AREA

OPTIMIZATION SUMMARY ALTERNATIVE G-30

HDR Engineering, Inc.

FIGURE 3.43-5

Table 3.45-1
Cost Estimate For Guadalupe River Diversion Near Lake Dunlap to Recharge Zone With Enhanced Springflow, Water Rights Transfer, and Unappropriated Flow (G-33) (Mid 1994 Prices)

Item	Diversion to Recharge Zone	
	Long-Term Average[1]	Drought Average[2]
Capital Costs		
Transmission and Pumping	$104,715,000	
Delivery System	19,642,000	
Total Capital Cost	$124,357,076	
Engineering, Contingencies, and Legal Costs	38,761,000	
Land Acquisition	1,139,000	
Environmental Studies and Mitigation	3,959,000	
Interest During Construction	7,935,000	
Total Project Cost	$176,151,000	
Annual Costs		
Annual Debt Service	$ 16,502,000	$ 16,502,000
Annual Operation and Maintenance	2,213,000	2,213,000
Purchase of Water[3]	1,787,000	1,787,000
Annual Power Cost	12,085,000	6,859,000
Total Annual Cost	$ 32,587,000	$ 27,361,000
Available Project Yield (acft/yr)	123,200	70,300
Annual Cost of Water ($/acft/yr)	$ 264	$ 389

[1] Long-term average based on 1934-89 historical period.

[2] Drought average based on 1947-56 historical period.

[3] Cost for purchase of water assumed to be $53/acft/yr based on drought average diversions from Lake Dunlap under existing water rights. No purchase costs included for diversion of enhanced springflow or unappropriated water.

However, if Edwards Aquifer pumpage is restricted to amounts less than 400,000 acft/yr during drought, then a larger diameter import pipeline could produce greater recharge enhancement.

2. On the basis of long-term average unit cost for importation and recharge facilities, a 96-inch diameter import pipeline ($260/acft/yr) could be chosen based on long-term average recharge enhancement.

Table 3

Cost Estimate for Guadalupe River Diversion Near Lake Dunlap to Recharge Zone with Enhanced Springflow, Water Rights Transfer, and Unappropriated Flow - Based on 96" Transmission Pipeline

(Mid 1994 Prices)

Item	Diversion to Recharge Zone	
	Long-Term Average[1]	Drought Average[2]
Capital Costs		
Transmission and Pumping	$128,744,000	
Delivery System	25,117,000	
Total Capital Costs	$153,861,000	
Engineering, Contingencies, and Legal Costs	$ 47,987,000	
Land Acquisition	1,280,000	
Environmental Studies and Mitigation	4,807,000	
Interest During Construction	9,853,000	
Total Project Costs	$217,788,000	
Annual Costs		
Debt Service	$ 20,402,000	$ 20,402,000
Operation and Maintenance	2,793,000	2,793,000
Purchase of Water	1,974,000	1,974,000
Power	14,581,000	7,116,000
Total Annual Cost	$ 39,750,000	$ 32,285,000
Average Project Yield (acft/yr)	152,800	74,600
Annual Unit Cost of Water ($/acft/yr)	$260	$433

[1] Long-term average based on 1934-89 historical period.

[2] Drought average based on 1947-56 historical period.

[3] Cost for purchase of water assumed to be $53 acft/yr based on drought average diversion from Lake Dunlap under existing water rights. No purchase costs included for diversion of enhanced springflow or unappropriated water.

Table 4

Cost Estimate for Guadalupe River Diversion Near Lake Dunlap to Recharge Zone with Enhanced Springflow, Water Rights Transfer, and Unappropriated Flow - Based on 120" Transmission Pipeline

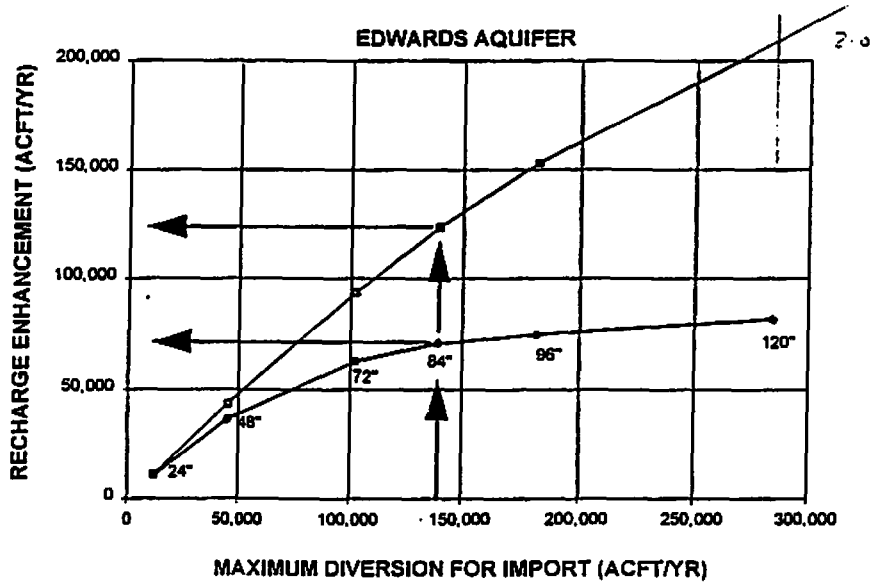
(Mid 1994 Prices)

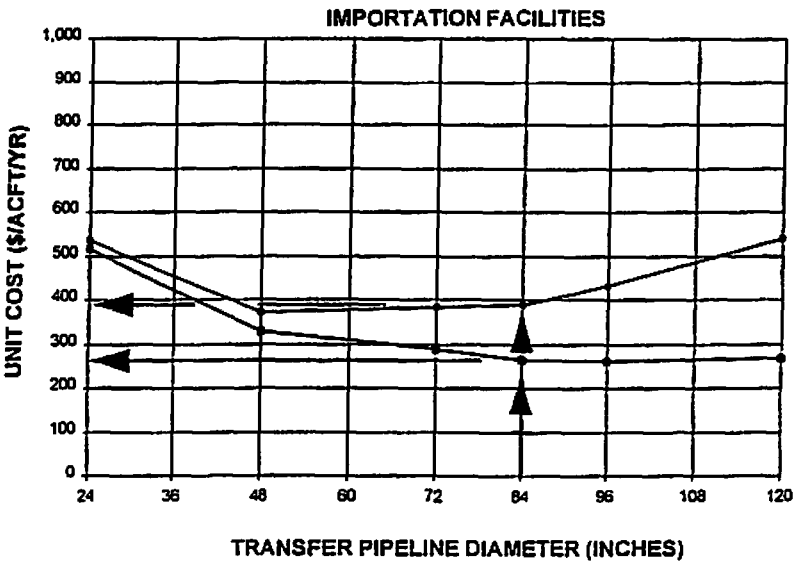
Item	Diversion to Recharge Zone	
	Long-Term Average[1]	Drought Average[2]
Capital Costs		
Transmission and Pumping	$194,553,000	
Delivery System	34,720,000	
Total Capital Costs	$229,273,000	
Engineering, Contingencies, and Legal Costs	$ 71,075,000	
Land Acquisition	1,550,000	
Environmental Studies and Mitigation	6,423,000	
Interest During Construction	14,453,000	
Total Project Costs	$322,774,000	
Annual Costs		
Debt Service	$ 30,237,000	$ 30,237,000
Operation and Maintenance	4,020,000	4,020,000
Purchase of Water	2,267,000	2,267,000
Power	19,264,000	7,539,000
Total Annual Cost	$ 55,788,000	$ 44,063,000
Average Project Yield (acft/yr)	208,900	81,800
Annual Unit Cost of Water ($/acft/yr)	$267	$539

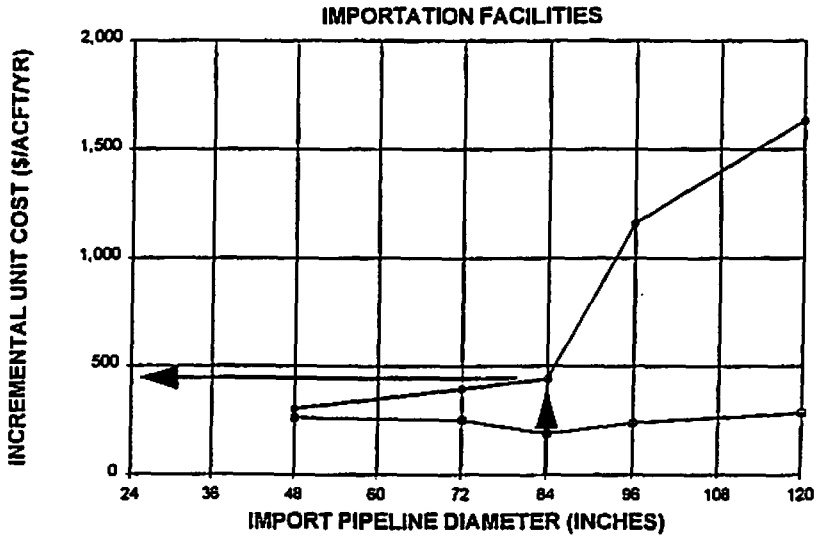
[1] Long-term average based on 1934-89 historical period.

[2] Drought average based on 1947-56 historical period.

[3] Cost for purchase of water assumed to be $53 acft/yr based on drought average diversion from Lake Dunlap under existing water rights. No purchase costs included for diversion of enhanced springflow or unappropriated water.







ASSUMPTIONS:

1. DIVERSIONS UNDER ENHANCED SPRINGFLOW, WATER RIGHTS UNUTILIZED IN 1989, AND UNAPPROPRIATED STREAMFLOW FROM LAKE DUNLAP FOR IMPORT TO THE EDWARDS AQUIFER RECHARGE ZONE IN NORTHERN BEXAR COUNTY.
2. COST OF RECHARGE ENHANCEMENT STRUCTURES INCLUDED TO ENSURE THAT IMPORTED WATERS ENTER THE EDWARDS AQUIFER.
3. ENHANCED SPRINGFLOWS RESULTING FROM SIMULATED REDUCTION OF FIXED EDWARDS AQUIFER PUMPAGE FROM 543,677 ACFT/YR (1989) TO 400,000 ACFT/YR.
4. HYDROPOWER WATER RIGHTS FULLY SUBORDINATED TO CANYON LAKE.
5. RETURN FLOWS SET AT RATES OBSERVED IN 1989.

LEGEND:

- LONG-TERM AVERAGE (1934-89)
- DROUGHT AVERAGE (1947-56)

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TRANS TEXAS WATER PROGRAM / WEST CENTRAL STUDY AREA

OPTIMIZATION SUMMARY ALTERNATIVE G-33

FIGURE 3.45-4