THE AUTHORIZED RED RIVER CHLORIDE CONTROL PROJECT WICHITA RIVER ONLY PORTION

USFWS MITIGATION RECOMMENDATIONS AND RESPONSES AND COORDINATION ACT REPORT

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May 24, 2002

USACE - Response to US Fish and Wildlife Service Mitigation Recommendations.

The Service anticipates that the Corps will give equal consideration to fish and wildlife resource needs (as required by the Fish and Wildlife Coordination Act) along with other features of this project. If the Corps proceeds with the proposed project, in order to rectify and compensate for a portion of the anticipated impact, the Natural Resource Agencies recommend that:

Recommendation No. 1.

The WRB project not proceed as formulated in the preferred alternative due to unmitigable impacts to important fish and wildlife resources. Other alternatives, such as desalinization, water blending, and pumping to streams or deep well injection, instead of to Truscott Reservoir, should be evaluated and incorporated into a limited project that meets the water requirements of the basin. Control of chlorides at all three areas (VII, VIII, and X) collectively should not be pursued as proposed due to their anticipated significant contribution to impacts to:

A. The Wichita River aquatic community,
B. Lake Texoma, Lake Kemp, and Lake Diversion sport fisheries,
C. Dundee State Fish Hatchery, and
D. Migratory birds and other resources from possible selenium contamination at the Truscott brine storage site.

USACE Response: *Do not concur. There are potentially a few minor effects, but there are no unmitigable impacts. A total of 24 alternatives have been evaluated including those recommended by the USFWS for transporting brines around Lakes Kemp and Diversion. These previously evaluated alternatives included components of deep-well injection and the USFWS/TPWD concepts to pump brine from existing brine streams to fresh water streams crossing private lands. These alternatives were eliminated from further consideration. Desalinization and blending were included as part of the formulation and economic evaluation process. The tentatively selected plan is Alternative 7a with chloride control at Areas VII, VIII, and X and disposal at Truscott Lake. The potential impacts associated with this plan are addressed in the draft Supplement to the Final Environmental Statement for the Authorized Red River Chloride Control Project, Wichita River portion only. The impacts associated with Alternative 7a do not warrant further reduction in plan components.*

Recommendation No. 2.

The Corps should cooperate with the respective states and affected agencies to achieve maximum control of man-made sources of brine. This may allow the Corps to reduce control of natural brines and still achieve most of the projected goals of the WRB and RRCC Projects.

USACE Response: *Concur. While the Corps supports the control of man-made brines, those efforts are already underway under state programs. The Red River Authority reports that 87%*

of all man-made brines have been stopped from entering the Wichita River. Most man-made brine contributions are non-point source contributions remaining from older oil and gas production practices. Control of the natural brine sources is more effective and predictable over time.

Recommendation No. 3.

The Corps reconsider their preferred alternative and consider eliminating brine control at Area VII or X, or reducing pumping and providing minimum flows at both sites. The Service and TPWD strongly recommend eliminating Area X because of its relatively high contribution to selenium levels at Truscott Brine Reservoir. Another alternative is to use deep injection at Areas VII or X. Brine could be returned or added to the Wichita River below Lake Diversion to avoid impacts to the Red River and Lake Texoma.

USACE Response: *Do not concur. The current study is a thorough reevaluation of assumptions, methodology, and alternatives. An array of 12 alternative ideas were proposed and reviewed with the natural resources agencies in 1998 in the first month of the study. That array contained most of the variations suggested above, and the last of the results of the Corps detailed studies were then coordinated with the natural resource agencies in the fall of 2001.*

For the first time, the agencies indicated their inability to support chloride control measures as formulated. The agencies proposed an additional 12 alternatives that generally relate to the last sentence of Recommendation No. 3. The study schedule was delayed for 8 months while the Corps evaluated the array of 12 USFWS/TPWD alternatives. Although it was a limited evaluation, the findings, when compared to the tentatively selected plan, indicated a reduction in benefits and reduced levels of chloride control. Also identified were a number of environmental concerns, a number of issues that could preclude implementation under Texas State law, general public disapproval (based on limited informal coordination), limited anticipated or negative chloride control and environmental outputs, no anticipated local landowner support, and no support from the chloride control project local sponsor, the Red River Authority. For these reasons, none of the USFWS/TPWD alternatives were evaluated further.

Although Recommendation No. 3 indicates that more alternatives should be considered, the agencies justifications for additional evaluations are not scientifically supported.

It is the USACE's opinion that selenium risks at Truscott Brine Disposal Reservoir are not excessive though uncertainties are recognized. A selenium monitoring plan, and a selenium action plan have been developed to address the concerns.

Recommendation No. 4.

Additional pools be created or existing rook enhanced to partially mitigate for reduced flows and provide refugia during droughts in portions of the South, Middle, and North Forks of the Wichita River affected by the WRB project. Salt cedar control also should be initiated to improve habitat and flows in reaches affected by the WRB project.

USACE Response: *Do not concur. The Corps' conservative projection of project effects on low flows for the North and Middle Forks (without consideration of future brush management changes to stream flow) shows slightly less effect than those projected (and experienced) on the South Fork below the Area VIII collection facility. Since 1987 when Collection Area VIII began pumping brine to Truscott Brine Reservoir, downstream flows have been monitored. While a period of 15-years of operation is unlikely to represent the full variation of conditions expected in the project's future, valuable and revealing information have been obtained concerning low flows. The most important finding has been that low flows on the South Fork have not been as low as originally projected. The contribution of relatively fresh ground water appears to have caused flow conditions to be somewhat higher and more continuous. While ground water contributions may be expected to have similar effects below the collection areas on the North and Middle Forks, the Corps is not relying on that assumption. Similarly, the Corps is not relying on the project implementation of brush management in the basin to increase watershed runoff but does include those management efforts in the projection of future conditions whether with- or without the implementation of chloride control. Evaluation of the project and future brush management indicate the percentage of zero flow days would only increase in the South Fork of the Wichita River by 0.2%, the main stem of the Wichita River by less than 0.05%, and in the North and Middle Forks of the Wichita River by 2.3%. Overall, when the combined effects of the brush management program and the WRCCP are considered, it is anticipated that there would be little effect (adverse or beneficial) on the fish communities, including the hardy salt tolerant species of greatest concern.*

The potential loss of refugia for fish during times of drought is not anticipated to be a problem. The greatest potential for adverse impacts of flow reduction on fish species in the river would be isolation during extreme low flow or zero flow periods. It is important to note that collections in 1998 (Gelwick et al. 2000) were made at the height of summer (August 1998), and is indicative of such conditions. Physical and chemical characteristics of the refugia pools located throughout the basin in August 1998 indicate that salinity concentrations rarely exceeded 10,000 mg/l, pools were well oxygenated relative to their location in the basin, and pool characteristics (percent canopy cover, dissolved oxygen, water temperature, etc.) were quite diverse.

Salt cedar control could potentially be made a part of the brush management plan, but would probably not be successful unless it was accomplished within the entire basin. Also, based on the strong association of pupfish with salt cedar in the study by (Gelwick et. al. 2000) salt cedar eradication could have adverse impacts on this species. The Corps and the Red River Authority have discussed additional studies for potential projects under the Corps environmental restoration program. Programs to supplement brush management efforts with salt-cedar eradication and restoration of native vegetation components are being discussed.

Recommendation No. 5.

Habitat for salt tolerant species, such as pupfish, be replaced by building and maintaining impoundments in the upper Wichita River watershed and stocked with pupfish.

USACE Response: *Partially concur. Pupfish habitat has already been created with the project. The Truscott Lake brine pool contains a large population of pupfish, along with mosquito fish*

and killifish. Pools associated with the collection facility at Area VIII and X also maintain populations of this species. The proposed Area VII collection facility would likewise be expected to have this species. There could be a point in the future when chloride concentrations at Truscott Lake may exceed levels that pupfish can survive. However, it is highly probable that some areas within the lake (such as inlets for receiving flows) should remain conducive for this species continued existence.

Recommendation No. 6.

To mitigate for the loss of flowing water habitat value, one or a combination of the following be implemented:

A. Eliminate Area VII or X and implement salt cedar control in addition to the proposed upland brush control. Brush control should be initiated and maintained at levels needed to restore flows to pre-project levels. If brush control is used to minimize low flows, it must be maintained over time. The Corps should budget for and commit to continuing the brush control efforts if the State does not continue the program. Brush control will be required several times during the proposed life of the WRB Project. The Service and TPWD would like to see additional mitigation for reduction in flows and impacts to salt tolerant fish that are not addressed through brush control.

B. Water from brine sources be pumped into created stream channels or existing intermittent stream channels to create perennial streams. Water from brine sources could be pumped into streams that enter the Wichita River below Lake Diversion or possibly into the Pease River watershed. This alternative could eliminate the need for Truscott Brine Reservoir and the spray fields. Another alternative could include continued operation of Truscott with Area VIII alone (assuming selenium would not exceed threshold levels) and pumping from one or both of the remaining brine sources to created or existing intermittent stream channels.

C. The Corps could purchase water rights and protect or restore flows in a watershed that is approved by the Natural Resources Agencies.

USACE Response: *In general, see responses to Comment 3 which briefly address the completed evaluations of various chloride control alternatives proposed by the Corps and coordinated with the USFWS and TPWD in the fall of 1998, and address the USFWS/TPWD alternatives proposed in the fall of 2001 and since evaluated by the Corps. All of the suggested items below have either been evaluated as chloride control features or combinations of features, or were evaluated as part of the with- or without project conditions, or are not appropriate for consideration. No additional evaluation of chloride control components or combinations is proposed.*

A. The Corps supports the eradication of salt cedar and the brush management efforts of Texas for their projected positive effects on water resources and the environment. While the potential positive changes that would result from reducing the current levels of these species is

recognized as beneficial within the Wichita River Basin Project Reevaluation and would compliment the chloride control project, the planned chloride control implementation is not dependant on these efforts. The Corps environmental program (including ecosystem restoration) is well suited to assist the State of Texas in both salt cedar eradication and brush management. The Corps has discussed potential assistance with the Red River Authority under our environmental program. Concerning the management aspect of brush management, we concur that once the cost of brush management has been expended the investment should be protected. We assume that the State of Texas, who is proposing to fund 75% of the cost, will be like-minded. The comment reference to "pre-project levels" related to flows is somewhat vague. The Service's assessment of species population size and distribution variation within a 25% range (in comment 11) is a more appropriate starting point and deals with biota and not flow.

B. See general comments above. The additional alternatives recommended in the comment, are generally identical to the 12 USFWS/TPWD alternatives proposed in the fall of 2001, which have been evaluated and eliminated from further consideration. Concerning acquisition of ***water rights****, the Corps finds no significant impact to flows (or biota) as related to implementation of chloride control measures. Stream flows in the upper Wichita River Basin are not used for irrigation, nor are they projected to be used for irrigation. Stream flows in the lower basin are not impacted by the project.*

C. See "water rights" in B above.

Recommendation No. 7.

Selenium concentrations at Truscott Brine Storage Reservoir be monitored throughout the life of the WRB project, or until realistic projections of anticipated conditions indicate that selenium concentrations will not exceed thresholds that would adversely affect wildlife resources. (See comments on the Selenium Monitoring Plan in Appendix E).

The Corps presently is evaluating alternative methods to reduce potential adverse effects to wildlife resources from exposure to selenium and has proposed monitoring Se levels in the water, sediment, and in fish and bird eggs at Truscott Reservoir. However, the potential adverse effects of the proposed action are long lasting and difficult to control or eliminate after they develop. Monitoring alone is not acceptable for such a serious potential problem. The Service is opposed to any implementation of the proposed WRB project until the Corps develops plans to avoid or mitigate for adverse affects to wildlife resources exposed to Se concentrations due to project operations (see previous comments on pages 18-21) and comments on the Se Action Plan in Appendix E). These plans should be approved by the Service and State resource agencies.

USACE Response: *Partially concur. Both monitoring and a multi-agency process-based action plan have been developed for implementation. Accordingly, selenium monitoring is part of the project Environmental Operating Plan (Appendix A).*

If required, selection of appropriate corrective measures for avoiding Se-related impacts on breeding birds at Truscott Brine Lake would be dependent upon a combination of a wide range

of environmental conditions that determine biological response to Se in the environment. Potential combinations of these factors over the life of the project are virtually limitless and impossible to predict. Many of these factors are discussed in Section 4 of the proposed selenium action plan (Appendix A) and have been thoroughly discussed with the Service during project coordination. Selection of a single remedial measure applicable to all future conditions is not possible, would be counterproductive at this stage of project development, and would be largely indefensible. A process-based action plan based on careful monitoring, observed conditions, application of changing science and technology, and multi-agency input is a more appropriate means of addressing these future conditions, should they occur.

Recommendation No. 8.

Measures to avoid the take of migratory birds be implemented when monitoring indicates that Se concentrations are approaching the reproductive impairment threshold. To this end, a plan should be prepared that details the measures to be used and their application at Truscott Brine Storage Reservoir and other parts of the WRB project. This plan should be included in the final Supplemental Environmental Impact Statement. Such action will be entirely the responsibility of the Corps. The proposed Selenium Action Plan (Appendix E) is a good start, but is not what the Natural Resource Agencies consider an action plan (see additional comments in Appendix E). Additional compensation and permits (in compliance with the Migratory Bird Treaty Act) for the loss of migratory birds and other resources may be required.

USACE Response: *Partially concur. The USACE agrees that a plan is needed to provide for monitoring and response to avoid the take of migratory birds, if required. Accordingly, a draft Selenium Action Plan has been developed and is included in Appendix A. The plan provides for multi-agency input into monitoring and selection of appropriate measures to avoid the take of migratory birds, if required. The USACE is convinced that this is the most appropriate science-based and defensible means of addressing these concerns.*

Recommendation No. 9.

Lands be managed to replace those terrestrial habitats lost due to implementation of the Corps preferred alternative. For Alternative 3 (7a) in the Corps system), this would consist of 4,081 ha (10,083 acres) at the Crowell mitigation site or other areas approved by the Natural Resource Agencies for impacts from construction and operation of Truscott Reservoir and pipeline rights-of-way. A management plan should be developed by the Corps and approved by the Service and TPWD.

USACE Response: *Concur. Approximately 12,000 acres of lands at the Crowell Brine Lake would be dedicated to wildlife mitigation for losses associated with completion of the WRCCP. These lands are currently being managed by the Truscott Lake Project Office and are being developed and managed in accordance with the management plan developed for inclusion as Appendix D to the Master Plan for the project.*

Recommendation No. 10.

The fish community structure of the Wichita and Red Rivers, focusing particularly on endemic species, be routinely monitored to determine its status until such monitoring surveys indicate that fish populations will remain secure with the WRB project. If population sizes or distributions following completion of the WRB project are reduced by 25% or greater, the Corps should prepare and implement a "conservation plan" designed to ensure the long-term survival of the affected species. At a minimum, an outline of such a "conservation plan" should be included in the final Supplemental EIS.

USACE Response: *Concur. This would be accomplished as part of the Environmental Operation Plan (EOP) for the project, which is contained in Appendix A of the draft SFES.*

Recommendation No. 11.

The Corps attempt to compensate for any loss of striped bass and other sport fish production at the Dundee State Fish Hatchery by funding renovations of the hatchery water supply intakes and installing a pump back system to return hatchery outflows to Lake Diversion.

USACE Response: *Do not concur. It is unclear how the proposed project would adversely impact fish production at the Dundee State Fish Hatchery and justify expenditure of Federal funds for renovation of replacement of the facility. The USACE cannot envision how the project would significantly affect Dundee Hatchery operations owing to impacts from water availability, water quality, or other project-related impacts. The USACE has proposed habitat improvements in Lake Kemp to partially mitigate for seasonal changes in pool elevation.*

The impacts of the project on spawning in Lakes Kemp Kemp and Diversion have been fully addressed in Section IV (3) of the draft SFES for the project. Table 4-13 of the draft SFES shows that fluctuations in the reservoir's elevation during the spawning season were predicted to be quite similar with the No Action Plan (no chloride control project) and the proposed plan (-3.18 to + 2.79 feet vs. –4.57 to +9.35 feet) These data suggest that during the spawning season, elevations remain relatively stable and spawning would not be affected by the WRCCP. Studies conducted by the TPWD indicate that habitat for successful recruitment is extremely limited at Lake Kemp (TPWD, 1996). When the reservoir is full (elevation 1144 feet NGVD or higher), most of the desired habitat is provided by submerged terrestrial vegetation (21.4% of the 21.6% provided by the two habitats). However, the pool elevation has only to drop a foot or two and submerged terrestrial vegetation is no longer available for fish to use. Presently sport fish recruitment in Lake Kemp is adversely affected by the lack of desired littoral zone habitat and this condition would continue with implementation of the WRCCP. Our analysis does show that pool fluctuations would be greater with the project after the spawning season than currently exists. Consequently, it is proposed that this impact be mitigated by providing and/or replacing suitable habitat such as brush rows within selected coves utilized for spawning.

Recommendation No. 12.

A mitigation fund to be established to pay for future mitigation projects.

USACE Response: *While no future mitigation efforts are expected, project-monitoring needs are expected to change over time in response to data trends. Monitoring at some locations or of some parameters may change. Monitoring and action plan efforts would be adaptive management processes. The Federal budget cycle would potentially delay adaptive management for the duration of the 2-year out-year cycle of budget preparation. An adaptive management fund would potentially eliminate that 2-year delay by providing a fund with which to implement timely monitoring additions or action plan startup until the normal budget cycle could be utilized. The concept of an adaptive management fund for the Wichita River Basin Project will be investigated.*

Recommendation No. 13.

Appropriate measures and best management practices be employed during WRB Project construction to minimize impacts due to construction of pumping stations and placement of pipelines.

USACE Response: *Concur. Best Management Practices would be implemented during construction of the remaining Wichita River Basin features.*

Recommendation No. 14.

The Corps monitor and mitigate for the effects of the proposed WRB Project on productivity in the Red River, Lake Texoma, Wichita River, Lake Kemp, and Lake Diversion where reductions in chloride levels are predicted.

The predicted losses to the fishery are cumulative over the life of the WRB Project and are significant. In-kind mitigation for these losses is not possible. The Corps is claiming benefits from the reduced salinities all the way to Shreveport, Louisiana, but is not factoring in the impacts to fish and wildlife resources and costs within this same area. The Corps has not proposed to avoid or mitigate for these adverse effects to the fishery and claims the effects are insignificant. It is disturbing that the Corps would fund studies that predict impacts to an important fishery and then refuse to alter the WRB Project to avoid those impacts or agree to provide any mitigation or compensation for impacts to the States' resources. The Corps does not own the fisheries resources that would be impacted. The fish are State resources and the states should determine if the losses are significant. The ODWC position has not changed since the RRCC Project, and they do not support any reduction in salinities at lake Texoma (see the ODWC letter in Appendix A). The Corps' failure to act on information provided from studies that they have funded or conducted brings up serious questions about intentions to avoid or

mitigate for adverse effects to natural resources (such as Se accumulations) during the life of the proposed WRB Project.

USACE Response: *Generally do not concur with the exception of recommendations for Lake Kemp. Monitoring at Lake Kemp has been included in the EOP for the project (Appendix A). Mitigation (via installation of additional brush habitat) for impacts associated with lake level fluctuations at Lake Kemp is proposed by the USACE.*

It is assumed that "predicted losses to the fishery" referenced in this recommendation refer to turbidity-related impacts, particularly at Lake Texoma and portions of the Red River above the lake. The potential for these impacts and scientific studies used to form conclusions in the USACE's analysis of this issue are thoroughly discussed in Section 4 of the SFES. In summary, analysis of this issue using the most recent, site-specific studies indicate an extremely minimal (if even measurable using scientific equipment) change in turbidity in Lake Texoma and the Red River above the reservoir with implementation of the proposed project. Accordingly, no turbidity-induced losses to the fishery are anticipated and no mitigation is required.

The "studies" referenced in this recommendation and in the ODWC letter was an early study (Gade et al. 1992) conducted using limited data for the entire Red River Chloride Control Project (RRCCP). Extrapolated values from the scientific literature and a lack of site-specific settling data were cited as shortcomings of this study by the Lake Texoma Workgroup (which included the USFWS, ODWC, and TPWD) during the RRCCP Environmental Issue Resolution Process. Because of these shortcomings, and at the recommendation of this workgroup, the Tulsa District funded, at considerable Federal expense, a site-specific settling study using actual Lake Texoma waters. As they represent the most recent and site-specific analysis of this issue, results of this study form the basis for the USACE's analysis of the turbidity issue at Lake Texoma. Also at the request of the USFWS and ODWC, the Tulsa District spent considerable time and effort applying results of these studies to Lake Texoma dissolved solids reductions anticipated with the proposed plan for chloride control in the Wichita River Basin to support preparation of the USFWS Coordination Act Report (CAR). Written evaluations of results of these analyses were provided to these agencies as the USFWS CAR was being prepared for the project. Despite these efforts, this recommendation seems to be based on earlier analyses and does not appear to include or consider results of the most recent site-specific studies requested by these resource agencies.

Based on the USACE's analyses of all information to date, the considerable Federal expense of monitoring and evaluating mitigation measures, as provided in this recommendation, are not justifiable.

Recommendation No. 15.

Several studies be conducted prior to construction to determine the full environmental impacts of the WRB project. These studies should, at a minimum, include:

A. Faunal survey of saline seeps and springs, focusing on the identification of any unique spring inhabitants (information on fish, reptiles and amphibians, and aquatic invertebrates, including mollusks, in the affected tributaries and Wichita River mainstem would be valuable but not essential). Although the habitat characteristics suitable for Hemigrapsus estellinensis may not be present at any of the other springs, there may be other rare, unique, or unrecorded species which inhabit these areas. Strong evidence indicates that the RRCC Project has caused the extinction of two spring inhabitants and the Service believes that thorough searches of the remaining seeps and springs should be conducted to prevent the occurrence of such an event elsewhere.

B. Monitoring of nutrients and pesticides in the irrigation return water, Wichita River and Red River.

C. In stream flows study to more fully evaluate the impact of reduced flows on aquatic organisms and riparian habitat, with emphasis on the upper Wichita River. Where possible, the study should determine impacts of extended low flow conditions on the distribution and abundance of aquatic organisms and vegetation encroachment in the channel.

D. Monitoring of salinity, turbidity, and productivity at Lake Texoma.

E. Siltation and water storage capacity study at Lake Kemp and Lake Diversion for the life of the WRB Project. The study would estimate a time frame for secure water supplies for the Dundee State Fish Hatchery.

USACE Response: *Partially concur. Monitoring for recommendations (A-C) have been included in the EOP for the project, which is contained in Appendix* A of the DSFES. *However, special studies for recommendations D and E are not required.*

The impacts associated with turbidity at Lake Texoma are fully described and addressed in Section 4 of DSFES. Turbidity-induced decreases in reservoir primary productivity, associated impacts on the lake fishery, reduced aesthetics, impaired recreational value, or other turbidity-related impacts would not be expected to occur with project implementation at Lake Texoma. Consequently expenditure of Federal funds for additional monitoring of salinity, turbidity, and productivity at Lake Texoma are not warranted.

The USACE has investigated the concerns with future storage capacity at Lake Kemp and Diversion and current estimates indicate that sufficient storage would be available at 100 years into project life to sustain the projected irrigation water use. Lake Kemp was originally constructed in 1924 by the City of Wichita Falls and Wichita County Water Improvement District. Lake Kemp was redesigned, with COE involvement, in the 1960's. The goal of the redesign and reconstruction was to add additional flood control storage. Loss of storage to sedimentation was taken into account during the design effort. Lake Kemp was designed with additional flood storage so the conservation pool could be raised at regular intervals throughout

the life of the project to regain storage lost to sedimentation. Pool rises were planned for 2008, 2028, 2048, and 2068 with the maximum conservation pool at elevation 1150.

The original design projected sediment loss equally throughout the conservation and flood pool. Subsequent sedimentation surveys indicate that the majority of sediment has been deposited in the conservation pool with limited loss of storage in the flood pool. Recent partial sedimentation surveys, using improved technology and methods, indicate that storage loss at Lake Kemp is not as dramatic as originally estimated.

Using recent partial sedimentation data and projected storage loss estimates, Lake Kemp capacity was estimated for 50 and 100 years into project life starting in 2005. An annual storage loss of 1451 acre-feet was used. Conservation storage at 50 years at elevation 1148 was estimated to be 261,000. Conservation storage at elevation 1150 at 100 years was estimated to be 223,000 acre-feet. Current conservation storage is estimated to be 263,000 acre-feet.

A computer routing program was developed to simulate existing conditions and future conditions after project completion. The computer routing program was designed to route monthly historical inflows, evaporation, and precipitation through Lake Kemp. The period of record used was WY 1949 to CY 2000. Monthly releases were based on the existing and projected water usage listed in Table 1. The program assumed that the top of conservation pool was elevation 1148 at 50 years and elevation 1150 at 100 years and all storage one foot above the top of the conservation pool was floodwater and immediately released. The program also assumed brush control implementation in 50% of the basin above Lake Kemp and below the collection areas.

Table 1
Existing and Projected Water Usage in Lake Kemp

	Existing Water Usage Acre Feet/Year	Projected Water Usage Acre Feet/Year
Irrigation	**80,000**	**120,000**
Municipal	**0**	**11,222**
Industrial	**10,000**	**20,000**
Recreation	**5,850**	**5,850**
TPWD Hatchery	**2,200**	**2,200**

The Wichita County Water Improvement District was required by Texas Senate Bill 1 to develop and implement a drought contingency plan for Lake Kemp in CY2000. The drought contingency plan created action levels that required reductions in water usage at specific elevations. The drought contingency requirements are listed in Table 2. The drought contingency water use requirements were installed in the routing program. Drought contingency action levels for 50 and 100 years into project life were chosen based on storage volumes similar to original storage volumes set by the CY2000 Drought Contingency Plan. The drought contingency action levels for 50 and 100 years are listed in Table 3.

Table 2
Drought Contingency Water Usage Assumptions

	Level I	Level II	Level III	Level IV
Irrigation	**100%**	**50%**	**25%**	**0%**
Municipal	**100%**	**100%**	**100%**	**100%**
Industrial	**100%**	**100%**	**100%**	**100%**
Recreation	**100%**	**0%**	**0%**	**0%**
TPWD Hatchery	**100%**	**0%**	**0%**	**0%**

Table 3
Drought Contingency Action Levels

	Conservation Pool, Top	Level I	Level II	Level III	Level IV
50 Years	1148	1148-1130	1130-1122	1122-1117	1117 & Below
100Years	1150	1150-1133	1133-1125	1125-1120	1120 & Below

The routing program output was sorted and durations were developed for critical elevations. Duration data for existing, existing with brush control, selected plan with brush control, and selected plan with brush control at 50 and 100 years into project life are listed in Table 4.

The routing program output indicates that sufficient storage will be available at 100 years into project life to sustain the projected irrigation water use. Only slight changes in the percent of time drought contingency action levels will be equaled or exceeded are seen at 50 and 100 years. With the top of conservation pool at it current level, elevation 1123 will be equaled or exceeded 85.2 to 88.3% of the time with the selected plan with 50% brush control. The corresponding drought contingency Level II elevation at 100 years, elevation 1133, will be equaled or exceeded 85.7 to 88.0% of the time.

Table 4
Lake Kemp Elevation Duration Data

Existing Drought Action Level Elevations	Percent of Time Equaled or Exceeded			
	1109	**1114**	**1123***	**1144****
Existing Conditions	100%	100%	100%	29.3%
Existing Conditions w/ 50% Brush Control -27.6%	100%	100%	100%	31.4%
Existing Conditions w/ 50% Brush Control – 38.9%	100%	100%	100%	33.3%
Selected Plan w/50% Basin Brush Control 27.6%	100%	99.3%	85.2%	13.2%
Selected Plan w/50% Basin Brush Control 38.9%	100%	99.7%	88.3%	14.3%

	Percent of Time Equaled or Exceeded			
50 Drought Year Action Level Elevations	**1117**	**1122**	**1130***	**1148****
Selected Plan w/50% Basin Brush Control 27.6%	100%	98.9%	85.4%	13.2%
Selected Plan w/50% Basin Brush Control 38.9%	100%	99.7%	88.0%	14.5%
	Percent of Time Equaled or Exceeded			
100 Drought Year Action Level Elevations	**1120**	**1125**	**1133***	**1150****
Selected Plan w/50% Basin Brush Control 27.6%	100%	98.2%	85.7%	14.5%
Selected Plan w/50% Basin Brush Control 38.9%	100%	98.4%	88.0%	14.6%

*Level II, 50% irrigation, 0% TPWD

***Top of conservation pool*

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
222 S. Houston, Suite A
Tulsa, Oklahoma 74127

May 8, 2002

Colonel Robert L. Suthard, Jr., District Engineer
U.S. Army Corps of Engineers
1645 South 101 East Avenue
Tulsa, Oklahoma 74128-4629

Dear Colonel Suthard:

The U.S. Fish and Wildlife Service has prepared the enclosed final Fish and Wildlife Coordination Act Report for the Wichita River Basin Project Re-evaluation. This final report has also been provided to the Oklahoma Department of Wildlife Conservation and Texas Parks and Wildlife Department.

The Service has been coordinating with the U.S. Army Corps of Engineers and the state agencies in the development of the final report. This report is fully coordinated and letters with the state agencies' positions are included in an appendix. Because new information continues to develop with this project, we will continue to work with all agencies to avoid or minimize potential impacts to natural resources. We will be happy to assist your staff in developing mitigation measures for the Wichita River Basin Project and answering any questions about the final report.

The Service greatly appreciates your cooperation in planning and managing Corps projects to minimize impacts to important natural resources. If you have questions or require additional information, please contact Mr. Kevin Stubbs of this office at 918/581-7458, extension 236.

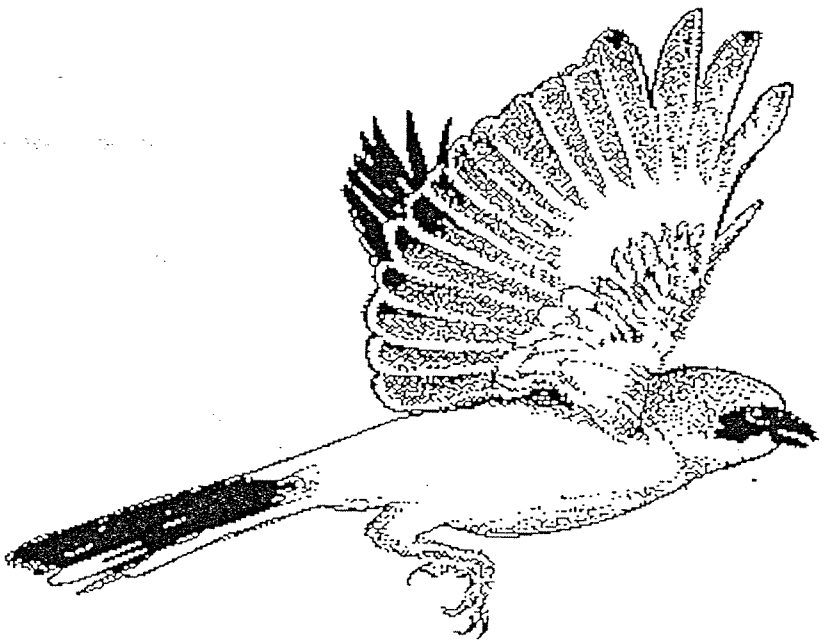
Sincerely,

Jerry J. Brabander
Field Supervisor

Enclosure
cc:
Director, Oklahoma Dept of Wildlife Conservation, Fisheries & Natural Resources, Oklahoma City, OK
Director, Texas Parks and Wildlife Department, Austin, TX
Regional Director (ARD-ES), Albuquerque, NM
USFWS Arlington FO

KS:ag:wrbfinalcarltr

U. S. FISH AND WILDLIFE COORDINATION ACT REPORT
On
WICHITA RIVER BASIN PROJECT REEVALUATION
Final Report For
U.S. Army Corps of Engineers, Tulsa District Office



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May, 2002

U. S. FISH AND WILDLIFE COORDINATION ACT REPORT
On
WICHITA RIVER BASIN PROJECT REEVALUATION
Final Report For
U.S. Army Corps of Engineers, Tulsa District Office

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INTRODUCTION

This Fish and Wildlife Coordination Act Report (Report) provides the U.S. Fish and Wildlife Service's (Service) evaluation of fish and wildlife resources likely to be affected by construction and operation of the Wichita River Basin portion (WRB Project) of the Red River Chloride Control Project (RRCC Project), Oklahoma and Texas. We request that this report be appended to the U.S. Army Corps of Engineers (Corps) final Environmental Impact Statement (EIS).

The Report identifies the anticipated effects of implementing project alternatives on fish and wildlife resources within the Wichita River Basin and the Red River from the mouth of the Wichita River and downstream to Denison Dam. The Report includes a discussion of measures recommended to avoid, reduce, or compensate for environmental impacts and habitat losses. This Report has been prepared under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and fulfills the reporting requirement set forth in Section 2(b) of the Act. Evaluation of the project was conducted by the Service in cooperation with Oklahoma Department of Wildlife Conservation (ODWC) and Texas Parks and Wildlife Department (TPWD). This Report includes a full review from ODWC and TPWD. However, all three agencies are continuing to coordinate evaluations of the WRB Project and evaluate new information and alternatives. This Report reflects the position of the Service, TPWD and ODWC as indicated in the appended letters (Appendix A).

BACKGROUND AND DESCRIPTION OF PROJECT PLANS

Planning for the RRCC Project began in 1959 as part of a joint U.S. Public Health Service-Tulsa District, Corps of Engineers water quality study to locate and control natural salt flows entering streams within the Arkansas and Red River basins. The purpose of the proposed Project and the RRCC Project is to reduce the chloride content of water in the Wichita and Red Rivers, and to increase its suitability for general municipal, industrial, and agricultural consumption.

Natural salt sources (Areas V - XV) were identified in the upper Red River Basin (U.S. Army Corps of Engineers 2001a). The primary natural sources of salt emissions were springs, seeps, and salt plains. Man-made brines, primarily from the oil field industry, municipal and other industrial dischargers, and urban and rural stormwater runoff, also contribute relatively minor amounts of chloride to the Wichita and Red Rivers.

Structural measures to control natural chloride emissions at eight sites were authorized in the Flood Control Acts of 1962, 1966, and 1970. Construction of chloride control measures in the Wichita River Basin (source areas VII, VIII, and X) was authorized by the Flood Control Act of 1966. Construction of control measures in the Wichita River Basin began in 1977, and portions of the project were declared operational in 1987. The WRB Project has been operational for approximately 15 years with pumping from Area VIII to Truscott Brine Lake. The Flood Control Act of 1966 was modified by the Flood Control Act of 1970, and amended by the Water Resources Development Acts of 1974, 1976, and 1986 to authorize construction of chloride control measures in the Arkansas River Basin and the remaining portions of the Red River Basin (source areas VI, IX, XIII, and XIV). In addition to separating the overall project into separate Arkansas River Basin and Red River Basin projects, the Water Resources Development Act of 1986 authorized construction at Areas VI, VII, IX, X, XIII, and XIV, provided that a review panel furnished a favorable report on the effectiveness of operation at Area VIII. This report was published in August of 1988 (Red River Chloride Control Project Evaluation Panel 1988).

Previous fish and wildlife planning assistance on the RRCC Project was provided in Fish and Wildlife Coordination Act Reports dated April 13, 1964, July 27, 1965, December 9, 1965, October 10, 1966, and May 4, 1976; a Supplemental Coordination Act Report dated October 29, 1976; and through comments on two Environmental Impact Statements. A previous report on the RRCC Project was submitted to the Corps in July 1996.

The proposed revised project consists of evaluating alternatives for controlling chloride emissions in the Wichita River Basin only. The Corps alternatives would involve continued operation of the previously constructed Area VIII collection facility and Area V, modification of Truscott Brine Lake, and evaluation of alternatives for control and disposal of chlorides from Areas VII and X (Figure1).

Proposed construction measures include low flow diversion dams, brine storage/evaporation reservoirs, evaporation spray fields, and associated pumping structures and pipelines. The specific structural measures proposed to accomplish the objectives of the WRB Project, by source area, were provided by the Corps in the draft Project Study Plan for the Wichita River Basin

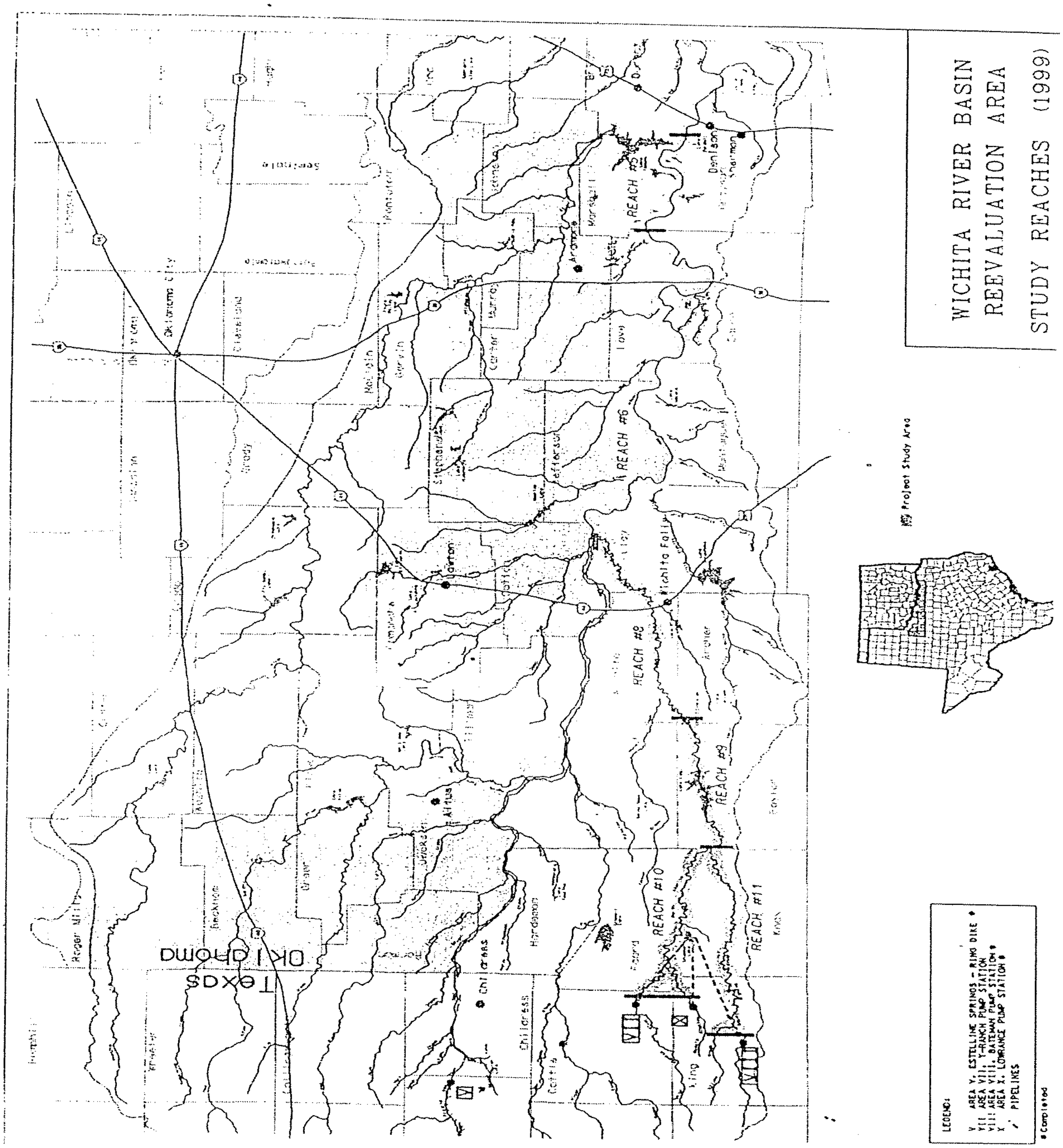

Figure 1. U.S. Army Corps of Engineers Project Map.

Project Reevaluation and revised in the Summarized Evaluation of the Potential for Selenium-Related Impacts on Wildlife (U.S. Army Corps of Engineers 2000). Twenty-four alternatives were evaluated and three alternatives were selected for further evaluation. These three alternatives are summarized, but are not described in detail in this Report.

Alternative 1 **(Alternative 8a in the Corps system)** is proposed operation of the WRB Project with Areas VII and VIII. Alternative 2 **(Alternative 12 in the Corps system)** is operation of the WRB Project with Areas VIII and X, and Alternative 3 **(Alternative 7a in the Corps system)** is operation of the Project with Areas VII, VIII, and X. All three of the above alternatives involve continued operation of Area VIII and Area V. All alternatives include spray fields at both ends of pipelines for Areas VII, VIII, and X to reduce the volume pumped, and all brines are proposed to be pumped through pipelines to Truscott Reservoir. Alternative 3 is the Corps preferred alternative.

The Corps also evaluated alternatives recommended by the Service and TPWD that involved pumping waters from brine sources to tributaries that enter the Red or Wichita Rivers below Lake Diversion. These alternatives were recommended to reduce or eliminate the potential for selenium related impacts at Truscott Reservoir and to mitigate for reduced flows and salinities in the Wichita River system below the brine diversion sites. Alternative 4 involved pumping brine source waters to Raggedy Creek or Paradise Creek. Variations of Alternative 4 included:

- pumping all three brine sources to tributaries and draining Truscott Reservoir,
- pumping one or two brine sources to tributaries and draining Truscott Reservoir, and
- pumping one or two brine sources to tributaries and maintaining pumping from Area VIII to Truscott Reservoir.

BRUSH CONTROL

The State of Texas has a proposed trial brush control program designed to augment stream flow by increasing runoff and improving water yields. The Corps has predicted that a brush control program would reduce the low flow impacts of the proposed WRB Project by increasing flows in affected streams and improving watershed yields at Lake Kemp (see Corps Table 19 in Appendix C). The Corps has proposed to participate in the brush control program by paying the landowner's share (25 percent) to implement brush control on lands within the watershed on the North and Middle Forks of the Wichita River between Lake Kemp and the brine collection areas. The Corps is proposing to only control brush in uplands and would leave a riparian buffer adjacent to affected streams. Salt cedar control along streams would not be a component of the proposed brush control project.

The Service and TPWD consider the Corps participation in the proposed brush control program to be a component of the WRB Project. The Corps would use any stream flow related benefits from a brush control program to offset WRB Project-related low flow impacts and would provide

funding to encourage implementation of the program. Treatment of a proposed brush control program as a without-project condition tends to minimize chloride control project impacts to stream fish communities (as reflected in low flow impacts analysis) and the yield of the Lake Kemp and Diversion water system (i.e. lake level elevation duration). The effects of the WRB Project on inflow to Lake Kemp and on reservoir elevations is masked by the inclusion of *possible* brush management since the Corps does not provide analysis of WRB Project effects (relative to lake elevation durations) without brush control in their low flow impacts analysis report. Indeed, if brush control is not implemented and the preferred alternative is implemented, then inflows to Lake Kemp will be less and the effects on lake levels will be greater than presented by the Corps. Consequently, the effects of the brush control program have been evaluated under the section on fish and wildlife resources with the project.

EXTENT OF CHLORIDE CONTROL

The WRB Project is projected to control approximately 32-76 percent of the chloride loading from the identified salt sources in the Wichita River above Lake Kemp. The evaluation of the WRB Project, as presented in this Report, is partially based on the projected levels of chloride control estimated to be achieved by the WRB Project.

However, the Service, ODWC, and TPWD (Natural Resource Agencies) understand that predicting exactly what level of chloride control would be achieved for each alternative is difficult and involves a margin of error. Consequently, the Natural Resource Agencies' evaluation of the project is based on the information provided by the Corps with the understanding that this is the best information available. This information (calculated by the Corps) on chloride reductions is provided for each reach of the WRB Project area in Appendix C.

DESCRIPTION OF THE PROJECT AREA

The Corps WRB Project area would encompass all of the Wichita River from the brine collection facilities downstream to the confluence with the Red River and the upper Red River from its confluence with the Wichita River downstream to Lake Texoma (Figure 1). Study reaches evaluated include Reach 10 (North and Middle Wichita), Reach 11 (South Wichita), Reach 9 (Wichita River and Lakes Kemp and Diversion), Reach 8 (Wichita River to its confluence with the Red River), Reach 6 (Red River to Lake Texoma), and Reach 5 (Lake Texoma). This area constitutes a major change from the authorized RRCC Project in that Reaches 7, 13, 14, and 15 (Elm Creek, the North Fork of the Red River, the Prairie Dog Town Fork of the Red River, the Pease River, and the Red River upstream from its confluence with the Wichita River) would be unaffected by implementation of the re-evaluated WRB Project except for the continued operation of Area V on the Prairie Dog Town Fork of the Red River. This Report will consider the effects of all previously constructed projects in addition to the Corps proposed projects. The project area for this Report generally includes the Prairie Dog Town Fork of the Red River downstream of Area V, the entire Wichita River Basin and the Red River from the confluence of the Wichita River downstream to the Denison Dam.

The Wichita River is a south bank tributary of the Red River that drains a long narrow basin of approximately 3,485 square miles in north-central Texas. The Wichita River is formed by the North, Middle, and South Forks which largely flow from southwest to northeast. These streams develop from small intermittent gullies in rolling hills and become perennial streams with well-defined floodplains. The basin is relatively arid with an average annual rainfall that ranges from 21 inches in the western portion to 28 inches in the eastern portion. The mean annual runoff from the basin above Lake Kemp is 185,400 acre-feet, equivalent to a flow of 256 cubic feet per second (cfs), but stream flows can be extremely erratic and extended periods of low flow are common.

The Red River and its tributaries constitute one of the last relatively healthy prairie river systems persisting in the Central United States. The natural chlorides that occur in the Red River Basin are the result of an ancient inland sea which existed over 200 million years ago. These brine emissions are a natural phenomenon and have influenced the unique aquatic community of the upper Red River Basin. Several endemic aquatic species, including a recently extirpated grapsoid crab and associated barnacle, characterize this ecosystem. The draft Supplemental EIS contains a more detailed description of the environmental setting of the entire RRCC Project area and should be consulted for additional information.

Vegetative communities occurring within the Red River Basin are predominantly a function of human influence. Existing vegetative communities throughout the entire basin include a number of different types composed of the various sub-climax seral stages. True climax communities are largely absent throughout this area having been modified by cultivation, fire control, and grazing.

Agriculture is the principal land use throughout the Red River basin. Native floodplain vegetation largely has been cleared or fragmented into small, isolated patches and replaced with tame pasture, hay, vegetables, and small grains. Typical crops include alfalfa, soybeans, corn, cotton, peanuts, grain sorghum, and other small grains. Oil and gas production also has fragmented native plant communities. Although highly impacted by human activity, remnant habitats still provide essential life requisites for aquatic and terrestrial life.

The Wichita River Basin is also dominated by agricultural land use, but soils suitable for farming are more limited, and the area is dominated by rangeland used primarily for grazing cattle. Most of the watershed is a mixture of juniper and mesquite shrubs and grassland, with some areas of cropland. Relatively little irrigated farming exists due to limited amounts of suitable soils, water quality, and water quantity concerns. The riparian community exists as a relatively narrow band in most of the watershed and consists largely of salt cedar (Tamarix chinensis), willow (Salix spp.), and some cottonwood (Populus deltoides).

FISH AND WILDLIFE RESOURCES WITHOUT THE PROJECT

TERRESTRIAL/WETLAND RESOURCES

Wetlands within the riparian zones of the WRB Project area, despite disturbances, are important ecosystems that provide habitat for a variety of fish and wildlife species. The forested and scrub/shrub wetlands, sloughs, and old river cutoffs provide loafing and nesting habitat for waterfowl, passerine, and other migratory and aquatic birds. Riverine and sandbar habitats in the Red River provide valuable habitat for several species of wildlife, including migrating and wintering sandhill cranes (Grus canadensis). The upper Red River in Tillman and Jackson Counties is known to be an important fall roosting area for sandhill cranes (Lewis 1974). Sandhill cranes also use this same area briefly during spring migration. The Service considers the sandhill crane to be a species of special emphasis. The federally-listed endangered bald eagle (Haliaeetus leucocephalus), whooping crane (Grus americana), and interior least tern (Sterna antillarum) also utilize these habitats.

In Oklahoma, forested wetlands within the riparian zone occupy less than 5 percent of the vegetative community of the upper Red River floodplain (Stinnett et al. 1987) and are largely limited to the 82-mile long reach between Texoma Reservoir and Terral, Oklahoma. The riparian corridor adjacent to the upper Red River averages less than 2,300 ft in width (Stinnett et al. 1987).

Grassland and shrubland habitats occupy 55 percent of the upper Red River floodplain, with cropland comprising about 13 percent (Stinnett et al. 1987). Much of the floodplain has been converted to pasture, hay, or cultivated for cotton, wheat, and grain sorghum. Upstream of Terral, the floodplain is wider and scrub/shrub wetlands gradually begin to replace forested wetlands.

The Wichita River is a south bank tributary of the Red River at about river mile 907. The long, narrow basin drains a subhumid area of 3,485 square miles in north-central Texas. The stream is formed by the North, Middle, and South Forks which originate in rolling hills and proceed easterly into the rolling prairie lands of north-central Texas. These streams develop from small intermittent gullies in the upper reaches to well-defined streams with narrow, high bank floodplains bordered by high bluffs in the lower reaches of the study areas. The drainage area above Lake Kemp Dam at river mile 126.7 is 2,100 square miles and between Lake Kemp and Wichita Falls at the mouth of Holliday Creek is 1,240 square miles. Average annual rainfall ranges from 21 inches in the western part of the basin to 28 inches in the eastern part of the basin. Average annual land pan evaporation is about 93 inches. Mean annual runoff from the basin above Lake Kemp is 185,400 acre-feet, equivalent to a flow of 256 cfs; however, there have been long periods of low flow and, at times, no flow.

Mesquite-juniper uplands in the WRB Project area provide medium value for game species such as white-tailed deer (Odocoileus virginianus), black-tailed jackrabbit (Lepus californicus), and Rio Grande turkey (Meleagris gallopavo). Habitat value is higher for other species such as

western diamondback rattlesnake (Crotalus atrox), Texas horned lizard (Phrynosoma cornutum), Texas kangaroo rat (Dipodomys elator), mourning dove (Zenaida macroura), bobwhite quail (Colinus virginianus), and many migratory birds that prefer a mixture of shrub and grassland habitats.

Salt Sources

Habitat in the vicinity of the identified salt sources is relatively undisturbed due to its isolation and limited potential for agricultural uses. Surrounding vegetative communities are dominated by honey mesquite (Prosopis glandulosa), junipers (Juniperus spp.), sumacs (Rhus spp.), and condalia (Condalia obtusifolia). A variety of forbs and grasses also occur. The general area is part of the Kansan province of Blair (1950), which incorporates almost all of the Red River basin upstream of Texoma Reservoir. The Kansan province is an ecotonal area between the short-grass prairies and deserts to the west and the eastern deciduous forests. The ecotone is important as a north-south dispersal corridor for species that are adapted to desert and semi-desert conditions and functions as a barrier to the east-west dispersal of forest adapted species (Blair 1954).

Bailey (1995) describes this area as the prairie brushland province. This province is characterized by arid grasslands in which shrubs and low trees grow singly or in bunches. Xerophytic grasses such as bluestem (Andropogon spp.), three-awn (Arista spp.), buffalograss (Buchloe dactyloides), and grama (Bouteloua spp.) are the characteristic vegetation. In much of this area mesquite grows in open stands among the grasses.

Blair and Hubbell (1938) and Blair (1950) divided the Kansan province into three distinct biotic districts. The WRB Project area lies within the Mesquite Plains biotic district. The general area is widely known for its production of scaled (Callipepla squamata) and bobwhite quail and mourning dove. Other game species, such as Rio Grande turkey, mule deer (Odocoileus hemionus), and white-tailed deer, do not maintain large populations in these mesquite and juniper dominated habitats. However, with management and adequate sources of water, fair populations can be supported. Feral hogs have become established in the area and do compete with game species for food and habitat. Water and wetlands are limited and waterfowl and shorebirds are relatively rare except in areas with suitable surface water, food, and resting/loafing areas. The area supports a relatively diverse assemblage of reptiles and migratory birds with a mixture of prairie and shrubland or woodland species.

Area VII. Area VII is located on the North Fork of the Wichita River, with the collected brines to be stored at Truscott Reservoir. The low flow collection structure would be located about 8 miles southeast of Paducah, Cottle County, Texas. The proposed 5-foot-high deflatable weir would impound a 14-acre area. The North Fork of the Wichita River has a drainage basin that is approximately 45 miles long and 7 to 20 miles wide. The average flow is about 16.8 cfs. The area has not been surveyed for terrestrial wildlife, but the habitat is similar to other parts of the WRB Project area.

Area VIII. Area VIII is located on the South Fork of the Wichita River. The Bateman Low Flow Dam at Area VIII is a deflatable, fabric-type weir 5 feet high and 49 feet long extending across

the existing stream channel. The low flow dam was constructed to impound a pool to facilitate pumping. The brine is currently transported by pipeline to Truscott Brine Lake, which was to be used as a disposal site for brines from both Areas VIII and X. The upper part of the basin is about 12 miles wide but diminishes to about 6 miles near the low flow dam. The average flow and chloride load at this locality was calculated to be 10.2 cfs and 188.6 tons at river mile 91.5. The project is complete and has been operational since 1987. The low flow collection structures and their pumps and pipelines to Truscott are located in shrub/grassland habitat with narrow riparian areas dominated by salt cedar and willows.

Area X. The Lowrance Pumping Station is located on the Middle Fork of the Wichita River at river mile 20.5 and is proposed for use as a brine collection structure for Area X. The drainage basin has an area of 60.4 square miles and begins about 9 miles north of Guthrie, 14 miles above the proposed structure. The basin is wedge-shaped in the upper reaches and widens to a width of 6 to 8 miles halfway to the proposed installation. The average flow and chloride load at this locality was calculated to be 8.3 cfs and 57.8 tons per day, respectively. The brine would be collected through the use of a low flow dam with a 5-foot-high inflatable weir, which would also operate identically to the one described for Area VII. The collected brine would be pumped through a pipeline to Truscott Brine Lake for permanent storage. The dam and pump house have been completed, but are not operational.

Truscott (Bluff Creek) Reservoir

All collected brines would be stored at Truscott Reservoir. This reservoir was designed to receive brine from Areas VIII and X. The dam may have to be modified to receive and store brines from Areas VII, VIII, and X's collection facilities. Construction of this brine storage reservoir was completed in 1982, and brines from Area VIII have been stored since 1987. The reservoir is located at river mile 3.6 on Bluff Creek, a tributary of the North Fork of the Wichita River, Knox County, Texas. The reservoir has a maximum pool of about 3,090 acres and a drainage area of 26.2 square miles. Total land acquisition at Truscott Reservoir was 3,800 acres. These lands are presently managed by the Corps.

There are no exceptionally rare wildlife resources known to be in the general area. The reservoir impounded a mixture of flood-plain areas with grassland/shrub habitat and canyon areas with steep slopes dominated by juniper shrubs. However, construction of Truscott Reservoir provided some public use areas and the reservoir may, at times, support wintering populations of waterfowl. Waterfowl and shorebird use may or may not decline depending upon the occurrence of suitable invertebrate populations. Some waterfowl will continue to use the Truscott Reservoir for resting and loafing despite high chloride concentrations. Waterfowl and shorebird use is not considered a benefit because selenium levels are expected to reach levels that may adversely affect birds feeding on fish or invertebrates at Truscott Reservoir. Attracting more waterfowl and shorebirds to an area that is surrounded by high selenium waters may not be beneficial. Five freshwater impoundments (about 200 total acres) constructed by the Corps provide good habitat for a variety of wildlife and public angling opportunities, but also have potential to accumulate selenium.

AQUATIC RESOURCES

Lake Texoma

Lake Texoma, a Corps multipurpose reservoir impounded by Denison Dam on the Red River, at river mile 725.9, is the only multipurpose reservoir on the main stem of the Red River. Authorized project purposes are flood control, hydroelectric power, water supply, regulation of Red River flows, improvement of navigation, and recreation.

Seven areas, totaling 56,245 acres, adjoining Texoma Reservoir are managed or operated by the Natural Resource Agencies for fish and wildlife and associated resources. These areas are Tishomingo National Wildlife Refuge (NWR), 16,464 acres; Hagerman NWR (11,319 acres); Washita Arm Public Hunting Area (PHA), 10,126 acres; Hickory Creek PHA (8,000 acres); Love Valley Wildlife Management Area (WMA), 7,726 acres; Fobb Bottom WMA (2,205 acres); and Eisenhower State Park (405 acres). Some of the most important terrestrial habitat in the Texoma Reservoir area occurs on these publicly managed lands. All but 4,080 acres in Eisenhower State Park and Hickory Creek WMA were specifically set aside for wildlife mitigation associated with construction and impoundment of Texoma Reservoir. Only two other reservoirs in Oklahoma have more land specifically managed for fish and wildlife resources than Texoma Reservoir.

Texoma Reservoir, despite its age, is an extremely productive aquatic resource and supports an excellent sport fishery. Approximately 73 species of fish have been recorded from Texoma Reservoir (University of Tulsa 1971); the primary sport fish species are striped bass (Morone saxatilis), largemouth bass (Micropterus salmoides), spotted bass (Micropterus punctulatus), white bass (Morone chrysops), white crappie (Pomoxis annularis), flathead catfish (Pylodictus olivaris), blue catfish (Ictalurus furcatus), and various sunfishes (Lepomis spp.). Reservoir strain smallmouth bass (Micropterus dolomieui) were stocked in Texoma Reservoir in 1981, and natural reproduction was confirmed in 1985 (Mauck 1986). Since that time, smallmouth bass populations have been expanding and growth rates have equaled or exceeded most of those reported in the literature (Gilliland and Horton 1989). The reservoir supports a popular fishery for all of the previously mentioned species. An important tailwater fishery also exists for striped bass and channel (I. punctatus), blue, and flathead catfish.

The striped bass fishery at Texoma Reservoir is extremely popular and is considered to be one of the most successful inland fisheries of its kind in the nation. Most inland striped bass fisheries in the United States are sustained by supplemental stocking, while Texoma is one of only seven reservoirs in the United States with naturally reproducing populations of striped bass (Gustaveson et al. 1984). The presence of suitable spawning habitat in the upper Red and Washita Rivers is largely responsible for the continued success of the Texoma Reservoir striped bass fishery.

Areas V and VIII of the RRCC Project are operational. Operation of these areas as designed, in conjunction with removal of man-made brines, may have already influenced chloride loads in the Red River. Chloride concentrations and specific conductance (an indirect measure of the amount of ionized salts) have declined. Evaluation of published U.S. Geological Survey Data since 1966

at the Gainesville, Texas gage indicated declining trends for both values, although the correlation coefficient is low.

Water Quality

The Red River from the mouth of the Wichita River to Texoma Reservoir is a perennial stream with a broad, meandering alluvial channel. Stream gradient is 1-1.4 feet/mile immediately upstream of Texoma Reservoir. Flow observations from a gage just upstream of the reservoir (I-35 bridge, river mile 791.5) determined the average annual discharge for the period of record (57 years) to be 3,205 cfs (Blazs et al. 1995).

Upstream of Texoma Reservoir, water chemistry exerts a considerable influence over observed fish communities. The quality of water in the upper Red River is influenced by very high mineral levels, particularly during low flow conditions. Water in the lower reaches of the Prairie Dog Town Fork (affected by Area V) frequently exceeds 25,000 ppm total dissolved solids (TDS); 3,000 ppm sulfate; and 10,000 ppm chloride.

Near Gainesville, Texas, TDS average approximately 2,000 ppm. Specific conductance averages almost 3,100 micromhos/centimeter (μmhos/cm), with maximum daily values as high as 6,830 μmhos/cm (Blazs et al. 1990). This segment of the river has historically exhibited relatively high nutrient loading, believed to be largely a result of municipal sewage effluent (Oklahoma State Department of Health 1982). By comparison, TDS decrease to roughly 330 mg/L and specific conductance averages about 715 μmhos/cm near the Arkansas State line due to inflows from numerous tributaries downstream of Denison Dam (Blazs et al. 1995).

The total drainage area of the Wichita River in the WRB Project area (Areas VII, VIII, and X) is more than 1,240 square miles. The principal streams are the North, Middle, and South Forks of the Wichita River. These three streams are perennial although periods of extreme low flow occur each year. The smaller tributaries are intermittent. Stream flow is extremely erratic and fluctuates from nearly zero to a recorded maximum of 13,000 cfs for the South Fork under flood conditions. The area is the source of more than 491 tons per day of sodium chloride, equivalent to 88 percent of the total chloride load entering Lake Kemp. The concentrations of dissolved solids and chlorides in the Wichita River are highly variable, but are slightly lower than the Red River at the confluence.

Aquatic Resources - Upper Red River

The Texoma Reservoir striped bass population spawns in the upper Red and Washita Rivers. Data indicate that spawning in the Red River occurs a considerable distance upstream of the I-35 bridge, and striped bass have been caught as far upstream as the confluence with the North Fork of the Red River. Striped bass produced in the Red River are essential to the maintenance of Texoma Reservoir striped bass fishery, and research on the percentage of striped bass that spawn in the Red River versus the Washita River is now being conducted. In the absence of natural reproduction, in either the Red or Washita Rivers, supplemental stocking would be required to

maintain striped bass populations at existing levels. Other fish previously described in the Texoma Reservoir section also use the Red and Washita Rivers, at least seasonally, for spawning.

Aquatic communities in the upper Red River are primarily influenced by high mineralization and a fairly uniform, sandy substrate. The fish fauna of the upper Red River Basin remains relatively intact, with only five species apparently extirpated from the basin (Wilde et. al. 1996). Seventy species of fish have been reported to occur in the upper Red River system and 60 of these are native (Wilde et. al., 1996). The fish community is largely dominated by minnows (Cyprinella, Notropis, and Hybognathus) (Matthews et al. 1991). Other groups include 1 darter, 9 centrarchids, 5 catfish, and 4 catostomid suckers. Three fish species, Red River pupfish (Cyprinodon rubrofluviatilis), Red River shiner (Notropis bairdi), and Red River speckled chub (Macrhybopsis aestivalis australis) are native only to the Red River drainage and are most abundant upstream of Texoma Reservoir.

The Red River pupfish is particularly unique in that it is primarily restricted to streams, or portions of streams, with salinities in excess of 10,000 mg/L and is known to survive in waters (Elm Fork) exhibiting chloride concentrations as high as 110,000 mg/L (Echelle and Hill 1972). However, Red River Pupfish do occur in waters with lower salinities, but usually are not an abundant species in such waters. Predation by and competition with other species was determined by Echelle and Hill (1972) to be the most likely factors limiting the success and survival of the species in stream segments with lower salinities. Oscar Creek, Jefferson County, Oklahoma, contains the easternmost population of Red River pupfish.

The freshwater mussel fauna of the upper Red River has not been studied extensively, although Isley (1925) and Valentine and Stansbery (1971) provided information on many of the Red River tributaries. Eight species were collected from the Wichita River Basin in 1997 (Howells 1997). The shifting, sandy substrate and high chloride content of the Red River likely precludes the establishment of a diverse mussel fauna. As of the date of this Report, the exotic zebra mussel (Dreissena polymorpha) had been reported from the Red River basin, but not upstream of Denison Dam.

At least two unique aquatic invertebrates, the grapsoid crab (Hemigrapsus estellinensis) and an undescribed barnacle, once inhabited the brine spring at Estelline, Texas (Creel 1964). These two species were likely extirpated when the Corps constructed the ring dike as part of the control measure associated with Area V (Brune 1981, Bolen and George 1971). The occurrence of other unique invertebrates at the brine seeps and springs in Oklahoma and Texas are unknown. A report prepared for the Corps (Killgore Research Center 1972) did not record any rare or unique invertebrates from the Wichita River Basin, but a faunal survey specific to the springs and seeps in the WRB Project area was apparently not conducted.

Aquatic Resources - Wichita River

Fish communities in the vicinity of the salt sources have been surveyed and include many of the species present within other portions of the upper Red River basin. Wilde et. al., (1996) reviewed existing fish collection records and found 43 species were reported from the Wichita

River and eight species were considered extirpated. Seven of the fifteen native cyprinids have not been collected since the 1950s. Lewis and Dalquest (1957) completed a fisheries survey at nine sites in the Wichita River system from 1953 to 1955. None of these sites coincide directly with one of the identified salt sources. Numbers of fish species collected from the upper Wichita River system varied from 10 to 17. Species richness was higher at the sites sampled downstream of Lake Kemp. Dominant fish species above Lake Kemp were Red shiner (Cyprinella lutrensis), plains killifish (Fundulus zebrinus), and plains minnow (Hybognathus placitus). However, these three species represented only 52 percent of the total catch. Salt tolerant endemics, such as the Red River pupfish, Red River shiner, and Red River speckled chub never comprised more than 34.7 percent of the total catch from any one station above Lake Kemp.

Echelle et al. (1995:Appendix VI of Corps 1995) conducted an assessment of the fish community in the Wichita River Basin above Lake Kemp, particularly in relation to the completed Bateman pump facility at Area VIII. Five sites on the North Fork of the Wichita River, two sites on the Middle Fork, seven sites on the South Fork, one site on the main stem Wichita, and one site in Truscott Brine Storage Reservoir were evaluated.

A total of 17 species of fish were collected, with no single species occurring at all 16 sites (Echelle et al. 1995). The most widely distributed species were Red River pupfish, Western mosquitofish (Gambusia affinis), Red shiner, plains killifish, and fathead minnow (Pimephales promelas). These five species represented over 93 percent of the fish collected during the survey. None of the other 12 species occurred at more than 6 sites. Only three species were found in Truscott Brine Storage Reservoir. The Red River pupfish was the only species that exhibited a positive correlation between salinity and abundance.

The TPWD (Findeisen and Howell 1998) also conducted fisheries and mussel surveys in the Wichita River Basin in 1997. This survey concentrated on the lower portion of the basin with 9 of the 11 sites located below Lake Kemp. They collected 31 species of fish and 8 species of freshwater mussels. Red shiners dominated (51.2 percent) the fish collected by seining, but plains minnow, western mosquitofish, inland silversides (Menidia beryllina), and Ghost shiners (Notropis buchanani) were frequently collected. Relatively small numbers of sportfish, including centrarchids, white bass, channel and flathead catfish, also were collected.

The Corps contracted with the Texas Agricultural Experiment Station (Gelwick et al. 2000) to analyze the distribution of fish in the Wichita and Red Rivers within the WRB Project area. Fisheries surveys in 1998 collected 45 species and analyzed the effects of environmental variables on species distributions. Species such as Red River pupfish and plains killifish were found in scattered locations associated with relatively high total dissolved solid levels.

FEDERALLY-LISTED, CANDIDATE, SPECIES OF CONCERN, AND STATE-LISTED SPECIES

The endangered interior least tern, the endangered whooping crane, and the endangered bald eagle occur within the proposed WRB Project area. The interior least tern is a summer resident (late April-early May to late August-early September) and frequently utilizes salt flats, riverine sandbars, and open shorelines and mud flats within the WRB Project area as nesting, feeding, and resting habitat. Terns have been observed foraging at Truscott Reservoir and are likely to use portions of the Wichita River for foraging during migration and nesting seasons. The Red River is the only portion of the WRB Project area that is known to provide nesting habitat for the least tern.

The entire WRB Project area also lies within the migration corridor of the whooping crane. Several recent confirmed and probable records of roosting and foraging by cranes exist for portions of the WRB Project area. Sightings have been confirmed from the extreme eastern portion of the WRB Project area in Texas. Six sightings were from Clay County near Byers, Texas, and the other was from Wichita County near the city of Electra, Texas. The upper Red River and surrounding wetland habitats, based on the proximity and number of observations, is suspected as being an important, but non-traditional stopover area for whooping cranes. Additional bird surveys conducted during 1997-1998 at Truscott Lake and the Area VIII collection facility found no sightings of whooping cranes.

In Oklahoma and Texas, the bald eagle is primarily a winter resident, occurring most years from early October until early May. During that time, bald eagles congregate around reservoirs and along larger rivers, in specific locations. Bald eagles have been observed throughout the 116-mile long corridor from the 98th Meridian westward to the confluence of the North Fork of the Red River. The highest concentration of bald eagles were observed from a few kilometers west of the I-44 crossing between Lawton, Oklahoma, and Wichita Falls, Texas eastward to approximately 9 miles south of the State Highway 79 crossing between Waurika, Oklahoma, and Byers, Texas. In 1989, there were 14 bald eagles observed in this 35-mile reach. A growing number of bald eagles are nesting in Oklahoma and Texas, and suitable nesting habitat is provided by reservoirs and larger rivers with trees nearby for nesting and perching. Within the WRB Project area, suitable nesting habitat is available at Texoma Reservoir and along portions of the Red River. It is possible and even likely that bald eagles will establish nesting pairs or territories in the WRB Project area within the life of the proposed WRB Project.

Impacts of the RRCC Project on federally-listed endangered or threatened species were assessed in the Service's July 6, 1994, biological opinion and will not be addressed in this Report. A copy

of the biological opinion was appended to the draft RRCC Project Supplemental EIS. Potential impacts of the WRB Project on federally-listed species were more recently addressed in the Corps biological assessment (U.S. Army Corps of Engineers 2001a).

Four species of concern that may have potential for Federal listing as threatened or endangered (paddlefish, Snowy plover, Texas kangaroo rat, and Texas horned lizard) also occur within the WRB Project area. Impacts of the RRCC Project on these species were not specifically addressed in the July 6, 1994, biological opinion. The Service has very little detailed information on the distribution and life history of these species, which complicates attempts to determine how the WRB Project would impact these species. However, the Service has attempted to predict such impacts based on available information.

The paddlefish (Polyodon spathula) once occurred throughout the lower Arkansas, Little, and Red River basins in Oklahoma. Paddlefish populations in the Red River below Texoma Reservoir are presumed to be very small and are probably maintained by recruitment from Arkansas and Louisiana. No recent natural reproduction of the Red River population has been documented in Oklahoma or Texas. Paddlefish have been stocked in Texoma Reservoir in an attempt to establish a self-sustaining population above Denison Dam.

The upper Red River probably represents peripheral, historic paddlefish habitat that once was used only during favorable conditions and is not considered to support suitable spawning habitat. Paddlefish numbers have been declining throughout much of the species' historic range in the United States. The State of Texas lists the paddlefish as State endangered.

In 1991, 10 adult Snowy plovers (Charadrius alexandrinus) and 1 Snowy plover chick were observed on the upper Red River. No Snowy plovers were sighted on the Red River below Denison Dam. The Red River is on the extreme southeastern edge of the breeding range for the Snowy plover, and observed low numbers were not unexpected. Information on the abundance of Snowy plovers along other Red River tributaries is not available.

Historically, Snowy plovers may never have been very abundant within the Red River Basin. Sutton (1967) recorded, collected or reported collections of Snowy plovers along the upper Red River from Old Greer, Wilbarger, Marshall, and Grayson Counties. More and Strecker (1929, as cited in Tyler 1979) noted they were found "all over" Wilbarger County, Texas, in spring and summer but nested only on the Pease River near Vernon. The only confirmed Red River nesting record was in Old Greer County, Oklahoma (Sutton 1967).

Declining Snowy plover populations have concerned ornithologists since the early 1970's. In 1989, fewer than 6,000 Snowy plovers had been counted east of the Rocky Mountains, indicating a 50 percent reduction in that population within the last decade (U.S. Fish and Wildlife Service 1989). Snowy plover populations west of the Rocky Mountains have been estimated to number between 5,000 and 10,000. However, Snowy plover census data are incomplete (U.S. Fish and Wildlife Service 1989), particularly in the interior plains states.

The Texas kangaroo rat historically occurred in two counties in Oklahoma and nine counties in Texas (Jones et al. 1988). Surveys conducted by Jones et al. (1988) throughout the historic range from 1985-87 documented Texas kangaroo rats from only four counties (Cottle, Hardeman, Wichita, and Wilbarger), all in north-central Texas. The following year additional surveys by Moss and Mehlhop-Cifelli (1990) also failed to record this species in Oklahoma. The Texas kangaroo rat inhabits mesquite grasslands on firm clay loam soils and tends to avoid areas of sandy soils. Habitat destruction/conversion to improved pasture appears to be the major threat to the species. TPWD lists this species as State threatened.

The Texas horned lizard (Phrynosoma cornutum) historically inhabited considerable portions of Kansas, Oklahoma, and Texas, as well as portions of Arizona, Colorado, New Mexico, and the States of Chihuahua, Coahuila, Durango, Nuevo Leon, San Luis Potosi, Sonora, Tamaulipas, and Zacatecas in Mexico. Recent evidence has indicated that the range of the Texas horned lizard (horned lizard) has been declining due to habitat alteration (farming and urbanization), use of insecticides, invasion of the red fire ant (Solenopsis invicta), and other factors.

The horned lizard has been documented from the following counties in the WRB Project area: Archer, Childress, Clay, Grayson, Hall, Hardeman, King, Knox, Montague, Wichita, and Wilbarger counties (Donaldson et al. 1993, TPWD 2000). Donaldson et al. (1993) observed two horned lizards at Copper Breaks State Park, five horned lizards on a large ranch near Vernon, and one horned lizard near Turkey in 1992. Although the Crowell proposed mitigation area was not surveyed for horned lizards, they likely occur in this area. Horned lizards probably also occurred in the area now flooded by Truscott Reservoir. TPWD lists this species as State threatened.

Other state listed species which may occur in the lower Red River Basin include shovelnose sturgeon (Scaphirhynchos platorhynchus), black-side darter (Percina maculata), and timber rattlesnake (Crotalus horridus).

Species of concern are those for which the Service has information indicating that listing may possibly be appropriate, but conclusive data on biological vulnerability and threats to their survival are not currently available to support proposed rules. These species have no legal protection under the Endangered Species Act, as amended, (although they may be protected by state laws) and are included in this report for planning purposes only. Consideration of these species during planning and construction of the WRB Project could help reverse the declining population trends and possibly help postpone or eliminate the need for future listing.

FISH AND WILDLIFE RESOURCES WITH THE PROJECT

The most obvious impacts of the WRB Project alternatives are all primarily related to inundation of terrestrial habitat at Truscott Brine Reservoir, and direct and indirect alteration of the hydrology (frequency, magnitude, and seasonality of stream flows), and water chemistry of both the Wichita River and Red River. Direct impacts to stream flows and water quality are related to pumping from impounded brine springs that will reduce flows and salinity. Indirect impacts to hydrology and water quality are expected due to project-related land use changes such as brush control and increases in irrigated agriculture.

TERRESTRIAL/WETLAND RESOURCES

Riparian habitat along the North, Middle, and South Forks could be affected by reduced flows associated with the WRB Project. Salt cedar has become established and dominates the riparian community in many areas of the upper Wichita River Basin. Non-native saltcedar can provide some of the benefits of native vegetation, such as shade, but is known to reduce flows and tends to form dense thickets along stream banks that crowd out native vegetation. As this species becomes more widespread, further channel restriction could occur. Some studies have found that salt cedar thickets decreased water flow velocities causing increased sediment deposition within the channel and on stream margins (Grozier 1965).

Encroachment by salt cedar is detrimental because this plant tends to form monocultures having little value for fish or wildlife. Kerpez and Smith (1987) cite numerous publications which demonstrated that salt cedar thickets have considerably lower value to fish and wildlife populations. Species richness, diversity, and density would be much lower in the upper Red River Basin if salt cedar became more abundant within the riparian zone. Only continuous inundation will prevent salt cedar from becoming established. Once salt cedar seedlings have become established, they can withstand considerable periods of inundation (Kerpez and Smith 1987, U. S. Fish and Wildlife Service 1981). Flow reductions in the North, Middle, and South Forks of the Wichita River could allow further encroachment of salt cedar. Reduced salinity in the affected streams may help control invasion of salt cedar or make native shrubs more competitive.

Truscott Reservoir, Pipelines and Salt Sources

Terrestrial habitat would be impacted by construction of pump houses and installation of pipelines. The areas impacted by the 100 ft. wide pipelines are based on the lengths of the

proposed or existing pipelines provided by the Corps. The area of the pipelines is 173.3 acres for Area VII, 266.7 acres for Area VIII, and 127.3 acres for Area X. The pipelines will have service roads that will be approximately 20 feet wide. The area of these roads was assumed to have no habitat value. The spray fields associated with these pipelines have areas of 30 acres for Area VII, 20 acres for Area VIII, and 15 acres for Area X. The area of these spray fields also was assumed to have no habitat value because all vegetation is eliminated by the salt spray.

Impacts at the Truscott Reservoir site primarily involve the direct loss of terrestrial habitat and indirectly contribute to aquatic impacts in the Wichita River and Red River. Selenium (Se) accumulation at Truscott Reservoir could have supplemental and long term impacts (in addition to destruction of terrestrial habitat) that are of great concern.

Truscott Reservoir has been collecting brines since 1987 and has already inundated approximately 1,744 acres, at elevation 1,470 ft. Near the end of the 115 year project, the reservoir is predicted to inundate up to 3,280 acres at an elevation of 1,502.71 ft with Alternative 3, which includes pumping from Areas VII, VIII, and X. Alternative 1 (Areas VII and VIII) would inundate up to 2,825 acres and Alternative 2 (Areas VIII and X) would inundate up to 2,192 acres. Areas inundated at different target years for Truscott Reservoir were calculated from elevation/area/capacity tables provided by the Corps (Appendix B). Buildings at the Project site were estimated to occupy about 15 acres which also have no habitat value.

Construction of the WRB Project would eventually result in the destruction of at least 3,417 to 3,482 acres of terrestrial habitat, the majority being mesquite-juniper grassland. The majority of the impacts would be due to construction and operation of the brine storage reservoir. The impacts from the construction of Truscott Brine Reservoir were included in this report because mitigation has not yet been provided for this portion of the WRB Project. The Service's Habitat Evaluation Procedures (HEP) were used to evaluate potential alterations of terrestrial wildlife habitat resulting from construction of the brine storage reservoirs and to formulate (in concert with the Service's Mitigation Policy) plans to avoid or offset adverse impacts. The HEP analysis is appended to this report (Appendix B).

Selenium (Se) Impacts

Continued operation of Truscott Reservoir also could potentially have an adverse impact on a variety of resident and migratory bird species due to Se contamination (U.S. Army Corps of Engineers 1993, 2000, 2001a). Selenium is a naturally occurring trace element found in certain arid soils of the western United States. Although Se is essential to most vertebrates in small quantities, higher concentrations are toxic. Fish and wildlife species may develop Se toxicosis either by direct poisoning or through bioaccumulation/biomagnification.

Selenium is easily leached from seleniferous soils and, under appropriate conditions, may accumulate in surface waters. Aquatic systems that accumulate Se most efficiently are shallow, standing, or slow moving waters that have low sediment flushing rates. The brine storage reservoirs are designed solely for disposal of brines and would operate as closed systems, i.e., no downstream discharge or flushing of trapped sediments. This condition is conducive to the

accumulation of Se leached from the surrounding soils or pumped there via brine water. Selenium contamination may become a very serious concern when the structures that trap these sediment laden surface waters are highly attractive to wildlife, particularly waterfowl and shore and wading birds.

Aquatic organisms readily take up Se and some inland aquatic invertebrates (rotifers, copepods, cladocera, and some insects) can exist at high salinities. Red River pupfish are very tolerant of high salinities and are expected to be able to survive in Truscott Reservoir for most if not all the proposed WRB Project life. Such organisms may continue to attract waterfowl and other aquatic birds to the brine storage reservoirs even though no other types of aquatic life may survive the elevated salinity levels. Semi-aquatic and aquatic birds are at higher risk because they are more continuously exposed to the Se hazard than are other bird species. Potential impacts could be expressed as reduced survival of embryos and deformities in chicks.

Selenium is metabolized very rapidly and only resident birds would likely exhibit reproductive impairment. Because most waterbirds are migratory and breed elsewhere, reproductive effects were not considered to be important except for certain species such as herons, egrets, and some shorebirds which may nest or spend considerable periods in the vicinity of the reservoir.

Some resident and migratory insectivorous birds, and possibly raptors, could also be affected through reproductive impairment in those individuals nesting in the surrounding uplands. The full impact of Se contamination on fish and wildlife resources cannot adequately be determined without additional information on background levels of Se in migratory and resident bird populations in the area.

There was considerable discussion regarding Se levels of concern related to brine disposal lakes for the original RRCC Project. Because of the demonstrated sensitivity of aquatic birds to waterborne Se, their potential use of brine disposal lakes, and substantial information regarding impacts on these species, birds were (and continue to be) the focus for a Se-related impact evaluation of the WRB Project. In 1992 and 2000, the Corps conducted an evaluation of the potential for Se-related impacts to wildlife from operation of Truscott Reservoir (U.S. Army Corps of Engineers 1993, 2000, 2001c). The Corps completed a study entitled, "Alternatives for Chloride Control - Wichita River Basin and Truscott Brine Lake, TX" (U.S. Army Corps of Engineers 2000), which is included in Appendix A of the Corps biological assessment (U.S. Army Corps of Engineers 2001a). The Se monitoring results for 1997-1998 are provided in a draft report for Truscott Brine Lake and associated brine collection areas (U.S. Army Corps of Engineers 2000).

Skorupa and Ohlendorf (1991) proposed a concentration of 10 μg/L waterborne Se as the avian reproductive impairment risk threshold, but additional studies (Lemly 1995, 1996) indicate a concentration of 2 μg/L should be used as a threshold. However, in October 2000, the Corps re-analyzed data for Se concentrations at Truscott Reservoir with four different alternatives. The risk threshold for potential impacts to birds from concentrations in the water was lowered to 2 μg/L based on newer information on Se impacts to wildlife. The Corps estimates that Se concentrations would never exceed 2 μg/L in Truscott Reservoir after approximately 100 years of

WRB Project operation, assuming the reservoir only received waters from the Area VIII salt source (U.S. Army Corps of Engineers 2000). However, all three proposed alternatives could result in Se concentrations that exceed 2 µg/L within 15 years or less and the preferred alternative (alternative with Areas VII, VIII, and X) is predicted by a Corps model to potentially reach 6.4 µg/L in about 80 years (U.S. Army Corps of Engineers 2000). Selenium concentrations are predicted to meet or exceed Environmental Protection Agency (EPA) chronic criteria levels (5.0 µg/L) in only 30 years with alternative 3 (U.S. Army Corps of Engineers 2000). See tables and plans in Appendix E for more information on predicted Se levels at Truscott Reservoir.

The conservative predicted maximum total Se concentration for Truscott Reservoir water is highest for alternative 3, which is disposal of brine from Areas VII, VII, and X at Truscott Lake. This concentration, 6.4 µg/L, is within the threshold range for avian reproductive impairment (2-10 µg/L), and closer to the upper end of this range relative to other alternatives (U.S. Army Corps of Engineers 2000). Accordingly, the potential for impacts on breeding birds is the highest of all evaluated alternatives. As with other alternatives, maximum estimated waterborne concentrations are well below the 34-µg/L threshold for non-reproductive impacts on young and adult birds. Predicted sediment concentrations are highest for this alternative (maximum 2.23 mg/kg) and slightly exceed the conservative lower end of the sediment threshold range used for this evaluation. Based on methodology and assumptions used for this evaluation of Se-related concerns associated with brine disposal alternatives, it appears reasonable to assume that all alternatives could be implemented without Se-induced impacts on non-breeding birds (e.g., wintering waterfowl) and relatively low Se-related sediment concerns for these species at Truscott Reservoir, Texas. Modeled estimates for Se concentrations for all alternatives are below estimated threshold values for non-reproductive impacts. Due to the limited use of Truscott Reservoir by migrating birds, there should be no Se-related effects on migratory species that only stay at the reservoir for relatively short periods of time and are not nesting near the reservoir. However, this statement is based on estimates from models that are based on a rather limited set of data and assumptions that may not be accurate over the life of the WRB Project. Selenium inputs and bird use both have potential to change.

The Service has concerns about the predicted Se concentrations in the preferred alternative because it not only exceeds the minimum threshold by more than three times, it also exceeds current EPA chronic criteria and Texas State water quality standards. These standards and criteria are established to protect aquatic life and human health and are based on research that shows adverse effects can occur at or above these levels. The Service and TPWD do not agree with the Corps that risks to breeding birds are only slight and that these risks are acceptable. The Service and TPWD believe this statement to be premature, based in part on information presented in paragraph 3, page ii, of the Corps 2001b report, which states,

> "Results of monitoring at Truscott Brine Lake are applicable for the monitoring period only and should not be interpreted to represent current or future conditions. The potential for increasing Se concentrations as the WRB Project progresses and complexities involved with Se dynamics are justification for continued monitoring of a variety of environmental media at Truscott Lake. This is particularly true if additional brine sources are added as input to the impoundment."

The Corps is presently evaluating potential methods to reduce potential adverse effects to wildlife from exposure to Se. They have proposed monitoring Se levels in the water, sediment, and in fish and bird eggs at Truscott Reservoir and have prepared a draft Se monitoring plan. The Corps also has prepared a draft Se action plan that outlines a process involving a scientific review panel that would recommend actions to avoid or mitigate for adverse effects related to WRB Project Se levels. However, the draft Se action plan is very preliminary and does not include any estimated costs or commitments to fund mitigation actions. The draft selenium action plan (undated), as it exists, is a workable concept, with much potential, but there is no commitment to implement any findings or recommendations provided by the multi-agency panel. Without a commitment to act upon the panel's findings, the draft does not constitute an "action plan", and the Service and TPWD cannot support that strategy. These potential costs must be factored into the analysis of costs and benefits for each alternative. Copies of the draft Se plans and Natural Resource Agency comments are included in Appendix E.

The potential exists for the Corps to participate in control of selenium sources on the North Fork of the Wichita River, which is on the 303(d)list prepared by the Texas Natural Resource Conservation Commission. There are indications that abandoned copper mines in the North Fork watershed may be sources of additional selenium to the river. If this proves to be a controllable source(s) of selenium, the potential for selenium bioaccumulation to harmful levels in biota could be reduced while still including Area VII in the chloride control plan. A Total Daily Maximum Load (TMDL) study on the North Fork of the Wichita River is expected to be completed by 2006. More information regarding the sources of selenium and potential control strategies will be available by the conclusion of the TMDL process. The Service and TPWD recommend that the Corps revise their Truscott Brine Lake selenium model to incorporate implementation of TMDL processes to reduce selenium concentrations in the North Fork Wichita River.

The potential adverse effects of the proposed action are long lasting and difficult to control or eliminate after they develop. The impacts of Se at the WRB Project will not stop at the end of the 100-year WRB Project, and the Project may continue beyond the 100 years. The cost of closing the WRB Project and safely dealing with the accumulations of salts and Se are likely to increase with time and need to be factored into the economic analysis and feasibility study. Monitoring alone is not acceptable for such a serious potential problem. The Corps has chosen the most damaging alternative instead of the least. Selection of the most damaging alternative does not indicate any commitment to complying with NEPA or the draft Se action plan which states that the objective of the plan is to "avoid, minimize, or compensate for (in that order) impacts to migratory birds resulting from the operation of any feature of the Wichita River Basin Project". The proposed WRB Project has potential to violate State and Federal laws including state water quality standards, the Migratory Bird Treaty Act, and NEPA.

Crowell Mitigation Area

Crowell Mitigation Area was originally purchased with the intent of constructing a brine collection reservoir at this site. However, plans to construct the reservoir have been dropped and the area is now proposed to be managed to mitigate for impacts of the proposed WRB Project.

The 10,000-acre area includes a small portion of the Pease River and its floodplain and adjoins the 1,933-acre Copper Breaks State Park (CBSP). The CBSP is a primary public use area within the region. Although not specifically managed for fish and wildlife by TPWD, the park is known to support important wildlife such as white-tailed deer, mule deer, quail, waterfowl, horned lizards, and a good diversity of migratory birds.

The Crowell Mitigation Area has been owned and managed by the Corps since 1994. The area is largely a mixture of shrub and grasslands with relatively small areas of old fields that are no longer farmed except for small food plots maintained by the Corps. Grazing has been eliminated on the area except for a small number of cattle that frequently trespass on the property. The Corps has also restored or built a few ponds to benefit wildlife. The area's wildlife habitat value has noticeably improved with this limited level of management and it now provides good habitat for some species such as dove, scissor-tailed flycatchers (Muscivora forficata) and other migratory birds. Surveys have not been conducted for all wildlife, but it is assumed to provide relatively good habitat for many native mammals, reptiles and amphibians. It also supports a good population of quail and a small, but probably growing number of popular game species such as deer and turkeys. Feral hogs were observed on the site and could present problems in managing the property for native wildlife.

The Crowell Mitigation Area's habitat value was assessed using the HEP method and compared to habitat values at the proposed WRB Project. Habitat values for evaluation species are presented in the HEP analysis (Appendix B).

Land Use Changes

If the full WRB Project becomes operational and salinities are sufficiently reduced , there may be an increase in irrigated agriculture and a noticeable shift in crop yields and cropping patterns on irrigable lands along the Wichita River and a portion of the Red River. The increase in irrigated agriculture is predicted by the Corps to increase nutrients and pesticides in the Wichita and Red River watersheds and may impact terrestrial wildlife.

As part of the current economic re-analysis, many of the Corps assumptions concerning irrigation were re-examined. This included re-defining reaches, soil delineation, land availability, irrigation modes, lift zones from the alluvium, and revised leaching fractions for irrigation. The re-definition of land suitable for irrigation resulted in a more narrow set of soil type characteristics suitable for irrigation. The inventory of land available by reach was modified and the amount of potential acres to be irrigated was reduced. The Corps determined that for the re-evaluation, available irrigable land would be restricted to land currently irrigated (crops or pasture) plus dryland acres which were currently being cropped. These lands would have moderate to low conversion costs and thus would be most likely candidates for irrigation. Under existing conditions, there are 15,000 acres of irrigated cropland. Implementation of the recommended plan would result in an increase of 43,202 acres of irrigated land for a total of 58,202 irrigated acres (U.S. Army Corps of Engineers 2001a). Approximately 42 acres of pasture, 3,011 acres of idle farmland, and 40,128 acres of dryland farmland could be converted to

irrigated farmland with the WRB Project. The Corps is assuming full conversion of these 43,202 acres will occur within five years of WRB Project completion.

The impacts to terrestrial wildlife due to the Corps predicted conversion of over 3,000 acres of pasture and idle farmland to irrigated crops is difficult to quantify, but is likely to be adverse for most species. Conversion of 40,128 acres of dryland to irrigated farmland is not anticipated to have a significant impact on terrestrial wildlife. However, the Service considers these values to be unlikely maximums or very optimistic estimates. Acreage of irrigated agriculture has actually declined in the WRB Project area despite a 20-30 percent reduction in chloride levels at Lake Kemp reportedly due to operations of the existing WRB Project. We also consider the Corps estimate of achieving full benefits, or full reductions in salinities, in 5 years to be unlikely or very optimistic. The existing portion of the WRB Project demonstrated no significant reductions in chloride levels at Lake Kemp after 5 years of operation (Baldys, et al. 1995) and the most recent measurements provided to us indicate project operation has only achieved about a 20 percent chloride reduction. The Corps predicted the Area VIII operations would reduce chloride levels by 34 percent.

While the number of irrigated acres may increase, most of the conversion would come from other types of agricultural lands. Much of the irrigation is proposed to occur in economic reaches 5 (main stem of the Red River downstream from the Clay/Montague County line to the I-35 bridge north of Gainesville) and 7 (Wichita River from Lake Diversion downstream to the mouth of the Wichita River but not above the Wichita County irrigation district canal). Irrigated land is projected to increase by 9,295 acres in economic reach 5 and 33,752 acres in economic reach 7. Minor amounts are projected to occur in economic reaches 6 and 12. The projected increases in economic reaches 5 and 6 may be unlikely or relatively unrelated to the proposed WRB Project due to projected decreases in salinities in this reach of only about 10 percent. A 10 percent reduction in chloride levels is not likely to be enough incentive for farmers to invest in irrigation equipment when most of the same crops can be grown in this area without irrigation. Texas A&M studies (Walker and Zinn 2000) also agree that the effects of the WRB Project on agriculture in reaches 5 and 6 along the Red River should likely be ignored. We also provided the Corps information on predicted chlorides, sulfates, and total dissolved solids to experts at Oklahoma State University and the NRCS and they agreed that a 10-11 percent reduction in chlorides was unlikely to have any significant impact on the amount of irrigated agriculture in reaches 5 and 6. The predicted change in chloride levels is not likely enough incentive to convert many farming operations from dryland to irrigated farming. The predicted salinities in reaches 5 and 6 are considered marginal for irrigated alfalfa and are likely to cause reduced yields.

After 15 years of operating the existing chloride removal project, irrigated agriculture in the WRB Project area has declined, yet the Corps predicts irrigated agriculture will increase by more than 43,000 acres within five years if the preferred alternative is implemented. However, this projection seems unrealistic. The five year period is supposedly based on similar water quality improvement projects in Texas, but we question how "similar types of water quality improvement projects" be any more similar or valid than the existing portion of the WRB Project? If a chloride reduction of 20-30 percent has not induced an increase in irrigated agriculture in 15 years, why would a 10 percent reduction in reach 5 induce farmers to begin

irrigation on 9295 acres of land within five years? We can understand that if chloride levels were further reduced (potentially up to a total of 76 percent), that it may increase irrigated agriculture. However, based on the history of this WRB Project, the predictions appear very optimistic.

Nutrients and Contaminants

During the environmental issue resolution process for the RRCC Project, there were numerous discussions concerning the potential for increased levels of nutrients and herbicides and pesticides associated with increased agriculture and irrigation return flows. A potential indirect impact associated with the WRB Project would be the increase of contaminant levels due to the increase of agriculture with the WRB Project. As determined from the Texas A&M studies, most of the agricultural changes are expected to occur from the conversion of dryland farming of bermuda grass/hay to irrigated farming of alfalfa. Estimates of present and future concentrations of nitrogen and phosphorus in the Wichita River were developed by Texas A&M (Walker 2001 in U.S. Army Corps of Engineers 2001a). With the WRB Project, the estimated mean discharge of nitrogen concentrations for the Wichita River, as measured at the Charlie gage, was projected to increase from 1.42 ppm to 10.88 ppm and phosphorous concentrations were projected to increase from 0.42 ppm to 1.64 ppm (Walker 2001 in U.S. Army Corps of Engineers 2001a). This increase in nutrient levels could potentially impact algal production in receiving waters. This could increase potential for fish kills related to golden algae and increase the potential for dissolved oxygen variability.

The transformation from dryland farming of bermuda grass and alfalfa to irrigated alfalfa also has the potential to increase levels of agri-chemicals in receiving streams. Presently, both herbicides and pesticides are applied to the dryland crops. With irrigation, mostly pesticides would be applied to irrigated alfalfa (U.S. Army Corps of Engineers 2001a). Consequently, with the WRB Project, the amount of herbicides available for transport into receiving streams is predicted to be less than presently exists. Under existing WRB Project conditions, both herbicides and pesticides are applied to existing crops and are potentially transported into receiving streams during rainfall events. With the WRB Project, the amount of herbicide applied to crops should be considerably reduced, but the rates of transport of other contaminants could be increased. This increase would be due to transport by rainfall events as currently exist and irrigation return flows.

The WRB Project also would result in minor alterations of downstream sediment delivery patterns (sediment loads, movements, and deposition) within affected streams due to sediment trapping (U.S. Army Corps of Engineers 1980, 1976). Construction of the brine lakes and their consequent trapping of stream-suspended loads will cause a slight reduction in the alluvial material currently being deposited within the Wichita River channel. Control facilities at Area VIII and X are expected to reduce the amount of alluvial material presently being deposited in Lake Kemp by about 10 percent (Killgore Research Center 1972). The Corps claims this will increase the life span of Lake Kemp. While this may be true, it has been about 30 years since the Corps raised the elevation of the dam at Lake Kemp and it is questionable if the reservoir would have adequate storage to supply full irrigation and municipal water demands for another 100 years without substantial investments in dredging or construction of new reservoirs.

AQUATIC RESOURCES

Impacts to Lake Texoma

The Corps has re-evaluated the 10-day sediment settling data for Lake Texoma water under laboratory conditions. Decreases in dissolved chloride levels would permit sediment to remain in suspension longer, thereby increasing turbidity. These studies predict relatively minor increases in turbidity due to WRB Project-related chloride reductions. The results of these experiments indicate that with-project turbidity at day 10 is approximately equal to the existing or without-project (includes operation of Area VIII and V) turbidity at day 8. No information was provided for turbidity beyond 10 days. The Natural Resource Agencies are more interested in potential effects on the average turbidity in the reservoir than on settling rates after a major inflow event. Lake Texoma can experience relatively long periods of time with no major runoff events.

The production of sport fish in Texoma Reservoir has potential to decline following WRB Project implementation, due to the reduction in chloride concentration (Gade et al. 1992). Decreases in dissolved chloride would permit clay particles to remain in suspension longer, thereby increasing turbidity and reducing light available for primary production (Gade et al. 1992). As primary productivity declines, organisms at higher trophic levels, such as most sport fish, are adversely affected.

Gade et al. (1992) predicted that overall sport fish harvest would decline about 2-3 percent with a chloride reduction of 11 percent. The largest decline (about 5 percent) in sport fish harvest would be expected to occur in the main body of the reservoir between Willis, Oklahoma and Preston Point. Striped bass generally occur in the main body of the reservoir (Willis to the dam, excluding Washita arm) from June to September when the reservoir is stratified, and in the Red River arm from October to May when the reservoir is not stratified (Schorr et al. 1995). The largest declines in fish harvest would occur in the principal sections inhabited by striped bass, affecting striped bass considerably more than other sport fishes.

Reduced salinity also can adversely impact survival of larval striped bass. Several studies indicate that any reduction from the existing salinity levels in the Wichita River, Red River and Lake Texoma would reduce survival of larval striped bass. Murray-Brown (1987) noted that larval survival was enhanced at all salinity treatments from 0.5 to 10 ppt. Shell (1974) reported a significantly higher mean survival rate for larvae in ponds with 1 ppt NaCl. Kane et al. (1988) found maintenance of 1.1 ppt NaCl enhanced larval survival compared to larvae exposed to a reduction from 1.1 to 0.6 ppt. The existing average salinity at Lake Texoma is about 1 ppt or 1000 mg/L and any reduction could adversely affect survival of larval striped bass.

These findings could have serious implications for recreational use and the regional economy. The value of the Texoma Reservoir fishery has increased considerably since striped bass were first stocked in 1965. In 1973, natural spawning by striped bass was confirmed, and stocking is no longer necessary to sustain this important fishery.

A reservoir-wide creel survey conducted in 1986-87 revealed that the total annual harvest by Texoma anglers was an estimated 853,688 fish with a total weight of 993,078 kilograms (2,184,772 lbs) (Hysmith 1988). A 3 percent reduction in annual harvest would be more than 65,543 pounds of fish. If multiplied by even half (50 years) of the WRB Project life, anglers would lose 3,277,158 pounds of harvested fish. Angler use and economic studies conducted simultaneously with the creel survey determined that the average fishing trip was 3 hours in duration, with an estimated 461,000 fishing trips to Texoma Reservoir during a 12-month period (Mauck 1987). The average amount spent by anglers per day for a trip during this period was $56 per person. The number of striped bass anglers in the years 1988 to 1993 varied from a low of 240,935 in 1990 to 424,589 in 1993. Using the average amount expended by anglers in 1987 ($56.00), the value of the striped bass fishery averaged $19.4 million during the years 1987 to 1993.

More recently, an overall economic impact analysis of the Texoma Reservoir fishery was conducted (Schorr et al. 1991, 1995). The fishery resource of Texoma Reservoir was estimated to be responsible for the expenditure of over $25.6 million annually within the local economy (Schorr et al. 1991, 1995). Striped bass anglers alone contribute over $22.7 million in annual expenditures to the Texoma Reservoir regional economy (Schorr et al. 1991).

A reanalysis of the economic impact of fishing activities at Lake Texoma was conducted by the Corps and Oklahoma State University (Amera et al. 1995). The Lake Texoma fishery was valued at $21.3 million, based on expenditures by anglers within the seven-county region. The striped bass fishery was valued at $16.9 million. The largest expenditures ($16.7 million) were associated with non-regional anglers.

The underlying assumption in these economic studies is that the overall value of the Lake Texoma fishery is directly related to angler participation and success. Reduced angler success would typically lead to reduced angler participation and use of the resource. A decline in angler participation would undoubtedly affect the regional economy. Based on the predicted reductions in water clarity and productivity in the reservoir (Gade et al. 1992), the RRCC Project would undoubtedly have serious adverse biological consequences on the Texoma Reservoir fishery and on the anglers who utilize this fishery. Although the degree to which sport fish harvest would decline in Lake Texoma is unknown, at least a slight reduction for at least 100 years or the life of the reservoir is possible. Assuming a direct relationship between sport fish harvest and angler expenditures, a 2-3 percent reduction in sport fish harvest would equate to an annual loss of up to $768,000 to the regional economy. Such an impact could have negative effects on the regional economy.

Other regional economic impacts could occur with a reduction in water clarity. Aesthetics is an important consideration for many recreational users in determining activity sites. Reduced water clarity would also affect boating, swimming, and related water-based recreational activities. Home sales and other real estate transactions could also decline if Lake Texoma were less aesthetically pleasing. However, these economic impacts have not been quantified.

Water Quality

Water quality would be affected directly and indirectly by the WRB Project. Salinity is directly and intentionally reduced in the WRB Project area, but other water quality effects are indirectly related to the project, such as predicted increases in nutrients and pesticides associated with predicted increases in irrigated agriculture.

The amount of cultivated land being irrigated is estimated to increase following completion of the WRB Project. Estimates of present and future concentrations of nitrogen and phosphorus in the Wichita River were developed by Texas A&M (Walker 2001 in U.S. Army Corps of Engineers 2001a). With the WRB Project, the estimated mean discharge of nitrogen concentrations for the Wichita River at the Charlie Gage were projected to increase from 1.42 ppm to 10.88 ppm, and phosphorous concentrations were projected to increase from 0.42 ppm to 1.64 ppm. This increase in nutrient levels could potentially impact algal production in receiving waters. This could increase potential for fish kills related to golden algae (Prymnesium parvum) and increase the potential for dissolved oxygen variability in the Red River and Lake Texoma.

The transformation from dryland farming of bermuda grass and alfalfa to irrigated alfalfa also has the potential to increase levels of agri-chemicals in receiving streams. Presently, both herbicides and pesticides are applied to the dryland crops. With irrigation, only pesticides would be applied to irrigated alfalfa (U.S. Army Corps of Engineers 2001a). Consequently, with the WRB Project, the amount of herbicides available for transport into receiving streams would be less than presently exists. Under existing WRB Project conditions, both herbicides and pesticides are applied to existing crops and are potentially transported into receiving streams during rainfall events. With the WRB Project, the amount of herbicide applied to crops should be considerably reduced, but the rates of transport of other contaminants could be increased. This increase would be due to transport by rainfall events as currently exist and irrigation return flows.

Where intensive irrigation and collection of return flows occur, elevated levels of pesticides, metals, and other potential contaminants, such as Se and arsenic, can develop (Adornato and Martin 1995). In particular, Se is uptaken readily by aquatic organisms and can remain at elevated levels for years after the waterborne inputs cease. Where contaminants such as these enter the river, fish and wildlife populations could be adversely affected.

Any increase in industrial and municipal growth within the upper Red River Basin due to implementation of the WRB Project would have a significant reduction in the waste assimilative capacity of Wichita and Red Rivers, particularly if the point source discharges directly into the river. For the upper Red River, even treatment efficiencies as high as 99 percent were estimated to result in the waste assimilative capacity being exceeded within 40 years following WRB Project completion (University of Oklahoma 1975).

The WRB Project would result in minor alterations of downstream sediment delivery patterns (sediment loads, movements, and deposition) within affected streams due to sediment trapping (U.S. Army Corps of Engineers 1980, 1976). Construction of the brine collection facilities and

their consequent trapping of stream-suspended loads will cause a slight reduction in the alluvial material currently being deposited within the Wichita River channel. Control facilities at Area VIII and X are expected to reduce the amount of alluvial material presently being deposited in Lake Kemp by about 10 percent (Killgore Research Center 1972).

Certain other water quality parameters, primarily dissolved oxygen, water temperature, and environmental contaminants, also would be altered due to an increase in the occurrence of low or no flow and reductions of in-stream habitat availability.

The primary water quality impact of the WRB Project is the reduction in chloride concentration. Many professionals inexperienced in aquatic ecology do not understand why a reduction in chlorides would be detrimental to an aquatic community if reduced chlorides results in "improved" water quality. However, this perspective typically considers only benefits to humans and ignores numerous ecological principals. The chlorides present throughout much of the upper Red River Basin are the remnants of an ancient inland sea which existed over 200 million years ago. As this sea evaporated, the brines were left behind. The non-marine aquatic ecosystem which subsequently developed persisted under extremely adverse environmental conditions, considering that very few non-marine organisms exhibit a high tolerance to chlorides. The chlorides functioned as one of the primary mechanisms under which the aquatic community evolved. The character of this unique ecosystem is intricately linked to the occurrence of these chlorides. As the chloride loads are reduced or eliminated, the defining element of this community will moderate or disappear, along with many of the saline tolerant inhabitants. An aquatic community would still exist after the WRB Project is operational, but the uniqueness that distinguished this ecosystem from all others will likely be diminished. The Wichita River is one of the most impacted tributaries in the upper Red River System, but it still supports most of it's native fish species. The Wichita River is still relatively unique and the uniqueness of native fish populations could be further reduced. The proposed WRB Project would implement even more of the factors that caused the existing declines, such as barriers to fish movement.

Water quality in the Wichita and Red Rivers would be altered with WRB Project implementation. The chloride concentration of water in the Wichita River is projected by the Corps to be reduced by 32-76 percent (depending on the alternative chosen) at Lake Kemp (see tables, Appendix C). The chloride levels in the North Fork of the Wichita River are predicted to be lowered by about 76 percent with the preferred alternative, and chloride levels in the South Fork would be lowered by about 62 percent with any of the alternatives (all alternatives include operation of Area VIII). The Red River chloride concentration in Reaches 5 and 6 (Red River and Lake Texoma) is projected to be reduced by about 10 percent with alternative 3. However, the extent and timing of chloride reductions is difficult to predict. Area VIII has been operational since 1987 and for about 5 years resulted in only a slight reduction in chlorides at Lake Kemp. More recent estimates of 20-33 percent reductions in chlorides have been measured at Lake Kemp.

As water chemistry within the upper Wichita River changes following completion of the WRB Project and salinity declines, the river may become more turbid. As turbidities increase, a reduction in productivity could occur in the Wichita River. Chlorides have a significant effect on

clay turbidity within a water body (Gade et al. 1992, Harrel and Dorris 1968, Mathis and Dorris 1968). Decreases in dissolved chloride could permit clay particles to remain in suspension longer, thereby increasing turbidity and reducing light availability for primary production (Gade et al. 1992). As primary productivity declines, organisms at higher trophic levels are adversely affected. The extent to which primary productivity will be affected is extremely difficult to predict, and is largely dependent upon the clay content of the bedload of the river. However, reductions in instream primary productivity could contribute to a decline in fish and invertebrate populations in the Wichita River, Lake Kemp, Lake Diversion, Red River, and Lake Texoma. Lake Kemp is predicted to be more turbid with implementation of the WRB Project (Schroeder et al. 2000). The average 10-day increase over pre-project conditions at Lake Kemp (pre-project was with Area VIII) was predicted to be about 35 percent and the time required for turbidity to decrease is predicted to be 40-70 percent greater (Schroeder et al. 2000). However, the effects of increased turbidity on productivity in Lake Kemp have not been analyzed. The sport fishery and other recreational uses at Lake Kemp and Lake Diversion could be aversely affected by increased turbidity. Water treatment costs for the TPWD Dundee State Fish Hatchery could also increase due to increased turbidity.

Upper Wichita River

The aquatic community of the upper Wichita River tributaries is expected to change in several ways following completion of the WRB Project:

- fish populations upstream of low-flow brine storage impoundments will become isolated, and species composition may shift toward more salt tolerant forms;
- fish populations downstream of low-flow brine storage impoundments are likely to shift toward more salt intolerant species and will have reduced habitat due to lower flows and
- reduced chloride concentrations will enhance survivability of some species, including larger piscivorous fishes which are generally intolerant of high salinities. Increased populations of piscivorous fishes will ultimately lead to decreased abundance of small non-game fishes.

Flow Regime

Fish species composition and abundance will likely change in relation to the anticipated modification of stream flows and water chemistry following completion of the WRB Project. Recent collections throughout the upper Red River system in Oklahoma have shown the fish community to be dominated by cyprinids (minnows) and strongly associated with existing water chemistry (Matthews et al. 1991). Fish species common to prairie/plains rivers are adapted to survive the harsh conditions of high temperatures and intermittent flow (Reash and Pigg 1990). These adaptations allow minnows to dominate fish communities under such conditions. Fishes, such as the endemic Red River shiner and Red River speckled chub, which are highly specialized to exist under these harsh conditions, will be most affected by alterations in stream flow.

Greater than 80 percent of the small forage fish occurring in the upper Red River and tributaries spawn during the period from late spring (May) through summer (August) (Miller and Robison 1973). Summer flood flows trigger reproductive activity in many of these species. Several species may even have secondary spawning peaks in August. Reduced flows and river stage during the summer months would significantly influence spawning activity and survivability of young in these fish, reducing recruitment. Alteration of summer flow conditions could be particularly detrimental to crucial phases of the reproductive cycle, particularly eggs, embryos, and fry, of certain fish species. Species which are extremely dependent upon the success of each year's reproductive efforts would experience the greatest impacts and could be eliminated entirely.

Reductions in flows are predicted for Reaches 10 and 11. Reductions in average water depth, and corresponding increased temperature variability, would reduce the suitability of deepwater scour holes that serve as refugia for fish during low water conditions. Eliminating or altering the environmental conditions of these refugia would drastically reduce the ability of the fish populations to re-populate the river following summer months. When portions of the river are de-watered, fish populations will be eliminated, or at best, severely depressed and may never recover to previous population levels.

At present, predatory and sport fish populations are relatively insignificant in the upper reaches of the Wichita River. The three most common sport fish, channel catfish, white crappie, and largemouth bass, together comprised less than 1 percent of the total number of fish collected by Findeisen and Howell (1998). However, as salinities decline, certain species, primarily those which do not tolerate high salinities, such as largemouth bass, green sunfish (Lepomis cyanellus), longear sunfish (L. megalotis), and white bass, may become a more common component of the fish community.

Largemouth bass, green sunfish, and white bass are predominantly piscivorous, and could be expected to exploit the abundant aggregations of forage fish within the upper Red River. Although predation is not expected to eliminate any forage fish populations, the fish populations in the upper Wichita River do not presently experience considerable pressure from predatory species, with the exception of commercial bait harvest. If reduced chloride content enhances the survivability of predatory species in the upper Wichita River, the resulting shift in composition of the fish community would be to the detriment of non-game fishes. The wide fluctuation in flows and water depths common in the upper Wichita River could help minimize the expansion of larger, predatory species.

Stream fish assemblages in the Wichita River basin have been severely altered by the presence of Lake Kemp, Diversion Lake, and the Area VIII impoundment (see Comment 62 offered by the Corps 2002; Wilde et al. 1996). To date almost half of the native minnows have been extirpated and others are in decline. The Corps' preferred alternative seeks to construct more small impoundments to capture low flows for disposal at Truscott Brine Lake. Alternative 3 is the most damaging because it impacts all three forks of the upper Wichita River basin and leaves no areas where prairie stream fishes can thrive. The WRB Project would affect this ecosystem by increasing the severity and duration of low flow events and moderating harsh conditions (i.e.

high salinities). These conditions are important for controlling fish distributions and preventing the homogenization of fish assemblages. If brush control is implemented as well then further dilutions of salinities could occur and accelerate the decline of prairie stream fishes.

Impacts to other Fish and Aquatic Organisms

Red River pupfish, and other endemic fish species adapted to high salinities, would be adversely impacted by the anticipated reduction in chloride concentrations. These changes in stream water chemistry, coupled with anticipated increased water withdrawals, would result in significant alterations in native aquatic species composition in at least the upper Wichita River Basin. Densities of pupfish were predicted to decline in reaches 6 through 11 with all proposed alternatives, although the declines were not statistically significant relative to existing conditions (Gelwick et. al 2000). Reduced salinities, increased turbidities, and reduced productivities related to the WRB Project all have potential to adversely affect the fishery in Lakes Kemp and Diversion and potentially increase water treatment costs for the Dundee State Fish Hatchery.

The Red River pupfish is just one of several species characteristic of the upper Red River system that serve to distinguish this region from other regions. Native plant and animal communities evolve under specific sets of environmental influences. In the case of the upper Red River aquatic community, the environmental influence was high salinities. Alteration of the influence of salinity would eventually lead to loss of the genetic variability responsible for sustaining this unique assemblage of both plants and animals. The loss of these species represents a significant reduction in the biodiversity of the upper Red River ecosystem.

The reduction in chloride load likely would affect components of the aquatic community in various ways. The freshwater mussel fauna of the upper Red River could benefit from a reduction in salinity. However, the unconsolidated, sandy substrate of the Red River is not conducive to establishment of a robust bivalve population and would likely inhibit any significant expansion of the mussel fauna.

However, reducing chloride loads in the upper Red River could enhance conditions favorable to colonization by zebra mussels. Zebra mussels, a harmful, non-indigenous species, have not yet been recorded from Lake Texoma or the upper Red River. Although little is known of the life history of the zebra mussel, experts believe that elevated chloride loads play an important role in limiting the expansion of this species. Zebra mussels apparently prefer salinities less than 4,000 ppm. The potential for colonization by zebra mussels is very low if salinities are above 35,000 ppm. Salinities in Lake Texoma, based on information contained in Gade et al. (1992), are well within the range tolerated by zebra mussels. A reduction in salinity would not likely have any significant effect on the ability of Lake Texoma water quality to limit zebra mussel infestations.

However, salinities in the upper Wichita River Basin are frequently above 4,000 ppm. Reducing salinities in the upper Wichita River and tributaries by as little as 45 percent would indirectly provide an environment favorable to the establishment and expansion of zebra mussels. The sandy substrate would not inhibit colonization by zebra mussels because they do not burrow into the substrate.

If zebra mussels became established in Lake Texoma following completion of the WRB Project, project operation would allow zebra mussels to colonize considerable sections of the upper Red River Basin. Colonization of the upper Red River would not only be detrimental to the native mussel fauna, but could also impact irrigators and municipalities dependent upon the Red River or its tributaries as a source of water. In this instance, controlling zebra mussels could become a significant expenditure for those municipalities and irrigators using water from the upper Red River. Zebra mussels have a well established characteristic of infesting and clogging water intake structures (Office of Technology Assessment 1993).

Although the reduction in salinity is anticipated to have a direct or indirect impact on several aquatic species, the Red River pupfish would exhibit the most drastic reductions in distribution and population size (University of Oklahoma 1975). The Red River pupfish is endemic to the upper Red River and thrives in this highly saline environment. Echelle et al. (1972) observed that decreasing salinities in the upper Red River Basin corresponded with increasing species density and gradual extinction of Red River pupfish. The Red River pupfish occurs in freshwaters only because of reinforcement from population centers occurring in high salinity areas. As these population centers are eliminated or decline in size following a reduction in salinity, reinforcement would decline or cease leading to a reduction in the range of the Red River pupfish. The continued existence of the entire pupfish population is dependent upon the continued viability of these more saline populations. The WRB Project would harm the existing population of Red River pupfish in the Wichita River by causing habitat fragmentation from construction of the low flow collection facilities and by otherwise degrading habitat conditions throughout much of its current range.

The fragmentation of Red River pupfish populations by the low-flow dams would serve to reduce gene flow between upstream and downstream populations and may further reduce abundance and distribution of the pupfish. Even when the dams are deflated, the concrete base serves as an effective barrier to dispersal. Irrigation diversion dams in the Pecos River in West Texas were found to be retarding gene dispersal of the introduced sheepshead minnow (C. variegatus), a close relative of the Red River pupfish (Echelle and Connor 1989). They speculated that, even though water often overflowed the tops of these barriers, upstream movements by C. variegatus would be particularly difficult. This phenomenon would also inhibit dispersal by Red River pupfish. The impact of isolation of Red River pupfish populations by the low-flow impoundments on the genetic integrity of the pupfish is unknown, but is a long-term factor that could likely contribute to inbreeding depression and related factors that also would reduce the survivability of these isolated populations.

The low-flow collection facilities also would allow fish species that are better adapted to lower salinities to exist downstream in areas of formerly higher salinities and prey on or compete with the pupfish, potentially decimating populations downstream of the impoundments.

Other evidence exists that confirms the effects of barriers on Red River pupfish populations and the importance of the upstream populations to the overall distribution of this species. In 1941, the Brazos River in Texas was impounded by Possum Kingdom Reservoir. Prior to impoundment, the Brazos River exhibited shallow water, homogeneous sandy substrate,

intermittent flow, and high turbidity characteristic of most prairie/plains streams. Salinities in the Brazos River prior to impoundment resembled those commonly found in the mainstem upper Red River. Anderson et al. (1983) examined the composition of non-game fish populations above and below the reservoir some 37 years after impoundment and found that non-game fish populations had changed considerably. Five species, emerald shiner (N. atherinoides), sand shiner, plains minnow, speckled chub, and Red/Brazos River pupfish (see following paragraph for an explanation of taxonomy of Red/Brazos River pupfish), typical of prairie/plains type stream environments were only found upstream of the reservoir. Flow conditions and salinity downstream of the reservoir had changed markedly following impoundment and were believed to be responsible for the observed changes in fish community composition. These same five species were absent from the fish fauna for at least 120 km (74 mi) downstream of the reservoir.

Winston et al. (1991) provided evidence that the low flow impoundments also may have adverse impacts to other Red River endemic fishes. They found that construction of Altus Reservoir, an effective barrier to upstream dispersal, was responsible for the extirpation of Red River speckled chubs, chub shiners (Notropis potteri), Red River shiner, and plains minnow. Species richness above Altus Reservoir was considerably lower than species richness below the reservoir.

The Corps contracted a study specifically to determine impacts from construction of the low-flow collection facilities on fish populations (U.S. Army Corps of Engineers 1995:Appendix VI = Echelle et al. 1995). Red River pupfish were extremely abundant below the Bateman Control Facility (Area VIII) and was used to justify the Corps conclusion that the RRCC Project would not have any impacts on native fish populations. However, such a position ignores the fact that the number of Red River pupfish collected declined markedly downstream of this site. No pre-project information exists at this site from which definitive conclusions could be drawn regarding the effect of the control facility on pupfish abundance. Without pre-project information, concluding that pupfish abundance increased or decreased as a result of WRB Project operation is extremely speculative.

Echelle et al. (1995) did compare their data with limited pre-project data collected at the same site in 1969 which serves to confirm the Service's concern that WRB Project operation may have a very significant impact on fish community composition. In 1994, Echelle et al. (1995) found seven additional species which were not collected from this identical site in 1969 before the Bateman control facility was constructed. This directly corresponds with changes in the relative abundance of certain fish species following WRB Project implementation. The principal investigators could not discount the possibility that a "seasonal effect" may have been responsible for the observed differences in fish community composition.

Other pre-project data exists which helps clarify the effects of the WRB Project and provides additional justification for the position of the Natural Resources Agencies that construction of the WRB Project has the potential to elicit serious, long-term changes in fish abundance and community structure. In 1953-54, Lewis and Dalquest (1957) conducted an extensive fisheries survey of the Wichita River Basin at nine stations. Four of these stations, two in the North Fork and two in the South Fork, are identical or in close proximity to those sampled by Echelle et al.

(1995). However, Echelle et al. (1995) was based on a one-time sample while Lewis and Dalquest (1957) collected at the same sites on 11 different occasions.

At the two stations on the North Fork, which is presently unaffected by the WRB Project, Lewis and Dalquest (1957) collected 14 species compared to 8 in the more recent study. Those species found by Lewis and Dalquest (1957) which did not occur in collections at similar sites by Echelle et al. (1995) were gizzard shad (Dorosoma cepedianum), river carpsucker (Cyprinus carpio), green sunfish, sharpnose shiner (N. oxyrhynchus), and chub shiner (N. potteri). Echelle et al. (1995) did not collect any species from these sites not previously found by Lewis and Dalquest (1957), although Echelle et al. (1995) did record suckermouth minnow (Phenacobius mirabilis) from a site between the two comparison sites.

Although there appears to be some difference in species composition, the differences are not significant. Echelle et al. (1995) did collect gizzard shad at a site between the two comparison sites and probably would have captured the species if repeated sampling had been funded by the Corps. Lewis and Dalquest (1957) captured river carpsucker only on one occasion and only one individual. River carpsucker was captured by Echelle et al. (1995) at two sites but not from the North Fork. Only two individuals were captured. This species appears to be very rare in the upper Wichita River Basin and repeated collections may have resulted in at least one capture of this species from the North Fork.

The sharpnose shiner and chub shiner are even more problematic. Echelle et al. (1995) did not encounter either of these two species. The sharpnose shiner did historically occur in the Wichita River System and was not recorded from that system in 1991 despite intensive survey efforts (Moss and Mayes 1993). The most recent observation of the sharpnose shiner from the Wichita River System was a capture in 1955 (Moss and Mayes 1993: Museum record KU 3405). No other information on the chub shiner in the Wichita River system was found.

At the two stations on the South Fork, one comparison site exists above and one below the Bateman Collection Facility. Lewis and Dalquest (1957) collected 14 species (12 above and 10 below) compared to 12 (7 species above to 11 below) by Echelle et al. (1995). Those species found by Lewis and Dalquest (1957) which did not occur in collections at similar sites by Echelle et al. (1995) were black bullhead (Ameirus melas), sharpnose shiner, and chub shiner. Again, Echelle et al. (1995) did not collect any species from these sites not previously found by Lewis and Dalquest (1957), although Echelle et al. (1995) did record bluegill sunfish (L. macrochirus) from a site above the two comparison sites.

Again there appears to be minor, insignificant differences in species composition. Echelle et al. (1995) did collect three black bullheads from a site above the two comparison sites and may have eventually captured the species at one of the lower sites. Black bullheads appear to have always been very rare in the upper Wichita River Basin. Lewis and Dalquest (1957) only captured a total of four individuals from the entire basin. All four fish came from only two sites, one in the North Fork and one in the South Fork. Black bullheads in each tributary were captured on only 1of the 12 sampling dates. As previously discussed, the occurrence of the sharpnose and chub shiners are problematic in that Echelle et al. (1995) did not encounter either of these two species.

Closer examination of the data from the two South Fork comparison sites reveals some interesting similarities. Both the 1953-54 and 1994 collections recorded speckled chubs and bullhead minnows (Pimephales vigilax) from the river near Benjamin, Texas, but not above at Guthrie, Texas. Both the 1953-54 and 1994 collections recorded gizzard shad and green sunfish above the control structures near the community of Guthrie. However, gizzard shad were observed from the river near Benjamin in 1957, prior to project construction, but were not observed by Echelle et al. (1995) at this site. Conversely, Lewis and Dalquest (1957) did not record green sunfish from the river near Benjamin although green sunfish were fairly numerous downstream of the control facility in 1994. Limited sampling observations may have hindered opportunity to capture gizzard shad by Echelle et al. (1995) because they did capture gizzard shad further downstream of this site. However, green sunfish were absent from all 12 collections at this site in 1957. The occurrence of green sunfish below the Bateman Collection Facility is consistent with anticipated increases in piscivorous fishes following reductions in chlorides.

Similarly, red shiner abundance was considerably higher in 1994 than in 1953-54. The increase in red shiners is consistent with the anticipated expansion of the less salt tolerant fish community following a reduction in chlorides. As previously predicted, such expansion of the fish community may result in increased competition with Red River pupfish, reducing abundance of pupfish.

Comparison of data on the distribution and abundance of the four most common inhabitants, the Red River pupfish, Red River shiner, plains killifish, and plains minnow reveals some disturbing trends. In 1953-54, Red River shiner, Red River pupfish, plains killifish, and plains minnows comprised 1.2, 34.7, 24.2, and 1.8 percent, respectively, of the total number of fish collected over the investigation at the Guthrie site. In 1994, some 7 years after construction of the Bateman Control Facility, Red River shiner, Red River pupfish, plains killifish, and plains minnows comprised 0, 1.7, 0, and 0 percent, respectively, of the total number of fish collected at this same site. This information indicates that the control facility may have had a profound effect on distribution of fishes above the structure.

Comparison of these same four species at the Benjamin site, located downstream of the control structure, is equally alarming. In 1953-54, Red River shiner, Red River pupfish, plains killifish, and plains minnows comprised 16.2, 13.1, 19.6, and 47.2 percent, respectively, of the total number of fish collected over the investigation. In 1994, some 7 years after construction of the Bateman Control Facility, Red River shiner, Red River pupfish, plains killifish, and plains minnows comprised 7.4, 10.1, 46.6, and 0.2 percent, respectively, of the total number of fish collected at this same site. Although, construction of the Bateman Control Facility cannot be singled out as the causative factor, the trends are disturbing and consistent with anticipated alterations of the fish community following reductions in chlorides due to implementation of the RRCC Project.

Several of the main concerns previously discussed under this section of the Report could be implicated as factors responsible for the observed trends. Echelle et al. (1995) suspected that a reduction in stream flow immediately below the control facility may have been responsible for the observed differences in the abundance of Red River pupfish. Echelle et al. (1995) also

identified the occurrence of the Red River pupfish as an extremely important factor in the observed variation in aquatic community composition and that the distribution and abundance of the Red River pupfish was directly related to salinity concentrations. Both the 1953-54 and 1994 studies demonstrated a general increase in species richness from the headwaters to the mouth of these streams, which was not unexpected. Combined with the fact that there was a negative correlation between salinity and number of species collected, reduced salinities after project construction likely facilitated increased species richness downstream of the control facilities. This increased species richness will certainly increase competition for the Red River pupfish and considerably reduce its distribution and abundance.

The increase in abundance of plains killifish below the control facility is not unexpected considering the greatly reduced salinities in the river below the control structure. Echelle et al. (1972) demonstrated a slight negative correlation ($p < 0.1$) between proportion of killifish in a collection (abundance) and increasing salinity. Other related factors also played a likely role in the expansion of the killifish after the Bateman facility became operational.

The plains killifish is the most closely related species, both ecologically and phylogenetically with the Red River pupfish. Echelle et al. (1972) postulated that larger Red River pupfish populations occurring in saline environments reduce important resources that would otherwise be available for plains killifish. Thus, as the salinity and number of pupfish decline, plains killifish populations expand to exploit this vacated niche.

As previously discussed, habitat fragmentation by the low-flow dams may also have had a significant adverse effect on Red River pupfish populations, although it is unlikely that any observable alteration of genetic material would have occurred since the impoundment became operation in 1987. The impoundment was more likely responsible for decreased dispersal which lead to reduced numbers of pupfish above the impoundment. Reduced salinities below the low-flow impoundment facilitated enhanced competition and lowered survivability and is the factor most likely responsible for reduced abundance of pupfish downstream.

Although Red River pupfish exhibit a rather broad tolerance of environmental conditions, the species remains most numerous in areas of high salinity. Echelle et al. (1972) suspected that Red River pupfish were more metabolically efficient at higher salinities than at lower salinities which, in part, explained the reduced abundance of pupfish at lower salinities. The broad niche exhibited by the Red River pupfish indicated that competition for resources likely occurs with a wide spectrum of species. This competitive interaction was thought to be especially critical in dilute waters where the pupfish was at a metabolic disadvantage. However, in the absence of other species, this physiological inefficiency does not seem to impair vitality. Thus, competition and predation appear to be the primary factor responsible for the virtual exclusion of Red River pupfish from less saline/fresh waters.

Gelwick et al. (2000) analyzed the potential effects of the WRB Project alternatives on Red River pupfish and predicted lower mean densities of pupfish in the Wichita River below the brine control structures and the Red River from the Wichita River confluence down to the Montague County line, for all three proposed alternatives. This analysis was based on the Corps' predicted

reductions in chloride levels for each alternative. Red River pupfish densities were strongly related to salinities and all three proposed alternatives have potential to reduce pupfish densities in most of the Wichita River Basin. Very little of the watershed above the brine control structures maintain water during droughts and most of these waters are not saline enough to favor pupfish and other salt tolerant species. The implications of the WRB Project on the continued existence of the Red River pupfish become more evident when information on Red River pupfish distribution is compared to stream reaches affected by the WRB Project. Many of the pupfish sites identified in 1998 (Gelwick et al. 2000) would be potentially affected by the WRB Project through direct affects to flows or salinities, or potentially through isolation of tributary populations.

The anticipated impacts to the Red River pupfish are significant in that this fish is one of 11 currently recognized species of pupfish (Cyprinodon) that occur in inland waters of the United States. Several additional species of pupfish occur in Mexico. Of these 11 species, 6 are either officially listed as threatened or endangered or have a subspecies that is officially listed as threatened or endangered. The American Fisheries Society Endangered Species Committee lists 32 species or subspecies of pupfish from North America as endangered, threatened, or of special concern, including all of those occurring in the United States except the Red River pupfish. The Tecopa (C. nevadensis calidae) and Monkey Spring (C. sp.) pupfishes are already extinct, as is the Parras pupfish (C. latifasciatus), a native of Mexico.

All of these listed species are imperiled, at least partly due to human activities. Pupfishes, as a group, have extremely localized distributions and are adapted to specific, often harsh, environments. These characteristics render them extremely vulnerable to habitat alterations, particularly those anticipated with the WRB Project. Consequently, the magnitude of the potential impacts to the Red River pupfish could be much more severe than originally believed in 1976. Those populations that do survive following RRCC Project implementation will be restricted to scattered refugia (University of Oklahoma 1975).

This information is particularly disturbing considering recent evidence which indicates that the Red River pupfish is comprised of two distinct allopatric forms. These forms, occupying the Red and Brazos Rivers, likely represent separate, independently derived species (Ashbaugh et al. 1994, Echelle and Echelle 1992). Ashbaugh et al. (1994) do not formally describe these species but consider the distinctiveness to warrant special consideration. They suggest that the two forms should be managed and maintained as separate entities. The reduction in the overall distribution of the "Red River" pupfish compounds the effects of this WRB Project with respect to the survival of pupfish in the upper Red River.

The Natural Resource Agencies consider construction of the WRB and RRCC Project to be a serious threat to the continued existence of the Red River form. Considering that construction and operation of control facilities at Area V already have led to the extirpation of two endemic species, the Service believes the potential reduction in the Red River pupfish population from WRB Project implementation to be of grave concern. The Natural Resource Agencies strongly recommend monitoring of the pupfish population and implementation of measures to minimize impacts and mitigate for any adverse effects to this species.

Fish populations below brine collection structures may face additional threats. Populations below collection structures are likely to shift towards species less tolerant of high salinities, but also would face reduced flows. When fish are isolated in pools during low or no flow periods, they must contend with increasing salinities as the pools area or volume are reduced. These less tolerant species are poorly adapted to these conditions and fish kills may result. Relatively few, if any, pupfish may be in these pools to survive and take advantage of these more saline conditions because, under more normal flows, WRB Project operations may have reduced salinities to a point that pupfish could no longer exist in these reaches due to competition with the less salt tolerant species.

Low Flows

Flows in the upper Wichita River, from the pump stations (Areas VII, VIII, and X) downstream to Kemp Reservoir would be directly affected by the WRB Project. The Corps conducted a low-flow analysis for the proposed alternatives and the results of this analysis are provided in Appendix C. Operation of the WRB Project was estimated by the Corps to reduce flows primarily in the North, Middle, and South Fork tributaries of the Wichita River. Flows in the Red River are not predicted to be directly affected although the Corps anticipates that the reduction in chlorides will also result in increased water consumption for agricultural purposes, primarily above Texoma Reservoir.

Average annual flows are not dramatically changed in most of the Wichita River Basin by the proposed WRB Project because the pumps are not operated during high flow events and pumping rates are only 4.2 cfs for Area X, 6.2 cfs for Area VIII, and 8.2 cfs for Area VII. However, the magnitude of the effect of the WRB Project on low flows is masked by the use of averages. The number of days with no or zero flow is greatly increased in the North Fork Wichita River by any alternative with pumping from Areas VII or X (U.S. Army Corps of Engineers 2001b). During the period of record (10/61 - 9/98, 37 years, or 13,505 days) only 2 days with no flow are recorded for Reach 10 (North Fork) under natural or no project conditions. In contrast, the number of days with no flow would increase to 1,131 (614 with brush control) with the Corps' preferred alternative (7a in the Corps system or alternative 3 in this report) with Areas VII, VIII, and X operational (U.S. Army Corps of Engineers 2001b). The effect on flows is serious. Even with brush control, the number of zero flow days is increased from two days in 37 years to 614, or an average of over 16 days per year with zero flow. The South Fork is predicted to be affected much less with an increase of only 35 days of no flow during the period of record compared to natural conditions (U.S. Army Corps of Engineers 2001b). Wichita River flows below the confluence of the North and South Forks (Reach 9) are predicted to be only slightly affected with an increase of only 5 days of no flow during the period of record with alternative 3.

The proposed brush control program would likely improve water availability within the basin. Assuming a 50 percent reduction of brush in the basin, the Corps predicts a net increase in watershed yield at Lake Kemp of 27.6 to 38.9 percent (based on NRCS watershed modeling). The number of zero flow days in the North and Middle Forks of the Wichita River (Reach 10), as measured during the period of record (37 years) at the Truscott gage, are predicted to decline from 1,131 to 614 days (27.6 percent yield increase) with Areas VII and X in operation and with

50 percent brush control (U.S. Army Corps of Engineers 2001b). This represents a 46 percent reduction in the number of zero flow days that would occur with the project. However, brush control does not completely eliminate low flow effects, and the effects are still very significant. Brush control and the resulting increases in flow also are expected to reduce salinity and increase impacts to salt tolerant fish species.

The State of Texas brush management program is a trial project and funding is not assured for the present or a 100 year period. There is no commitment by the state or Corps to fund brush control for the life of the WRB Project and no commitment by landowners to participate in the program. Inclusion in the Region B Water Plan, or in any regional plan for that matter, does not dictate construction of a project. Water plans do not fund construction nor implementation of recommended projects. Regional water plans developed under Senate Bill 1 recommended 17 billion dollars of water development projects throughout the State of Texas. Funding for many of these projects has not been identified. With all these uncertainties, we do not consider the Corps position that brush control will occur with or without the WRB Project to be reasonable. The Service will not assume low flow impacts will be moderated by brush management for the life of the WRB Project unless the Corps is willing to fund such actions and get commitments from an appropriate number of landowners.

Flows in the lower Wichita River and Red River downstream are not predicted by the Corps and Texas A&M to change much with any WRB Project alternative, despite a predicted increase in demand for water for irrigated agriculture. The U.S. Army Corps of Engineers (2001a) predicted an increase in area irrigated from the current 12,000 acres to more than 57,500 acres with alternative 3. The amount of irrigated land is expected to increase by 45,500 acres. Even if the predicted increase in demand for irrigation doesn't affect flows in the river, it is likely to affect reservoir levels and fluctuations at Lake Kemp. Increased demands for water from Lake Kemp and Lake Diversion are likely to have adverse affects on the sport fishery and recreational opportunities at these two reservoirs.

Dundee State Fish Hatchery

Increased demands for water also may threaten the water supply of TPWD's Dundee State Fish Hatchery below Lake Diversion. This hatchery is one of the largest in the southwestern United States and is very important to TPWD. The Dundee State Fish Hatchery is a critical facility in TPWD's hatchery system and is located directly downstream of Lake Diversion, approximately 23 miles southwest of Wichita Falls in Archer County. Original construction in 1927 included 44 earthen ponds totaling 32.9 acres. Hatchery ponds were renovated in 1958 and expanded to 91 earthen ponds totaling 78.31 acres in1977. In 1993, 75 percent of the production ponds received complete renovation including plastic liners and state-of-the-art harvest basins. Dundee is the primary source of striped bass production for the state. Dundee also produces all the smallmouth bass stocked statewide as well as a significant proportion of catchable-size channel catfish for agency outreach events. Since 1963, Dundee has produced almost 300 million fish (20 species) for Texas' public waters and out-of-state trades. TPWD has provided over 30

million fish of 9 species for Lakes Kemp and Diversion. Water for this facility is acquired by gravity flow though 14-and 30-inch pipelines from Lake Diversion. The reservoir is owned/operated by Wichita County Water Improvement District No. 2 (WCWID No. 2) and the City of Wichita Falls. A 1977 contract with these entities permits the hatchery to divert 2,200 acre-feet of water per year.

Severe water level fluctuations in Lake Kemp will impact Lake Diversion and the Dundee Hatchery. Of great concern is the ability to keep Lake Diversion at or near conservation pool (1,052 msl) because hatchery intakes are located at 1,051 (30" main intake line) and 1,047 msl. Relatively small fluctuations in Lake Diversion can create significant differences in the hatchery's physical ability to obtain water. Without a reliable source of water, Dundee State Fish Hatchery cannot fulfill its critical functions. Further, increased turbidity of intake water would raise the water treatment cost for hatchery operations.

The Service does not agree with the Corps that water availability to the Dundee hatchery would be unaffected by the WRB Project. Lake Kemp and Lake Diversion are not new reservoirs and the reduced storage capacity (due to sedimentation) of these reservoirs over time may not allow full proposed benefits through increased irrigation and municipal water supply for the life of the 100 year WRB Project. It has been about 30 years since the Corps raised the elevation of the dam at Lake Kemp and it is questionable if the reservoir would have adequate storage to supply full irrigation and municipal water demands for another 100 years without substantial investments in dredging or construction of new reservoirs. As the storage capacity of Lake Kemp decreases, the security of water supplies for the hatchery becomes more uncertain. The proposed WRB Project-related increases in demands for water reduces the security of the hatchery water supply over time relative to existing conditions. The Service has requested information on the storage capacity of Lake Kemp and Lake Diversion over the life the WRB Project. Has the Corps factored in the reduced water storage over time in the feasibility analysis? Without a reliable source of water, Dundee Hatchery cannot fulfill its critical functions. TPWD has identified viable solutions (see TPWD comment letter in Appendix A).

Certain other water quality parameters, primarily dissolved oxygen, water temperature, environmental contaminants, and turbidity, also would be altered due to an increase in the occurrence of low, or no flow and reductions in instream habitat availability. In certain instances, algal blooms may occur. Blooms of bio-toxic species, such as Prymnesium parvum, could cause significant fish kills, but are difficult to predict. Fish kills attributed to this species have occurred in the Colorado, Brazos, and Pecos River basins of Texas (Linam et al. 1991, Palafox and Glass 1989, James and De La Cruz 1989). Alteration of the hydrology and salinity dynamics of the Wichita River ecosystem by the WRB Project would indicate that such blooms may be less likely to occur due to decreases in salinities, but may be more likely to occur due to nutrient loading and other effects of WRB Project implementation.

Prymnesium parvum is present in the Wichita River system and has been a problem at the Dundee State Fish Hatchery. Effects of the proposed WRB Project on Prymnesium parvum are

unknown. Problems associated with this algae in the Wichita River downstream could increase with implementation of the WRB Project through increased nutrient levels, but may be reduced by lower salinities.

MITIGATION/ALTERNATIVES ANALYSIS

The Service's Mitigation Policy (Federal Register 46[15]: 7644-7663) provides guidance for formulation of measures to offset WRB Project impacts. The purpose of the policy is to foster consistent and effective Service recommendations, to allow construction agencies and applicants to anticipate those recommendations and plan for mitigation needs at an early date, and to reduce Service-developer conflicts and delays. The policy is based on two principles:

- that mitigation, through impact avoidance, rectification, and compensation (in this sequence) be sought for the most valued resources, and,

- that the degree of mitigation correspond to the value and scarcity of the impacted resources. The Resource Categories in the Mitigation Policy are key elements in determining the appropriate planning goals for mitigating WRB Project related habitat losses.

The most valuable fish and wildlife resources in the WRB Project area that would be affected by the proposed WRB Project include the aquatic community of the Wichita River and Red River; aquatic habitat and sport fishery resources of Lake Kemp, Lake Diversion and Lake Texoma; and mesquite-juniper uplands. These resources are essential to, or support, fish and wildlife species that are highly valuable, such as neotropical migrant songbirds, federally-listed and state-listed threatened and endangered species, and various other game and non-game fish and wildlife species. The WRB Project also could affect migratory birds and other wildlife if toxic levels of Se are allowed to develop at Truscott Brine Storage Reservoir.

The aquatic environments of the Wichita and Red Rivers provide medium value habitat for native fish species such as largemouth bass, channel catfish, white bass, river carpsucker, and some species of minnows. The rivers provides extremely valuable habitat for other small, non-game fishes such as the plains minnow, Red River pupfish, Red River shiner, and Red River speckled chub. Several of these species are endemic to the Red River system and serve to distinguish this fish community from others within the region. The loss of these species would represent a noteworthy reduction in the biodiversity of the upper Red River ecosystem. Therefore, we have determined the mitigation goal for these fish and wildlife resources to be no net loss of in-kind habitat value (resource category 2).

The aquatic habitats of Lake Kemp, Lake Diversion and Lake Texoma provide high to medium value habitat for a variety of fish species, including a number of sport fishes. The value of these fisheries is based largely on striped bass, white bass, largemouth bass, crappie, and catfish. Large, multi-purpose reservoirs are rare on a local or regional basis, so the high value and uniqueness of the aquatic resources and the recreational values supported by the reservoir sport fisheries would be difficult to replicate. Therefore, we have determined the mitigation goal for these fish and wildlife resources to be no net loss of in-kind habitat value (resource category 2).

Mesquite-juniper uplands in the WRB Project area provide medium value for such evaluation species as white-tailed deer, black-tailed jackrabbit, and Rio Grande turkey. Habitat value is higher for other species such as western diamondback rattlesnake, Texas horned lizard, Texas kangaroo rat, mourning dove, and Northern bobwhite quail. Mesquite-juniper brushlands are relatively abundant in the WRB Project area and elsewhere in the region. The mitigation goal for project-related losses of mesquite-juniper uplands is no net loss of habitat value while minimizing loss of in-kind habitat value. This habitat is equivalent to a resource category 3.

The Fish and Wildlife Coordination Act, and the more recent National Environmental Policy Act, provide for the mitigation of adverse effects of a proposed WRB Project on fish and wildlife resources. Mitigative measures designed to offset habitat losses associated with the WRB Project have been formulated under the principles outlined in the Service's Mitigation Policy. Mitigation can include avoidance, minimization (reduction), rectification (restoration), and compensation (replacement) in that sequenced order of priority. Many of the impacts of the WRB Project, as proposed, are difficult to avoid, minimize, or compensate for (in kind). Impacted aquatic habitats in the Wichita River Basin are difficult to replace. Mitigation for impacts of the existing portion of the WRB Project are long overdue and should be initiated as soon as possible. Construction and WRB Project related impacts have been ongoing for 25 years.

Mitigation, through rectification and compensation, for fish and wildlife resource losses associated with the proposed WRB Project have been developed, where possible, for some resources and are presented by resource type in the following sections. All potential mitigation costs should be factored into the Corps' feasibility analysis and selection of alternatives.

AQUATIC RESOURCES

Few options are available to successfully mitigate for the loss of stream habitats and the accompanying impacts on riverine fish and wildlife communities, including habitat for endemic fishes. Maintenance of stream flows is the most effective means of protecting aquatic habitats. However, there are no large reservoirs within the WRB Project area which could be used to augment post-project stream flow conditions, and increased stream flows from potential brush control measures will not fully mitigate for project-induced impacts. Vegetation encroachment, reduced salinities, and reduced flow conditions could not be prevented in the absence of a source

of additional water to provide adequate instream flows. Without adequate in-stream flows, the channel will narrow, aquatic habitat will be reduced, and species composition will be altered. Such losses are difficult to replace or mitigate for in-kind.

WRB Project impacts to streams could be minimized or mitigated by limiting the degree or magnitude of the existing action or creating new stream habitat to replace habitats that would be lost. Placement of in-stream habitat structures, salt cedar control, and creation of additional pools of perennial water may help sustain larger populations of fish during summer low/no flow conditions, and may benefit other aquatic species. The Service recommends creation and maintenance of at least the existing density of perennial pools or an alternative of one perennial pool per mile of stream impacted on the North and Middle Forks of the Wichita River.

These measures will help but will not replace stream habitat lost to reduced flows and lowered salinities. Chloride control at Areas VII and X contributes significantly to impacts on Lakes Kemp and Diversion and the Wichita River aquatic system. Eliminating chloride control at one or both of these salt sources would minimize impacts to the aquatic resources of the Wichita River and greatly reduce mitigation costs for low flow and reduced salinity impacts. As an alternative to replace stream habitat values, the Corps could purchase water rights in a similar watershed and protect or restore flows in a watershed that is approved by the Natural Resource Agencies.

The Service and TPWD supports dropping Area X from the preferred alternative. By dropping Area X, the Middle Fork of the Wichita could serve as a refugia for prairie stream fishes and reduce impacts to assemblages in the North Fork downstream of its confluence with the Middle Fork. In addition, the Service and TPWD support continued inclusion of the Wichita River Ecosystem as an element of the Corps Environmental Operational Plan (EOP) and establishment of a refugia habitat program as a tool to help stream fishes endure long-lasting impacts of any element of the WRB Project.

To replace habitat for salt tolerant species such as pupfish, impoundments could be built in the upper Wichita River watershed and stocked with pupfish. Only pupfish should be stocked and the impoundments monitored to insure that no other fish are introduced. These impoundments should be located near the river or major tributaries so that pupfish could enter the river when the impoundments overflow. In many places, the groundwater salinity is relatively high and could be used to support pupfish in a series of impoundments within the watershed. The Service recommends creation and maintenance of at least 2 acres of pupfish habitat for each 5 miles of stream impacted by the WRB Project.

Compensation for the loss of natural reproduction, productivity, and recruitment of sport fishes in Lakes Texoma, Kemp, and Diversion could partially be accomplished through artificial stocking. However, the reduced productivity and carrying capacity of the reservoirs likely would preclude significant restoration of the fish populations. WRB Project impacts to sport fishery resources conflict with the Service's mitigation goal of no net loss of in-kind habitat value.

Compensation for impacts to the Dundee State Fish Hatchery's water supply should be in addition to compensation for impacts to the fishery. The mitigation proposal and cost estimates to adequately replace the hatchery capabilities that would be lost at the Dundee hatchery are being developed by TPWD. Present alternatives involve relocating the intake for the hatchery, potential pump back of hatchery discharge to Lake Diversion, and changing priorities of water usage to allow adequate supplies of water for the hatchery at all times.

Construction and operation of the WRB Project would have irretrievable and cumulative effects on the aquatic ecosystems of the upper Wichita River and Red River. The impacts of reduced productivity of streams and reservoirs due to reduced salinity and increased turbidity are nearly impossible to mitigate for in-kind. These impacts are unacceptable to the Service without adequate mitigation and would conflict with the Service's mitigation goal of no net loss of in-kind habitat value.

Lake Texoma Reduced Productivity

A previous study (Gade et al. 1992) was used to predict impacts of the RRCC Project on productivity and sportfish harvest in Lake Texoma. This same study was used to analyze potential effects of proposed WRB Project. The Corps predicts an 11 percent reduction of chlorides in Lake Texoma with implementation of the preferred WRB Project alternative. This corresponds to a 2-3 percent reduction in sportfish abundance in Lake Texoma. While this is a relatively small percentage, it amounts to a loss of a large number of fish and a big impact to a popular fishery when multiplied over 100 years or the life of the reservoir. Even the existing portion of the WRB Project (Area VIII) could have adverse impacts to Lake Texoma productivity and is predicted to reduce chloride levels by about 4 percent. The Service and ODWC are opposed to any reductions in productivity and fisheries at Lake Texoma because in-kind mitigation is not possible for these impacts. Even small reductions in productivity and potential impacts to the fisheries are important because they are long term (100 years or more) and impact a large area. WRB Project modifications to avoid impacts to productivity in the Red River should be developed in cooperation with the Natural Resource Agencies and implemented for the life of the WRB Project.

It is difficult, if not impossible, to mitigate (in kind) for these impacts (See previous comments on impacts to Lake Texoma). A potential mitigation measure would be to return salt to the Wichita River downstream of Lake Diversion to avoid WRB Project related impacts to Lake Texoma and other aquatic resources. The Service will not support any of the proposed alternatives until the Corps has developed mitigation measures for impacts to Lake Texoma that satisfy the State Natural Resource Agencies.

Selenium Impacts at Truscott Reservoir

Selenium impacts at Truscott Reservoir could be avoided by eliminating pumping from Areas VII and X. Deep well injection could be used at these sites to accomplish WRB Project goals.

MESQUITE-JUNIPER UPLANDS

According to the HEP compensation analysis (Appendix B), using the Service's mitigation goal for resource category 3 habitats, the loss of 3,474 acres of mesquite-juniper shrubland at Truscott Reservoir and associated pipelines would require acquisition and management of 10,083 acres. The Corps already owns 10,000 acres at the formerly proposed Crowell brine reservoir site and the Corps intends to use this area for mitigation. The 10,083 acres estimated through the HEP analysis was based on implementation of Alternative 3 and a verbal description by project managers of the types or extent of wildlife management that would occur at the Crowell mitigation site. Management would include fencing to control or eliminate grazing, food plots, construction and maintenance of ponds, and some controlled burns. The Service's analysis assumed that existing levels of management of the entire 10,000 acres, with the addition of controlled burning on a quarter of the area would be maintained for 100 years. The area required for mitigation was based on an assumption that the described levels of wildlife management would continue for the life of the WRB Project. The area required for mitigation of mesquite-juniper shrubland losses could increase or decrease depending on the level of management provided by the Corps or the alternative selected. The Corps should develop a management plan and commit funds and staff to manage and monitor habitat at the Crowell mitigation site or allow TPWD to manage the mitigation lands. TPWD is willing to manage the Crowell mitigation lands, if the Corps provides maintenance funds. Administration by the Corps would be under the terms and conditions of a General Plan as provided in Section 3 of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

Additional information regarding mitigation for terrestrial impacts of the proposed WRB Project is included in Appendix B.

RECOMMENDATIONS

The Service expects the Corps to give equal consideration to fish and wildlife resource needs (as required by the Fish and Wildlife Coordination Act) along with other features of the WRB Project. If the Corps proceeds with the proposed WRB Project, in order to rectify and compensate for a portion of the anticipated impact, the Service recommends that:

1. The WRB Project not proceed as formulated in the preferred alternative due to unmitigable impacts to important fish and wildlife resources. Other alternatives, such as desalinization, water blending, and pumping to streams or deep well injection, instead of to Truscott Reservoir, should be evaluated and incorporated into a limited project that meets the water requirements of the basin. Chloride control at all three Areas (VII, VIII, and X) collectively should not be pursued as proposed due to their anticipated significant contribution to impacts to:

   A. The Wichita River aquatic community,

   B. Lake Texoma, Lake Kemp, and Lake Diversion sport fisheries,

   C. Dundee State Fish Hatchery, and

   D. Migratory birds and other resources from possible selenium contamination at the Truscott brine storage site.

2. The Corps cooperate with the respective states and affected agencies to achieve maximum control of man-made sources of brine. This may allow the Corps to reduce control of natural brines and still achieve most of the projected goals of the WRB and RRCC Projects.

3. The Corps reconsider their preferred alternative and consider eliminating brine control at Area VII or X, or reducing pumping and providing minimum flows at both sites. The Service and TPWD strongly recommend eliminating Area X because of its relatively high contribution to Se levels at Truscott Brine Storage Reservoir. Another alternative is to use deep well injection at Areas VII or X. Brines could be returned or added to the Wichita River below Lake Diversion to avoid impacts to the Red River and Lake Texoma.

4. Additional pools be created or existing rook enhanced to partially mitigate for reduced flows and provide refugia during droughts in portions of the South, Middle, and North Forks of the Wichita River affected by the WRB Project. Salt cedar control also should be initiated to improve habitat and flows in reaches affected by the WRB Project.

5. Habitat for salt tolerant species, such as pupfish, be replaced by building and maintaining impoundments in the upper Wichita River watershed and stocked with pupfish.

6. To mitigate for the loss of flowing water habitat value, one or a combination of the following be implemented:

   A. Eliminate Area VII or X and implement salt cedar control in addition to the proposed upland brush control. Brush control should be initiated and maintained at levels needed to restore flows to pre-project levels. If brush control is used to minimize low flows, it must be maintained over time. The Corps should budget for and commit to continuing the brush control efforts if the State does not continue the program. Brush control will be required several times during the proposed life of the WRB Project. The Service and TPWD would like to see additional mitigation for reduction in flows and impacts to salt tolerant fish that are not addressed through brush control.

   B. Water from brine sources be pumped into created stream channels or existing intermittent stream channels to create perennial streams. Water from brine sources could be pumped into streams that enter the Wichita River below Lake Diversion or possibly into the Pease River watershed. This alternative could eliminate the need for Truscott Brine Storage Reservoir and the spray fields. Another alternative could include continued operation of Truscott with Area VIII alone (assuming selenium would not exceed threshold levels) and pumping from one or both of the remaining brine sources to created or existing intermittent stream channels.

   C. The Corps could purchase water rights and protect or restore flows in a watershed approved by the Natural Resource Agencies.

7. Selenium concentrations at Truscott Brine Storage Reservoir be monitored throughout the life of the WRB Project, or until realistic projections of anticipated conditions indicate that selenium concentrations will not exceed thresholds that would adversely affect wildlife resources. (See comments on the Selenium Monitoring Plan in Appendix E).

The Corps presently is evaluating alternative methods to reduce potential adverse effects to wildlife resources from exposure to selenium, and has proposed monitoring Se levels in the water, sediment, and in fish and bird eggs at Truscott Reservoir. However, the potential adverse effects of the proposed action are long lasting and difficult to control or eliminate after they develop. Monitoring alone is not acceptable for such a serious potential problem. The Service is opposed to any implementation of the proposed WRB Project until the Corps develops plans to avoid or mitigate for adverse effects to wildlife resources exposed to Se concentrations due to project operations (see previous comments on pages 18-21 and comments on the Selenium Action Plan in Appendix E). These plans should be approved by the Service and State resource agencies.

8. Measures to avoid the take of migratory birds be implemented when monitoring indicates that Se concentrations are approaching the reproductive impairment threshold. To this end, a plan should be prepared that details the measures to be used and their application at Truscott Brine Storage Reservoir and other parts of the WRB Project. This plan should be included in the final Supplemental Environmental Impact Statement. Such action will be entirely the responsibility of the Corps. The proposed Selenium Action Plan (Appendix E) is a good start, but is not what the Service and TPWD consider an action plan (see additional comments in Appendix E). Additional compensation and permits (in compliance with the Migratory Bird Treaty Act) for the loss of migratory birds and other resources may be required.

9. Lands be managed to replace those terrestrial habitats lost due to implementation of the Corps preferred alternative. For Alternative 3 (7a in the Corps system), this would consist of 10,083 acres at the Crowell mitigation site or other areas approved by the Natural Resource Agencies for impacts from construction and operation of Truscott Reservoir and pipeline rights-of-way. A management plan should be developed by the Corps and approved by the Service and TPWD.

10. The fish community structure of the Wichita and Red Rivers, focusing particularly on endemic species, be routinely monitored to determine its status until such monitoring surveys indicate that fish populations will remain secure with the WRB Project. If population sizes or distributions following completion of the WRB Project are reduced by 25 percent or greater, the Corps should prepare and implement a "conservation plan" designed to ensure the long-term survival of the affected species. At a minimum, an outline of such a "conservation plan" should be included in the final Supplemental EIS.

11. The Corps attempt to compensate for any loss of striped bass and other sport fish production at the Dundee State Fish Hatchery by funding renovations of the hatchery water supply intakes and installing a pump back system to return hatchery outflows to Lake Diversion.

12. A mitigation fund to be established to pay for future mitigation projects.

13. Appropriate measures and best management practices be employed during WRB Project construction to minimize impacts due to construction of pumping stations and placement of pipelines.

14. The Corps monitor and mitigate for the effects of the proposed WRB Project on productivity in the Red River, Lake Texoma, Wichita River, Lake Kemp, and Lake Diversion where reductions in chloride levels are predicted.

    The predicted losses to the fishery are cumulative over the life of the WRB Project and are significant. In-kind mitigation for these losses is not possible. The Corps is claiming benefits from the reduced salinities all the way to Shreveport, Louisiana, but is not factoring in the impacts to fish and wildlife resources and costs within this same area. The Corps has not proposed to avoid or mitigate for these adverse effects to the fishery and claims the effects are insignificant. It is disturbing that the Corps would fund studies that predict impacts to an important fishery and then refuse to alter the WRB Project to avoid those impacts or agree to provide any mitigation or compensation for impacts to the States' resources. The Corps does not own the fisheries resources that would be impacted. The fish are State resources and the states should determine if the losses are significant. The ODWC position has not changed since the RRCC Project, and they do not support any reduction in salinities at Lake Texoma (see the ODWC letter in Appendix A). The Corps' failure to act on information provided from studies that they have funded or conducted brings up serious questions about intentions to avoid or mitigate for adverse effects to natural resources (such as Se accumulations) during the life of the proposed WRB Project.

15. Several studies be conducted prior to construction to determine the full environmental impacts of the WRB Project. These studies should, at a minimum, include:

    A. Faunal survey of saline seeps and springs, focusing on the identification of any unique spring inhabitants (information on fish, reptiles and amphibians, and aquatic invertebrates, including mollusks, in the affected tributaries and Wichita River mainstem would be valuable but not essential). Although the habitat characteristics suitable for Hemigrapsus estellinensis may not be present at any of the other springs, there may be other rare, unique, or unrecorded species which inhabit these areas. Strong evidence indicates that the RRCC Project has caused the extinction of two spring inhabitants and the Service believes that thorough searches of the remaining seeps and springs should be conducted to prevent the occurrence of such an event elsewhere.

B. Monitoring of nutrients and pesticides in the irrigation return water, Wichita River and Red River.

C. Instream flow study to more fully evaluate the impact of reduced flows on aquatic organisms and riparian habitat, with emphasis on the upper Wichita River. Where possible, the study should determine impacts of extended low-flow conditions on the distribution and abundance of aquatic organisms and vegetation encroachment in the channel.

D. Monitoring of salinity, turbidity, and productivity at Lake Texoma.

E. Siltation and water storage capacity study at Lake Kemp and Lake Diversion for the life of the WRB Project. The study would estimate a time frame for secure water supplies for the Dundee State Fish Hatchery.

SUMMARY AND POSITION OF NATURAL RESOURCE AGENCIES

WRB Project-related alterations in stream hydrology, morphology, and riparian vegetative characteristics are expected due to predicted flow and sediment diversions, water quality changes, increased consumptive water use, and vegetative encroachment along affected stream segments. Changes in stream water chemistry, coupled with anticipated increased water withdrawals, would alter the aquatic ecosystem, reducing the diversity and abundance of native aquatic species in the Wichita River and affected tributaries. Increased turbidity due to reduced chloride levels could reduce productivity and impact popular fisheries at Lakes Kemp, Diversion, and Texoma. Completion of control structures at Areas VII, VIII, and X have and are anticipated to result in the destruction of additional mesquite-cedar uplands. Construction of control facilities at these same areas also will adversely modify aquatic habitat and impact the biological communities historically inhabiting these streams.

The primary goal of the U. S. Fish and Wildlife Service, Oklahoma Department of Wildlife Conservation, and Texas Parks and Wildlife Department concerning the WRB Project is that fish and wildlife resources and the habitats upon which they depend be maintained and/or appropriately replaced through balanced project planning and full consideration of long-term impacts. This basic position is supported by language in the Fish and Wildlife Coordination Act, which states that wildlife conservation shall receive equal consideration with other features of water resource development projects. The Fish and Wildlife Coordination Act further requires the Corps to give full consideration to the report and recommendations of the Secretary of the Interior and the State agencies as contained herein.

The Service, TPWD and ODWC recommend that the Project not go forward as formulated in the preferred alternative (Alternative 3). The WRB Project could result in unmitigable and long-term losses to important fish and wildlife habitats, particularly terrestrial and aquatic resources of the Wichita River, and recreational fishing opportunities at Lakes Texoma, Kemp, and Diversion. In addition, the Truscott Brine Storage Reservoir may become a contaminant sink to the detriment of resident and migratory wildlife populations. Proceeding with this WRB Project in light of these adverse environmental impacts would conflict with the spirit and intent of the Fish and Wildlife Coordination Act and the NEPA. The Fish and Wildlife Coordination Act requires equal consideration of fish and wildlife resources, but the proposed WRB Project frequently considers potential impacts to natural resources as insignificant while claiming questionable benefits within that same portion of the Project area. The WRB Project, as presently formulated, does not give equal consideration to fish and wildlife resources. Little effort is made to avoid

impacts and mitigation is minimized while attempting to maximize the economic benefits of the WRB Project. This project appears to take the most expedient route to remove chlorides at great cost to the fish and wildlife resources within the upper Wichita River system. The Natural Resource Agencies would prefer a modified project that combined some of the proposed control measures with other alternatives which would not result in water shortages for the Dundee State Fish Hatchery, reduced flows in the Wichita River, reduced productivity at reservoirs, and the creation of a long-term Se threat to wildlife at Truscott Brine Storage Reservoir. Other alternatives, such as dropping Area VII or X, and adding or returning chlorides below Lake Diversion, could allow most of the WRB Project goals to be achieved and reduce potential impacts and long-term costs. While the impacts of such a modified project to fish and wildlife resources would not be eliminated, they could be much reduced in scope. Any of the proposed alternatives will require mitigation that effectively minimizes the negative effects to the unique aquatic community of the Wichita and Red Rivers. These mitigation measures should be incorporated into an Environmental Operational Plan for the WRB Project

This reevaluation study was not a comprehensive evaluation of potential solutions for water supply demands in the Wichita River Basin. The Corps considered various alternatives by salt source, but all involve collection and then disposal of brines at Truscott Reservoir. Considering the anticipated environmental impacts of the WRB Project, the Service regards this to be less than adequate. The Corps did not reevaluate the feasibility of the entire project, or the existing portion of the WRB Project. Instead they chose to reevaluate only the feasibility of constructing and operating the remainder of the WRB Project. An alternative to close the existing portion of the WRB Project was not considered, and of the alternatives that were considered, the Corps chose the most damaging one. Selecting the most damaging alternative does not indicate any commitment to comply with NEPA or the draft selenium action plan which states that the objective of the plan is to "avoid, minimize, or compensate for (in that order) impacts" resulting from the operation of any feature of the WRB Project. The proposed WRB Project skips avoid and minimize, and provides only partial compensation for impacts. Alternative 3 also has potential to violate State and Federal laws, including state water quality standards, the Migratory Bird Treaty Act and NEPA.

The Natural Resource Agencies recognize that future water supply demands, particularly for water that is cost effective to treat, may exist within the Wichita River Basin. However, the agencies believe other less damaging alternatives are available to utilize water in the Wichita River Basin that have not been adequately considered. In determining the feasibility of alternatives, the Corps fails to incorporate the full costs of constructing the existing WRB Project, impacts to sport fisheries and other fish and wildlife resources, closing the WRB Project, and remediating for a project that potentially will accumulate toxic levels of Se and large quantities of concentrated salts. These costs are unavoidable and most will only continue to increase over the life of the WRB Project. The full costs of mitigating for all aquatic and terrestrial impacts also need to be considered.

These are not one-time costs or impacts. The costs associated with the operation and maintenance of a WRB Project that pumps brines for more than 100 years are considerable, and so are the impacts. The potential impacts and mitigation costs of the proposed WRB Project are long term and are likely to extend beyond the life of the project.

A revised project that utilizes a combination of alternative measures to meet the water needs of the WRB Project area would be more appropriate. Such a revised (reformulated) project could, in our view, provide the water without the extent of impacts to the Wichita and Red Rivers. One component of a revised project could involve blending with other available water sources. The North Texas Municipal Water District has constructed a system that blends Texoma Reservoir water with water from Lake Lavon, Texas, indicating the feasibility of such an approach. The City of Wichita Falls is constructing a desalinization system (reverse osmosis and electrodialysis) to allow it to utilize water from Lake Diversion in its current condition. The proposed WRB Project does not provide any additional water for the City of Wichita Falls; it only reduces the treatment costs. Reclamation of municipal effluents (i.e., return flow reclamation) and construction of more city reservoirs are other options that would not require more than 100 years of Corps involvement and costs.

These other alternatives may not have been feasible or were cost prohibitive at the time the original EIS was prepared. However, such alternatives could be used in conjunction with a reduced WRB Project to provide adequate water with a lesser degree of adverse impacts to the biological community. For example, the Greater Texoma Utility Authority has constructed a desalinization (demineralization) plant to utilize water from Lake Texoma. Likewise, most reservoirs in north-central Texas presently receive varying amounts of treated wastewater effluent. This water becomes a component of water supply. Lake Lavon for instance, receives wastewater effluent from the Wilson Creek wastewater treatment plant. To date, no impacts on the water quality of Lake Lavon have been detected (U.S. Army Corps of Engineers 1993). The North Texas Municipal Water District provides water to their customers from Lake Lavon. Both of these examples indicate the feasibility of such alternatives.

The Corps also has not fully investigated other alternatives such as the one proposed by the Service to return salt to the watershed below Lake Diversion. Some of these alternatives have not been fully investigated, but initially appear to be feasible, and have potential to reduce costs, reduce impacts to the environment, and provide most of the predicted benefits. The impacts of reduced productivity of streams and reservoirs due to reduced salinity and increased turbidity are nearly impossible to mitigate for in-kind. These impacts are unacceptable to the Service without adequate mitigation and would conflict with the Service's mitigation goal of no net loss of in-kind habitat value (resource category 2). The Service and ODWC are opposed to any reductions in productivity and fisheries at Lake Texoma, without acceptable mitigation for these impacts. The Service and TPWD recommend eliminating Area X or VII to reduce low flow impacts, terrestrial impacts, and potential Se-related contamination problems at Truscott Brine Reservoir. The Service will not support any of the proposed alternatives until the Corps has developed mitigation measures that satisfy the Natural Resource Agencies.

The proposed WRB Project is a significant part of the RRCC Project and until the RRCC Project is deauthorized, we will continue to consider all the potential effects of the larger project. It would be inappropriate and a violation of the NEPA to piecemeal the RRCC Project in attempts to avoid addressing associated impacts and conflicts. The Corps' failure to consider the cumulative effects and costs of previously constructed portions of the RRCC Project is a violation of NEPA and is misleading to the public. The Service does not support the RRCC Project and will object to any attempts to implement the RRCC Project in stages.

The Wichita and Red Rivers exhibit naturally elevated levels of chlorides, with the composition, structure and diversity of the aquatic biological community reflecting this influence. From a biological and ecological viewpoint the presence of a high chloride content is important to the continued function of the native aquatic environment of the upper Red River. Water quantity and quality are naturally limited in the project area and manipulations of these aquatic resources should be carefully considered to provide sustainable human uses without long-term damages to the watershed and aquatic biological community.

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APPENDIX A

Comments

on the

April 2002 USFWS
Draft Coordination Act Report
for the
Wichita River Basin Project Reevaluation

DEPARTMENT OF THE ARMY
U.S. ARMY, CORPS OF ENGINEERS, TULSA DISTRICT
1645 SOUTH 101ST EAST AVENUE
TULSA, OKLAHOMA 74128-4609

March 20, 2002

Planning, Environmental, and Regulatory Division
Environmental Analysis and Compliance Branch

Mr. Jerry J. Brabander
Field Supervisor
U.S. Fish and Wildlife Service
222 South Houston, Suite A
Tulsa, OK 74127

Dear Mr. Brabander:

This concerns the Draft Fish and Wildlife Coordination Act Report (DCAR) for the Wichita River Reevaluation project dated February 28, 2002. We have reviewed the DCAR and minor editorial comments and changes are noted on the enclosed copy of the DCAR, enclosure 1. The more significant comments and concerns have been stated and addressed in a formal list of comments, enclosure 2.

New information, enclosure 3, is also provided as a result of recent discussions with your staff about Oklahoma Department of Wildlife Conservation concerns with respect to this projects' potential increases in turbidity at Lake Texoma resulting from decreased dissolved salt concentrations. The new data and analysis should answer the questions with respect to the potential for increases in lake turbidity at both Lakes Texoma and Kemp. After your review of the new information our staff would be available to discuss it with the Service and the resource agencies, if desired.

We appreciate all your efforts in meeting the February 28, 2002 schedule for the DCAR. Our schedule for completing the draft supplement to the final environmental statement for the project is June 2002. To meet this schedule we request a fully coordinated final CAR by April 29, 2002 for inclusion in the supplement and reevaluation report, which will be made available to the public for review and comment. Please provide five (5) hard copies of the final CAR and an electronic copy, if possible.

If you have any questions on our comments please contact Jim Randolph at, 918-669-4396.

Sincerely,

for Larry D. Hogue, P.E.
Chief, Planning, Environmental, and
Regulatory Division

Encl.

March 18, 2002

TULSA DISTRICT COMMENTS ON U.S. FISH AND WILDLIFE SERVICE DRAFT COORDINATION ACT REPORT

Comment 1: Reference to the RRCCP throughout this document is somewhat misleading. Although Area V (Estelline Springs) is constructed and has decreased chloride loadings in the upper Red River by as much as 240 tons per day, the Wichita River Basin Reevaluation of the Authorized Red River Chloride Control Project is limited to Areas VII, VIII, and X and therefore restricted to the Wichita River Basin. The constant references to the "entire RRCC project area" misrepresents the scope of the current reevaluation effort and may be misleading and/or confusing to the public.

Comment 2: Page 5, fourth paragraph. Suggest using the hydrologic reaches developed by H&H Branch to be consistent with the draft supplement to the FES (DSFES). This information can be provided electronically for inclusion in the CAR.

Comment 3: Page 5, first paragraph, sixth line: The WRB project has been operational for approximately 15 years (not 11 as stated) (May 1987 to present).

Comment 4: Page 6, Map. Recommend using the same Figure to be used in the DSFES for consistency. This information can be forwarded electronically for inclusion in the CAR.

Comment 5: Page 7, second paragraph. Suggest using the same numbering system for alternatives that will be presented in the DSFES. A total of twenty-four alternatives were evaluated (twenty-five with No-Action Plan) which includes those recommended by the Service, as shown on the attached list.

Comment 6: Page 8. Terrestrial/Wetland Resources - The last sentence on this page begins "The upper Red River in Tillman and Jackson Counties....." Tillman and Jackson Counties are not within the project area and are upstream of the confluence of the Red and Wichita Rivers. The only impact to the Red River is due to Area V, in operation since 1964.

Comment 7: Page 9, last paragraph. Suggest using Bailey's (1980) description of the ecosystem of the project. It is more up to date than Blair (1950).

Comment 8: Page 11, Second paragraph. The Truscott Lake project office has constructed five freshwater impoundments around the lake. These impoundments have created approximately 200 acres of freshwater habitat. Most are stocked with sport fish species and provide additional fresh water angling opportunities in the area.

Comment 9: Page 11, second paragraph, line 7-9: Justification should be provided as to why waterfowl and shorebird use of Truscott Brine lake would not be a benefit until such

a time when selenium concentrations reach levels that may adversely impact birds (if ever). As described in Tulsa District Se documents (see USACE 2001), as long as trends measured in 1997-1998 monitoring continue, Truscott Lake may provide Se-related benefits to the region by providing a low Se aquatic resource in an area characterized by high Se in surrounding systems. These conditions are clearly described in the Tulsa District's Se monitoring report (USACE 2001), which was provided to the USFWS but never cited in this draft Coordination Act Report.

Comment 10: Page 12, third paragraph. The CAR references a report by Wright (1994) concerning historical trends in water quality at the Gainesville gage on the Red River. Specific statements are made concerning the declining trend in specific conductance from 1979 through 1986, the period prior to Area VIII implementation. Statements are also made concerning the increasing trend of turbidity through the same period. No reference is made concerning flow during this period of record. Without a comparison of flow, these statements concerning water quality are difficult to evaluate. This paragraph should include a discussion of flow or the whole paragraph should be deleted.

Comment 11: Page 12. Aquatic Resources, Lake Texoma. The third paragraph indicates that USGS data analyzed by Wright (1994) observed a 3.5 NTU increase per year in turbidity and a decrease of 200 uS/cm per year at the Red River gage on I-35 near Gainesville, TX (07316000). Concentration, rather than loadings, data was used for this analysis. Because many of the samples utilized in this study were taken at the peak of the hydrograph the subsequent trend analysis performed on specific conductance and turbidity are not correlated to discharge at the gage. An analysis of discharge should accompany this discussion.

Comment 12: Page 12. Water Quality. While the water quality of water flowing from the upper Red River substantially influences the water quality of subsequent downstream reaches its inclusion here is not relevant to the question at hand. The specific inclusion of the lower reaches of the Prairie Dog Town Fork and its associated chloride concentrations (as well as loadings) are not within the project area. The fish and wildlife resources in this stream reach are not impacted directly or indirectly by chloride control efforts and chloride control in the Prairie Dog Town Fork is not within the scope of the Wichita River Basin Reevaluation.

Comment 13: Page12, third paragraph, and last 3 sentences. If conclusions are to be drawn from this information, some brief explanation of the methods used to derive these results should be given.

Comment 14: Page 13. Aquatic Resources, Upper Red River. Paragraph beginning "Aquatic communities in the upper Red River....". While it is understood that by its very nature the Wichita River Basin falls within the general area of the "upper Red River" this reevaluation of the authorized Red River Chloride Control Project is, excluding Area V, totally contained within the Wichita River Basin. While it is important from a scientific standpoint to document and understand the species richness and diversity within the upper Red River Basin, the impacts to fish species richness and diversity resulting from

the proposed project should be evaluated within the scope of the proposed project and not extrapolated to other areas of the "upper Red River Basin" that fall well outside (and upstream of) the project boundaries. Within the Wichita River Basin, 70 species were identified as occurring historically (Wilde et al., 1996). Only 45 species were present in a 1999 survey of the basin with 21 species present at a relative abundance of greater than 1% (Gelwick et al., 2000). Of the native cyprinid species 8 of 16 have been extirpated from the basin and 3 species have shown declines in relative abundance since the 1950's (Wilde et al., 1996). The most detrimental impacts to the fish community within the basin are a result of the segmentation of the basin by Lakes Kemp and Diversion with movement of fish between the upper and lower portions of the basin virtually non-existent since the impoundment of Lake Kemp in 1924.

Comment 15: On page 13, last paragraph; the primary salinity range of 10,000 mg/l to a maximum of 110,000 mg/l is stated. On page 15, third paragraph, last sentence, states an out of context and incomplete conclusion concerning pupfish populations in various reaches and fails to mention the limited variability among with-project projections and very limited variability in contrast to the without-project projection condition. Of note for this comment though, the discussion also fails to reflect on the actual sample locations and related salinity in those sample locations or the general river reaches and related salinities in contrast to the primary salinity range of Red River pupfish.

Comment 16: Page 13, third paragraph. The next to the last sentence should read "The area is the source of 491 tons per day" as stated in the Concentration Duration and Low Flow Analysis Report, page 17.

Comment 17: Page 14. Aquatic Resources, Upper Red River. Paragraph beginning "Fish communities in the vicinity of the salt sources have not been specifically documented....." is incorrect. While the data do not allow for an intense analysis of the community as a whole, the assemblage of the Wichita River Basin has been examined and documented by Gelwick et al. (2000). This study examined the spatial distribution of fishes throughout the basin with the attempt to relate distribution to environmental factors and "salinity" gradients. The results of the environmental gradient analysis were mixed due in part to environmental conditions present at the time of sampling.

Comment 18: Page 15. Aquatic Resources, Upper Red River. Paragraph beginning " The Corps contracted the Texas Agriculture Experiment Station ...." misrepresents the results of the stochastic models of density for Red River pupfish in Reaches 6 through 11. Although the models did predict various rates of decline, the models present the mean plus or minus 1 standard deviation and range between the 5th and the 95th percentile. The range of the plus/minus 1 SD and the 5th and 95th percentile exhibit a great deal of overlaps resulting in no significance being gained. In other words the estimated declines in pupfish densities among the various alternatives analyzed are not significantly different from the without-project (current) conditions.

Comment 19: Page 15, sixth line from bottom. Bird surveys were conducted from 1997-1998 (not 1999 as stated).

Comment 20: Pages 13-15, description of the aquatic resources. No mention is made of the compendium of fish collections for the Upper Red River compiled by Dr. Gene Wilde, Texas Tech University in 1996. This document was produced as a result of the requests from natural resource agencies during the environmental resolution process for the RRCCP. He summarizes noted changes in the fish community structure of the upper Red River and the Wichita River over quite a long period of record. This data provides a most comprehensive evaluation of sampling efforts on the Red and Wichita Rivers and should be referenced and his observations noted. There have been several extirpations for the Wichita River, and several obvious changes in relative abundance of some species. Sixteen cyprinids are native to the Wichita River, but eight have disappeared since the 1950's. Other cyprinids are showing similar declines and may become extirpated.

Comment 21: Page 18, Terrestrial/Wetland Resources. The CAR has spent considerable time and effort describing the growth and spread of salt cedar in the basin. Salt cedar is not a result of the selected plan or any other aspect of this project. Salt cedar has a tolerance for higher salinity and out competes less salt tolerant species. The improved water quality in the Wichita River basin, as a result of the selected plan, combined with selected brush control would appear to have the potential to decrease salt cedar's competitive edge. It would seem that the presence of salt cedar is a without project condition and recommend discussing it as such.

Comment 22: Page 18, Terrestrial/Wetland Resources. The paragraph beginning "Encroachment by salt cedar is detrimental....". While it is agreed that salt cedar can adversely impact stream flow and is generally considered to be of little value to fish and wildlife, the reduction in chloride loading (and subsequently chloride concentration) in the upper Wichita Basin resulting from project implementation could allow for a greater competitive advantage to native plant species such as the willow (*Salix* sp.). However willow also has the same capacity as salt cedar to become established in dense thickets, which could impede flow and increase sedimentation of the streambed. Furthermore, one important aspect of the upper Wichita River Basin is that the riparian corridor was not likely to be comprised of a great number of woody species and the riparian zone was more likely to be that of a typical prairie stream with a riparian zone comprised of mostly grasses similar to the riparian habitat along Oscar Creek. One interesting facet of the study conducted by Gelwick et al. (2000) indicates that in the upper Wichita Basin (Reaches 9, 10, and 11) the presence of salt cedar accounts for 53.6% of the variability in pupfish densities indicating that in the absence of salt cedar pupfish densities in these reaches could be lower than they are currently.

Comment 23: Page 18, last paragraph. It is unclear how described conditions are project-related impacts. Please provide further explanation as to how these conditions would be expected to occur with the project.

Comment 24: Page 19, first full paragraph. Please provide data to support the statement: "The existing portion of the WRB Project took at least 10 years to achieve 20-30 percent reductions at Lake Kemp.".

Comment 25: Page 19, Land Use Changes, first paragraph. Texas A&M University, Texas Agricultural Experiment Station (TAES) completed the agricultural evaluation of the Wichita River Basin project for chloride control based on a reevaluation of assumptions and data used in prior studies completed by Texas A&M. This included consolidating soil types into those used for irrigation or most suitable for irrigation. Based on TAES estimates about 23,000 acres of agricultural land is irrigated in the study area. Some counties have reported increases in irrigation while others have declined. Texas A&M has recognized in their report that the overall decline of about 2,000 acres from 1987 to 1992 for the 13 counties is not connected to water quality, but due to other factors such as urbanization and declining farm incomes. If it were profitable for a farmer to irrigate, the farmer would most likely irrigate. Based on TAES estimates the area under agricultural cover for nine Texas counties in the region has increased 36 percent from 1977 to 1997 using LANDSAT imagery. It is clear that Knox, Wichita, Clay, Archer, and Baylor counties, through which the South Wichita and Wichita Rivers flow, had more land under agriculture in 1997 than in 1977. (TAES, Sept 2000 report)

Also, the basis for achieving full economic benefits after five- years is based on TAES experience with similar types of water quality improvement projects in Texas.

Comment 26: Page 19, Land Use Changes, first paragraph. Brine discharges from an RO plant will occur without or with the project, the major difference is that with the project the concentrations of chlorides flowing into the RO plant are less than without the project. The RO plant does not make brine.

The purpose of the Wichita River basin project is to evaluate the potential benefits and costs of collecting and disposing of chlorides in the Wichita and Red River basins. The overall economic evaluation takes into consideration desalinization by RO and EDR, and blending with other sources of water. The purpose of the economic evaluation is not to develop a water plan for that portion of the State of Texas, or Oklahoma, Arkansas, and Louisiana, that my be affected by the control of chlorides in the Wichita River Basin; however it is to determine if construction should continue in those areas in the Wichita River basin as part of improving water quality for municipal, industrial, and agricultural purposes, in reservoirs that already exist, which may reduce the need to develop new reservoirs in the near future.

Comment 27: Page 19, last complete sentence. Reverse osmosis does not create chloride mass. The total load of suspended and dissolved solids that enter a reverse osmosis plant also leave the plant in product and waste streams. The load is neither increased nor decreased by the plant. In the case of the proposed Wichita Falls treatment plant the load of suspended and dissolved solids that enter the plant will be a small portion of the total load of the Wichita River (irrespective of withdrawal from Lake Kemp or Lake Diversion). The load that leaves the plant is then returned to the Wichita

River and is the same composition and relatively (due to losses during municipal use) the same load that was removed from the Wichita River. Therefore, your statement that, "Discharges of chlorides into the Wichita River from the Wichita Falls reverse osmosis treatment plant may make chloride reductions in the Red River less than 10 percent" may require reconsideration.

Comment 28: Page 19. Land Use Changes, last paragraph. When taking into consideration the wastewater outfall of the City of Wichita Falls RO treatment plant it is important to note that the total daily load of TDS in the Wichita River will not decrease due to the fact that the irrigation channel and RO plant both will discharge into the Wichita River. The increase would be in the concentration of TDS in the stream reach below the RO discharge. The majority of the chloride reduction will have already taken place at Areas VII, VIII, and X and TDS removed through the RO process are going to be discharged back into the system.

Comment 29: Page 20, Brush Control. The actual zero flow days monitored and the predicted number of zero flow days was calculated by reach for Reaches 9, 10, and 11. The CAR does not indicate which reach is being referenced in this paragraph. Second, there is no mention of the period of record (POR). The POR is important in assessing the percent increase in the number of zero flow days for the POR 1 October 1966 through 30 September 1998 (13505 days) for Reaches 10 and 11. The POR for Reach 9 was December 1959 through September 1979 (7604) days The 614 days of zero flow is incorrect. Under the original calculations the number of zero flow days was predicted to by 1131 days out of 13505 with all areas constructed and no brush management. Because the State of Texas is to implement brush management the without-project conditions were changed to reflect this basin-wide activity. Over this period of record the actual number of zero flow days was 2 out of 13505 days. Under with-project conditions and the conservative 27.6% watershed yield with 50% brush management the number of zero flow days would increase from 2 days, or 0.01% of the time, to 315 days, or 2.3% of the time. Brush management is slated to occur in the Wichita River Basin with or without USACE involvement. The TD is not utilizing brush management as mitigation for reduced flow, brush management activities will occur as part of the State of Texas Water Plan and as a result represents **without-project conditions**.

Comment 30: Page 20, paragraph 2, next to last line. The CAR states the percent change in zero flow days at the Truscott gage is 306%. Please check your percent calculations.

Comment 31: Page 20, first partial paragraph. Please provide contact names (cited as personal communication) at Oklahoma State University and the NRCS and methods that were used to form conclusions stated in this paragraph. These conclusions can then be evaluated.

Comment 32: Page 21, second full paragraph. In addition to the recognized reduction in sediment loads, a reduction in downstream selenium load can also be added to this

paragraph as another result of project operation. These benefits should be recognized in a balanced assessment of impacts.

Comment 33: Page 21, Nutrients and Contaminants. N: P under without-project conditions could increase. However, the prediction that the increased N: P ratio could lead to golden algae blooms is arguable and several published studies detailing the effects nitrogen and phosphorus concentrations on golden algae densities are mixed

Comment 34: Page 21, Nutrients and Contaminants. Paragraph beginning "The WRB Project also would result in minor alterations.....". Basically it appears that the USFWS is discussing sediment transport in the upper reaches of the Wichita River Basin, primarily Reaches 9, 10, and 11. In these reaches any sediment transported from the upper reaches is eventually deposited in Lake Kemp. While the loss of sediment transport could alter channel morphology in Reaches 9, 10, and 11 the 10 percent reduction in alluvial material currently being transported to Lake Kemp could likely increase the functional life-span of the reservoir as well and buffer the fish community of the reservoir from loss of thermal refugia resulting from volume loss do to sedimentation. Changes that might occur in channel morphology due to head scour resulting from a decrease in sediment transport could have the potential to increase bank destabilization and errodibility in the short term but this risk is considered to be slight. Over the long term the channel would be stabilized based on the reduced rates of sediment transport at some point in the future and the system would become "stable".

Comment 35: Page 22, first full paragraph. It should be noted that evaluations for Truscott Brine Lake cited in the earliest Tulsa District Se report (cited as U.S. Army Corps of Engineers 1993b) were based on very limited data for this system and were updated following presentation of additional data in subsequent reports.

Comment 36: Page 22, second full paragraph last sentence. The word "becomes" should be changed to "may become" or "may potentially become". The level of concern is related to concentrations in environmental media.

Comment 37: Page. 22, third full paragraph last sentence. "Expected impacts would be expressed as reduced survival embryos and deformities in chicks." This could more appropriately be stated as "Potential impacts could be expressed as reduced survival of embryos and deformities in chicks." This more accurately reflects the uncertainties involved.

Comment 38: Page. 22, fourth full paragraph, last sentence. Information substantiating nesting of "shorebirds" around the reservoir (presumably Truscott Lake?) should be presented. These birds were not noted nesting around Truscott Lake during intensive breeding bird surveys conducted in 1997 to 1998.

Comment 39: Page 22, fifth full paragraph. Exposure (alone) to Se does not facilitate reproductive impairment to birds or other organisms, as impacts are concentration-dependent. Information requested on "background" levels for the area was provided in

the Tulsa District's monitoring report (USACE 2001), which was provided to the USFWS but never cited in this draft Coordination Act Report.

Comment 40: Page 22, paragraph beginning "Aquatic organisms...", ends with the statement that, "Expected impacts would be expressed as reduced survival embryos and deformities in chicks" would lead readers to believe this is an inevitable site specific conclusion of scientific study related to Truscott Brine Disposal Reservoir, when, in fact, that is not the case. Generalized statements of selenium and selenium impacts should be carefully titled and segregated from site specific findings, conclusions, and, especially, speculation (in regard to this paragraph and throughout the selenium discussion and all other discussions).

Comment 41: Page. 23, first partial paragraph. As noted in the cited Tulsa District report (cited as U.S. Army Corps of Engineers 2000) the 2 ug/l threshold values has been developed for protection of "fish and wildlife" and is therefore not restricted to birds. In fact, thorough evaluation of the literature used to develop these thresholds reveals that the lower end may be based on protection of salmonid (e.g., trout, salmon) and centrarchid (sunfish) fish species and not birds. While this is certainly a valid approach for overall criteria which can be applied to all systems, conservative uncertainties are involved when these criteria are applied to a specific system (e.g., a brine lake) and a given group of organisms (e.g., birds). As also noted in Tulsa District reports, this lower threshold is based on dissolved Se concentration and total concentrations (used in Tulsa District analyses) corresponding to these levels might be higher. When these factors are considered and combined with a conservative modeling approach, use of this lower threshold value might be considered as "ultraconservative" for Truscott Lake evaluations (as stated in the report). A discussion of this conservative approach and degree of uncertainty is provided in the report but not recognized in Se-related discussion in the draft Coordination Act Report.

Comment 42: Page. 23, first partial paragraph. Phrases such as "would result" and "are predicted" would be more appropriately expressed as "could potentially result" and "could potentially reach" as these predictions express potential concentrations under a conservative set of assumptions and not definitive impacts, as implied. In addition, tables and plans cited to be found in Appendix F could not be found.

Comment 43: Page. 23, first (only) full paragraph. Most of the discussion in this paragraph is quoted directly from Tulsa District reports on the Se issue. The third sentence reads: "Accordingly, the potential for impacts on breeding birds is the highest of all evaluated alternatives." The original sentence in the Tulsa District report reads: "Accordingly, the potential for impacts on breeding birds might still be relatively low for this alternative and limited to sensitive to moderately-sensitive avian species but is the highest of all evaluated alternatives." It is requested that the full information provided in these reports be presented in a balanced assessment of this issue.

Comment 44: Bottom of page 23, top of page 24. As previously requested, the degree of conservatism and uncertainty associated with potential impacts should be factored into

these conclusions. These considerations are thoroughly discussed in Tulsa District reports on this topic.

Comment 45: Page 24, first full paragraph. Both the Se monitoring plan and Se action plan are intentionally "very preliminary". The intent is to allow panel members, as a team, to collectively design monitoring and action activities for a balanced approach to this issue. This degree of multi-agency input is seen as an advantage to this process.

Comment 46: Page 24, second and third full paragraph. Complex issues preventing definitive selection of alternatives (should they ever be necessary) for avoiding Se-related impacts have been thoroughly discussed with the USFWS and are summarized in Section 4 of the draft Selenium Action Plan (included as Appendix F of the draft Coordination Act Report). These issues should be included in this discussion.

Comment 47: Page 24, first, partial paragraph, the reference to "criteria ... established to protect ... human health..." could easily be misinterpreted by a general reader. While the alluded Texas water quality standards do also deal with human health, it should be made clear that there are no human health issues related to the Truscott Brine Disposal Reservoir or any feature of the chloride control project.

Comment 48: General comment on selenium-related issues: The Tulsa District conducted extensive Se monitoring and bird surveys over a two-year period (1997 – 1998) at Truscott Brine Lake and brine collection facilities. The results, which shed considerable light on Se dynamics and bird use under current project conditions, were presented in a monitoring report (USACE 2001), which was provided to the USFWS. Results of this effort are never mentioned in this draft Coordination report but would provide valuable information on the Se issue for the reader. Please consider including results of this effort in Se-related discussion in future revision of the Coordination Act Report for the project.

Comment 49: Page 26, paragraph 2. The increased irrigation withdrawals predicted by TAMU were used in the low flow modeling for Reaches 5 and 6. The low flow modeling results indicate there will be no change in flow in these reaches even with increased irrigation withdrawals. Please review the data presented in the COE Concentration Duration and Low Flow Analysis Report on page 9, Table 6. While this statement would be applicable to some reaches, not all reaches are impacted in such a manner.

Comment 50: Page 26, first full paragraph, it is unclear if this is paragraph is intended to relate to project impacts or is a general discussion of cause and effect related to stream flow impacts on biota.

Comment 51: Page 26, last full paragraph, the first sentence while generally correct, overstates the extent of reduced flows and disregards the diminishing effect of reduced flows with increasing downstream distance. The statement later in the paragraph that references "... tributaries of the Wichita River" is imprecise and can be construed to

mean more tributaries than only the affected segments of the North, Middle and South Forks

Comment 52: Page 27, paragraph 1. Based on data presented in the COE Concentration Duration Analysis Report, there is only an increase of five zero flow days below the confluence of the North and South Fork of the Wichita River. Please review Table 7 on page 10 of the report. This section should also note that this data is for a 37-year period of record.

Comment 53: Page 27. Reduced Flows. This comment addresses the confusion concerning water availability to the Dundee State Fish Hatchery and the predicted frequency of water unavailability. The regional drought contingency plan has various water release rates for irrigation, municipal, industrial, recreation, and fish and wildlife uses when implemented. When the Lake Kemp elevation reaches 1123 ft msl, water releases for fish and wildlife and recreation purposes are halted and a 50% reduction in irrigation releases occurs with 100% releases maintained for municipal and industrial uses. The drought contingency plan for Lake Kemp maintains releases for municipal and industrial uses under the various contingencies outlined in this drought contingency plan. The elevation projections provided to the Service by the TD do predict an increase in the frequency of elevations in Lake Kemp of 1123 ft or lower, however the TPWD Dundee Fish Hatchery is allocated water from the municipal and industrial allotment and not the recreation and fish and wildlife allotment (Jimmy Banks, personal communication, November 2001). Water allocation for the hatchery is important to this discussion because water releases from Lake Kemp, for fish and wildlife purposes, are discontinued under the current contractual agreement when the lake reaches an elevation of 1123 feet above mean sea level. More critical to the hatchery is the maintaining of elevations above 1049 and 1047 feet above mean sea level in Lake Diversion. At elevations below 1049 feet above mean sea level the hatchery looses the ability to make withdrawals from Lake Diversion through the 30-inch siphon. At elevations below 1047 feet above mean sea level the hatchery loses the ability to make withdrawals through the 14-inch stem pipe at which point the physical water supply available to the hatchery is discontinued. Because of the agreements in place between the Water Improvement District and TPWD, it is our view that water supply to the Dundee Hatchery is not an issue of availability but rather a contractual issue between the primary parties.

Comment 54: Page 27 - 28. The statement that implementation of the preferred alternative will result in Lake Kemp dropping below 1123 ft msl about 40% of the time is incorrect. This issue has been repeatedly addressed with the correct information provided to resource agencies via numerous conversations and a letter dated November 30, 2001. The correct information is contained in Table 19, page 24 of the Concentration/Duration and Low Flow analysis report (USACE 2001), which was provided to the resource agencies in December 2001. Please use this information in future CAR revisions. The USACE will be happy to discuss this issue further if confusion still exists.

Comment 55: Page 27, first full paragraph, the reference to lake level fluctuations in Lake Diversion is not correct. Lake Diversion's level is maintained by the Wichita

County Water Improvement District No. 2 within a two foot elevation zone to facilitate the Dundee Hatchery water withdrawal facility limitations. The reference to increased water demand at Lake Diversion and sport fishery and recreation impacts are not correct. Lake Diversion cannot be effectively operated (raised or lowered to capture local runoff) to produce water supply yield due to the Hatchery intake limitations and therefore has little or no yield producing effect. Discussion of impacts to the Dundee Hatchery water are misrepresented by the omission of discussion of the state water plan, drought contingency plan, the contract for free water to the hatchery (between the hatchery, the water improvement district, and the City of Wichita Falls), the amount of water under contract related to the total water supply storage available in Lake Kemp, the fact that the chloride control project does not reduce the availability of water supply or impose physical limitations, that sufficient water supply is available in Lake Kemp, or that the state brush management plan proposed by the Red River Authority for the Wichita River Basin would add several times the yield under contract for the hatchery. Further, the statement here (and four other locations noted within the DCAR) implying the chloride control project would "...cut off water to the hatchery about 40 percent of the time" has been corrected by the Corps in numerous coordination meetings, phone conversations, and by letter. While a potential to impact the drought contingency condition was identified as part of the Corps evaluations, it is an avoidable issue if parties to the contract are willing to negotiate. Continued use of the 40 percent figure and presentation of the idea that the chloride control project will cut off water to the hatchery is incorrect and should be corrected in future revisions of the CAR.

Comment 56: Page 27, the paragraph starting with Prymnesium parvum, may be very misleading to most readers. A reader may infer that project "reduced flows" could increase P. parvum problems at the hatchery. Reduced flows in the upper Wichita Basin are not relevant to the hatchery. Similarly, a reader may infer that increased nutrient level may cause hatchery problems. The project may potentially increase nutrient levels in reaches downstream of the hatchery and downstream of the hatchery's source of water (Lake Kemp), however, the occurrence of a P. Parvum bloom in the Wichita River may be significantly different than the documented blooms in Lake Kemp and the hatchery.

Comment 57: Page 28, paragraph 2. This paragraph is using the same incorrect data (40% figure) referenced in previous comments.

Comment 58: Page 28, second full paragraph. Please provide justification for the definitive statement that "Blooms of Prymnesium parvum would be expected . . . ." It would seem that there is considerable uncertainty for this issue.

Comment 59: Page 28, second full paragraph, the discussion fails to mention that low and no flow conditions naturally occur in a much larger number of smaller tributaries in the upper Wichita River Basin and that blooms may occur there as well. The statement that "Blooms ... would be expected if accidental spillway releases of highly concentrated brine water from the brine storage reservoirs occurred following the probable maximum flood... in which the structures failed to contain stored brines." Needs justifying explanation. The term "accidental spillway releases" has no meaning for the Truscott

Brine Storage Reservoir. The spillway (a broad section of earth) is a high level, uncontrolled, emergency feature designed to assure the safety of the embankment. There can be no single accidental release, let alone two or more "releases". The plural "reservoirs" occurs twice in the statement. There is only one (1) brine storage reservoir. The assumption that the release would contain brine, let alone highly concentrated brine, following a 100-year flood, on top of a maximum brine pool, plus additional rainfall (to just begin to flow over the spillway) is speculative, at best. There is potentially less speculative support for the assumption that the less dense (lighter) fresh water would fill above the more dense (heavier) concentrated brine and therefore the flow across the spillway would be relatively fresh water. Lastly, the concept of an algae bloom occurring in the midst of a disastrous regional flood event would seem unlikely and at such a time might seem of little concern to those dealing with the record flood event. Comments about P. parvum from the previous page apply to the last sentence of this paragraph.

Comment 60: Page 29, first full paragraph. Please provide justification for the definitive statement: "Where contaminants such as these enter the river, fish populations would be adversely affected." It would seem that these impacts would be concentration-dependent and that there is considerable uncertainty as to what these concentrations might be.

Comment 61: On page 29, the paragraph beginning "The WRB..." refers to "brine lakes". Better terms would be, low flow dams, collection facilities, brine collection areas, and brine collection pools.

Comment 62: Page 30, first partial paragraph at top of page. This paragraph gives the impression that the Wichita River system is a unique ecosystem. It should be noted that it has already been severely altered by construction of Lakes Kemp and Diversion and the Area VIII collection system and Truscott Lake. The data presented by Wilde (1996) portrays these impacts to the fish community and should be referenced here.

Comment 63: Page 30, second full paragraph, this paragraph typifies a recurring writing style in the D CAR in which a basic premise is stated and from that point on in the paragraph the premise is treated as fact. For example, the first sentence contains the phrase, "...the river MAY [emphasis added] become more turbid". But in the next sentence, the premise has been lost and the statement is, "... a reduction in productivity WOULD [emphasis added] occur in the Wichita River. Later, "...primary productivity WILL be affected...". Writing these sections from an objective point of view would result in less biased reader opinions.

Comment 64: Page 30-31, Lake Texoma. With reference to the paragraphs discussing the effects of salinity on larval striped bass survival. The areas of Lake Texoma where larval fish are most likely to be encountered (the Red and Washita River arms) are areas where salinity averages 0.6 to 0.8 ppt. Since recruitment to the striped bass fishery in Lake Texoma appears to be quite good, this would indicate that the projected reductions in salinities in the Wichita River Basin are not likely to impact survival rates of larval

striped bass at the Dundee Hatchery since they do not appear to affect survival rates in Lake Texoma.

Comment 65: Pages 30-32 (Impacts to Lake Texoma). A large portion of the information presented in this section is conceivable, but speculative in terms of definitive impacts. Statements that the project "would undoubtedly have serious adverse biological consequences on the Texoma Reservoir fishery and the anglers who utilize this fishery" are based on compounding assumptions at multiple levels that may or may not hold true for the reservoir, its productivity, and its fishery. As this has only recently surfaced as a major issue with resource agencies for the Wichita River Basin Chloride Project (as it was for the original RRCCP) the Tulsa District has recently evaluated means of more clearly defining turbidity-related impacts. A copy of this analysis is attached (enclosure 3). The analysis, based on site-specific settling data, indicates **extremely minor** (if even measurable) increases in turbidity in Lake Texoma or the Red River above the lake. Accordingly, no turbidity-related impacts are anticipated. Results of these new analyses should be included in future revisions of the CAR.

Comment 66: On page 32, second paragraph. General. The Texoma recreation change issue in not relevant to the discussion of the project impacts. From our data on water quality of Texoma, there is no projected measurable change in the recreation resource at Texoma related to the project.

Specific: There is no indication that the Wichita Basin project would significantly impact sport fish harvest at Lake Texoma. The cited studies addressed recreation related expenditures not the "overall value of the Lake Texoma fishery". The study only addressed expenditures associated with recreation, a portion of which would occur in the local economy with or without the fishery. The inferred linkages of the project to any change in the sport fishery then to sport angler use of Texoma then further to sport angler expenditures, is not support by the study data or in theory. The last sentence in the paragraph implies that the Amera et al study made assumption about linear relationship between fish harvest and angler expenditures, when no such assumption was implicitly or explicitly expressed in the study. Directly linear application to a "2-3" percent reduction in harvest to a 2-3 percent decline expenditures is an unsound application of the study findings.

Comment 67: Page 35, first and second paragraphs. This is not a true depiction of the Wichita River. The system is already modified with construction and operation of Lakes Diversion and Kemp. Suggest using data from (Wilde 1996), which describes this condition and impacts, which have occurred or are occurring to the fish community of the Wichita River.

Comment 68: Page 43, second paragraph. The Service states the Lake Kemp/Diversion sport fisheries will be impacted by reduced inflows and increased reservoir fluctuations. Studies indicate that inflows into Lake Kemp (with brush management) would not be significantly decreased by the selected plan. When looking at the period of record zero flow days would only be decreased by a very small percentage of time.

Comment 69: Page 43, third paragraph. As a point of clarification, the study by Gade et al. (1992) did not evaluate reductions in sport fish abundance (as stated in the CAR). Rather, sport fish harvest by anglers was evaluated.

Draft Selenium Monitoring Plan

Comment 70: the Se Action Plan panel would ultimately establish monitoring frequencies. The USACE would be amenable to frequencies agreed upon by the panel following a review of existing data. Please note that monthly water sampling for Se at brine source areas (Areas VII, VIII, X) was initiated by the USGS (under contract to the USACE) in the fall of 1996 and has continued to date. One of the purposes of this sampling is to determine variability in Se concentrations in source brines as noted in this comment.

Draft Selenium Action Plan

Comment 71: See previous comment 43 regarding evaluation of potential risks discussed on p. 23 of the draft CAR. The USACE knows of no other way to evaluate these issues than to use existing data that have been generated as a result of study activities. Conclusions are based on information collected to date and may change as additional data become available.

Plan Objectives

Comment 72: A good point is made in the second paragraph of this comment. Accordingly, an option of operational changes, including discontinued pumping from one or more areas or ultimate discontinuation of the project will be added to the list of potential options in the Action Plan.

Action Plan Process

Comment 73: Adding USGS to panel composition, should they chose to participate, is a good suggestion. This agency will therefore been added to panel composition in the plan. As noted in the plan, panel recommendations would be based on panel consensus and recommendations would be forwarded to USACE for consideration in project operations. As this is a USACE project, the USACE would retain ultimate decision-making for the project.

Potential Remedial Measures

Comment 74: Note that the authorized purpose for Truscott Brine Lake is brine disposal. Additionally, the loss of terrestrial habitat to be inundated (or already inundated in the case of standing trees, etc) by Truscott Lake has already been mitigated for at the USACE Crowell property. It is therefore unclear why removing this habitat would require additional mitigation. Rationale for this comment should be provided.

U.S. Fish and Wildlife Service Response to Tulsa District Corps of Engineers' Comments on the Draft Fish and Wildlife Coordination Act Report for the Wichita River Basin Project Reevaluation

Comment 1: The Service does not consider references to the RRCCP in the Draft Coordination Act Report inappropriate or misleading. However, we will attempt to clarify any impacts that are not related to the WRB Project. The proposed Project is a significant part of the RRCCP and until the RRCCP is deauthorized, we will continue to consider all the potential effects of the larger project. It would be inappropriate and a violation of the NEPA to piecemeal the RRCCP in attempts to avoid addressing impacts and conflicts associated with the project. The Corps' failure to consider the cumulative effects and costs of previously constructed portions of the RRCCP is a violation of NEPA and is misleading to the public. The Natural Resource Agencies do not support the RRCCP and will object to any attempts to implement the RRCCP in stages. If the Corps has plans to implement the remainder of the RRCCP, it would be the Corps that is misleading or confusing the public by proposing the project in increments and failing to consider the full extent of cumulative effects.

Comment 2: Yes we agree to use hydrologic reaches consistent with the Corps draft supplement to the FES (DSFES) and have requested this electronic information.

Comment 3: We agree to correct this error.

Comment 4: The existing map provides the same information and does not require two figures to provide information on hydrologic reaches and project features.

Comment 5: We agree to provide the equivalent Corps numbers for alternatives. There was no attached list with this information.

Comment 6: The Corps has not provided mitigation for impacts of the existing portions of the RRCCP and we are evaluating the combined impacts of the existing and proposed projects. See our response to Comment 1. The Natural Resource Agencies do not agree that the only impact to the Red River is due to Area V. The Corps has acknowledged that salinity will be reduced and turbidity will be increased in the Red River by the proposed project. These types of changes can affect aquatic species composition, abundance and diversity, as well as water quality.

Comment 7: We agree to incorporate Bailey's description.

Comment 8: We will add this information to the Report. Please provide a map or aerial photographs that show the locations of these impoundments. We recommend that these impoundments and the fish in them be monitored for selenium. Impoundments in this area can accumulate selenium and fish within them could become a health risk to people and wildlife that consume them.

Comment 9: If the Corps will propose to operate the WRB Project so selenium concentrations never meet or exceed the lowest threshold levels for impacts to wildlife, the project may benefit

waterfowl and shorebirds. However, if the project provides habitat that later becomes toxic, we cannot consider that a benefit unless the Corps is going to restore or replace that habitat and avoid all toxic effects to wildlife. Attracting more waterfowl and shorebirds to an area that is surrounded by high selenium waters may not be beneficial and could a violation of the Migratory Bird Treaty Act. Many migratory birds exhibit site fidelity and consistently return to the same general areas to nest. Habitat created by the Corps at Truscott Reservoir could lure birds to a toxic site if selenium concentrations at the reservoir become toxic, or if birds attracted to Truscott Reservoir feed at nearby toxic sites.

Comment 10: We agree to modify or eliminate this paragraph.

Comment 11: See response for comment 10.

Comment 12: Area V is on the Prairie Dog Town Fork and is part of the RRCCP. This is background information and the Draft Report does not claim that this area will be affected by projects in the Wichita River Basin. See responses to comments 1 and 6.

Comment 13: See response for comment 10.

Comment 14: The Wichita River is covered in later paragraphs and we will incorporate some of the information you have provided in this comment. However, your comments are not entirely accurate. Only 43 species were documented in the Wichita River by Wilde et. al., (1996). The 70 species were in the Upper Red River. A total of eight species have been extirpated, however, there were only 15 native cyprinids and seven of those have been extirpated. Also see responses to comments 1 and 6.

Comment 15: We will clarify the salinity range for pupfish, because they do occur in waters with lower salinity than the primary range given in the Draft Report. We do not agree with the remainder of this comment. If we included all the information described in this comment, we might as well include the entire referenced report (Gelwick et.al. 2000). Due to the severe drought during this study, sample locations and in some cases the presence of pupfish were probably more closely related to the presence of water than they were to salinities or other factors.

Comment 16: We will make this correction.

Comment 17: We agree and will make this correction.

Comment 18: We will clarify our statement, but we do not agree with this comment. The Draft Report does not claim that the predicted declines in pupfish densities are statistically significant. If the Corps wants to limit information used in this WRB Project re-evaluation to those statistically significant with 95 percent confidence intervals, then much of the data supplied by the Corps would not be usable. For example, none of the Corps studies have been able to show statistically significant chloride reductions at Lake Kemp due to operations of the existing portion of the WRB Project. Yet, after 15 years of operation with no statistically significant

evidence that the project is effective, the Corps proposes to continue operating this portion of the Project with or without implementation of any of the alternatives.

Comment 19: We will make this correction.

Comment 20: We will add this information.

Comment 21: We will clarify information on salt cedar. The Service recommends including salt cedar control in the Corps' proposed actions.

Comment 22: We agree with most of this comment, but willows have not been known to dominate the riparian zones in this watershed like salt cedar and willows provide more habitat value to native species. While salt cedar may provide some shade and habitat value for pupfish, the correlation of salt cedar and pupfish densities is probably more closely related to salinity.

Comment 23: We will clarify this information, although we do not directly claim that these are project-related effects. Project-related reduced flows could allow further encroachment of salt cedar.

Comment 24: We will correct this statement to reflect no significant change in five years and cite the 1995 USGS study.

Comment 25: The Corps assumptions and economic justification for expansion of irrigated agriculture are difficult to understand. According to this comment, total agriculture has increased, but irrigated agriculture in the project area has declined despite chloride reductions at Lake Kemp (assumed to be due to existing operations of the WRB Project). These reductions in irrigated agriculture are assumed to be unrelated to water quality. If these factors that caused the reductions in irrigated agriculture are still present, then additional chloride reductions may have little effect. After 15 years of operating the existing chloride removal project, irrigated agriculture has declined, yet the Corps predicts irrigated agriculture will increase by more than 43,000 acres within five years if the preferred alternative is implemented. Does the Corps consider this realistic? How could the "similar types of water quality improvement projects" be any more similar or valid than the existing portion of the WRB Project? Why would you ignore the existing information? If a chloride reduction of 20-30 percent has not induced an increase in irrigated agriculture in15 years, why would we expect a 10 percent reduction in reach 5 to induce farmers to begin irrigation on 18,699 acres of land within five years? We can understand that if chloride levels were further reduced (potentially up to a total of 76 percent), that it may increase irrigated agriculture, but based on the history of this project, the predictions appear very optimistic.

Comment 26: We agree that the RO plant won't make brine and we will clarify this in the Report. The idea that the proposed project will reduce the need to develop new reservoirs is questionable. The City of Wichita Falls has already determined that it is more cost effective to use RO treatment with the existing water quality in Lake Kemp relative to building a new reservoir. The proposed project will reduce their treatment costs, but will not provide any

additional water. Over the life of the WRB Project most existing reservoirs will have filled with sediment and new reservoirs will have to be considered with or without the project.

Comment 27: See response to comment 26.

Comment 28: We agree that the total chloride load in the Wichita River may be relatively unaffected by the RO plant unless the city begins treating water from outside the watershed. However, chloride concentrations returning to the river may be different for water going through the irrigation system relative to water going through a RO plant. Chloride concentrations near the RO plant discharge may be elevated.

Comment 29: We agree that the period of record should be added, but averaging the number of zero flow days over the entire period of record is deceptive and tends to minimize the effects of the WRB Project. If information on zero flow days in the Draft Report is incorrect, it is because the Corps provided incorrect data. The information supplied by the Corps in the December Concentration Duration and Low Flow Analysis (Table 15, page 21) lists 614 days of zero flow with brush control in the North Wichita River basin. Why has this now been reduced to 315? The effect on flows is still serious. Even with brush control, the number of zero flow days is increased from two days in 37 years to 315, or an average of nearly 9 days per year. If the correct number is 614, there will be an average of over 16 days per year with zero flow. In attempts to clarify these conflicting numbers, we have been informed by the Corps that 614 days is correct. We will modify numbers and language in the Report if the Corps provides evidence that existing numbers are incorrect.

We do not agree that brush control is a without-project condition. The State of Texas brush management program is a trial project and funding is not assured, and certainly not for a 100 year period. The Corps is (or was) proposing to fund the landowners share or 25 percent of the brush control in the North Wichita River watershed (below the brine collection areas). If the Corps is claiming the brush management program will reduce project-related low flow impacts and is providing funding for the program, then it should be considered part of the project and funding should be allocated to continue the brush management program if the State of Texas does not continue it. If the Corps is unwilling to do this then additional mitigation for low flow effects needs to be developed. Inclusion in the Region B Water Plan, or in any regional plan for that matter, does not dictate construction of a project. Water plans do not fund construction nor implementation of recommended projects. Regional water plans developed under Senate Bill 1 recommended 17 billion dollars of water development projects throughout the State of Texas. Funding for many of these projects has not been identified. There is no commitment by the state or Corps to fund brush control for the life of the project and no commitment by landowners to participate in the program. With all these uncertainties, we do not consider the Corps position to be reasonable. We will not assume low flow impacts will be moderated by brush management for the life of the project unless the Corps is willing to fund such actions and get commitments from an appropriate number of landowners.

Treatment of a proposed brush control program as a without-project condition tends to minimize chloride control project impacts to stream fish communities (as reflected in low flow impacts

analysis) and the yield of the Lake Kemp and Diversion water system (i.e. lake level elevation duration). The effects of the project on inflow to Lake Kemp and on reservoir elevations is masked by the inclusion of *possible* brush management since the Corps does not provide analysis of project effects (relative to lake elevation durations) without brush control in their Concentration Duration and Low Flow Analysis Report. Indeed, if brush control is not implemented and the preferred alternative is implemented, then inflows to Lake Kemp will be less and the effects on lake levels will be greater than presented by the Corps.

Comment 30: We will recheck the calculations when we are sure we have the right numbers to work with (614 or 315).

Comment 31: We will provide these contacts.

Comment 32: This information will be added.

Comment 33: We did not mention N:P ratios. Our Report suggests that nutrient loading could increase the golden algal blooms. If the studies are mixed then we need more research, but our suggestion may still be true and warrants consideration in the evaluation of potential project impacts.

Comment 34: We understand the Corps comment, but it brings up other questions. Lake Kemp and Lake Diversion are not new reservoirs and the reduced storage capacity (due to sedimentation) of these reservoirs may not allow full proposed benefits towards the end of the 100 year project. Has the Corps factored in the reduced water storage over time?

Comment 35: We cited the updated reports.

Comment 36: We will make this correction.

Comment 37: We will clarify this.

Comment 38: We will clarify this. No shorebirds were found nesting near Truscott Lake in 1997 and 1998, but this is a 100 year project and two years of bird surveys do not rule out the potential for nesting in the future.

Comment 39: We will make this correction and cite your report.

Comment 40: We will clarify this.

Comment 41: We will cite your report, but will not go into details about how the Corps Se model was designed. Readers will have to read your reports to get this specific information.

Comment 42: We will clarify this language and make sure all tables are included.

Comment 43: We do not agree with the language in the Corps report. The data the Corps model

is based on, is far too limited and variable to support the Corps claims. We do not consider it a balanced assessment. Readers can read the Corps reports to get the Corps viewpoint.

Comment 44: See Comment 41.

Comment 45: No Comment.

Comment 46: The issues have been discussed at length, but not resolved. The point of this section is that potential actions and their potential costs should be factored into selection of alternatives. The draft Selenium Action Plan is included in Appendix F and the Corps summary can be found there.

Comment 47: The Corps has not provided any information to support this claim that there are no human health issues related to the Project.

Comment 48: Results of monitoring report are mentioned but not cited. We will cite your monitoring report.

Comment 49: This paragraph is under the heading of Upper Wichita River and makes no reference to irrigation withdrawals. Part of this comment is addressed on page 27 of the Draft Report.

Comment 50: It is intended to be both.

Comment 51: We will clarify the tributaries affected.

Comment 52: We will correct this error.

Comment 53: Recent clarification of the hatchery's status correctly identifies TPWD's water right as part of the industrial allocation and not subject to reduction at Lake Kemp elevation 1123 msl (Jimmy Banks, Wichita County Water Improvement District No. 2, pers. comm.). Although TPWD was unable to assess predicted lake levels due to project implementation without brush management, it is absolutely clear that the Corps' preferred alternative with 50% brush management at 27.6% yield shows dramatically lower lake elevations in Lake Kemp (Corps low flow analysis report dated December 2001).

Severe fluctuations in Lake Kemp could impact Lake Diversion and the Dundee Hatchery. Of great concern is the ability to keep Lake Diversion at or near conservation pool (1052 msl) because hatchery intakes are located at 1051 (30" main intake line) and 1047 msl. Relatively small fluctuations in Lake Diversion can create significant differences in the hatchery's physical ability to obtain water. Without a reliable source of water, Dundee State Fish Hatchery cannot fulfill its critical functions.

Comment 54: The confusion appears to be related to the Corps commitment to brush control. See our response to comment 29. The predicted increases in water yields are based on modeling

and actual results may not follow model predictions. In reality the correct information is unknown. We will list impacts to Lake Kemp elevations with and without brush control.

Comment 55: See our response to comments 29, 53, and 54. Also note that TPWD would not have to negotiate if the Project were not implemented.

Comment 56: We will clarify this language. Please see the Sager et al. report provided to the Corps by TPWD.

Comment 57: See our response to comment 54.

Comment 58: We will clarify or delete this.

Comment 59: See our response to comment 58.

Comment 60: We will clarify this statement.

Comment 61: We will make this correction.

Comment 62: The information is for the upper Red River ecosystem, not just the Wichita River. See response to comment 14. The Wichita River is still relatively unique and the uniqueness of native fish populations could be further reduced. The Proposed Project would involve even more of the factors that caused the existing declines such as barriers to fish movement.

Comment 63: We will clarify this language.

Comment 64: Nearly all published literature on this subject indicates larval striped bass survival would be adversely affected by the predicted reductions in salinity in the Wichita and Red Rivers. Without some measurement of survival with and without project effects you cannot make the assumptions made in this comment. You don't know that survival rates are good now or even assuming they are, that they are not reduced from what they could be at higher salinities. Recruitment involves much more than larval survival rates and we strongly suggest we use the best available information or conduct additional research before jumping to such conclusions. The connection between recruitment in Lake Texoma and success at a striped bass production facility is invalid.

Comment 65: The Corps response to concerns about increased turbidity and impacts to productivity and the Red River/Lake Texoma fishery has been to reanalyze data and claim that impacts will be very minor. The predicted losses to the fishery are cumulative over the life of the project and are significant losses. In-kind mitigation for these losses is not possible. The Corps has not proposed to avoid or mitigate for these adverse effects to the fishery and claims the effects are insignificant. The Natural Resource Agencies are offended that the Corps would fund studies that predict impacts and then refuse to alter the project to avoid those impacts or agree to provide any mitigation or compensation for impacts to the states resources. The Corps does not own the fisheries resources that would be impacted. The fish and other aquatic resources are

state resources and the states should determine if the losses are significant. Even minor adverse impacts to state resources should require mitigation or compensation. The Corps continues to miss the point of our comments. We are only claiming minor annual impacts, but the Corps continues to refuse to avoid, mitigate, or compensate the states. At the same time the Corps is claiming benefits from the waters affected and ignoring cumulative adverse effects. We are only asking for equal treatment. If the Corps is going to count minor benefits, then they also should count minor impacts and their costs.

Comment 66: We will attempt to clarify any assumptions in this section. However, we disagree that impacts to the sport fishery and recreation are not relevant. The fact that your data indicates no measurable change is a function of the level of data collection efforts and problems in measuring relatively small changes in biological systems the size and complexity of Lake Texoma. The fact that it is practically impossible or infeasible to measure a 2-3 percent decline in annual fish populations, does not mean that it won't occur. The assumption that sport fish abundance, fish harvest, and angler expenditures are related is no more of a stretch than the Corps assumption that a 10-11 percent reduction in chlorides will have no effect on the fishery in the Red River or Lake Texoma. The uncertainty of projecting the effects of a proposed project of this scale over a 100 year period does not allow anyone to say with any confidence that the sport fish population or harvest will not be significantly impacted. The Corps has acknowledged that salinity will be reduced and turbidity will be increased in the Red River by the proposed project. These types of changes can affect aquatic species composition, abundance and diversity, as well as water quality.

Comment 67: See response to comment 62.

Comment 68: See response to comment 29 and 54. Inflows are only part of the statement. The increase in fluctuations is primarily related to increased withdrawals.

Comment 69: We will correct this error.

Comment 70-73: No comment.

Comment 74: The Corps was given credit for the habitat value remaining at the Truscott brine reservoir site and only terrestrial habitat is being mitigated by the Crowell lands.

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Mr. Jerry J. Brabander
Field Supervisor
U.S. Fish and Wildlife Service
Ecological Services
222 South Houston, Suite A
Tulsa, OK 74127

Dear Mr. Brabander:

The Texas Parks and Wildlife Department (TPWD) has reviewed the draft Fish and Wildlife Coordination Act Report (CAR), dated February 28, 2002, for the U.S. Army Corps of Engineers Wichita River Chloride Control Project. We commend your staff for the excellent job of summarizing the complex issues associated with this large-scale project.

Dropping the Middle Fork component (Area X) from the Corps' preferred alternative as you have suggested would reduce or minimize impacts to fish and wildlife resources (see attached technical comments) while having little effect on project goals because the Middle Fork watershed is relatively small and contributes relatively little chloride to Lake Kemp. We suggest this approach coupled with an adequate Environmental Operational Plan (EOP). The EOP should include the full range of pre-emptive and remedial measures necessary to protect fish and wildlife resources and should contain the Corps' commitment to act upon steering committee recommendations.

The Department is concerned that the implementation of the Corps' preferred alternative would lead to accumulation of selenium at project facilities and pose threats to fish and wildlife resources. With full project implementation, the Corps' own analysis predicts that selenium concentrations at Truscott Brine Lake will exceed State Surface Water Quality Standards chronic criteria for selenium within 30 years and exceed risk thresholds within 5 years. Selecting an alternative that decreases the amount of selenium transported to Truscott Brine Lake will decrease the potential for bioaccumulation of selenium.

The effects of the proposed project on inflow to Lake Kemp and on reservoir elevations are masked by the inclusion of possible brush management as a without-project condition since the Corps does not provide analysis of project effects (relative to lake elevation durations) without brush control in their low flow impacts analysis report. Indeed, if brush control is not implemented and the preferred alternative is, then inflows to Lake Kemp will be less and fluctuations in lake levels will be more severe than presented by the Corps. Treatment of a proposed brush control program as a without-project condition tends to minimize chloride control project impacts to stream fish communities (as reflected in low flow impacts analysis) and could reduce potential mitigation or compensation obligations. Implementation of brush control in the upper Wichita River watershed has not been funded.

The Department is becoming more involved in research regarding control of salt cedar across the state. We recommend that any plans involving salt cedar control should be coordinated with the Texas Invasive Riparian Plants and Water Task Force sponsored by

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the Texas Department of Agriculture to ensure there are no conflicts with this type of research being conducted by any other state or federal agency.

One of the Department's main concerns is related to effects of the project upon the operation of Dundee State Fish Hatchery. This concern did not come to the attention of TPWD until late in 2001 when the Corp released information pertinent to operations. It was only after that notice that TPWD could ascertain the presence and extent of that issue. Recent clarification of the hatchery's status correctly identifies TPWD's water right as part of the industrial allocation and not subject to reduction at Lake Kemp elevation 1123 msl (Jimmy Banks, Wichita County Water Improvement District No. 2, pers. comm.). Although we were unable to assess predicted lake levels due to project implementation without brush management, it is absolutely clear that the Corps' preferred alternative with 50% brush management at 27.6% yield shows dramatically lower lake elevations in Lake Kemp (Corps low flow analysis report dated December 2001).

Severe fluctuations in Lake Kemp will impact Lake Diversion and the Dundee Hatchery. Of great concern is the ability to keep Lake Diversion at or near conservation pool (1052 msl) because hatchery intakes are located at 1051 (30" main intake line) and 1047 msl. Relatively small fluctuations in Lake Diversion can create significant differences in the hatchery's physical ability to obtain water. Without a reliable source of water, Dundee State Fish Hatchery cannot fulfill its critical functions.

Mitigation for impacts to the Dundee State Fish Hatchery's water supply should be in addition to other mitigation. TPWD has been working with local authorities and a viable solution exists that the Corp should consider. Present alternatives suggest relocating the intake for the hatchery, treatment of incoming water to reduce turbidity, and pump back of hatchery effluent to Lake Diversion where it can be reallocated by the water district. Relocating the hatchery intake in Lake Diversion to a minimum elevation of 1043 msl and providing treatment to reduce anticipated increases in turbidity would ensure that the hatchery is able to use water under all foreseeable conditions. Relocating the hatchery intake in conjunction with the pump back alternative would not only ensure continued operation of the Dundee Fish Hatchery, but would provide the water district with additional water and operating flexibility allowing the district to operate and control lake elevations independent of current hatchery water needs.

The Corps should develop cost estimates for accomplishing this alternative collaboratively with TPWD and the district and consider this among issues that need mitigation. If the Corps develops this alternative collaboratively with TPWD, then we will accept the anticipated additional operating expenses as part of the Dundee State Fish Hatchery operations.

TPWD supports the use of Corps land near Crowell, Texas, as mitigation for terrestrial impacts resulting from construction and operation of the project provided the land is managed to meet and maintain approved habitat values. In addition, TPWD is willing to manage the mitigation lands if the Corps provides operation and maintenance funds for that site. As related to mitigation for impacts to aquatic resources and as measures to reduce the risk of species extirpation, TPWD supports creation and maintenance of at least the existing density of perennial pools or an alternative of one perennial pool per mile of stream impacted. TPWD supports creation and maintenance of impoundments to be used for conservation of Red River pupfish populations.

The Corps, in comments on the draft CAR, considers references to the Red River Chloride Control Project (RRCCP) to be somewhat misleading. The proposed project is a significant part of the RRCCP. Until the RRCCP is de-authorized all of the potential effects of the larger project must be considered. It would be inappropriate to propose the project in increments and purposefully fail to consider the full extent of cumulative impacts.

If you have any comments or questions related to the Department's position as outlined above and in the attached technical comments please contact Mr. Kevin Mayes at (512) 754-6844.

Sincerely,

Robert L. Cook
Executive Director

RLC:KBM:ds

TPWD Technical Comments on U.S. Fish and Wildlife Service Draft Coordination Act Report

Selenium Accumulation in Project Facilities

The Department concurs with the Service regarding selenium issues raised on pages 22 through 24 of the draft CAR. According to the Corps models, inclusion of water from any combination of areas VII, VIII, and X will elevate water-borne selenium concentrations in Truscott Reservoir above the risk threshold level of 2 µg/l in no more than 15 years. The Corps' preferred alternative would increase selenium concentrations in Truscott to greater than 2 µg/l within 5 years and selenium concentrations are predicted to exceed State Surface Water Quality Standards chronic criteria (5 µg/l) in 30 years. Risks to sensitive birds are neither slight nor acceptable.

The Corps preferred alternative, transporting brine waters from Areas VII, VIII, and X to Truscott, is the alternative that is expected to maximize selenium concentrations in Truscott. A better way to avoid adverse selenium impacts would be for the Corps to select a less damaging alternative. For example, if brine waters from either Area VII or X were not collected and transported to Truscott, the predicted maximum selenium concentration in Truscott would be less than 5 µg/l. However, projected selenium concentrations would still be above the risk threshold level of 2 µg/l within 15 years.

The potential exists for the Corps to participate in control of selenium sources on the North Fork of the Wichita River, which is on the 303(d) list prepared by the Texas Natural Resource Conservation Commission. There are indications that abandoned copper mines in the North Fork watershed may be sources of additional selenium to the river. If this proves to be a controllable source(s) of selenium, the potential for selenium bioaccumulation to harmful levels in biota could be reduced. A Total Maximum Daily Load (TMDL) study on the North Fork of the Wichita River should be completed by 2006. More information regarding the sources of selenium and potential control strategies will be available by the conclusion of the TMDL process.

The draft selenium action plan (undated), as it exists, is a workable concept, with much potential. However, there is no commitment to implement any findings or recommendations provided by the multi-agency panel. Without a commitment to act upon the panel's findings, the draft proposal does not constitute an "action plan". Measures that propose to eliminate certain levels of food web organisms in order to avoid selenium impacts in higher trophic levels are inappropriate.

The Corps (2001) has suggested that, "as long as trends measured in 1997-1998 continue, Truscott Brine Lake may provide selenium-related benefits to the region by providing a low selenium aquatic resource in an area characterized by high selenium in surrounding systems." The Department believes this statement to be premature, based in part on information presented in paragraph 3, page ii, of the Corps 2001 report, which states,

> "Results of monitoring at Truscott Brine Lake are applicable for the monitoring period only and should not be interpreted to represent current or future conditions. The potential for increasing Se concentrations as the project progresses and complexities involved with Se dynamics are justification for continued monitoring of a variety of environmental media at Truscott Lake. This is particularly true if additional brine sources are added as input to the impoundment."

Wichita River Stream Fish Assemblages

Stream fish assemblages in the Wichita River basin have been severely altered by the presence of Lake Kemp and Diversion Lake and the Area VIII impoundment and diversion on the South Fork Wichita River. To date half of the native minnows have been extirpated and others are in decline (Wilde et al. 1996). The Corps' preferred alternative seeks to capture low flows for disposal at Truscott Brine Lake. This alternative is the most damaging because it impacts all three forks of the upper Wichita River basin and leaves no areas within the basin where prairie stream fishes can thrive. The project would affect this ecosystem by increasing the severity and duration of low flow events and moderating harsh conditions (i.e. naturally elevated salinities). The latter conditions influence native fish distributions and prevent the homogenization of fish assemblages. By dropping Area X, which the Department supports, the Middle Fork of the Wichita River would serve as a refugia for prairie stream fishes and reduce impacts to assemblages in the North Fork downstream of its confluence with the Middle Fork. It is appropriate to include the Wichita River ecosystem as an element of the EOP and to establish a refugia habitat program as a tool to help stream fishes endure long-lasting impacts.

Environmental Operational Plan (EOP)

The Corps provided a draft EOP in February 2002. Some form of adaptive management is the best approach to dealing with large amounts of uncertainty in environmental impact analyses, especially involving projects with long-lasting, large-scale impacts. Completion of the EOP needs to be coordinated with Department staff. The Corps should also be willing to act upon steering committee recommendations.

The EOP should include an element to address concerns about toxic golden algae that have recently caused fish kills in Lake Kemp and Diversion Lake. To determine if conditions suitable for golden alga problems are likely, the plan should include:

- a limnological study of the impounded waters at the collection facilities (nutrient levels, algal composition, etc.);
- an assessment of relationships between salinity levels, algal composition, and hydrology before, during, and after releases from the inflatable weir.

Since the golden alga is already present in Lake Kemp and Diversion Lake, it is not a question of whether the alga will occur but whether conditions will exist that give this alga a competitive edge over the rest of the algal community and lead to further extensive fish kills.

The draft EOP includes a limnological monitoring program for Lake Kemp. Because there are many uncertainties regarding the potential effects of the project on chloride reductions, changes in turbidity and productivity, and consequent effects on sport fisheries, the EOP should also incorporate monitoring programs, threshold decision programs, and preemptive/remedial measures for Lake Kemp, Diversion Lake, and Lake Texoma. These EOP elements should not be limited to monitoring of water quality parameters and plankton (i.e. productivity) but must also include expanded biological parameters to include sport fish populations.

References

U.S. Army Corps of Engineers. 2001. Selenium monitoring results: Truscott Brine Lake, TX and associated brine collection areas, 1997-1998. Tulsa District Corps of Engineers, Tulsa, Oklahoma.

Wilde, G.R., R.R. Weller, C.D. Smith, and R. Jimenez, Jr. 1996. Review and synthesis of existing fish collection records for the upper Red River Basin above Lake Texoma. Department of Range, Wildlife, and Fisheries Management, Texas Tech University, Lubbock, TX.

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April 25, 2002

Mr. Jerry Brabander
U.S. Fish and Wildlife Service
Ecological Services
222 S Houston, Suite A
Tulsa, OK 74127

Dear Mr. Brabander:

In correspondence dated 17 August 1994, the Oklahoma Department of Wildlife Conservation (Department) outlined opposition to the U.S. Army Corps of Engineers (USACE) Red River Chloride Control Project. Following careful review of the revised project, now called the Wichita River Basin Project Reevaluation (WRB project) and the U.S. Fish and Wildlife Service (USFWS) Draft Fish and Wildlife Coordination Act Report (DCAR), the Department provides the following comments.

Although none of the chloride control structures are currently proposed for construction in Oklahoma, the USACE has predicted that implementation of the Wichita River components of the WRB project in Texas will adversely impact Texoma Reservoir. A significant body of literature documents the relationship between reduced chloride concentrations, increased turbidity and resulting decline in primary productivity. The USACE predicts an 11% reduction in chlorides in Texoma Reservoir with implementation of the preferred WRB project alternative (Areas V, VII, VIII and X) which, according to Gade (1992), would result in a 2-3 % annual reduction in sportfish harvest in Texoma Reservoir.

Texoma Reservoir is one of the premier fisheries in the United States. Creel survey data indicate anglers harvest more than two million pounds of fish annually (Hysmith 1988). Recent economic impact analyses place the value of the Texoma Reservoir fishery at more than $25 million annually (Schorr et al. 1991, 1995). Assuming a 2-3% annual reduction in sportfish harvest, anglers could lose more than three million pounds of sportfish over a fifty year period (half the projected life of the WRB project). Impacts to the area economy may be more difficult to define, but the loss of three million pounds of sportfish represents a significant economic impact that must be addressed in evaluation of the WRB project.

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The Department position on the Red River Chloride Control Project, the WRB project, or any "reevaluation"of the original project remains unchanged. 17 August 1994 correspondence specifically referenced our concern regarding adverse impacts to Texoma Reservoir water quality and fishery resources. The Department finds it disturbing that the USACE appears to be taking a piecemeal approach to implementing chloride control in the Red River to avoid addressing impacts associated with the overall project (Area V, which is removing 240 tons of naturally occurring chlorides per day, is ignored in the current WRB project "reevaluation"). The USACE has funded studies that predict adverse impacts to state resources, but seems unwilling to provide mitigation or develop alternatives to avoid these impacts.

We cannot support the proposed WRB project alternatives or implementation of any chloride control components until the USACE has developed suitable mitigation measures to offset adverse impacts to Texoma Reservoir. It is not clear how the USACE would mitigate impacts to primary productivity and reduction in sportfish in Texoma Reservoir, but the Department hopes to begin these discussions at the earliest opportunity.

The Department appreciates the opportunity to comment and looks forward to continued coordination with the USACE and resource agencies. Please contact Mr. Barry Bolton at 405/521-3721 if you have questions or if you require additional information.

Sincerely,

Greg D. Duffy

cc: Colonel Robert L. Suthard, Jr., USACE
Robert L. Cook, Director, Texas Parks and Wildlife

APPENDIX B

HEP Analysis for Terrestrial Mitigation

April 2002 USFWS
Coordination Act Report
Wichita River Basin Project Reevaluation

APPENDIX B

2001 Draft Habitat Evaluation Proceedures (HEP)

for the Wichita River Basin Reevaluation

USFWS Fish and Wildlife Coordination Act Report

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INTRODUCTION

This appended report is the U.S. Fish and Wildlife Service's reanalysis of mitigation requirements associated with terrestrial impacts of the U.S. Army Corps of Engineers' (Corps) Wichita River Basin Project. The Service's Habitat Evaluation Procedures (HEP) methodology was not used for aquatic impacts or potential impacts of contaminants at Truscott Reservoir and the compensation needs calculated in this appended report are for direct terrestrial impacts only. The reanalysis of terrestrial impacts was conducted using the HEP process and includes updated habitat evaluations, compensation needs, and estimated costs.

EVALUATION METHODOLOGY

The Service's HEP methodology was used to evaluate potential alterations of fish and wildlife habitat resulting from the construction and operation of the proposed project. The HEP provides better predictive capabilities and a more objective approach to determining remedial actions than does the user-day approach. In concert with the Service's Mitigation Policy, the HEP can be used to formulate quantitative plans to offset adverse impacts. The HEP is an objective, repeatable habitat based impact assessment methodology with the capability to analyze predicted changes in future habitat quantity and quality, providing a tool to assess conditions with and without the project. The HEP are based on the primary assumption that quality of habitat for selected species can be described by a Habitat Suitability Index (HSI) derived through measurement of habitat variables that have been identified as essential to the existence of the selected evaluation species.

The Habitat Suitability Index value, expressed on a scale from 0 to 1, reflects habitat quality for each evaluation species, with 0 representing no habitat and 1.0 representing optimum habitat. The index value is multiplied by the area of available habitat (acres) to obtain Habitat Units for the species. Habitat Units become the common denominator for making baseline assessments and, when annualized over the period of analysis, are useful for project evaluations and in formulating mitigation recommendations.

In an attempt to determine mitigation needs at Truscott Reservoir and associated pumps and pipelines, the Service conducted a HEP analysis, with data collected at project sites and assumed habitat values for areas already inundated at the reservoir. Vegetation data unrelated to HEP had been collected for the reservoir prior to construction and this data was used to estimate habitat types and areas prior to implementation of the project. Actual data could not be collected from Truscott because the reservoir has been operational for 14 years.

Data collection at the Truscott Reservoir site was conducted by a study team composed of two Service representatives (Kevin Stubbs and Steve Hensley), Jim Randolph with the Environmental Analysis and Support Branch of the Corps' Planning Division, and Jacqueline Renee Fields and Dr. Ray Telfair of the Texas Parks and Wildlife Department (TPWD). The HEP analysis of the Crowell mitigation site was conducted by the same team except the two TPWD representatives

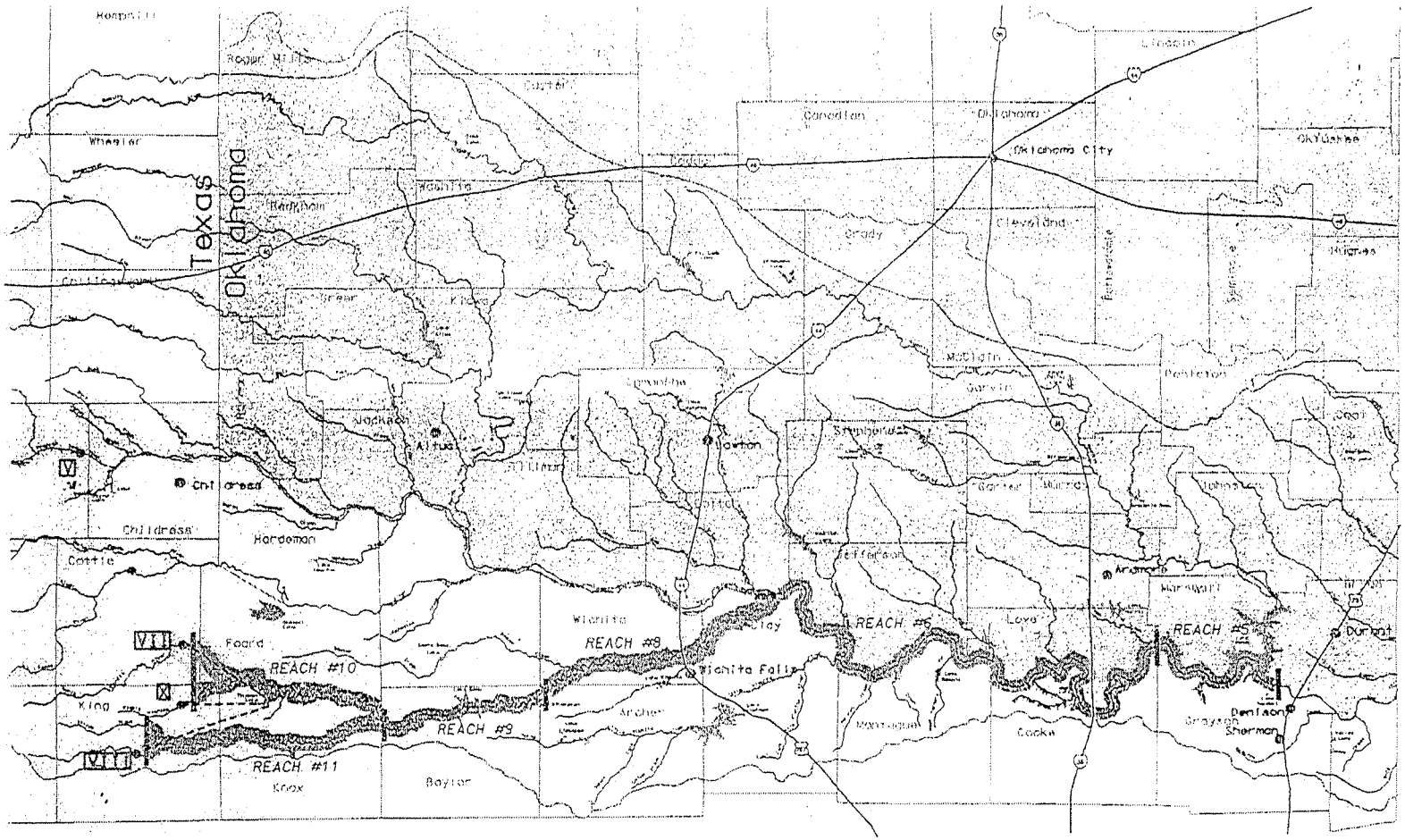
were not available to assist. Habitat variables were measured along transects in all cover types. The variables measured and an example of the form used for each transect are included in appendix C-1. The percent herbaceous canopy cover, percent shrub crown cover, forb distribution, percent grass canopy cover, percent of shrubs less than 1.5 meters tall, average height of herbaceous vegetation, distance to cropland, distance to seasonal herbland or deciduous savanna, abundance of perch sites, distance to suitable roost and nest trees, and average height of shrubs were all measured at each site. Cover types were weighted by their relative abundance in determining HSI values.

Project Area and Cover Types

Construction of chloride control measures in the Wichita River Basin (source areas VII, VIII, and X) was authorized by the Flood Control Act of 1966 (Fig. 1). Construction of control measures in the Wichita River Basin began in 1977 and portions of the project were declared operational in 1987. The WRB Project has been operational for approximately 14 years with pumping from Area VIII to Truscott Brine Lake. Most of the terrestrial impacts of the proposed Project are related to inundation at Truscott Brine Reservoir and construction and maintenance of pipelines, spray fields, and pumping stations.

Truscott Brine Reservoir has been collecting brines since 1987 and has already inundated approximately 706 hectares (ha) or 1744 acres, at elevation 1470 ft. The reservoir is predicted to inundate up to 1327 ha (3280 acres) at an elevation of 1502.71 ft with alternative 3, which includes pumping from Areas VII, VIII, and X. Cover types for areas of Truscott Reservoir that were already inundated were determined from vegetation maps prepared by Killgore Research Center (1972) prior to construction of the reservoir (appendix C-2). Cover types included mesquite dominated grassland, grassland with some juniper and mesquite, juniper dominated shrubland, and small areas of riparian habitat. Data was collected from similar cover types at locations near the reservoir site. The majority of the lands at the 3,800 acre Truscott project site are primarily juniper dominated shrubland and mesquite dominated grassland.

Figure 1.



Project Study Area

LEGEND:

V AREA V, ESTELLINE SPRINGS - RING DIKE *
VII AREA VII, Y-RANCH PUMP STATION
VIII AREA VIII, BATEMAN PUMP STATION *
X AREA X, LOWRANCE PUMP STATION *
PIPELINES

* Completed

WICHITA RIVER BASIN
REEVALUATION AREA
STUDY REACHES (1999)

Evaluation Species

The field sparrow, bobwhite quail, loggerhead shrike, scissor-tailed flycatcher, and black-tailed jackrabbit were selected as evaluation species after consultation with staff from the Texas Parks and Wildlife Department (TPWD) and the Corps. Service "blue book " models or models developed by the Service for central Oklahoma as part of the Terrestrial Habitat Evaluation Criteria Handbook were selected to assess the quality of habitat in each cover type.

EVALUATION OF IMPACTS

Target years range from 0 to 115. Key target years are :

Target year 0, because it represents the baseline or preproject conditions
Target year 1, the year construction began
Target year 75, a major fire is assumed for the mitigation area and Truscott (no project)
Target year 115, which is the end of the designed life of the project

The Service included analysis of impacts of the existing portions of the project as well as proposed alternatives because the Corps has not yet provided any mitigation for existing portions of the project. Operations of existing and proposed portions of the project are interdependent and the impacts can not easily be separated.

Assumptions

Truscott Reservoir and Pipelines

1. The inundated portion of the reservoir, building sites, spray fields, and roads on pipelines would not provide any habitat for the evaluation species and would have a zero HSI value for all evaluated species.
2. Without project, grazing pressure did not increase or decrease over the life of the evaluation period .
3. Without project, the shrub density increases over the evaluation period due to a lack of or control of fires until target year 75 when a major wildfire greatly reduces shrub densities.
4. HSI values for Truscott lands that are not inundated will decline in the first twenty years due to continued increases in shrub density and then remain relatively stable for the life of the project due to limited brush control.
5. Evaluation species are not affected equally by increasing shrub densities, but very high densities of shrubs create poor habitat and lower HSI values for all of the evaluation species.
6. The existing level of management, such as food plots and elimination or control of grazing is assumed to continue for the life of the project.

Crowell Mitigation Area

1. Grazing pressure did not increase or decrease over the life of the evaluation period without project.
2. Without project, the shrub density increases over the evaluation period due to a lack of or control of fires until target year 75 when a major wildfire greatly reduces shrub densities. Shrub densities then increase again through the life of the project.
3. Management would include fencing to control or eliminate grazing, food plots, construction and maintenance of ponds, and some controlled burns. The described levels of wildlife management would continue for the life of the project.
4. Evaluation species are not affected equally by increasing shrub densities, but very high densities of shrubs create poor habitat and lower HSI values for all of the evaluation species.
5. There is no significant threat of development or related losses. Without the project, the area would be rangeland and managed in a manner similar to what it was before Corps ownership. The mitigation value is the improvement of habitat conditions relative to pre-project values.

HSI Values, Areas, and Habitat Units

Truscott Reservoir

The total acquisition at Truscott Brine Reservoir is 3,800 acres. The reservoir has been collecting brines since 1987 and has already inundated approximately 706 hectares (ha) or 1744 acres, at elevation 1470 ft. Near the end of the 115 year project, the reservoir is predicted to inundate up to 1327 ha (3280 acres) at an elevation of 1502.71 ft with Alternative 3, which includes pumping from Areas VII, VIII, and X. Alternative 1 (Areas VII and VIII) would inundate up to 1143 ha (2825 acres) and Alternative 2 (Areas VIII and X) would inundate up to 887 ha (2192 acres). Areas inundated at different target years for Truscott Reservoir were calculated from elevation/area/capacity tables provided by the Corps (appendix C-3). Inundated areas were assumed to have no habitat value. Buildings at the Project site were estimated to occupy about 15 acres which also have no habitat value.

The areas for the 100 ft. wide pipelines is based on the lengths of the proposed or existing pipelines provided by the Corps. The area of the pipelines is 70.1 ha (173.3 acres) for Area VII, 107.9 ha (266.7 acres) for Area VIII, and 51.5 ha (127.3 acres) for Area X. The pipelines will have service roads on them that will be approximately 20 feet wide. The area of these roads was assumed to have no habitat value. The spray fields associated with these pipelines have areas of 30 acres for Area VII, 20 acres for Area VIII, and 15 acres for Area X. The area of these spray fields also was assumed to have no habitat value.

The total area for each alternative is :
Alternative 1 (Areas VII and VIII) = 1736 ha or 4290 acres
Alternative 2 (Areas VIII and X) = 1711 ha or 4229 acres

Alternative 3 (Areas VII, VIII, and X) = 1794 ha or 4432 acres

Areas, HSI values, and habitat units are calculated for each target year and each species in Form C's in appendix C-4. Form C's are included for all three proposed alternatives and a no project alternative. Average annual habitat units, with and without the proposed project, are presented in Tables 1 and 2.

Table 1. Average annual habitat units (AAHU) at Truscott Reservoir (and pipelines) without-project and with-project (Alternative 3).

Species	AAHUs without	AAHUs with	Net Change
Field Sparrow	2220.43	674.94	-1545.49
Bobwhite Quail	2180.35	649.45	-1530.90
Loggerhead Shrike	1765.86	495.94	-1269.92
Scissor-tailed Flycatcher	3940.43	1313.04	-2627.39
Black-tailed Jackrabbit	1635.60	415.88	-1219.72

Table 2. Net change in average annual habitat units for alternatives 1-3 resulting from the construction and operation of the proposed project.

Species	Alternative 1	Alternative 2	Alternative 3
Field Sparrow	-1358.14	-1158.88	-1545.49
Bobwhite Quail	-1342.87	-1145.42	-1530.90
Loggerhead Shrike	-1125.40	-975.17	-1269.92
Scissor-tailed Flycatcher	-2257.49	-1861.22	-2627.39
Black-tailed Jackrabbit	-1094.23	-966.59	-1219.72

Crowell Mitigation Area

Crowell Mitigation Area was originally purchased with the intent of constructing a brine collection reservoir at this site. However, plans to construct the reservoir have been dropped and the area is now proposed to be managed to mitigate for impacts of the proposed project. The 10,000 acre area includes a small portion of the Pease River and its floodplain and adjoins the 782 ha (1,933 acre) Copper Breaks State Park (CBSP).

The Crowell Mitigation Area has been owned and managed by the Corps since 1994. The area is largely a mixture of shrub and grasslands with relatively small areas of old fields that are no longer farmed except for several small food plots maintained by the Corps. Grazing has been eliminated on the area except for a small number of cattle that frequently trespass on the property. However, the area still suffers from past overgrazing. The Corps also has restored or built a few ponds to benefit wildlife. The area's wildlife habitat value has noticeably improved with this limited level of management and it now provides good habitat for some species such as dove, scissor-tailed flycatchers and other migratory birds (Table 3). The habitat value for most species would improve with additional management to control brush encroachment. Controlled burns and manual or chemical brush control will be needed to maintain good habitat for species that prefer grassland or a mixture of grassland and shrubs.

Table 3. Average annual habitat units (AAHUs) without- and with proposed management for the Crowell mitigation site.

Species	AAHUs Without	AAHUs With	Net Change
Field Sparrow	4442.61	5297.83	855.22
Bobwhite Quail	3949.13	5215.65	1266.52
Loggerhead Shrike	6360.87	8422.17	2061.30
Scissor-tailed Flycatcher	7031.30	8985.22	1953.91
Black-tailed Jackrabbit	6555.65	8544.35	1988.70

Surveys have not been conducted for all wildlife species, but it is assumed to provide relatively good habitat for many native birds, mammals, reptiles and amphibians. It also supports a good population of quail, doves, and a small but probably growing number of popular game species such as deer and turkeys. Feral hogs were observed on the site and could present problems in managing the property for native wildlife.

The Crowell Mitigation Area's habitat value was assessed using the HEP method and compared to habitat values at the Truscott portion of proposed Project. Cover types and areas were delineated from visual observations onsite and aerial photography.

COMPENSATION ANALYSIS AND MITIGATION

Habitat compensation analysis for all terrestrial Project impacts was conducted with the HEP. The Service Mitigation Policy (Federal Register 46[15]: 7644-7663) provides guidance for formulation of measures to offset project impacts. The purpose of the policy is to foster consistent and effective Service recommendations, allow construction agencies and applicants to anticipate those recommendations and plan for mitigation needs at an early date, and to reduce conflicts and delays. The policy is based on two principles: (1) that impact avoidance, reduction

or compensation be recommended for the most valued resources, and (2) that the degree of mitigation correspond to the value and scarcity of the impacted resources. The Resource Categories in the Mitigation Policy are key elements in determining the appropriate planning goals for mitigating project related habitat losses.

Habitat in the vicinity of the Crowell and Truscott brine storage reservoirs is relatively undisturbed due to its limited potential for intensive uses such as agriculture. This general area is part of the Kansan province of Blair (1950) which incorporates almost all of the upper Red River basin upstream of Texoma Reservoir. The Kansan province is an ecotonal area between the short-grass prairies and deserts to the west and the eastern deciduous forests. The ecotone is important as a north-south dispersal corridor for species that are adapted to desert and semi-desert conditions and functions as a barrier to the east-west dispersal of forest adapted species (Blair, 1954).

Blair and Hubbell (1938) and Blair (1950) divided the Kansan province into three distinct biotic districts. The brine reservoir lies within the Mesquite Plains biotic district. One mammal, the Texas kangaroo rat (Dipodomys elator) and three fishes, the Red River pupfish (Cyprinodon rubrofluviatilis), Red River speckled chub (Macrhybopsis aestivalis australis), and Red River shiner (Notropis bairdi) are endemic or largely restricted to the Mesquite Plains biotic district. Risser et al. (1980) identified a portion of the Mesquite Plains district in Oklahoma as a unique wildlife ecosystem. The general project area is widely known for its production of scaled (Callipepla squamata) and bobwhite (Colinus virginianus) quail and mourning dove (Zenaida macroura) and provides medium to high value habitat for these species. Other species, such as Rio Grande turkey (Meleagris gallopavo) and white-tailed deer (Odocoileus virginianus), do not maintain large populations in these mesquite and cedar dominated habitats. This habitat provides medium value habitat for these species. Waterfowl and shorebirds are relatively rare except in areas with suitable surface water, foods and resting/loafing areas. Habitats within the proposed mitigation site provide medium to low value habitat for these species. The mesquite and cedar shrublands provide medium to high value habitat for a number of birds, reptiles and amphibians. However, the large expanse of relatively undisturbed natural landscape within the general project area indicates that the mesquite and juniper vegetative communities are not unique or scarce on an ecoregional basis. Our goal in mitigating project-related losses is to insure no net loss of habitat value while minimizing loss of in-kind habitat value. These habitats are equivalent to a resource category 3.

According to the compensation analysis, using the Service's mitigation goal for resource category 3 habitats, the loss of acres of mesquite/juniper shrubland at Truscott would require acquisition and management of the proposed 10,000 acres plus an additional 83 acres (includes estimated losses from pipeline rights-of-way) to achieve compensation for project induced losses for Alternative 3 with Areas VII, VIII, and X (Table 4). Alternative 1 (Areas VII and VIII) would require 8,833 acres, and Alternative 2 (Areas VIII and X) would require 7,516 acres to compensate for Project impacts. The Corps compensation at Crowell is based on the level of habitat improvement achieved, relative to the habitat value of the land prior to Corps ownership

or management. The compensation areas for all three alternatives are dependent on the level of management the Corps is willing to apply and the values listed above require at least the existing level of management plus some controlled burns (about 1/4 of the mitigation area, see assumptions for Crowell and Table 1). The described levels of wildlife management would need to be implemented for the life of the project. The 10,083 acres could be reduced if the Corps was willing to incorporate more intensive wildlife management. With intensive management the area required for compensation could be reduced to 5806 acres for Alternative 3. More intensive management would involve conversion of non-native vegetation such as the old world bluestem grasslands to native vegetation, more brush control and controlled burns, more food plots, better water distribution via ponds and guzzlers, control of non-native animals such as the feral hogs, and continued control of grazing.

Table 4. Areas (acres) needed to compensate for habitat losses resulting from the construction and operation of the proposed project.

Alternative 1 (Areas 7,8)	Alternative 2 (Areas 8,10)	Alternative 3 (Areas 7,8,10)
8,833.90	7,516.05	10,083.40

The project also should bear the recurring costs of operation and maintenance of the mitigation area. Operation and maintenance of the area is estimated to be about $10 per acre, per year. The total cost is expected to be $100,000 annually. Funds would be used for the continued operation of mitigation features and maintenance of fences, roads, and visitor facilities, erosion control, vegetation control/manipulation, and other miscellaneous needs.

Table 5. Estimated development costs for the proposed mitigation area to be located at Crowell reservoir.

Action	Costs
Land Acquisition	1,971,300
Habitat plot development, including 10 acres of permanent habitat plantings 100 acres @ $200/acre	20,000
Pond excavation and construction 5 (¼ -1 acre) ponds @ $7000 each	35,000
Game guzzler installation 10 units @ $40 each	400

Engineering, design, and planning	23,000
Administration	34,000
Fencing	220,000
Total	2,303,700

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APPENDIX B-1

TO
APPENDIX B
OF
AUGUST 2001 USFWS

Coordination Act Report

on

Wichita River Basin Reevaluation Project

Example Data Form

Crowell

Wichita River, ~~Truscott and pipelines~~
HEP FIELD DATA FORM

Cover Type - **Scrubland and herbland** Sample Site_____
Date_____

Data Collected
By_____

00.....01.....02.....03.....04.....05.....06.....07.....08.....09.....10

10.....11.....12.....13.....14.....15.....16.....17.....18.....19.....20

20.....21.....22.....23.....24.....25.....26.....27.....28.....29.....30

30.....31.....32.....33.....34.....35.....36.....37.....38.....39.....40

40.....41.....42.....43.....44.....45.....46.....47.....48.....49.....50

Information From Transect

(1) % herbaceous canopy cover_____
The ground shaded by vertical projection of all nonwoody vegetation
(2) forb distribution, Jack rabbit Seasonal Herbland only_____
Non-woody vegetation, excluding grasses, none, scattered, continuous
(3) % shrub crown cover _____
% of ground shaded by canopies of woody vegetation < 5m in height
~~(4) Number of trees per 0.4 ha, red-tail~~ _____

(5) % grass canopy cover, _____
% of ground shaded from vertical grasses
(6) % total shrubs less than 1.5 m, field sparrow_____

(7) Average height of herbaceous vegetation _____

~~(8) % of ground that is bare or lightly covered with litter, LB~~ _____

~~(9) % canopy cover of vegetation taller than grasses, LB only~~ _____

(10) distance to cropland, quail (m) _____

(11) distance to seasonal herbland or deciduous savanna (m), quail _____

~~(12) Average height of trees(m), red-tail~~ _____

(13) Abundance of perch sites per 0.4 ha, scissor-tail, red-tail _____

(14) distance to suitable roost and nest trees, red-tail, scissor-tail _____

(15) Average height of shrubs, jack rabbit_____

(16) Availability of perch sites, shrike _____
A=none, B= wires or fences available, C=wires, or fences and trees

APPENDIX B-2

TO
APPENDIX B
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Wichita River Basin Reevaluation Project

Truscott habitat types prior to inundation

Figure 2. Distribution of vegetation types within the proposed Truscott Brine Lake. 1=Juniper Scrub, 2=Mesquite-Grassland Savannah, 3=Mesquite Thicket, 4=Riparian.

APPENDIX B-3

TO
APPENDIX B
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on

Wichita River Basin Reevaluation Project

Truscott elevation/area/capacity table

TABLE 1

ELEVATION / AREA / CAPACITY TABLE FOR TRUSCOTT ALTERNATIVES
Starting Elevation: 1470 (current)

Years	Elevation, Area, Capacity	Area/# Spray Fields			
		Alt. 1	Alt. 2	Alt. 3	Alt. 4
		VIII-1	VIII, VII-2	VIII, X-2	VII, VIII, X-2
5	Elev. (ft)	1463.73	1468.69	1466.31	1472.43
	Area (m^2)	5.77E+06	6.96E+06	6.37E+06	7.67E+06
	Vol (m^3)	3.70E+07	4.67E+07	4.18E+07	5.50E+07
	Z (m)	6.41E+00	6.71E+00	6.56E+00	7.17E+00
	SSV (mm/yr)	7.91E+00	6.56E+00	7.17E+00	5.95E+00
10	Elev. (ft)	1462.6	1473.11	1466.63	1478.63
	Area (m^2)	5.52E+06	7.79E+06	6.45E+06	8.72E+06
	Vol (m^3)	3.51E+07	5.66E+07	4.24E+07	7.05E+07
	Z (m)	6.36E+00	7.27E+00	6.57E+00	8.08E+00
	SSV (mm/yr)	8.27E+00	5.86E+00	7.08E+00	5.23E+00
15	Elev. (ft)	1463.8	1475.46	1469.17	1482.64
	Area (m^2)	5.79E+06	8.19E+06	7.08E+06	9.47E+06
	Vol (m^3)	3.72E+07	6.25E+07	4.78E+07	8.16E+07
	Z (m)	6.42E+00	7.63E+00	6.75E+00	8.62E+00
	SSV (mm/yr)	7.88E+00	5.57E+00	6.45E+00	4.82E+00
20	Elev. (ft)	1462.1	1476.5	1467.86	1484.53
	Area (m^2)	5.41E+06	8.36E+06	6.76E+06	9.85E+06
	Vol (m^3)	3.43E+07	6.50E+07	4.50E+07	8.71E+07
	Z (m)	6.34E+00	7.78E+00	6.66E+00	8.84E+00
	SSV (mm/yr)	8.44E+00	5.46E+00	6.75E+00	4.63E+00
25	Elev. (ft)	1463.51	1477.75	1469.64	1486.76
	Area (m^2)	5.73E+06	8.58E+06	7.18E+06	1.03E+07
	Vol (m^3)	3.67E+07	6.84E+07	4.86E+07	9.42E+07
	Z (m)	6.40E+00	7.97E+00	6.77E+00	9.15E+00
	SSV (mm/yr)	7.97E+00	5.32E+00	6.36E+00	4.43E+00
30	Elev. (ft)	1464.68	1479.64	1470.48	1489.14
	Area (m^2)	6.00E+06	8.90E+06	7.37E+06	1.08E+07
	Vol (m^3)	3.88E+07	7.32E+07	5.06E+07	1.02E+08
	Z (m)	6.47E+00	8.22E+00	6.87E+00	9.44E+00
	SSV (mm/yr)	7.61E+00	5.13E+00	6.19E+00	4.23E+00

Table 1 (Continued)

Years	Elevation, Area, Capacity	Area/# Spray Fields			
		Alt. 1	Alt. 2	Alt. 3	Alt. 4
		VIII-1	VIII, VII-2	VIII, X-2	VII, VIII, X-2
35	Elev. (ft)	1467.7	1482.62	1473.34	1492.64
	Area (m^2)	6.71E+06	9.47E+06	7.82E+06	1.15E+07
	Vol (m^3)	4.46E+07	8.16E+07	5.71E+07	1.14E+08
	Z (m)	6.65E+00	8.62E+00	7.30E+00	9.91E+00
	SSV (mm/yr)	6.80E+00	4.82E+00	5.84E+00	3.97E+00
40	Elev. (ft)	1463.35	1479.65	1469.35	1489.97
	Area (m^2)	5.74E+06	8.91E+06	7.13E+06	1.10E+07
	Vol (m^3)	3.67E+07	7.34E+07	4.82E+07	1.05E+08
	Z (m)	6.39E+00	8.24E+00	6.76E+00	9.55E+00
	SSV (mm/yr)	7.95E+00	5.12E+00	6.40E+00	4.15E+00
45	Elev. (ft)	1464.56	1480.59	1470.63	1491.17
	Area (m^2)	5.98E+06	9.08E+06	7.38E+06	1.12E+07
	Vol (m^3)	3.86E+07	7.59E+07	5.09E+07	1.08E+08
	Z (m)	6.45E+00	8.36E+00	6.90E+00	9.64E+00
	SSV (mm/yr)	7.63E+00	5.03E+00	6.18E+00	4.08E+00
50	Elev. (ft)	1464.51	1480.63	1470.61	1491.35
	Area (m^2)	5.95E+06	9.08E+06	7.38E+06	1.12E+07
	Vol (m^3)	3.84E+07	7.59E+07	5.09E+07	1.09E+08
	Z (m)	6.45E+00	8.36E+00	6.90E+00	9.73E+00
	SSV (mm/yr)	7.67E+00	5.03E+00	6.18E+00	4.08E+00
55	Elev. (ft)	1464.61	1482.05	1471.13	1492.89
	Area (m^2)	5.98E+06	9.38E+06	7.46E+06	1.15E+07
	Vol (m^3)	3.86E+07	8.01E+07	5.20E+07	1.15E+08
	Z (m)	6.45E+00	8.54E+00	6.97E+00	1.00E+01
	SSV (mm/yr)	7.63E+00	4.87E+00	6.12E+00	3.97E+00
60	Elev. (ft)	1464.68	1481.11	1471.16	1492.16
	Area (m^2)	6.00E+06	9.18E+06	7.48E+06	1.14E+07
	Vol (m^3)	3.88E+07	7.73E+07	5.22E+07	1.12E+08
	Z (m)	6.47E+00	8.42E+00	6.98E+00	9.82E+00
	SSV (mm/yr)	7.61E+00	4.97E+00	6.10E+00	4.00E+00

Table 1 (Continued)

Years	Elevation, Area, Capacity	Area/# Spray Fields			
		Alt. 1	Alt. 2	Alt. 3	Alt. 4
		VIII-1	VIII, VII-2	VIII, X-2	VII, VIII, X-2
65	Elev. (ft)	1467.06	1484.49	1473.1	1495.21
	Area (m^2)	6.56E+06	9.85E+06	7.79E+06	1.20E+07
	Vol (m^3)	4.34E+07	8.71E+07	5.66E+07	1.23E+08
	Z (m)	6.62E+00	8.84E+00	7.27E+00	1.03E+01
	SSV (mm/yr)	6.96E+00	4.63E+00	5.86E+00	3.80E+00
70	Elev. (ft)	1469.08	1485.43	1475.19	1496.4
	Area (m^2)	7.06E+06	1.00E+07	8.14E+06	1.22E+07
	Vol (m^3)	4.76E+07	8.99E+07	6.17E+07	1.27E+08
	Z (m)	6.74E+00	8.99E+00	7.58E+00	1.04E+01
	SSV (mm/yr)	6.47E+00	4.56E+00	5.61E+00	3.74E+00
75	Elev. (ft)	1468.65	1486.83	1474.6	1497.45
	Area (m^2)	6.96E+06	1.03E+07	8.04E+06	1.24E+07
	Vol (m^3)	4.67E+07	9.42E+07	6.03E+07	1.31E+08
	Z (m)	6.71E+00	9.15E+00	7.50E+00	1.06E+01
	SSV (mm/yr)	6.56E+00	4.43E+00	5.68E+00	3.68E+00
80	Elev. (ft)	1465.09	1482.24	1471.45	1493.09
	Area (m^2)	6.09E+06	9.39E+06	7.53E+06	1.16E+07
	Vol (m^3)	3.95E+07	8.04E+07	5.29E+07	1.15E+08
	Z (m)	6.49E+00	8.56E+00	7.03E+00	9.91E+00
	SSV (mm/yr)	7.49E+00	4.86E+00	6.06E+00	3.93E+00
85	Elev. (ft)	1465.06	1483.87	1471.87	1494.47
	Area (m^2)	6.09E+06	9.73E+06	7.59E+06	1.18E+07
	Vol (m^3)	3.95E+07	8.54E+07	5.38E+07	1.20E+08
	Z (m)	6.49E+00	8.78E+00	7.09E+00	1.02E+01
	SSV (mm/yr)	7.49E+00	4.69E+00	6.01E+00	3.87E+00
90	Elev. (ft)	1467.82	1485.7	1474.54	1496.5
	Area (m^2)	6.74E+06	1.01E+07	8.02E+06	1.22E+07
	Vol (m^3)	4.48E+07	9.08E+07	6.00E+07	1.28E+08
	Z (m)	6.65E+00	8.99E+00	7.48E+00	1.05E+01
	SSV (mm/yr)	6.77E+00	4.52E+00	5.69E+00	3.74E+00

Table 1 (Continued)

Years	Elevation, Area, Capacity	Area/# Spray Fields			
		Alt. 1	Alt. 2	Alt. 3	Alt. 4
		VIII-1	VIII, VII-2	VIII, X-2	VII, VIII, X-2
95	Elev. (ft)	1467.92	1486.24	1474.39	1496.77
	Area (m^2)	6.76E+06	1.02E+07	8.00E+06	1.23E+07
	Vol (m^3)	4.50E+07	9.23E+07	5.98E+07	1.29E+08
	Z (m)	6.66E+00	9.05E+00	7.48E+00	1.05E+01
	SSV (mm/yr)	6.75E+00	4.47E+00	5.71E+00	3.71E+00
100	Elev. (ft)	1470.4	1488.23	1476.59	1498.7
	Area (m^2)	7.28E+06	1.06E+07	8.38E+06	1.27E+07
	Vol (m^3)	4.95E+07	9.87E+07	6.53E+07	1.36E+08
	Z (m)	6.80E+00	9.31E+00	7.79E+00	1.07E+01
	SSV (mm/yr)	6.27E+00	4.31E+00	5.45E+00	3.59E+00

Z = average depth
SSV = sediment settling velocity

12,700,000
1,270 ha

3. SUMMARY OF FIELD DATA

Water quality data collected as part of the Tulsa District's Wichita River Basin monitoring program include Se data for brine source areas as well as for Truscott Brine Lake. Limited Se data were collected at brine source areas VIII and VII by the Tulsa District as part of initial evaluations for Crowell Lake in 1992. As part of a long-term monitoring effort, monthly water sample collection and Se analyses by the U.S. Geological Survey (USGS) under contract to the Tulsa District was initiated at all potential brine collection areas in the basin beginning in November 1996. This monitoring effort continues to the present. Total and dissolved Se concentrations measured at Areas VIII, VII, and X to date are included in Table 2.

APPENDIX B-4

TO
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Coordination Act Report

on

Wichita River Basin Reevaluation Project

HEP forms

Description of project alternatives (PA) and management plans (MP) for the HEP analysis
Wichita River Basin Reevaluation Project

PA1 = Alternative 1, Areas VII and VIII, no project

PA2 = Alternative 2, Areas VIII and X, no project

PA3 = Alternative 3, Areas VII, VIII, and X, no project

PA4 = Alternative 1, Areas VII and VIII, with project, existing level of management

PA5 = Alternative 2, Areas VIII and X, with project, existing level of management

PA6 = Alternative 3, Areas VII, VIII, and X, with project, existing level of management

MP1 = Alternative 1, Areas VII and VIII, with project, intensive management

MP2 = Alternative 2, Areas VIII and X, with project, intensive management

MP3 = Alternative 3, Areas VII, VIII, and X, with project, intensive management

MP4 = Crowell Mitigation Area, no project

MP5 = Crowell Mitigation Area, with project, proposed level of management

MP6 = Crowell Mitigation Area, with project, intensive management

Area Needed For Equal Compensation
(Form H Results)

Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Plan Alternative: PA 5 (with project) TRUSCOTTWPAREAS8&10
Compared To: PA 2 (without project) TRUSCOTTNPALT2
Management Plan: MP 5 (with project) CROWELLMITAREACURMAN
Compared To: MP 4 (without project) CROWELLMITAREANOPROJ
Candidate Management Area Size: 10000.00
Source of Relative Value Indices: All Equal To 1.0

Evaluation Species ID#	Name	Net Change In AAHU's: Plan Alternative	Net Change In AAHU's: Management Plan
1	FIELD SPARROW	-1158.88	855.22
2	BOBWHITE	-1145.42	1266.52
3	SHRIKE	-975.17	2061.30
4	FLYCATCHER	-1861.22	1953.91
5	JACKRABBIT	-966.59	1988.70
	Area Needed For Compensation:		7516.05

Area Needed For Equal Compensation
(Form H Results)

Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Plan Alternative: PA 6 (with project) TRUSCOTTWITHPALL3
Compared To: PA 3 (without project) TRUSCOTTNPALT3ALL3
Management Plan: MP 5 (with project) CROWELLMITAREACURMAN
Compared To: MP 4 (without project) CROWELLMITAREANOPROJ
Candidate Management Area Size: 10000.00
Source of Relative Value Indices: All Equal To 1.0

Evaluation Species ID#	Name	Net Change In AAHU's Plan Alternative	Management Plan
1	FIELD SPARROW	-1545.49	855.22
2	BOBWHITE	-1530.90	1266.52
3	SHRIKE	-1269.92	2061.30
4	FLYCATCHER	-2627.39	1953.91
5	JACKRABBIT	-1219.72	1988.70
	Area Needed For Compensation:		10083.40

Area Needed For Equal Compensation
(Form H Results)

Date: 07/17/2001

Study Name: TRUSCOTTANDPIPELINES
Plan Alternative: PA 4 (with project) TRUSCOTTWP7&8
Compared To: PA 1 (without project) TRUSCOTTNPAREAS7&8
Management Plan: MP 5 (with project) CROWELLMITAREACURMAN
Compared To: MP 4 (without project) CROWELLMITAREANOPROJ
Candidate Management Area Size: 10000.00
Source of Relative Value Indices: All Equal To 1.0

Evaluation Species ID#	Name	Net Change In AAHU's Plan Alternative	Management Plan
1	FIELD SPARROW	-1358.14	855.22
2	BOBWHITE	-1342.87	1266.52
3	SHRIKE	-1125.40	2061.30
4	FLYCATCHER	-2257.49	1953.91
5	JACKRABBIT	-1094.23	1988.70
	Area Needed For Compensation:		8833.90

PA 6 Truscott with Project
assuming existing level of managment

Target Year: 0

Species ID#	Area	HSI	HU's
1	4432.00	0.56	2481.92
2	4432.00	0.47	2083.04
3	4432.00	0.39	1728.48
4	4432.00	0.92	4077.44
5	4432.00	0.33	1462.56

Area Needed For Equal Compensation
(Form H Results)

Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Plan Alternative: PA 4 (with project) TRUSCOTTWP7&8
Compared To: PA 1 (without project) TRUSCOTTNPAREAS7&8
Management Plan: MP 5 (with project) CROWELLMITAREACURMAN
Compared To: MP 4 (without project) CROWELLMITAREANOPROJ
Candidate Management Area Size: 10000.00
Source of Relative Value Indices: All Equal To 1.0

Evaluation Species ID#	Name	Net Change In AAHU's: Plan Alternative	Net Change In AAHU's: Management Plan
1	FIELD SPARROW	-1358.14	855.22
2	BOBWHITE	-1342.87	1266.52
3	SHRIKE	-1125.40	2061.30
4	FLYCATCHER	-2257.49	1953.91
5	JACKRABBIT	-1094.23	1988.70
	Area Needed For Compensation:		8833.90

Area Needed For Equal Compensation
(Form H Results)

Date: 07/17/2001

Study Name: TRUSCOTTANDPIPELINES
Plan Alternative: PA 5 (with project) TRUSCOTTWPAREAS8&10
Compared To: PA 2 (without project) TRUSCOTTNPALT2
Management Plan: MP 5 (with project) CROWELLMITAREACURMAN
Compared To: MP 4 (without project) CROWELLMITAREANOPROJ
Candidate Management Area Size: 10000.00
Source of Relative Value Indices: All Equal To 1.0

Evaluation Species ID#	Name	Net Change In AAHU's: Plan Alternative	Net Change In AAHU's: Management Plan
1	FIELD SPARROW	-1158.88	855.22
2	BOBWHITE	-1145.42	1266.52
3	SHRIKE	-975.17	2061.30
4	FLYCATCHER	-1861.22	1953.91
5	JACKRABBIT	-966.59	1988.70
	Area Needed For Compensation:		7516.05

Area Needed For Equal Compensation
(Form H Results)

Date: 07/17/2001

Study Name: TRUSCOTTANDPIPELINES
Plan Alternative: PA 6 (with project) TRUSCOTTWITHPALL3
Compared To: PA 3 (without project) TRUSCOTTNPALT3ALL3
Management Plan: MP 6 (with project) CROWELLMITAREAINTMAN
Compared To: MP 4 (without project) CROWELLMITAREANOPROJ
Candidate Management Area Size: 10000.00
Source of Relative Value Indices: All Equal To 1.0

Evaluation Species ID#	Name	Net Change In AAHU's Plan Alternative	Net Change In AAHU's Management Plan
1	FIELD SPARROW	-1545.49	3152.17
2	BOBWHITE	-1530.90	3297.83
3	SHRIKE	-1269.92	3004.35
4	FLYCATCHER	-2627.39	2356.09
5	JACKRABBIT	-1219.72	2301.74
	Area Needed For Compensation:		5805.92

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 1 (without project) TRUSCOTTNPAREAS7&8
Life of Project: 115
Evaluation Species: 1 FIELD SPARROW AAHU's: 2149.29

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.58	2488.20
1	4290.00	0.58	2488.20
20	4290.00	0.45	1930.50
50	4290.00	0.30	1287.00
75	4290.00	0.70	3003.00
90	4290.00	0.60	2574.00
115	4290.00	0.50	2145.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 1 (without project) TRUSCOTTNPAREAS7&8
Life of Project: 115
Evaluation Species: 2 BOBWHITE AAHU's: 2110.49

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.48	2059.20
1	4290.00	0.48	2059.20
20	4290.00	0.43	1844.70
50	4290.00	0.40	1716.00
75	4290.00	0.65	2788.50
90	4290.00	0.55	2359.50
115	4290.00	0.48	2059.20

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 1 (without project) TRUSCOTTNPAREAS7&8
Life of Project: 115
Evaluation Species: 3 SHRIKE AAHU's: 1709.29

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.40	1716.00
1	4290.00	0.40	1716.00

20	4290.00	0.36	1544.40
50	4290.00	0.32	1372.80
75	4290.00	0.50	2145.00
90	4290.00	0.45	1930.50
115	4290.00	0.40	1716.00

Form C: Average Annual Habitat Units

Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 1 (without project) TRUSCOTTNPAREAS7&8
Life of Project: 115
Evaluation Species: 4 FLYCATCHER

AAHU's: 3814.18

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.94	4032.60
1	4290.00	0.94	4032.60
20	4290.00	0.85	3646.50
50	4290.00	0.80	3432.00
75	4290.00	0.95	4075.50
90	4290.00	0.94	4032.60
115	4290.00	0.94	4032.60

Form C: Average Annual Habitat Units

Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 1 (without project) TRUSCOTTNPAREAS7&8
Life of Project: 115
Evaluation Species: 5 JACKRABBIT

AAHU's: 1583.20

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.33	1415.70
1	4290.00	0.33	1415.70
20	4290.00	0.30	1287.00
50	4290.00	0.20	858.00
75	4290.00	0.60	2574.00
90	4290.00	0.50	2145.00
115	4290.00	0.33	1415.70

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 2 (without project) TRUSCOTTNPALT2
Life of Project: 115
Evaluation Species: 1 FIELD SPARROW AAHU's: 2118.73

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4229.00	0.58	2452.82
1	4229.00	0.58	2452.82
20	4229.00	0.45	1903.05
50	4229.00	0.30	1268.70
75	4229.00	0.70	2960.30
90	4229.00	0.60	2537.40
115	4229.00	0.50	2114.50

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 2 (without project) TRUSCOTTNPALT2
Life of Project: 115
Evaluation Species: 2 BOBWHITE AAHU's: 2080.48

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4229.00	0.48	2029.92
1	4229.00	0.48	2029.92
20	4229.00	0.43	1818.47
50	4229.00	0.40	1691.60
75	4229.00	0.65	2748.85
90	4229.00	0.55	2325.95
115	4229.00	0.48	2029.92

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 2 (without project) TRUSCOTTNPALT2
Life of Project: 115
Evaluation Species: 3 SHRIKE AAHU's: 1684.98

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4229.00	0.40	1691.60
1	4229.00	0.40	1691.60

20	4229.00	0.36	1522.44
50	4229.00	0.32	1353.28
75	4229.00	0.50	2114.50
90	4229.00	0.45	1903.05
115	4229.00	0.40	1691.60

Form C: Average Annual Habitat Units

Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 2 (without project) TRUSCOTTNPALT2
Life of Project: 115
Evaluation Species: 4 FLYCATCHER

AAHU's: 3759.95

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4229.00	0.94	3975.26
1	4229.00	0.94	3975.26
20	4229.00	0.85	3594.65
50	4229.00	0.80	3383.20
75	4229.00	0.95	4017.55
90	4229.00	0.94	3975.26
115	4229.00	0.94	3975.26

Form C: Average Annual Habitat Units

Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 2 (without project) TRUSCOTTNPALT2
Life of Project: 115
Evaluation Species: 5 JACKRABBIT

AAHU's: 1560.68

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4229.00	0.33	1395.57
1	4229.00	0.33	1395.57
20	4229.00	0.30	1268.70
50	4229.00	0.20	845.80
75	4229.00	0.60	2537.40
90	4229.00	0.50	2114.50
115	4229.00	0.33	1395.57

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 3 (without project) TRUSCOTTNPALT3ALL3
Life of Project: 115
Evaluation Species: 1 FIELD SPARROW AAHU's: 2220.43

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4432.00	0.58	2570.56
1	4432.00	0.58	2570.56
20	4432.00	0.45	1994.40
50	4432.00	0.30	1329.60
75	4432.00	0.70	3102.40
90	4432.00	0.60	2659.20
115	4432.00	0.50	2216.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 3 (without project) TRUSCOTTNPALT3ALL3
Life of Project: 115
Evaluation Species: 2 BOBWHITE AAHU's: 2180.35

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4432.00	0.48	2127.36
1	4432.00	0.48	2127.36
20	4432.00	0.43	1905.76
50	4432.00	0.40	1772.80
75	4432.00	0.65	2880.80
90	4432.00	0.55	2437.60
115	4432.00	0.48	2127.36

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 3 (without project) TRUSCOTTNPALT3ALL3
Life of Project: 115
Evaluation Species: 3 SHRIKE AAHU's: 1765.86

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4432.00	0.40	1772.80
1	4432.00	0.40	1772.80

20	4432.00	0.36	1595.52
50	4432.00	0.32	1418.24
75	4432.00	0.50	2216.00
90	4432.00	0.45	1994.40
115	4432.00	0.40	1772.80

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 3 (without project) TRUSCOTTNPALT3ALL3
Life of Project: 115
Evaluation Species: 4 FLYCATCHER AAHU's: 3940.43

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4432.00	0.94	4166.08
1	4432.00	0.94	4166.08
20	4432.00	0.85	3767.20
50	4432.00	0.80	3545.60
75	4432.00	0.95	4210.40
90	4432.00	0.94	4166.08
115	4432.00	0.94	4166.08

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 3 (without project) TRUSCOTTNPALT3ALL3
Life of Project: 115
Evaluation Species: 5 JACKRABBIT AAHU's: 1635.60

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4432.00	0.33	1462.56
1	4432.00	0.33	1462.56
20	4432.00	0.30	1329.60
50	4432.00	0.20	886.40
75	4432.00	0.60	2659.20
90	4432.00	0.50	2216.00
115	4432.00	0.33	1462.56

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 4 (with project) TRUSCOTTWP7&8
Life of Project: 115
Evaluation Species: 1 FIELD SPARROW AAHU's: 791.15

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.56	2402.40
1	3437.00	0.56	1924.72
10	2213.00	0.50	1106.50
20	2071.00	0.40	828.40
50	1892.00	0.40	756.80
75	1587.00	0.40	634.80
90	1643.00	0.40	657.20
115	1312.00	0.40	524.80

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 4 (with project) TRUSCOTTWP7&8
Life of Project: 115
Evaluation Species: 2 BOBWHITE AAHU's: 767.63

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.47	2016.30
1	3437.00	0.47	1615.39
10	2213.00	0.45	995.85
20	2071.00	0.40	828.40
50	1892.00	0.40	756.80
75	1587.00	0.40	634.80
90	1643.00	0.40	657.20
115	1312.00	0.40	524.80

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 4 (with project) TRUSCOTTWP7&8
Life of Project: 115
Evaluation Species: 3 SHRIKE AAHU's: 583.88

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units

0	4290.00	0.39	1673.10
1	3437.00	0.39	1340.43
10	2213.00	0.35	774.55
20	2071.00	0.30	621.30
50	1892.00	0.30	567.60
75	1587.00	0.30	476.10
90	1643.00	0.30	492.90
115	1312.00	0.30	393.60

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 4 (with project) TRUSCOTTWP7&8
Life of Project: 115
Evaluation Species: 4 FLYCATCHER AAHU's: 1556.69

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.92	3946.80
1	3437.00	0.92	3162.04
10	2213.00	0.87	1925.31
20	2071.00	0.82	1698.22
50	1892.00	0.82	1551.44
75	1587.00	0.82	1301.34
90	1643.00	0.82	1347.26
115	1312.00	0.82	1075.84

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 4 (with project) TRUSCOTTWP7&8
Life of Project: 115
Evaluation Species: 5 JACKRABBIT AAHU's: 488.97

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.33	1415.70
1	3437.00	0.33	1134.21
10	2213.00	0.30	663.90
20	2071.00	0.25	517.75
50	1892.00	0.25	473.00
75	1587.00	0.25	396.75
90	1643.00	0.25	410.75
115	1312.00	0.25	328.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 5 (with project) TRUSCOTTWPAREAS8&10
Life of Project: 115
Evaluation Species: 1 FIELD SPARROW AAHU's: 959.85

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4229.00	0.56	2368.24
1	3400.00	0.56	1904.00
10	2507.00	0.50	1253.50
20	2429.00	0.40	971.60
50	2276.00	0.40	910.40
75	2114.00	0.40	845.60
90	2118.00	0.40	847.20
115	1908.00	0.40	763.20

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 5 (with project) TRUSCOTTWPAREAS8&10
Life of Project: 115
Evaluation Species: 2 BOBWHITE AAHU's: 935.06

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4229.00	0.47	1987.63
1	3400.00	0.47	1598.00
10	2507.00	0.45	1128.15
20	2429.00	0.40	971.60
50	2276.00	0.40	910.40
75	2114.00	0.40	845.60
90	2118.00	0.40	847.20
115	1908.00	0.40	763.20

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 5 (with project) TRUSCOTTWPAREAS8&10
Life of Project: 115
Evaluation Species: 3 SHRIKE AAHU's: 709.81

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units

0	4229.00	0.39	1649.31
1	3400.00	0.39	1326.00
10	2507.00	0.35	877.45
20	2429.00	0.30	728.70
50	2276.00	0.30	682.80
75	2114.00	0.30	634.20
90	2118.00	0.30	635.40
115	1908.00	0.30	572.40

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 5 (with project) TRUSCOTTWPAREAS8&10
Life of Project: 115
Evaluation Species: 4 FLYCATCHER AAHU's: 1898.73

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4229.00	0.92	3890.68
1	3400.00	0.92	3128.00
10	2507.00	0.87	2181.09
20	2429.00	0.82	1991.78
50	2276.00	0.82	1866.32
75	2114.00	0.82	1733.48
90	2118.00	0.82	1736.76
115	1908.00	0.82	1564.56

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 5 (with project) TRUSCOTTWPAREAS8&10
Life of Project: 115
Evaluation Species: 5 JACKRABBIT AAHU's: 594.10

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4229.00	0.33	1395.57
1	3400.00	0.33	1122.00
10	2507.00	0.30	752.10
20	2429.00	0.25	607.25
50	2276.00	0.25	569.00
75	2114.00	0.25	528.50
90	2118.00	0.25	529.50
115	1908.00	0.25	477.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 6 (with project) TRUSCOTTWITHPALL3
Life of Project: 115
Evaluation Species: 1 FIELD SPARROW AAHU's: 674.94

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4432.00	0.56	2481.92
1	3732.00	0.56	2089.92
10	2494.00	0.50	1247.00
20	1804.00	0.40	721.60
50	1458.00	0.40	583.20
75	1166.00	0.40	466.40
90	1215.00	0.40	486.00
115	958.00	0.40	383.20

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 6 (with project) TRUSCOTTWITHPALL3
Life of Project: 115
Evaluation Species: 2 BOBWHITE AAHU's: 649.45

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4432.00	0.47	2083.04
1	3732.00	0.47	1754.04
10	2494.00	0.45	1122.30
20	1804.00	0.40	721.60
50	1458.00	0.40	583.20
75	1166.00	0.40	466.40
90	1215.00	0.40	486.00
115	958.00	0.40	383.20

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 6 (with project) TRUSCOTTWITHPALL3
Life of Project: 115
Evaluation Species: 3 SHRIKE AAHU's: 495.94

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units

0	4432.00	0.39	1728.48
1	3732.00	0.39	1455.48
10	2494.00	0.35	872.90
20	1804.00	0.30	541.20
50	1458.00	0.30	437.40
75	1166.00	0.30	349.80
90	1215.00	0.30	364.50
115	958.00	0.30	287.40

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 6 (with project) TRUSCOTTWITHPALL3
Life of Project: 115
Evaluation Species: 4 FLYCATCHER AAHU's: 1313.04

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4432.00	0.92	4077.44
1	3732.00	0.92	3433.44
10	2494.00	0.87	2169.78
20	1804.00	0.82	1479.28
50	1458.00	0.82	1195.56
75	1166.00	0.82	956.12
90	1215.00	0.82	996.30
115	958.00	0.82	785.56

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 6 (with project) TRUSCOTTWITHPALL3
Life of Project: 115
Evaluation Species: 5 JACKRABBIT AAHU's: 415.88

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4432.00	0.33	1462.56
1	3732.00	0.33	1231.56
10	2494.00	0.30	748.20
20	1804.00	0.25	451.00
50	1458.00	0.25	364.50
75	1166.00	0.25	291.50
90	1215.00	0.25	303.75
115	958.00	0.25	239.50

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 5 (with project) CROWELLMITAREACURMAN
Life of Project: 115
Evaluation Species: 1 FIELD SPARROW AAHU's: 5297.83

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	10000.00	0.48	4800.00
1	10000.00	0.48	4800.00
10	10000.00	0.53	5300.00
30	10000.00	0.53	5300.00
50	10000.00	0.45	4500.00
70	10000.00	0.65	6500.00
90	10000.00	0.55	5500.00
115	10000.00	0.45	4500.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 5 (with project) CROWELLMITAREACURMAN
Life of Project: 115
Evaluation Species: 2 BOBWHITE AAHU's: 5215.65

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	10000.00	0.38	3800.00
1	10000.00	0.38	3800.00
10	10000.00	0.42	4200.00
30	10000.00	0.52	5200.00
50	10000.00	0.42	4200.00
70	10000.00	0.60	6000.00
90	10000.00	0.60	6000.00
115	10000.00	0.60	6000.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 5 (with project) CROWELLMITAREACURMAN
Life of Project: 115
Evaluation Species: 3 SHRIKE AAHU's: 8422.17

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units

0	10000.00	0.80	8000.00
1	10000.00	0.80	8000.00
10	10000.00	0.89	8900.00
30	10000.00	0.92	9200.00
50	10000.00	0.82	8200.00
70	10000.00	0.75	7500.00
90	10000.00	0.85	8500.00
115	10000.00	0.85	8500.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 5 (with project) CROWELLMITAREACURMAN
Life of Project: 115
Evaluation Species: 4 FLYCATCHER AAHU's: 8985.22

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	10000.00	0.82	8200.00
1	10000.00	0.82	8200.00
10	10000.00	0.91	9100.00
30	10000.00	0.95	9500.00
50	10000.00	0.85	8500.00
70	10000.00	0.85	8500.00
90	10000.00	0.95	9500.00
115	10000.00	0.90	9000.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 5 (with project) CROWELLMITAREACURMAN
Life of Project: 115
Evaluation Species: 5 JACKRABBIT AAHU's: 8544.35

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	10000.00	0.76	7600.00
1	10000.00	0.76	7600.00
10	10000.00	0.84	8400.00
30	10000.00	0.90	9000.00
50	10000.00	0.84	8400.00
70	10000.00	0.84	8400.00
90	10000.00	0.88	8800.00
115	10000.00	0.84	8400.00

Form D: Net Change in AAHU's Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 5 (with project) CROWELLMITAREACURMAN
Compared To: -MP 4 (without project) CROWELLMITAREANOPROJ
Life of Project: 115

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	FIELD SPARROW	5297.83	4442.61	855.22
2	BOBWHITE	5215.65	3949.13	1266.52
3	SHRIKE	8422.17	6360.87	2061.30
4	FLYCATCHER	8985.22	7031.30	1953.91
5	JACKRABBIT	8544.35	6555.65	1988.70

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 4 (without project) CROWELLMITAREANOPROJ
Life of Project: 115
Evaluation Species: 1 FIELD SPARROW AAHU's: 4442.61

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	10000.00	0.48	4800.00
1	10000.00	0.48	4800.00
10	10000.00	0.45	4500.00
30	10000.00	0.35	3500.00
50	10000.00	0.30	3000.00
70	10000.00	0.60	6000.00
90	10000.00	0.53	5300.00
115	10000.00	0.40	4000.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 4 (without project) CROWELLMITAREANOPROJ
Life of Project: 115
Evaluation Species: 2 BOBWHITE AAHU's: 3949.13

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	10000.00	0.38	3800.00
1	10000.00	0.38	3800.00
10	10000.00	0.35	3500.00
30	10000.00	0.30	3000.00
50	10000.00	0.20	2000.00
70	10000.00	0.60	6000.00
90	10000.00	0.50	5000.00
115	10000.00	0.40	4000.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 4 (without project) CROWELLMITAREANOPROJ
Life of Project: 115
Evaluation Species: 3 SHRIKE AAHU's: 6360.87

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units

0	10000.00	0.80	8000.00
1	10000.00	0.80	8000.00
10	10000.00	0.75	7500.00
30	10000.00	0.70	7000.00
50	10000.00	0.50	5000.00
70	10000.00	0.50	5000.00
90	10000.00	0.70	7000.00
115	10000.00	0.65	6500.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 4 (without project) CROWELLMITAREANOPROJ
Life of Project: 115
Evaluation Species: 4 FLYCATCHER AAHU's: 7031.30

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	10000.00	0.82	8200.00
1	10000.00	0.82	8200.00
10	10000.00	0.80	8000.00
30	10000.00	0.70	7000.00
50	10000.00	0.50	5000.00
70	10000.00	0.70	7000.00
90	10000.00	0.80	8000.00
115	10000.00	0.70	7000.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 4 (without project) CROWELLMITAREANOPROJ
Life of Project: 115
Evaluation Species: 5 JACKRABBIT AAHU's: 6555.65

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	10000.00	0.76	7600.00
1	10000.00	0.76	7600.00
10	10000.00	0.73	7300.00
30	10000.00	0.65	6500.00
50	10000.00	0.50	5000.00
70	10000.00	0.60	6000.00
90	10000.00	0.75	7500.00
115	10000.00	0.70	7000.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 6 (with project) CROWELLMITAREAINTMAN
Life of Project: 115
Evaluation Species: 1 FIELD SPARROW AAHU's: 7594.78

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	10000.00	0.48	4800.00
1	10000.00	0.48	4800.00
10	10000.00	0.60	6000.00
30	10000.00	0.80	8000.00
50	10000.00	0.80	8000.00
70	10000.00	0.80	8000.00
90	10000.00	0.80	8000.00
115	10000.00	0.80	8000.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 6 (with project) CROWELLMITAREAINTMAN
Life of Project: 115
Evaluation Species: 2 BOBWHITE AAHU's: 7246.96

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	10000.00	0.38	3800.00
1	10000.00	0.38	3800.00
10	10000.00	0.50	5000.00
30	10000.00	0.70	7000.00
50	10000.00	0.80	8000.00
70	10000.00	0.80	8000.00
90	10000.00	0.80	8000.00
115	10000.00	0.80	8000.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 6 (with project) CROWELLMITAREAINTMAN
Life of Project: 115
Evaluation Species: 3 SHRIKE AAHU's: 9365.22

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units

0	10000.00	0.80	8000.00
1	10000.00	0.80	8000.00
10	10000.00	0.90	9000.00
30	10000.00	0.95	9500.00
50	10000.00	0.95	9500.00
70	10000.00	0.95	9500.00
90	10000.00	0.95	9500.00
115	10000.00	0.95	9500.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 6 (with project) CROWELLMITAREAINTMAN
Life of Project: 115
Evaluation Species: 4 FLYCATCHER AAHU's: 9387.39

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	10000.00	0.82	8200.00
1	10000.00	0.82	8200.00
10	10000.00	0.91	9100.00
30	10000.00	0.95	9500.00
50	10000.00	0.95	9500.00
70	10000.00	0.95	9500.00
90	10000.00	0.95	9500.00
115	10000.00	0.95	9500.00

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 6 (with project) CROWELLMITAREAINTMAN
Life of Project: 115
Evaluation Species: 5 JACKRABBIT AAHU's: 8857.39

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	10000.00	0.76	7600.00
1	10000.00	0.76	7600.00
10	10000.00	0.84	8400.00
30	10000.00	0.90	9000.00
50	10000.00	0.90	9000.00
70	10000.00	0.90	9000.00
90	10000.00	0.90	9000.00
115	10000.00	0.90	9000.00

Form C: Average Annual Habitat Units

Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 1 (with project) TRUSCOTTWMANAG7&8MP1
Life of Project: 115
Evaluation Species: 1 FIELD SPARROW

AAHU's: 1248.81

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.56	2402.40
1	3437.00	0.56	1924.72
10	2213.00	0.60	1327.80
20	2071.00	0.65	1346.15
50	1892.00	0.70	1324.40
75	1587.00	0.70	1110.90
90	1643.00	0.70	1150.10
115	1312.00	0.70	918.40

Form C: Average Annual Habitat Units

Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 1 (with project) TRUSCOTTWMANAG7&8MP1
Life of Project: 115
Evaluation Species: 2 BOBWHITE

AAHU's: 1234.14

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.47	2016.30
1	3437.00	0.47	1615.39
10	2213.00	0.50	1106.50
20	2071.00	0.60	1242.60
50	1892.00	0.70	1324.40
75	1592.00	0.75	1194.00
90	1643.00	0.75	1232.25
115	1312.00	0.75	984.00

Form C: Average Annual Habitat Units

Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 1 (with project) TRUSCOTTWMANAG7&8MP1
Life of Project: 115
Evaluation Species: 3 SHRIKE

AAHU's: 1018.44

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units

0	4290.00	0.39	1673.10
1	3437.00	0.39	1340.43
10	2213.00	0.42	929.46
20	2071.00	0.50	1035.50
50	1892.00	0.60	1135.20
75	1592.00	0.60	955.20
90	1643.00	0.60	985.80
115	1312.00	0.60	787.20

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 1 (with project) TRUSCOTTWMANAG7&8MP1
Life of Project: 115
Evaluation Species: 4 FLYCATCHER AAHU's: 1768.76

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.92	3946.80
1	3437.00	0.92	3162.04
10	2213.00	0.94	2080.22
20	2071.00	0.95	1967.45
50	1892.00	0.95	1797.40
75	1592.00	0.95	1512.40
90	1643.00	0.95	1560.85
115	1312.00	0.95	1246.40

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 1 (with project) TRUSCOTTWMANAG7&8MP1
Life of Project: 115
Evaluation Species: 5 JACKRABBIT AAHU's: 883.29

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.33	1415.70
1	3437.00	0.33	1134.21
10	2213.00	0.37	818.81
20	2071.00	0.40	828.40
50	1892.00	0.50	946.00
75	1592.00	0.55	875.60
90	1643.00	0.55	903.65
115	1312.00	0.55	721.60

Form C: Average Annual Habitat Units

Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 2 (with project) TRUSCOTWMANAG8&10MP2
Life of Project: 115
Evaluation Species: 1 FIELD SPARROW

AAHU's: 1534.13

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4229.00	0.56	2368.24
1	3400.00	0.56	1904.00
10	2507.00	0.60	1504.20
20	2429.00	0.65	1578.85
50	2276.00	0.70	1593.20
75	2114.00	0.70	1479.80
90	2118.00	0.70	1482.60
115	1908.00	0.70	1335.60

Form C: Average Annual Habitat Units

Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 2 (with project) TRUSCOTWMANAG8&10MP2
Life of Project: 115
Evaluation Species: 2 BOBWHITE

AAHU's: 1525.08

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4229.00	0.47	1987.63
1	3400.00	0.47	1598.00
10	2507.00	0.50	1253.50
20	2429.00	0.60	1457.40
50	2276.00	0.70	1593.20
75	2114.00	0.75	1585.50
90	2118.00	0.75	1588.50
115	1908.00	0.75	1431.00

Form C: Average Annual Habitat Units

Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 2 (with project) TRUSCOTWMANAG8&10MP2
Life of Project: 115
Evaluation Species: 3 SHRIKE

AAHU's: 1256.72

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units

0	4229.00	0.39	1649.31
1	3400.00	0.39	1326.00
10	2507.00	0.42	1052.94
20	2429.00	0.50	1214.50
50	2276.00	0.60	1365.60
75	2114.00	0.60	1268.40
90	2118.00	0.60	1270.80
115	1908.00	0.60	1144.80

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 2 (with project) TRUSCOTWMANAG8&10MP2
Life of Project: 115
Evaluation Species: 4 FLYCATCHER AAHU's: 2162.42

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4229.00	0.92	3890.68
1	3400.00	0.92	3128.00
10	2507.00	0.94	2356.58
20	2429.00	0.95	2307.55
50	2276.00	0.95	2162.20
75	2114.00	0.95	2008.30
90	2118.00	0.95	2012.10
115	1908.00	0.95	1812.60

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 2 (with project) TRUSCOTWMANAG8&10MP2
Life of Project: 115
Evaluation Species: 5 JACKRABBIT AAHU's: 1092.91

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4229.00	0.33	1395.57
1	3400.00	0.33	1122.00
10	2507.00	0.37	927.59
20	2429.00	0.40	971.60
50	2276.00	0.50	1138.00
75	2114.00	0.55	1162.70
90	2118.00	0.55	1164.90
115	1908.00	0.55	1049.40

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 3 (with project) TRUSCOTWMAN78&10MP3
Life of Project: 115
Evaluation Species: 1 FIELD SPARROW AAHU's: 1037.91

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4432.00	0.56	2481.92
1	3732.00	0.56	2089.92
10	2494.00	0.60	1496.40
20	1804.00	0.65	1172.60
50	1458.00	0.70	1020.60
75	1166.00	0.70	816.20
90	1215.00	0.70	850.50
115	958.00	0.70	670.60

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 3 (with project) TRUSCOTWMAN78&10MP3
Life of Project: 115
Evaluation Species: 2 BOBWHITE AAHU's: 1012.81

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4432.00	0.47	2083.04
1	3732.00	0.47	1754.04
10	2494.00	0.50	1247.00
20	1804.00	0.60	1082.40
50	1458.00	0.70	1020.60
75	1166.00	0.75	874.50
90	1215.00	0.75	911.25
115	958.00	0.75	718.50

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 3 (with project) TRUSCOTWMAN78&10MP3
Life of Project: 115
Evaluation Species: 3 SHRIKE AAHU's: 837.11

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units

0	4432.00	0.39	1728.48
1	3732.00	0.39	1455.48
10	2494.00	0.42	1047.48
20	1804.00	0.50	902.00
50	1458.00	0.60	874.80
75	1166.00	0.60	699.60
90	1215.00	0.60	729.00
115	958.00	0.60	574.80

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 3 (with project) TRUSCOTWMAN78&10MP3
Life of Project: 115
Evaluation Species: 4 FLYCATCHER AAHU's: 1482.67

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4432.00	0.92	4077.44
1	3732.00	0.92	3433.44
10	2494.00	0.94	2344.36
20	1804.00	0.95	1713.80
50	1458.00	0.95	1385.10
75	1166.00	0.95	1107.70
90	1215.00	0.95	1154.25
115	958.00	0.95	910.10

Form C: Average Annual Habitat Units Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 3 (with project) TRUSCOTWMAN78&10MP3
Life of Project: 115
Evaluation Species: 5 JACKRABBIT AAHU's: 723.96

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4432.00	0.33	1462.56
1	3732.00	0.33	1231.56
10	2494.00	0.37	922.78
20	1804.00	0.40	721.60
50	1458.00	0.50	729.00
75	1166.00	0.55	641.30
90	1215.00	0.55	668.25
115	958.00	0.55	526.90

Form C: Average Annual Habitat Units

Date: 07/22/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 1 (without project) TRUSCOTTNPAREAS7&8
Life of Project: 115
Evaluation Species: 1 FIELD SPARROW

AAHU's: 2149.29

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.58	2488.20
1	4290.00	0.58	2488.20
20	4290.00	0.45	1930.50
50	4290.00	0.30	1287.00
75	4290.00	0.70	3003.00
90	4290.00	0.60	2574.00
115	4290.00	0.50	2145.00

Form C: Average Annual Habitat Units

Date: 07/22/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 1 (without project) TRUSCOTTNPAREAS7&8
Life of Project: 115
Evaluation Species: 2 BOBWHITE

AAHU's: 2110.49

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.48	2059.20
1	4290.00	0.48	2059.20
20	4290.00	0.43	1844.70
50	4290.00	0.40	1716.00
75	4290.00	0.65	2788.50
90	4290.00	0.55	2359.50
115	4290.00	0.48	2059.20

Form C: Average Annual Habitat Units

Date: 07/22/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 1 (without project) TRUSCOTTNPAREAS7&8
Life of Project: 115
Evaluation Species: 3 SHRIKE

AAHU's: 1709.29

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.40	1716.00
1	4290.00	0.40	1716.00

20	4290.00	0.36	1544.40
50	4290.00	0.32	1372.80
75	4290.00	0.50	2145.00
90	4290.00	0.45	1930.50
115	4290.00	0.40	1716.00

Form C: Average Annual Habitat Units Date: 07/22/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 1 (without project) TRUSCOTTNPAREAS7&8
Life of Project: 115
Evaluation Species: 4 FLYCATCHER AAHU's: 3814.18

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.94	4032.60
1	4290.00	0.94	4032.60
20	4290.00	0.85	3646.50
50	4290.00	0.80	3432.00
75	4290.00	0.95	4075.50
90	4290.00	0.94	4032.60
115	4290.00	0.94	4032.60

Form C: Average Annual Habitat Units Date: 07/22/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 1 (without project) TRUSCOTTNPAREAS7&8
Life of Project: 115
Evaluation Species: 5 JACKRABBIT AAHU's: 1583.20

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	4290.00	0.33	1415.70
1	4290.00	0.33	1415.70
20	4290.00	0.30	1287.00
50	4290.00	0.20	858.00
75	4290.00	0.60	2574.00
90	4290.00	0.50	2145.00
115	4290.00	0.33	1415.70

Form D: Net Change in AAHU's

Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: PA 6 (with project) TRUSCOTTWITHPALL3
Compared To: PA 3 (without project) TRUSCOTTNPALT3ALL3
Life of Project: 115

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	FIELD SPARROW	674.94	2220.43	-1545.49
2	BOBWHITE	649.45	2180.35	-1530.90
3	SHRIKE	495.94	1765.86	-1269.92
4	FLYCATCHER	1313.04	3940.43	-2627.39
5	JACKRABBIT	415.88	1635.60	-1219.72

Form D: Net Change in AAHU's Date: 06/21/2001

Study Name: TRUSCOTTANDPIPELINES
Action: MP 6 (with project) CROWELLMITAREAINTMAN
Compared To: MP 4 (without project) CROWELLMITAREANOPROJ
Life of Project: 115

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	FIELD SPARROW	7594.78	4442.61	3152.17
2	BOBWHITE	7246.96	3949.13	3297.83
3	SHRIKE	9365.22	6360.87	3004.35
4	FLYCATCHER	9387.39	7031.30	2356.09
5	JACKRABBIT	8857.39	6555.65	2301.74

Area Needed For In-Kind Compensation
(Form H Results)

Date: 07/22/2001

Study Name: TRUSCOTTANDPIPELINES
Plan Alternative: PA 4 (with project) TRUSCOTTWP7&8
Compared To: PA 1 (without project) TRUSCOTTNPAREAS7&8
Management Plan: MP 5 (with project) CROWELLMITAREACURMAN
Compared To: MP 4 (without project) CROWELLMITAREANOPROJ
Candidate Management Area Size: 10000.00

Evaluation Species ID#	Name	Net Change In AAHU's Plan Alternative	Management Plan	Area Needed For Compensation
1	FIELD SPARROW	-1358.14	855.22	15880.59
2	BOBWHITE	-1342.87	1266.52	10602.79
3	SHRIKE	-1125.40	2061.30	5459.66
4	FLYCATCHER	-2257.49	1953.91	11553.70
5	JACKRABBIT	-1094.23	1988.70	5502.23

Area Needed For In-Kind Compensation
(Form H Results)

Date: 07/22/2001

Study Name: TRUSCOTTANDPIPELINES
Plan Alternative: PA 5 (with project) TRUSCOTTWPAREAS8&10
Compared To: PA 2 (without project) TRUSCOTTNPALT2
Management Plan: MP 5 (with project) CROWELLMITAREACURMAN
Compared To: MP 4 (without project) CROWELLMITAREANOPROJ
Candidate Management Area Size: 10000.00

Evaluation Species ID#	Name	Net Change In AAHU's: Plan Alternative	Management Plan	Area Needed For Compensation
1	FIELD SPARROW	-1158.88	855.22	13550.67
2	BOBWHITE	-1145.42	1266.52	9043.85
3	SHRIKE	-975.17	2061.30	4730.83
4	FLYCATCHER	-1861.22	1953.91	9525.62
5	JACKRABBIT	-966.59	1988.70	4860.42

Area Needed For In-Kind Compensation
(Form H Results)

Date: 07/22/2001

Study Name: TRUSCOTTANDPIPELINES
Plan Alternative: PA 6 (with project) TRUSCOTTWITHPALL3
Compared To: PA 3 (without project) TRUSCOTTNPALT3ALL3
Management Plan: MP 5 (with project) CROWELLMITAREACURMAN
Compared To: MP 4 (without project) CROWELLMITAREANOPROJ
Candidate Management Area Size: 10000.00

Evaluation Species ID#	Name	Net Change In AAHU's: Plan Alternative	Management Plan	Area Needed For Compensation
1	FIELD SPARROW	-1545.49	855.22	18071.28
2	BOBWHITE	-1530.90	1266.52	12087.43
3	SHRIKE	-1269.92	2061.30	6160.76
4	FLYCATCHER	-2627.39	1953.91	13446.82
5	JACKRABBIT	-1219.72	1988.70	6133.27

APPENDIX C

Tables for Chloride Reduction and Flow Reduction

April 2002 USFWS
Coordination Act Report
Wichita River Basin Project Reevaluation

TABLE 1

HOSSTON DURATION TABLE

REACH 1 - RED RIVER

	NATURAL								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	342	291	253	205	96	40	24	16	11
Sulfates	236	191	169	139	72	35	23	17	10
TDS	1054	908	841	680	398	198	153	115	81

	MODIFIED W/7, 8 & 10								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	307	263	227	184	87	37	22	14	9
Sulfates	223	180	160	131	69	33	22	16	9
TDS	989	852	788	639	376	186	144	107	76

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	337	289	249	203	96	40	24	16	10
Sulfates	245	198	176	144	76	36	24	18	10
TDS	1087	937	867	703	413	205	158	118	84

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	276	237	204	166	78	33	20	13	8
Sulfates	201	162	144	118	62	30	20	15	8
TDS	890	767	709	575	338	167	129	96	69

	MODIFIED W/7 & 8								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	311	267	232	186	88	37	22	15	9
Sulfates	226	184	162	133	71	33	22	17	9
TDS	1000	862	799	648	380	188	146	109	77

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	342	294	255	205	97	41	24	16	10
Sulfates	249	202	178	146	78	37	25	18	10
TDS	1100	948	878	712	418	207	160	119	85

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	280	240	208	168	79	33	20	13	8
Sulfates	204	166	146	120	64	30	20	15	8
TDS	900	776	719	583	342	169	131	98	70

TABLE 6

GAINESVILLE DURATION TABLE

REACH 6 - RED RIVER

	MODIFIED W/8 & 10								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1790	1556	1450	1277	937	523	335	242	136
Sulfates	1175	891	781	662	478	275	173	129	73
TDS	4490	3870	3575	3219	2391	1375	891	654	360

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1969	1712	1595	1405	1031	575	369	266	150
Sulfates	1293	980	859	728	526	303	190	142	80
TDS	4939	4257	3933	3541	2630	1513	980	719	396

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1611	1400	1305	1149	843	471	302	218	122
Sulfates	1058	802	703	596	430	248	156	116	66
TDS	4041	3483	3218	2897	2152	1238	802	589	324

	MODIFIED W/8 ONLY								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1817	1577	1470	1284	950	530	341	244	138
Sulfates	1184	908	796	674	486	279	177	131	75
TDS	4545	3926	3628	3263	2426	1393	902	660	364

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1999	1735	1617	1412	1045	583	375	268	152
Sulfates	1302	999	876	741	535	307	195	144	83
TDS	5000	4319	3991	3589	2669	1532	992	726	400

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1635	1419	1323	1156	855	477	307	220	124
Sulfates	1066	817	716	607	437	251	159	118	68
TDS	4091	3533	3265	2937	2183	1254	812	594	328

TABLE 7

TERRAL DURATION TABLE

REACH 7 - RED RIVER

	NATURAL								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	2129	1833	1700	1500	1183	684	442	317	164
Sulfates	1024	907	850	785	632	391	268	191	107
TDS	5290	4576	4258	3845	3053	1824	1192	852	466

	MODIFIED W/7, 8 & 10								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1870	1607	1496	1329	1048	607	393	282	148
Sulfates	964	848	794	728	591	366	252	179	100
TDS	4507	3955	3655	3344	2716	1667	1116	804	438

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	2057	1768	1646	1462	1153	668	432	310	163
Sulfates	1060	933	873	801	650	403	277	197	110
TDS	4957	4351	4020	3678	2988	1833	1228	884	482

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1683	1446	1346	1196	943	546	354	254	133
Sulfates	868	763	715	655	532	329	227	161	90
TDS	4056	3560	3289	3009	2444	1500	1005	723	394

	MODIFIED W/7 & 8								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1900	1636	1520	1350	1065	615	400	286	149
Sulfates	985	864	809	743	602	373	256	182	102
TDS	4591	4021	3724	3396	2754	1695	1135	822	446

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	2090	1800	1672	1485	1172	677	440	315	164
Sulfates	1084	950	890	817	662	410	282	200	112
TDS	5050	4423	4096	3735	3030	1864	1249	904	491

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1710	1472	1368	1215	959	554	360	257	134
Sulfates	887	778	728	669	542	336	230	164	92
TDS	4132	3619	3351	3056	2479	1525	1022	740	401

TABLE 8

TERRAL DURATION TABLE

REACH 7 - RED RIVER

	MODIFIED W/8 & 10								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1986	1712	1590	1408	1112	642	416	296	156
Sulfates	999	876	821	754	611	378	260	185	104
TDS	4729	4147	3845	3503	2841	1745	1169	842	461

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	2185	1883	1749	1549	1223	706	458	326	172
Sulfates	1099	964	903	829	672	416	286	204	114
TDS	5201	4562	4229	3853	3125	1919	1286	926	507

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1787	1541	1431	1267	1001	578	374	266	140
Sulfates	899	788	739	679	550	340	234	167	94
TDS	4256	3732	3460	3152	2557	1570	1052	758	415

	MODIFIED W/8 ONLY								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	2018	1741	1615	1430	1128	650	422	302	158
Sulfates	1014	893	837	769	621	386	264	188	106
TDS	4839	4267	3935	3594	2900	1761	1169	848	461

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	2220	1915	1777	1573	1241	715	464	332	174
Sulfates	1115	982	921	846	683	425	290	207	117
TDS	5322	4694	4328	3953	3190	1937	1286	932	507

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1816	1567	1454	1287	1015	585	380	272	142
Sulfates	913	804	753	692	559	347	238	169	95
TDS	4355	3840	3541	3234	2610	1585	1052	763	415

TABLE 9

WICHITA FALLS DURATION TABLE

REACH 8 - WICHITA RIVER

	NATURAL								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	2802	2454	2264	2065	1656	1178	784	534	238
Sulfates	1282	1025	925	798	598	436	292	200	90
TDS	6650	5790	5340	4893	3898	2812	1868	1266	557

	MODIFIED W/7,8 & 10								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	967	830	758	673	511	338	238	164	64
Sulfates	522	416	376	323	243	178	119	81	37
TDS	2350	2020	1850	1656	1316	927	646	433	184

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1064	913	834	740	562	372	262	180	70
Sulfates	574	458	414	355	267	196	131	89	41
TDS	2585	2222	2035	1822	1448	1020	711	476	202

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	870	747	682	606	460	304	214	148	58
Sulfates	470	374	338	291	219	160	107	73	33
TDS	2115	1818	1665	1490	1184	834	581	390	166

	MODIFIED W/7 & 8								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1192	1023	935	832	645	441	312	210	86
Sulfates	710	567	513	448	338	247	165	113	52
TDS	2998	2580	2367	2134	1718	1221	834	554	238

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1311	1125	1029	915	710	485	343	231	95
Sulfates	781	624	564	493	372	272	182	124	57
TDS	3298	2838	2604	2347	1890	1343	917	609	262

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1073	921	842	749	581	397	281	189	77
Sulfates	639	510	462	403	304	222	149	102	47
TDS	2698	2322	2130	1921	1546	1099	751	499	214

TABLE 10

WICHITA FALLS DURATION TABLE

REACH 8 - WICHITA RIVER

	MODIFIED W/8 & 10								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1806	1552	1431	1296	1048	738	502	339	148
Sulfates	886	706	636	554	406	296	199	136	62
TDS	4285	3724	3442	3143	2530	1813	1217	823	362

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1987	1707	1574	1426	1153	812	552	373	163
Sulfates	975	777	700	609	447	326	219	150	68
TDS	4714	4096	3786	3457	2783	1994	1339	905	398

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1625	1397	1288	1166	943	664	452	305	133
Sulfates	797	635	572	499	365	266	179	122	56
TDS	3857	3352	3098	2829	2277	1632	1095	741	326

	MODIFIED W/8 ONLY								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	2032	1748	1614	1465	1182	836	565	382	166
Sulfates	1072	858	772	667	500	365	244	168	76
TDS	4950	4304	3982	3632	2920	2098	1402	946	418

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	2235	1923	1775	1612	1300	920	622	420	183
Sulfates	1179	944	849	734	550	402	268	185	84
TDS	5445	4734	4380	3995	3212	2308	1542	1041	460

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1829	1573	1453	1319	1064	752	509	344	149
Sulfates	965	772	695	600	450	329	220	151	68
TDS	4455	3874	3584	3269	2628	1888	1262	851	376

TABLE 11

LAKE KEMP DURATION TABLE

REACH 9

	NATURAL								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1985	1843	1751	1628	1312	1106	1016	934	696
Sulfates	953	890	869	838	755	631	575	523	386
TDS	4650	4305	4115	3838	3254	2762	2515	2325	1745

	MODIFIED W/7,8 & 10								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	489	434	409	377	318	257	233	212	166
Sulfates	540	510	494	456	395	323	294	268	202
TDS	1580	1430	1343	1275	1108	897	815	742	541

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	538	477	450	415	350	283	256	233	183
Sulfates	594	561	543	502	435	355	323	295	222
TDS	1738	1573	1477	1403	1219	987	897	816	595

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	440	391	368	339	286	231	210	191	149
Sulfates	486	459	445	410	356	291	265	241	182
TDS	1422	1287	1209	1148	997	807	734	668	487

	MODIFIED W/7 & 8								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	648	601	568	528	431	361	328	301	227
Sulfates	633	601	584	554	491	407	369	337	250
TDS	1968	1818	1735	1634	1441	1193	1090	992	728

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	713	661	625	581	474	397	361	331	250
Sulfates	696	661	642	609	540	448	406	371	275
TDS	2165	2000	1909	1797	1585	1312	1199	1091	801

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	583	541	511	475	388	325	295	271	204
Sulfates	570	541	526	499	442	366	332	303	225
TDS	1771	1636	1562	1471	1297	1074	981	893	655

TABLE 12

LAKE KEMP DURATION TABLE

REACH 9

	MODIFIED W/8 & 10								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1170	1080	1027	951	776	651	596	545	406
Sulfates	725	687	669	633	562	467	423	385	290
TDS	2954	2735	2606	2438	2115	1763	1607	1471	1094

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1287	1188	1130	1046	854	716	656	600	447
Sulfates	798	756	736	696	618	514	465	424	319
TDS	3249	3009	2867	2682	2327	1939	1768	1618	1203

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1053	972	924	856	698	586	536	491	365
Sulfates	653	618	602	570	506	420	381	347	261
TDS	2659	2462	2345	2194	1904	1587	1446	1324	985

	MODIFIED W/8 ONLY								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1340	1245	1187	1100	891	751	690	630	470
Sulfates	829	781	763	733	657	547	497	454	335
TDS	3425	3157	3020	2825	2422	2050	1862	1718	1270

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1474	1370	1306	1210	980	826	759	693	517
Sulfates	912	859	839	806	723	602	547	499	369
TDS	3768	3473	3322	3108	2664	2255	2048	1890	1397

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	1206	1121	1068	990	802	676	621	567	423
Sulfates	746	703	687	660	591	492	447	409	302
TDS	3083	2841	2718	2543	2180	1845	1676	1546	1143

TABLE 13

TRUSCOTT DURATION TABLE

REACH 10 - N. WICHITA RIVER

	NATURAL								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	9812	8187	7340	6335	4965	3201	2056	1230	410
Sulfates	3860	3240	2960	2643	2284	1691	1190	800	325
TDS	22500	18875	16560	14325	11455	7800	5250	3275	1200

	MODIFIED W/Areas 7 & 10 IN PLACE								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	7600	4180	2440	1682	1197	585	127	0	0
Sulfates	3170	2395	1600	1145	910	530	160	0	0
TDS	17350	10750	6550	4505	3285	1735	450	0	0

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	8360	4598	2684	1850	1317	644	140	0	0
Sulfates	3487	2635	1760	1260	1001	583	176	0	0
TDS	19085	11825	7205	4956	3614	1909	495	0	0

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	6840	3762	2196	1514	1077	527	114	0	0
Sulfates	2853	2156	1440	1031	819	477	144	0	0
TDS	15615	9675	5895	4055	2957	1562	405	0	0

	MODIFIED W/Area 7 ONLY								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	8500	5375	3270	2400	1837	1113	626	270	0
Sulfates	3420	2835	2130	1627	1376	965	615	315	0
TDS	19100	13400	8950	6490	5070	3250	1940	890	0

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	9350	5913	3597	2640	2021	1224	689	297	0
Sulfates	3762	3119	2343	1790	1514	1062	677	347	0
TDS	21010	14740	9845	7139	5577	3575	2134	979	0

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	7650	4838	2943	2160	1653	1002	563	243	0
Sulfates	3078	2552	1917	1464	1238	869	554	284	0
TDS	17190	12060	8055	5841	4563	2925	1746	801	0

TABLE 14

TRUSCOTT DURATION TABLE

REACH 10 - N. WICHITA RIVER

	MODIFIED W/Area 10 ONLY								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	8750	6975	6150	5300	4140	2610	1600	850	1
Sulfates	3245	2555	2300	2045	1769	1285	870	530	1
TDS	19300	15575	13450	11640	9325	6200	3985	2295	1

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	9625	7673	6765	5830	4554	2871	1760	935	1.1
Sulfates	3570	2811	2530	2250	1946	1414	957	583	1.1
TDS	21230	17133	14795	12804	10258	6820	4384	2525	1.1

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	7875	6278	5535	4770	3726	2349	1440	765	0.9
Sulfates	2921	2300	2070	1841	1592	1157	783	477	0.9
TDS	17370	14018	12105	10476	8393	5580	3587	2066	0.9

TABLE 15

BENJAMIN DURATION TABLE

REACH 11 - S. WICHITA RIVER

	NATURAL								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	15080	12900	11840	10450	7437	3002	1087	0	0
Sulfates	3820	3405	3240	3105	2710	1645	858	0	0
TDS	29400	26080	24040	21750	16025	7410	3110	0	0

	MODIFIED W/AREA 8 IN PLACE								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	7350	5750	4875	4110	2790	1053	185	0	0
Sulfates	3265	2930	2704	2447	1948	1057	335	0	0
TDS	17650	14000	12330	10700	7625	3250	790	0	0

	MODIFIED + 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	8085	6325	5363	4521	3069	1158	204	0	0
Sulfates	3592	3223	2974	2692	2143	1163	369	0	0
TDS	19415	15400	13563	11770	8388	3575	869	0	0

	MODIFIED - 10%								
	Percent of Time Equalled or Exceeded								
Concentrations	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides	6615	5175	4388	3699	2511	948	167	0	0
Sulfates	2939	2637	2434	2202	1753	951	302	0	0
TDS	15885	12600	11097	9630	6863	2925	711	0	0

Reach #10 as a result of the combined implementation of Areas 7 & 10. Minor percent increases result from the completion of Areas 7 and 10 separately. Zero flow days in Reach #11 increase by only 0.27% from natural conditions as a result of the implementation of Area 8. This indicates that there is significant contribution from ground water in this reach. Minor percent increases are seen in the number of zero flow days in Reach #9 indicating that flow from the upper reaches of the Wichita River Basin is a very small percentage of the total flow entering Lake Kemp and Reach #9.

A review of the period of record for Reaches 6, 7, and 8 indicate that there have been no zero flow days under natural conditions. Review of the low flow routing output for these downstream reaches reveal that implementation of all project alternatives will result in no reduction in flow. This can be attributed to increased irrigation return flow and decreased irrigation water usage due to improved water quality. Minor increases in flow are seen as a result of projected increases in irrigation and irrigation return flow. Minimum flows for the downstream reaches are listed on the flow duration curves in Appendix ?.

TABLE 7
LOW FLOW DAYS

Location	Plan	Average Q	No. of Days =/<0	No. of Days =/<1
Benjamin	Natural	42.9	1195	1821
	With Area VIII	42.5	1230	2055
Truscott	Natural	66.9	2	201
	With Area X	66.5	125	211
	With Area VII	64.8	334	485
	With Areas VII & X	62.2	1131	1350
Lake Kemp	Natural	228.2	109	181
(1.42 x Seymour)	With Area VIII8	228.1	109	182
(12/59 79 WY)*	With Areas VIII & X	228.0	110	184
	With VII & VIII	227.8	114	196
	With Areas VII, VIII, & X	227.6	114	202

*Seymour gage data was multiplied by a factor of 1.42 to simulate inflows into Lake Kemp. Seymour gage data was available for 12/59 7/79

Table 13
Lake Kemp Concentration Duration Data

	Natural Conditions								
	Percent of Time Equaled or Exceeded								
	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides (mg/l)	1,985	1,843	1,751	1,628	1,312	1,106	1,016	934	696
Sulfates (mg/l)	953	890	869	835	755	631	575	523	386
TDS (mg/l)	4,650	4,305	4,115	3,838	3,254	2,762	3,515	2,325	1,745
	Plan V (W/ Areas VII, VIII, & X)								
	Percent of Time Equaled or Exceeded								
	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides (mg/l)	489	434	409	377	318	257	233	212	166
Sulfates (mg/l)	540	510	494	456	395	323	294	268	202
TDS (mg/l)	1,580	1,430	1,343	1,275	1,108	897	815	742	541

Wichita Falls is expected to begin utilizing Lake Kemp as a municipal drinking water source within the next three years. The current Lake Kemp water quality will require the city to treat the water using reverse osmosis to meet secondary drinking water requirements. Implementation of the selected plan will improve water quality at Lake Kemp but treatment will still be required. Implementation of the selected plan is expected to result in reduced treatment cost for the city of Wichita Falls.

The Red River Basin has an estimated the total chloride load of 3,300 tons/day. The selected plan will remove 409 tons/day resulting in a 12% reduction in total chloride load for the Red River Basin. The concentration duration study revealed that under natural conditions, the chloride concentrations at Lake Texoma equal or exceed 196 mg/l 99% of the time and is greater than 345 mg/l 50% of the time. With implementation of the selected plan, chloride concentrations will equal or exceed 147 mg/l 99% of the time and will be greater than 309 mg/l 50% of the time. This represents a 11% reduction in chloride concentration at Lake Texoma. Table 14 presents Lake Texoma concentration data.

Table 14
Lake Texoma Concentration Duration Data

	Natural Conditions								
	Percent of Time Equaled or Exceeded								
	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides (mg/l)	469	436	423	409	345	271	241	216	165
Sulfates (mg/l)	315	301	289	273	228	164	146	129	91
TDS (mg/l)	1,294	1,234	1,207	1,166	995	791	722	634	474
	Plan V (W/ Areas VII, VIII, & X)								
	Percent of Time Equaled or Exceeded								
	1%	5%	10%	20%	50%	80%	90%	95%	99%
Chlorides (mg/l)	417	391	376	365	309	245	215	192	147
Sulfates (mg/l)	296	283	273	257	217	155	138	123	87
TDS (mg/l)	1,190	1,136	1,109	1,075	921	730	665	582	435

BRUSH CONTROL PROGRAM IMPACT ANALYSIS

Due to growing concern in the Wichita River Basin about the availability of water and its effect on economic growth and development, the Red River Authority of Texas in cooperation with the Texas State Soil and Water Conservation Board (TSSWCB) initiated a study to determine the feasibility of implementing a brush control and management program to increase water yield. The Texas Legislature designated the TSSWCB as the lead agency to conduct watershed studies in conjunction with the Texas Agricultural Experiment Station and Extension Service, river authorities, and other local entities.

The study was accomplished under the direction of the Texas State Soil and Water Conservation Board in partnership with the Red River Authority of Texas. Texas Agricultural Experiment Station and Texas Agricultural Extension Service, the USDA Natural Resource Conservation Service (NRCS), Blackland Research Center and local Soil and Water Conservation Districts.

The results of the study revealed that implementation of the proposed brush control program may be expected to provide a net increase in overall watershed yield at Lake Kemp between a minimum of 27.6% to a maximum of 38.9% based on the report's estimated average inflow into Lake Kemp of 119,100 acre feet per year.

Several resource agencies have expressed concern over the projected increase in zero flow days on the upper Wichita River after WRCCP implementation. The resource agencies were concerned that increases in zero flow days could impact species adapted to the brine flows of the Wichita River. An investigation was initiated to assess the impact of the brush control program on low flow days projected for the chloride control implementation.

Table 15
Truscott Gage
Flows Less than or Equal to 0 CFS and 1 CFS

	Days Natural	Days 7,8,10	Days 7,8,10 50% Brush Control
Flow <= 0 CFS	2	1,131	614
Flow <= 1 CFS	201	1,350	831

The brush control program has currently been included in Texas Senate Bill 1 and the Region B Water Plan. Implementation of the program is expected to occur regardless of decisions made on the Wichita River Chloride Control Project. The brush control program is expected to alter future without-project conditions. Low flow modeling was performed for the stream reaches above Lake Kemp to estimate the program's impact. Assuming only a 50% program implementation for only the areas above Lake Kemp and below the collection areas, the brush management program would decrease the number of future zero flow days at the Benjamin gage by 124 days (13% decrease) and 5 days at Lake Kemp (5% decrease). Table 16 presents low flow data for projected future brush control without project modeling results.

Table 16
Zero Flow Days
Projected Future Brush Control Without Project Condition

	Benjamin Gage Zero Flow Days	Truscott Gage Zero Flow Days	Seymour/Kemp Zero Flow Days
Natural Conditions	1195	2	109
50% Brush Control	1053	2	104

Implementation of the brush control program on the North and Middle Wichita Forks of the Wichita River have the potential of reducing the number of zero flow days at the Truscott gage from 1131 days with Areas VII and X in operation to 614 days with 50% brush removal. This represents a 54% reduction in the number of with project zero flow days. Implementation of the brush control program on the North and Middle Forks of the Wichita River is a technically feasible alternative to reducing with-project zero flow day impacts.

Table 19
Lake Kemp Elevation Duration Data

Elevation	Percent of Time Equaled or Exceeded							
	1114	1120	1123	1125	1130	1135	1140	1144
Existing Conditions	100%	100%	100%	99.8%	99.3%	91.2%	70.1%	29.3%
Existing Conditions w/ 50% Brush Control - 27.6%	100%	100%	100%	100%	99.5%	94.0%	73.3%	31.4%
Existing Conditions w/ 50% Brush Control – 38.9%	100%	100%	100%	100%	99.5%	95.9%	74.1%	33.3%
Selected Plan w/ 50% Brush Control @ Truscott– 27.6%	98.9%	89.3%	83.1%	75.9%	63.3%	48.0%	24.7%	10.7%
Selected Plan w. 50% Brush Control @ Truscott– 38.9%	98.9%	89.9%	83.9%	76.7%	63.7%	48.6%	25.0%	11.4%
Selected Plan w/50% Basin Brush Control 27.6%	99.3%	91.4%	85.2%	78.9%	66.5%	51.5%	29.4%	13.2%
Selected Plan w/50% Basin Brush Control 38.9%	99.7%	92.4%	88.3%	82.1%	69.8%	53.8%	32.7%	14.3%

FWS PRELIMINARY MITIGATION ESTIMATES FOR RED RIVER CHLORIDE CONTROL PROJECT

TRUSCOTT BRINE STORAGE RESERVOIR

According to the HEP compensation analysis (Appendix B), using the Service's mitigation goal for resource category 3 habitats, the loss of 3,474 acres of mesquite-juniper shrubland at Truscott Reservoir and associated pipelines would require acquisition and management of 10,083 acres. The Corps already owns 10,000 acres at the Crowell mitigation site that are intended to be used for mitigation. The 10,083 acres estimated through the HEP analysis was based on an assumption that existing levels of wildlife management would continue. The area required for mitigation of mesquite-juniper shrubland losses could increase or decrease depending on the level of management provided by the Corps. The Corps already owns most if not all of the land needed to mitigate for terrestrial impacts, but the cost of that land and management costs should be considered in the economic evaluation of the proposed Project. Acquisition costs were $1,514,051, based on acquisition costs of $371/hectare, including minerals. Acquisition costs could be higher at current market prices and should be adjusted to reflect these costs in the Corps' evaluation. Funds for initial development also should be provided. Initial development costs would include fencing ($154,000-$220,000), monumenting ($100,000), pond construction ($25,000-$50,000), road improvements ($200,000), and food plot development ($20,000). Total development costs are estimated to be $499,000-$590,000. Operation and maintenance of the candidate mitigation area also would be required. Operation and maintenance of the area is estimated to be about $25 per hectare per year; a total annual cost of $102,025. TPWD has expressed a willingness to manage the Crowell mitigation area if development and operating costs (estimated $2,000,000 for 10 years) are provided.

DUNDEE STATE FISH HATCHERY

Hatchery Improvements

Recent clarification of Dundee State Fish Hatchery's status correctly identifies TPWD's water right as part of the industrial allocation and not subject to reduction at Lake Kemp elevation 1,123 msl (Jimmy Banks, Wichita County Water Improvement District No. 2, pers. comm.). Although TPWD was unable to assess predicted lake levels due to project implementation without brush management, it is absolutely clear that the Corps' preferred alternative with 50% brush management at 27.6% yield shows dramatically lower lake elevations in Lake Kemp (Corps 2001a).

Severe fluctuations in Lake Kemp will impact Diversion Lake and the Dundee Hatchery. Of great concern is the ability to keep Diversion Lake at or near conservation pool (1,052 msl) because hatchery intakes are located at 1,049 (30" main intake line) and 1,047 msl. Relatively small fluctuations in Diversion Lake can create significant differences in the hatchery's physical ability to obtain water. Without a reliable source of water, Dundee State Fish Hatchery cannot fulfill its critical functions.

Compensation for impacts to the Dundee State Fish Hatchery's water supply should be in addition to compensation for impacts to sport fisheries. Present alternatives suggest relocating the intake for the hatchery, treatment of incoming water to reduce turbidity and destroy golden alga, pump back of treated hatchery discharge to Diversion Lake or the irrigation canal to benefit the water district, and ensuring the hatchery is able to use and return waters under all foreseeable conditions. The proposal turns Dundee State Fish Hatchery into a large "reuse" system that returns all source water to a destination selected by the district and thereby, provides the district with additional operating flexibility and additional water. The district could then operate lake elevations independent of current TPWD needs at Dundee and more easily conserve the reduced amount of available water as a result of the project. Current funding limitations preclude TPWD from conducting an independent engineering study on the impacts of the proposed project on hatchery operations, however, it is intuitively clear that the alternative proposed above will ensure Dundee's continued operation and significant benefits for the anglers of Texas. The Corps should develop cost estimates for accomplishing the alternative collaboratively with TPWD and the district and consider this alternative solution among issues that require mitigation/compensation.

Annual operating funds may be required to help maintain hatchery production and transport fish that could be used to partially mitigate for impacts to sport fisheries. If the Corps develops the reuse alternative collaboratively with TPWD, then TPWD will accept the additional operating expenses as part of the Dundee State Fish Hatchery operations.

AQUATIC IMPACTS

(See recommendations) Costs are unknown and need to be developed in cooperation with the Corps and Natural Resource Agencies.

APPENDIX D

Preliminary Mitigation Estimates

April 2002 USFWS
Coordination Act Report
Red River Chloride Control Project

U.S. Fish and Wildlife Service Comments
Draft Selenium Monitoring Plan and Action Plan

Draft Selenium Monitoring Plan

The Service and TPWD are concerned that the monitoring frequencies proposed by the Corps are inadequate. Given the known variability of existing data and the complexity of selenium dynamics, in our view, a monitoring frequency of every three years will not accomplish the objectives of this plan. The Service and TPWD recommend at least five years of monitoring selenium to establish baseline data and determine the variability of source concentrations. The Service recommends that the Corps monitor on a monthly basis until the multi-agency selenium panel established by the Corps can review the data and determine the appropriate sampling frequency.

Draft Selenium Action Plan (Action Plan)

Background - The Service and TPWD agree with the Corps that the extremely complex nature of selenium dynamics in aquatic systems makes it very difficult to predict any project related impacts to birds or any other animals or plants in the Project area. The Service and TPWD do not concur with the Corps' claims "that the potential for Se-related impacts associated with this project is not excessive" and that risks are reasonable. The limited quantity and variability of data collected to date leads us to believe that the Corps' claims are extremely optimistic and cannot be supported for a 100 year project. Despite conservative assumptions, the Corps model is based on only three years of data and any projections over the100 year project life are highly speculative. The model may represent the best available information, but it cannot strongly support any conclusions about selenium-related risks to wildlife. The Service and TPWD agree with the Corps that selenium-related impacts to wildlife could develop over the life of the project and recommend that additional data be collected and analyzed before drawing conclusions about the risks.

Plan Objectives

Existing data suggest selenium concentrations could exceed state water quality standards and levels that have been shown to adversely affect wildlife. This should make the focus of the Action Plan to avoid any potential adverse selenium-related impacts to wildlife. The stated objectives do include monitoring and implementing corrective measures prior to expression of adverse impacts. However, the fact that the Corps has selected the alternative with the most potential to exceed selenium threshold levels makes it difficult for the Natural Resource Agencies to believe that avoiding adverse selenium related impacts is a high priority for the Corps.

Other portions of the Action Plan also bring the Corps' commitment to avoiding adverse impacts into question. Many of the potential remedial measures concentrate on removing birds or fish instead of

avoiding accumulations of selenium, and obvious measures such as reducing or curtailing brine pumping are not mentioned in the Action Plan.

Action Plan Process

The Action Plan proposes to create a multi-agency panel of scientists to review data and provide recommendations for corrective measures. The Service is not opposed to this strategy if there is a commitment to implement actions approved by the panel. The purpose of a multi-agency panel of scientists is questionable if their recommendations are ignored. There is no stated commitment to act in this Action Plan.

Panel Composition- The Service recommends that the USGS be added to the panel. The USGS has recognized expertise in this field and would help provide science- based information and recommendations. Another option is for the Corps to contract with an unbiased science-based foundation to conduct selenium evaluations and not use any of the proposed agencies in the Action Plan.

Panel Decisions and Recommendations- The process for panel decisions and recommendations needs to be defined. It is unlikely that all panel members will agree, and it is not clear what process will be used to resolve differences. Panel decisions are meaningless unless actions are taken to implement them.

Potential Remedial Measures

The Service and TPWD do not support any potential remedial measures that eliminate populations of organisms to avoid selenium impacts to higher trophic levels. We also do not support measures that propose to haze birds or destroy nesting habitat without mitigation. The purpose of this Action Plan is to avoid project-related adverse effects to wildlife, and intentionally destroying populations or habitat is not an acceptable way to accomplish this purpose. The Corps should focus on measures that do not allow selenium concentrations to reach "Action levels". Instead, many of the proposed measures appear to treat the symptoms rather than the cause. The Service strongly recommends that the Corps consider measures, such as reduced pumping or deep well injection to control selenium concentrations in Truscott Brine Reservoir. Selenium concentrations with Alternative 3 have potential to violate State and Federal laws, including the Migratory Bird Treaty Act. Proposed remedial measures such as hazing and habitat destruction could be just as harmful to migratory birds as elevated selenium concentrations and could also be a violation of the Migratory Bird Treaty.

APPENDIX E

Draft Selenium Monitoring Plan and Action Plan

April 2002 USFWS
Coordination Act Report
Red River Chloride Control Project

DRAFT

CHAPTER 5

SELENIUM MONITORING PLAN

1.0 OVERVIEW

This document describes a monitoring plan for evaluating potential selenium (Se)- related impacts associated with the Wichita River Basin Project (WRBP), Texas. Details of this monitoring plan are similar to those originally developed by an interagency workgroup assigned to this and related environmental concerns associated with the Red River Chloride Control Project, as originally formulated. In addition, this plan is similar in design to that employed for initial baseline selenium monitoring for the WRBP during 1997 and 1998 (USACE 2001). The purpose of this document is to summarize details of a proposed design for monitoring for initial consideration by the Se action plan panel. A process-based action plan incorporating Se monitoring for addressing Se-related concerns for the WRBP is included as Appendix xx. This monitoring plan represents an initial design which could be modified by the action plan panel as appropriate.

2.0 OBJECTIVES

The overall, long-term objective of Se monitoring will be to collect data capable of supporting technically-based decisions aimed at avoiding development of toxic concentrations of Se to biota residing at or temporarily using WRBP areas. As such, it is the intent of this plan to generate data appropriate for documenting the need for as well as the success of any action-based response to potential Se-related impacts, should they appear likely. Associated with this overall objective would be complementary goals of determining temporal trends in Se dynamics, establishment of site-specific Se-related relationships among abiotic and biotic system components, evaluating Se concentrations relative to threshold action values, and estimating variability in Se concentrations in environmental media at project areas.

3.0 GEOGRAPHIC SCOPE

Because the WRBP incorporates multiple project features varying in design characteristics and geographic location, it is necessary to define monitoring requirements for several general types of project areas. Design and location of these areas are briefly identified below for purposes of summarizing required monitoring locations. Complete design details and locations for all facilities can be found in WRBP design documents.

3.1 Truscott Brine Lake. The brine disposal reservoir associated with the WRBP is Truscott Brine Lake, a constructed reservoir which has been operational since 1987. Truscott Lake is designed for evaporative reduction in brine volume and is operated as a total retention (no outflow) system.

3.2 Brine Collection Facilities. Brine collection areas include one completed and operational facility (Area VIII on the South Fork of the Wichita River, TX), one area with completed collection facilities but no pipeline (Area X on the Middle Fork of the Wichita River, Texas), and one proposed collection facility on the North Wichita River, Texas (Area VII). In general, collection facilities incorporate collection of brines by means of inflatable weirs that pool waters for pumping to disposal areas during low flows, but provide for normal passage of waters during high flows. Due to high flow flushing and constant pumping of brines during collection periods, collection facilities are not designed as total retention systems.

3.3 Irrigation Return Flow Areas. Implementation of the WRBP would result in improved quality of waters available for irrigation in the basin. This could potentially increase loading of Se and other contaminants via irrigation return flows. Magnitude of potential increased discharge resulting from irrigation return flows by stream reach is provided in the Final Supplement to the Environmental Statement (FSES) for the project. In addition, identification and quantification of areas of increased irrigation associated with the WRBP will be accomplished via GIS imagery (see details of this monitoring effort in the overall Environmental Operational Plan) as the project progresses. This process will help in identification of areas for focused monitoring for potential irrigation-related impacts.

4.0 MONITORING COMPONENTS

Ecosystem components to be monitored are summarized below. Collectively, these media were chosen to provide an overall assessment of Se partitioning among system components and to provide data for key components necessary for risk evaluations.

4.1 Water. All water samples will be collected by subsurface filling of sample containers and will be analyzed initially for total Se (unfiltered samples) in waters where concentrations are consistently below analytical quantitation limits. Such conditions were observed in Truscott Lake during 1997-1998 monitoring efforts (USACE 2001). For waters where concentrations exceed analytical quantitation limits, analyses will include both total and dissolved (0.45 um filtered) Se. Analyses for these samples will also include total suspended solids to facilitate evaluation of solid/dissolved phase partitioning. While methods for Se analysis will be chosen based on best available detection limits for a brine matrix, it is anticipated that EPA Method 7742 (hydride generation) will be used. For quality assurance/quality control (QA/QC) purposes, triplicate samples will be collected at an approximate 10% frequency. Quality control samples will be analyzed as field duplicates by the primary laboratory, while quality assurance samples will be analyzed by a separate laboratory. Laboratory QA/QC procedures will include method blank and matrix spike analyses. All analytical data collected as part of this monitoring plan will be subjected to data validation procedures.

4.2 Sediment. If possible, all sediment samples will be collected as core samples, with the upper 8 cm analyzed for total Se (dry weight basis). This depth is within the general range reported as the active sediment layer for Se processes in aquatic systems (Rudd et al. 1980; Oremland et al. 1989, 1990). In depositional areas of Truscott Lake, samples from shallower sediment depths (1 to 4 cm) will be analyzed as an aid in evaluating depositional patterns. Sediment samples will also be analyzed for total organic carbon (TOC) and subjected to particle size analyses. For QA/QC purposes, triplicate samples (following homogenization) will be collected at an approximate 10% frequency. Quality control samples will be analyzed as field duplicates by the primary laboratory, while quality assurance samples will be analyzed by a separate laboratory.

4.3 Fish. Fish will be analyzed for Se concentrations on a whole-body basis. Fish will be obtained by seining or other appropriate collection methods. If multiple species are

available, those most representative of common forage species for birds will be collected. Fish will be analyzed as distinct samples unless compositing is required to obtain adequate sample mass for analysis. For the sake of consistency, every attempt will be made to collect fish of the same species and size at all sites throughout the monitoring study period.

For initial monitoring efforts during 1997 and 1998, the Red River pupfish (*Cyprinodon rubrofluviatilis*) and plains killifish (*Fundulus zebrinus*) were the only species identified for collection at Truscott Brine Lake and the Area VIII collection facility. A wider range of species were present at Area X (USACE 2001).

4.4 Invertebrates. While collected species will likely vary by season and sampling location, every attempt will be made to collect a species representing a common forage organism. Every attempt will be made to collect similar taxa (at least to genus or family level) at all sampling sites. Depending upon the species available, it may be necessary to composite individuals (of the same taxa) to obtain sufficient sample mass for analysis.

During initial monitoring efforts (USACE 2001), invertebrates of suitable mass for Se analyses could not be located at Truscott Brine Lake or the Area VIII collection facility. Specific studies aimed at more detailed evaluation of presence and seasonality of invertebrates might be necessary for future monitoring efforts if these organisms are to be included for Se analyses.

4.5 Avian Eggs. Bird eggs will be analyzed as a measure of Se transfer to avian species breeding at and around WRBP areas. An important consideration for this sampling effort will be selection of bird species that represent maximum potential for Se exposure. In general, maximum exposure occurs to sedentary species which spend the majority of foraging time in highly localized environments (Skorupa and Ohlendorf 1991). Following initial surveys of breeding bird use, species with highest potential for Se accumulation will be selected for egg analyses. Logistical considerations (anticipated nest numbers, acceptability of egg sacrifice, etc.) will also be evaluated. For the sake of consistency, every attempt will be made to collect eggs of the same species throughout the monitoring period.

If possible, two avian species (one piscivorous and one invertebrate-eating) will be selected for egg analyses. If available, 1 egg will be randomly selected from 12 individual nests for each species (total of 24 eggs) and analyzed for total Se (dry weight basis).

For initial monitoring efforts during 1997 and 1998, intensive bird surveys revealed that breeding semi-aquatic birds were limited in both species and numbers of individuals at Truscott Brine Lake. The red-winged blackbird (*Agelaius phoeniceus*), an insectivore during the breeding season, was the only relatively sedentary insectivorous species observed breeding in the vicinity of the reservoir and was selected for egg collection and analysis. No sedentary piscivorous birds were observed nesting near Truscott Lake for either year. Eggs of the great blue heron (*Ardea herodias*) and double-crested cormorant (*Phalacrocorax auritus*), both mobile piscivores, were collected and analyzed for Se as no sedentary fish-eating species were observed nesting in the area.

5.0 SAMPLING LOCATIONS AND FREQUENCIES

Anticipated sampling locations and frequencies for all project areas are summarized below. In general, it is initially estimated that monitoring activities would be conducted once every three years over the life of the project. This frequency could be based on observed results and modified by the Se action plan panel as appropriate.

5.1 Truscott Brine Lake. Initial sampling at Truscott Brine Lake was conducted in 1997 and 1998 (USACE 2001). Baseline data from this impoundment should provide valuable information on estimated variability in Se concentrations for various system components. Anticipated locations and frequencies for monitoring components associated with Truscott Brine Lake are summarized below.

5.1.1 Water. Water samples will be collected at four locations at Truscott Brine Lake. These locations will be those used for initial monitoring and will be located at an open water location near the dam, at mid-lake, near the upper end of the impoundment, and at a shallow, near-shore location in the extreme upper end of the lake near the area of brine inflows. On each sampling date, two water samples will be collected at the two deep, down-lake sites: one at a depth of 0.5 m below the surface and one at a depth approximately 0.5 m above the sediments. Owing to shallow water depths, surface samples only will be collected at the two up-lake sites. Accordingly, a total of six water samples (exclusive of QA/QC samples) will be collected on each sampling date. Water samples will be collected once a month for a consecutive period of 12 months.

5.1.2 Sediments. If possible, sediment samples will be collected at seven locations. Sampling sites will include those established for water sample collection as well as three longitudinally intermediate locations. During each 1-year monitoring period, sediment samples will be collected at each of the seven sites on two sampling dates: once when the reservoir is vertically mixed and once during a period of thermal stratification (summer). During initial monitoring efforts, sediment sample collection was sometimes difficult owing to dense submersed aquatic vegetation at sites near the upper end of the reservoir.

5.1.3 Fish and Invertebrates. For each monitoring period, fish and invertebrate (if possible) samples will be collected on one sampling date each. These biota will be collected from areas receiving maximum bird use (shorelines). Sampling periods will most likely coincide with periods of maximum abundance (particularly for invertebrates). If possible, 30 fish samples (15 individuals of 2 species) and 20 invertebrate samples will be collected on each of the sampling dates.

5.1.4 Avian Eggs. Bird eggs will be collected at Truscott Brine Lake over the breeding season (spring to early summer) during each 1-year monitoring period. Exact dates will coincide with availability of eggs for selected species. If possible, 12 eggs will be randomly selected from 12 nests of 2 avian species (1 fish-eating and 1 invertebrate-eating). Accordingly, total number of eggs collected during each year-long monitoring period at Truscott Lake will be 24, if logistically possible.

If present, the red-winged blackbird will be selected for the insectivorous species as this bird was used for initial monitoring efforts. If nesting by sedentary piscivorous species is observed, these birds will be selected for egg analyses. If such species are not present, the value of using more mobile species (e.g., cormorants, great blue herons) will need to be discussed by the Se action plan panel as uncertainties are associated with egg Se data for these species.

5.2 Collection Facilities. Sampling locations at brine collection facilities will vary according to operational status (complete vs. proposed). Details for baseline sampling of all media at collection facilities are provided below.

5.2.1 Water. On each sampling date, one water sample will be collected at operational brine collection facilities at three locations: at an area upstream of the collection "pool" area, within the collection pool, and at an area downstream of the collection facility. While distances between sites will be dependent upon site-specific geography and access, the intent is to evaluate potential differences in concentrations due to ponding and evaporative effects at collection areas through comparison with up- and downstream "control" areas. At areas proposed for collection facility construction, one water sample will be collected at the proposed construction location. Once constructed, sampling locations will be three in number as described above. For all facilities (constructed and proposed), water sampling frequency will be once a month for a baseline period of 12 months.

5.2.2 Sediments. One sediment sample will be collected at locations described above for water samples (dependent upon operational status). Sampling frequency will be two sample collection events over a 1-year monitoring period. As thermal stratification is not anticipated at collection facilities, samples will be collected once during the summer and once during winter.

5.2.3 Fish and Invertebrates. Fish and invertebrate samples at brine collection facility locations will be collected at sites described above for water samples (dependent upon operational status). At each location, 10 individuals each of two species and 10 invertebrate samples will be collected. For all facilities (constructed and proposed), samples will be collected twice during the 1-year monitoring period.

5.2.4 Avian Eggs. Bird eggs will be collected in the vicinity of brine collection facilities over the breeding season (spring to summer) during each 1-year monitoring period. Exact dates will vary according to egg availability for selected species. If possible, egg numbers described above for reservoir sampling (2 species - 12 eggs each) will be collected from the vicinity of each brine collection facility. However, due to their limited size and varying habitat at these areas, collected egg numbers may be dependent upon available nests of breeding birds present in the area.

Intensive bird surveys during 1997 and 1998 failed to locate any semi-aquatic nesting birds in the vicinity of Area VIII. If these patterns persist at this location or are similar at other brine collection facilities (which they may or may not be), bird egg sampling may be limited for these project features.

5.3 Irrigation Return Flow Areas. A stream water quality monitoring program has been implemented for the WRBP to monitor project impacts on water quality, stream flow, and plan effectiveness (see other chapters of this EOP). Gaging stations have been established in the Wichita River Basin for monitoring stream flows and water quality on stream segments associated with this project. Gage locations and data collection details are provided in other portions of this EOP. Gage maintenance and data collection are to be performed by the USGS under contract to the Tulsa District.

In summary, in-situ information (flow, temperature, and conductivity) is available at each gage on a continuous hourly basis accessible via satellite. Chemical quality data consisting of various nutrients (nitrogen and phosphorus), chlorides, pH, total hardness, alkalinity, sulfates, silica, fluorides, total dissolved solids, total suspended solids, calcium, magnesium, sodium, and potassium will be collected at 4- to 6-week intervals. In addition, total and dissolved metals (barium, manganese, zinc, selenium, nickel, arsenic, iron, mercury, silver, cadmium, copper, lead, chromium) will also be collected at 4- to 6-week intervals. Pesticides will be measured twice a year. This program is anticipated to continue throughout the life of the project. While biological data are not available through this program, baseline data for water quality in project areas will be generated through these efforts.

Future increases in irrigated cropland and changes in irrigation patterns will be monitored through survey and GIS-based studies. Details of these monitoring efforts are provided in other chapters of the EOP. This process will help in future identification of areas for focused monitoring of irrigation return flow-related impacts.

6.0 BREEDING BIRD SURVEYS

In addition to sampling activities described above, breeding bird surveys are an integral part Se monitoring efforts for this project.

While initial bird surveys will be necessary for selection of species for avian egg analyses, more detailed surveys aimed at determining actual bird use (species and numbers) of Truscott Brine Lake and collection facilities would be critical in data interpretation, impact analysis, and evaluation of corrective action measures, if required. Intensive bird surveys were conducted during initial monitoring efforts for the project (see Appendix A of USACE (2001) for methods and results). Surveys employing similar methodology would initially be employed for future monitoring efforts. Survey methodology design could be modified by the Se action plan panel as appropriate. These surveys would most likely be designed and implemented by ornithologists under contract to the Tulsa District.

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DRAFT

SELENIUM ACTION PLAN
WICHITA RIVER BASIN CHLORIDE CONTROL PROJECT

1. OVERVIEW

This document describes a process-based action plan for evaluating, anticipating, and addressing selenium- (Se) related impacts should they occur in association with the U.S. Army Corps of Engineers (USACE) Tulsa District's (TD) Wichita River Basin Project. The action plan combines elements of environmental monitoring, periodic data review and trend analysis by a multi-agency panel, use of science contemporary to the evaluation period, and a process for selection and implementation of corrective action measures appropriate for anticipated conditions, should such action be necessary. This plan presents remedial activities that could conceivably be implemented for addressing Se concerns, but also provides reasons why definitive selection and design of specific response measures at this point in project implementation are not possible owing to the myriad possibilities of future physical, chemical, and biological conditions that could occur over the life of the proposed project and dictate appropriate response action(s). As an alternative, the plan outlines a flexible, process-based approach that provides for multi-agency input into decisions regarding definition of Se-related impacts and selection of actions, if necessary, to appropriately address these concerns. Finally, the plan definitively states the Tulsa District's commitment to a science-based evaluation process and, if necessary, implementation of appropriate response activities to ensure that Se-related concerns are adequately addressed for the life of the project.

2. BACKGROUND

Selenium-related issues associated with the Wichita River Basin Project have been detailed in several documents prepared by the Tulsa District. A complete overview of Se concerns associated with the entire Red River Chloride Control Project as originally

formulated, a Se literature review, and a detailed description of evaluation methodology was initially provided in USACE (1993). While much of this evaluation focused on proposed Crowell Brine Lake, Texas, similar methodology has been applied to evaluation of project features of the Wichita River Basin Project – principally Truscott Brine Lake, Texas. The 1993 document should therefore be reviewed for a basic understanding of Se-related concerns associated with the project and methods used to evaluate potential Se-related impacts.

In 1997 and 1998, an intensive two-year monitoring study was conducted by the TD to evaluate Se concentrations in a variety of environmental media at Truscott Brine Lake, TX and the current brine collection area (Area VIII on the South Fork of the Wichita River) in the Wichita River Basin (USACE 2001). Monitoring efforts included collection and Se analysis of water, sediment, fish, aquatic vegetation, and avian eggs, liver, and ingested food samples. In addition, a key component to the monitoring effort was an intensive, two-year bird survey with an emphasis on semi-aquatic breeding birds. The monitoring report (USACE 2001) should be thoroughly reviewed for an understanding of selenium-related conditions following approximately 11 years of project operation. Most significantly, this monitoring effort provided valuable site-specific data for further understanding of Se dynamics at Truscott Brine Lake and the Area VIII collection facility. These data were used for refinement of impact evaluations for proposed Wichita River Basin project features.

Finally, potential Se-related impacts associated with a variety of alternatives for chloride control in the Wichita River Basin were evaluated by the Tulsa District (USACE 2000). Site-specific monitoring data described above were used to refine previous highly-conservative means of predicting future water and sediment Se concentrations in Truscott Brine Lake for an array of potential alternatives. In addition, findings from the scientific literature regarding threshold range concentrations for protection of fish and wildlife and published subsequent to earlier TD reports were identified and added to impact analyses for alternatives. Methods, assumptions, and conclusions regarding these

analyses are presented in USACE (2000) and should be reviewed for an understanding of Se-related issues for project alternatives.

Owing to extreme complexity of Se dynamics in aquatic systems, numerous conservative (i.e., intentionally biased toward environmental protection) assumptions were applied by the TD in both predictive modeling of future potential water and sediment Se concentrations at Truscott Brine Lake, as well as selection of threshold values protective of breeding birds. Although this high degree of conservatism was somewhat reduced by application of site-specific monitoring data (USACE 2000), predictions are still believed to be defensively conservative. These assumptions and their conservative nature are thoroughly discussed in project-related documents (USACE 1993, 2000, 2001) but are often not considered when results of these evaluations are cited as definitive future project impacts. Recognition of both the complexity of this issue as well as the conservative nature of these evaluations should always accompany any discussion of potential Se-related impacts associated with the project.

To date, conservative studies completed by the Tulsa District conclude that the potential for Se-related impacts associated with this project is not excessive and that reasonable risks are associated with project implementation. However, it is certainly recognized that Se dynamics and potential impacts on wildlife, like many environmental issues, involve complex processes that are often site-specific, difficult to evaluate, and can most likely never be fully defined short of project construction and environmental monitoring. Accordingly, it is possible that conditions contributing to Se-related impacts to wildlife could develop over the life of the project. For this reason, a science-based process for both monitoring and implementing corrective measures appropriate for anticipated conditions should accompany project operation. This plan has been prepared to address these concerns.

3. PLAN OBJECTIVES

Objectives of the selenium action plan for the Wichita River Basin Project are to: (1) develop a procedural mechanism for monitoring Se-related conditions during project operations, (2) use resulting data for anticipating future conditions prior to expression of adverse impacts, and (3) if required, implement appropriate corrective measures based on input from a multi-agency panel of scientists. Specifically stated, the objective of this plan would be to:

> *Implement a multi-agency, process-based action plan to avoid, minimize, or compensate for (in that order) adverse selenium-related impacts to migratory birds resulting from operation of any project feature of the Wichita River Basin Project.*

While participation by other agencies would be an integral part of the process, the Tulsa District would be responsible for funding, conducting, and summarizing results of monitoring studies, organizing the action plan process, and implementing appropriate response measures as needed.

4. RANGE OF FUTURE SCENARIOS

If required, selection of appropriate corrective measure(s) for mitigating Se-related impacts on breeding birds at Truscott Brine Lake (as well as other project features) would be dependent upon a combination of a wide range of environmental conditions that determine biological response to Se in the environment and impacts on avian species. A long list of these factors has been identified in the Se literature (see USACE 1993). The almost unlimited potential combinations of these conditions result in the extremely complex and site-specific nature of Se dynamics in aquatic systems and a commensurate range of potential remedial measures to address these concerns. The long-term nature of the Wichita River Basin Project as well as changing conditions as the project ages (e.g. changes in pool elevations and volumes) further complicate this issue.

While certainly not all-inclusive, a partial list of factors which could influence future conditions and selection of appropriate Se-related response measures for Truscott Brine Lake and associated brine collection areas for the Wichita River Basin Project include the following:

- **Bird Use** -- A range of possibilities for number of individuals, number of different species, feeding guilds of breeding birds present (i.e., insectivorous vs. piscivorous vs. herbivorous), mobile or sedentary nature of birds nesting at a facility, wide differences in Se sensitivity among avian species (see Skorupa et al. 1996), and presence/absence of endangered bird species are possible. While extensive bird use surveys over an initial two year period (1997-1998) at Truscott Brine Lake revealed that nesting by semi-aquatic birds was limited to only a few species and nest numbers among these species was low (USACE 2001), these use patterns could certainly change over the life of the project and dictate a wide range of potential remedial measures to minimize avian exposure.

- **Avian Habitat Conditions** -- Changing conditions of nature and areal extent of habitat for semi-aquatic breeding birds (e.g., presence / absence of snags, mudflats, littoral vegetation) are possible over life of the project and could influence potential remedial measures for discouraging breeding bird use of project facilities if necessary to minimize Se exposure.

- **Avian Prey Species Composition** – Given anticipated changes in salinity in Truscott Lake, abundance and species composition of prey items (fish, invertebrates, vegetation) available to semi-aquatic birds may vary over the life of the project. If amenable to control, composition of the prey base may be an important factor in selection of remediation options for minimizing avian exposure to dietary selenium. If it were to occur, elimination of certain prey organisms (e.g., fish) owing to extreme chloride concentrations could eliminate exposure to certain classes of birds (e.g., piscivorous species). Uncertainties are associated with composition of the prey base for aquatic birds over the life of the project.

- **Selenium Status of Surrounding Landscape** -- The importance of "landscape mosaics" in influencing Se exposure in avian species has been documented (USFWS 1990). In addition, high concentrations of naturally-occurring Se in aquatic environments surrounding Truscott Lake have been identified (USACE 2001). Relative changes in Se status of Truscott Lake and surrounding environments over the life of the project may influence decisions regarding selection of appropriate remedial measures.

- **Speciation of Se in Project Waters and Sediments** – Selenium chemistry is highly complex owing to the existence of multiple oxidation states, numerous Se-containing organic compounds, and biogeochemical interactions among these

forms. These forms also vary widely in their bioavailability and resulting toxicity to aquatic organisms (see discussion in USACE 1993). If identifiable and amenable to control, Se speciation may be an important factor in selection of remedial alternatives.

- **Level of Aquatic Productivity and Algal Species Composition** -- Bioconcentration of Se by primary producers is a process potentially leading to expression of toxic effects in upper trophic levels of aquatic systems. Similarly, overall degree of productivity has been demonstrated to be an important factor in expression of Se toxicity in higher trophic levels. Influence of productivity and potential means of control may therefore play a role in determining appropriate response to Se-related issues for the project.

- **Vertical Stratification Patterns in Truscott Brine Lake** -- As Se is generally immobilized under reduced conditions (see discussion in USACE 1993), future stratification patterns (particularly permanent meromixis) could strongly influence Se conditions in Truscott Brine Lake and could likewise play an important role in remedial measure selection. While this could be of major importance, uncertainties exist as to future stratification patterns for the reservoir.

It is readily apparent that wide-ranging potential combinations of factors described above, over the life of the Wichita River Basin Project, are virtually limitless and impossible to predict. Accordingly, selection of a single remedial measure applicable to all future conditions is not possible and counterproductive at this stage in project development. A process-based plan based on careful monitoring, observed conditions, and application of changing science and technological advances is a more appropriate means for addressing these future concerns, should they occur. A process designed for accomplishing these goals is described in this plan.

5. ACTION PLAN PROCESS

The overall Se action plan for the Wichita River Basin Project would consist of multi-agency panel review of periodic monitoring data, existing environmental conditions, current state of science related to Se issues, definition of Se status of project features, and evaluation and recommendation of corrective measures, if required. Recommended specifics for each of these components of the action plan are described below.

a. Panel Composition. A panel charged with implementation of this action plan would be composed of one representative from each of the following agencies: Tulsa District U.S. Army Corps of Engineers (Tulsa District), Ecological Services Tulsa Office of the U.S. Fish and Wildlife Service (USFWS), Texas Parks and Wildlife Department (TPWD), Texas Natural Resource Conservation Commission (TNRCC), and the Red River Authority (RRA) of Texas. Panel members familiar with Se-related issues would be selected for participation by each agency. The panel would be charged with responsibilities of evaluating adequacy of monitoring plans, reviewing monitoring data, predicting future conditions, calling on needed resources (e.g. subject matter experts) for assistance, and evaluating and recommending corrective measures if needed. Multi-agency membership on the panel would take advantage of various areas of expertise and agency perspective for a balanced evaluation of Se-related issues.

Tulsa District responsibilities would include convening and organizing panel meetings, funding and conducting monitoring studies, preparing reports summarizing monitoring activities, conducting panel briefings on monitoring results, and implementing corrective measures and any associated studies as recommended by the panel. While panel meetings could be convened at the request of any member or as warranted by changing conditions, it is anticipated that the panel would initially meet once annually or more frequently as new data are available for review (see monitoring section).

b. Monitoring. Initial monitoring associated with this action plan would be accomplished according to the Tulsa District Se monitoring portion of the Environmental Operating Plan (EOP). Details of this plan are provided in the EOP (Appendix xx). Initially, these monitoring activities would be very similar to those conducted for the Wichita River Project during 1997-1998 (USACE 2001) though the monitoring plan could be modified by the panel as appropriate to address changing concerns or conditions. In addition to basic monitoring described above, the panel could recommend and oversee additional monitoring efforts as appropriate. Responsibilities for funding

and implementing all monitoring studies would rest with the Tulsa District though other agencies could participate in sample collection or other monitoring activities as desired. Initial estimates of frequency of monitoring data collection are provided in the EOP but could be altered by recommendation of the panel.

c. Data Review. A primary role of the Se action plan panel would be review of periodic Se monitoring data for the project. This data review would provide an increasing understanding of site-specific Se dynamics for various project features (e.g. Truscott Brine Lake, brine collection areas) as the project progresses as well as provide valuable information for future trend estimation. Data review could also provide information for guiding future monitoring efforts, identifying a need for additional monitoring in specific areas, or justifying the need for corrective action. The Tulsa District would be responsible for providing all raw data as well as a written summary report to the panel for all monitoring efforts. The format for this report would be similar to that provided for initial monitoring efforts (USACE 2001). The Tulsa District would likewise prepare a visual presentation summarizing monitoring data for the panel. This presentation, as well as written monitoring reports, would be prepared in an electronic format suitable for electronic posting and review by the public and all resource agency personnel.

Upon review of monitoring data, the Se action plan panel might request assistance or guidance from national experts on Se-related issues. These experts could be asked to conduct a formal data review or attend meetings to discuss findings with the panel. If such assistance is required, the Tulsa District would coordinate these efforts and provide needed funding for expert data review. Such assistance proved useful to a 1996 State and Federal interagency workgroup evaluating Se-related issues for the original Red River Chloride Control Project.

d. Definition and Anticipation of Conditions Requiring Corrective Action. An important function of this plan would be to define Se-related conditions requiring some form of corrective action and to anticipate these needs in advance of adverse

impacts to migratory birds. An advantage to the process-based action plan would be the ability to use contemporary science as well as site-specific conditions and monitoring results in these evaluations. The Se action plan panel would be charged with making these determinations using information derived from the process described in this plan.

In 1996, a State and Federal interagency workgroup was formed to evaluate Se-related impacts for the entire Red River Chloride Control Project as originally formulated. One task considered by this workgroup was determination of threshold action concentrations for Se in various ecosystem components that were developed for protection of avian species based on current scientific literature. The workgroup defined "concern levels" as those that indicate component concentrations are approaching levels that may warrant increased monitoring / evaluation. "Action levels" were defined as those that require remediation / mitigation actions to reduce potential impacts. Resulting values for critical biological components as defined by this group are provided below.

Component	Concern Level	Action Level
Fish (whole body, dry wt)	3 ppm mean	5 ppm mean
Invertebrates (whole body, dry wt)	3 ppm mean	5 ppm mean
Avian Eggs* (dry wt)	5 ppm >25%	10 ppm**

* Sedentary, semi-aquatic species
** Geometric mean

These values are provided in this action plan as examples of threshold values that might be deemed currently appropriate for application to the Wichita River Basin project. Appropriateness of these values, derivation of potentially more appropriate indices, site-specific concerns, application of updated Se literature, and other matters pertaining to establishment of threshold conditions requiring corrective action would be a major component of this process-based action plan and the responsibility of the action plan panel.

e. Evaluation and Selection of Corrective Action Alternatives. If required, a final responsibility of the Se action plan panel would be to evaluate a range of corrective

measures appropriate for addressing Se-related concerns for specific features of the Wichita River Basin Project. This process would permit use of contemporary science and technology as well as site-specific conditions in selection of appropriate response measures. The Tulsa District would be responsible for funding and conducting any studies needed for alternative evaluation. Finally, the panel would make recommendations for implementation of corrective measures as well as monitoring efforts required to ensure effectiveness of these measures.

f. Panel Decisions and Recommendations. Action plan panel decisions and recommendations would be by consensus of panel members. If consensus cannot be reached on any subject matter, it is likely that the process will have provided the advantage of generating the necessary information and scientific data (based on input from all agencies) to facilitate science-based resolution of these matters in the most appropriate forum. Such information would most likely be lacking in the absence of a plan similar to that described here.

6. POTENTIAL REMEDIAL MEASURES

As outlined in Section 4 of this plan, an almost unlimited combination of conditions affecting Se-related impacts and selection of actions appropriate for addressing these concerns are possible for this project. Accordingly, selection of a single remedial measure appropriate for all conditions is not possible at this stage in project development. If required, identification of efficient and appropriate response action(s) would most effectively be accomplished by implementation of the process described in this plan.

While development of detailed plans for remediation of Se-related impacts are not feasible at this time, several general categories of potential measures are conceivable given current knowledge of the subject. These categories are provided in this plan as examples of potential measures for evaluation and implementation. Site-specific

relevance as well as technical or economic feasibility would vary for these measures and may or may not be appropriate for this project. Brief descriptions of potential measures, should they be warranted, are provided below.

- **Habitat Alteration to Discourage Nesting of Impacted Bird Species.** If Se-related impacts associated with the project were to occur, these impacts would most likely be associated with decreased reproductive capacity of birds nesting near Truscott Brine Lake. If potentially-impacted species can be identified through monitoring, it may be possible to alter limited nesting habitat requirements to discourage nesting of these species in the project area. As a single example, if the affected species prove to be cormorants nesting in inundated dead snags, mechanical removal of these trees may be possible, forcing these birds to abandon the project area in search of more suitable nesting sites. Similar alterations (e.g., placement of riprap or control of shoreline slopes) to shorebird nesting habitat (if it exists and is limited in areal extent) could be implemented if monitoring identifies these species as affected.

- **Food Chain Alteration / Elimination.** As Se-related impacts are largely related to food chain dynamics of aquatic systems, Se impacts could conceivably be mitigated by altering and/or eliminating specific populations of organisms (e.g., algae, invertebrates, fishes) resulting in Se bioaccumulation and transfer to higher organisms (most likely bird species). Due to high chloride levels, species diversity of these aquatic organisms would likely be limited (though numbers of individuals could likely be high) and subject to possible control through alteration in habitat or physicochemical means. Monitoring efforts could identify species for possible control.

- **Bioremediation.** Bioremediation techniques involve the use of aquatic organisms in reducing Se levels. Potential treatment systems using bacteria, algae, aquatic plants, and other organisms could be investigated for their applicability to the project. Phytoremediation using Se-accumulating plants (e.g., canola, kenaf) is an emerging technology receiving increased research attention and is proving promising for Se treatment under certain conditions (Terry and Zayed 1998). Brine inflows could potentially be transported through such systems for reduction of Se loading to Truscott Brine Lake if necessary.

- **Enhanced Volatilization.** Atmospheric volatilization has proven to result in significant loss of Se mass in certain aquatic systems (see discussion in USACE 1994). This technique is particularly favorable due to permanent loss of Se from these systems. Volatilization rates are dependent upon a number of physical, chemical, and biological interactions but have been artificially increased with certain amendments. Site-specific research and alteration of conditions favorable to volatilization could conceivably be used to reduce Se mass in project waters.

- **Alternate Habitat Construction Using Habitat-Based Protocol.** Another potential remedial technique for Se-related impacts associated with the Wichita River Basin Project could be implementation of habitat-based protocols for Se based on those developed by the U.S. Fish and Wildlife Service (1995a, 1995b). These protocols, one for determination of compensation habitat and the other for determination of alternative habitat required for impact avoidance, are based on the concept of landscape-level dilution of avian exposure to Se and have been applied in the San Joaquin Valley of California. These protocols could potentially be modified (if necessary) to be applicable to Truscott Brine Lake or other project features.

- **Hazing.** Hazing is the intentional disturbance of birds with the intent to keep them from inhabiting certain areas. Hazing has sometimes been employed to prevent crop destruction by birds. Hazing could potentially be employed during the breeding season as a low-cost and effective measure to prevent nesting by birds potentially at risk to Se exposure.

- **Induced Changes in Se Speciation.** While dynamics of Se speciation are currently poorly understood, it is known that certain Se species are more prone to bioaccumulation and manifestation of impacts on higher trophic level organisms. Current research indicates that organic forms may be the most environmentally damaging in this respect. As research on this subject progresses, it may be possible to artificially control Se speciation in order to maintain forms with less bioaccumulation potential. Research continues in this area.

- **Chemical Treatment.** A potential, but currently costly alternative to mitigating Se-related impacts might be chemical treatment of brines for Se removal. While technically feasible (using techniques such as chemical coagulation with ferric sulfate), these techniques are currently costly in terms of chemical requirements and operation and maintenance costs relative to other measures. However, monitoring data could identify a reduced level of treatment balancing treatment costs and protection of the environment from Se impacts. Emerging technology in this area is likely over the life of the project and could prove useful in addressing Se concerns.

- **Alteration/ Management of Vertical Stratification Patterns in Truscott Brine Lake.** Selenium species favored by chemically reduced conditions have low solubilities and may accumulate in deep sediments of vertically stratified aquatic systems. Removal of Se from the water column in these systems can reduce algal uptake, bioavailability, and impacts on higher trophic level organisms. It is very possible that permanent stratification due to brine-induced density differences may develop in Truscott Brine Lake, potentially reducing Se-related impacts. If needed, it is conceivable that stratification patterns favorable to Se reduction could be manipulated through future alteration of brine input elevations and flow patterns.

- <u>Manipulation of Sulfur:Selenium Molar Ratios.</u> Several authors have reported that sulfur may limit the bioavailability of Se (Maier et al. 1987) or provide significant protection against Se toxicity for certain organisms. Recent research has documented reduced Se bioaccumulation due to manipulation of sulfur:selenium ratios for both algae (Williams et al. 1994) and aquatic invertebrates (Hansen et al. 1993). Manipulation of elemental molar ratios could conceivably be used to minimize impacts in Truscott Brine Lake, if needed, and could prove particularly promising given high sulfate concentrations already present in this system.

If measures listed above or other alternative means of control were employed, the range of potential remedial measures for alleviating Se concerns at Truscott Brine Lake or other project features could range from very simple and inexpensive to more complex, costly solutions. Based on current conditions and bird use patterns, some measure employing habitat alteration to discourage nesting semi-aquatic birds would appear particularly suitable for addressing Se-related impacts at Truscott Lake. Intensive bird use surveys during 1997 and 1998 revealed semi-aquatic breeding birds at the lake were limited in both species and numbers and utilized a limited, narrow range of habitat. It is likely that habitat alteration could have been quickly and inexpensively implemented during this period had Se concerns called for such action. While habitat alteration might prove useful under current patterns of bird use and habitat, these conditions could certainly change over the life of the project and require alternate remedial measures. These changing conditions and corresponding corrective measures would be addressed most efficiently by a process-based action plan similar to that described here.

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